CIVIL ACTION COVER SHEET	DOCKET NUMBER	Massachusetts Trial Court Superior Court COUNTY

Plaintiff	Town of Lee Massachusetts	**Defendant:**	Monsanto,Corporatiom, 800 N. Lindbergh Blvd St. louis MO 63141; Solutia Inc. 575 Hayville Cente Dr. St. Louis MO 63141; Pharmacia LLC 100 Rt 206 N. Peapack, NJ 07977; General Electric 5 Necco Street Boston MA 02210
ADDRESS:	32 MaiN Street	ADDRESS:	
Lee, MA 02138			
Plaintiff Attorney:	Cristobal Bonifaz, Esq.	**Defendant Attorney:**	UNKNOWN
ADDRESS:	Law Office of Cristobal Bonifaz	ADDRESS:	
180 Maple Street			
Conway, MA 01341			
BBO:	548405	BBO:	

TYPE OF ACTION AND TRACK DESIGNATION (see instructions section on next page)

CODE NO.	TYPE OF ACTION (specify)	TRACK	HAS A JURY CLAIM BEEN MADE?
AA1 and B21	Damages to the Town		☒ YES ☐ NO

***If "Other" please describe:**

Is there a claim under G.L. c. 93A? ☐ YES ☐ NO

Is there a class action under Mass. R. Civ. P. 23? ☐ YES ☐ NO

STATEMENT OF DAMAGES REQUIRED BY G.L. c. 212, § 3A

The following is a full, itemized and detailed statement of the facts on which the undersigned plaintiff or plaintiff's counsel relies to determine money damages. (Note to plaintiff: for this form, do not state double or treble damages; indicate single damages only.)

TORT CLAIMS

A. Documented medical expenses to date

1. Total hospital expenses
2. Total doctor expenses
3. Total chiropractic expenses
4. Total physical therapy expenses
5. Total other expenses (describe below)

NOT APPLICABLE

Subtotal (1-5): $0.00

B. Documented lost wages and compensation to date

C. Documented property damages to date

D. Reasonably anticipated future medical and hospital expenses

E. Reasonably anticipated lost wages

F. Other documented items of damages (describe below)

NOT APPLICABLE

TOTAL (A-F): $0.00

G. Briefly describe plaintiff's injury, including the nature and extent of the injury:

The Town of Lee is seeking damages for the Housatonic River Contamination with PCBs and for Damages Related to PCB Dump to be built in Lee, MA

CONTRACT CLAIMS

☐ This action includes a claim involving collection of a debt incurred pursuant to a revolving credit agreement. Mass. R. Civ. P. 8.1(a).

Item #	Detailed Description of Each Claim	Amount
1.	NOT APPLICABLE	
	Total	

Signature of Attorney/Self-Represented Plaintiff: X

Date:

RELATED ACTIONS: Please provide the case number, case name, and county of any related actions pending in the Superior Court.

NONE

CERTIFICATION UNDER S.J.C. RULE 1:18(5)

I hereby certify that I have complied with requirements of Rule 5 of Supreme Judicial Court Rule 1:18: Uniform Rules on Dispute Resolution, requiring that I inform my clients about court-connected dispute resolution services and discuss with them the advantages and disadvantages of the various methods of dispute resolution.

Signature of Attorney: X s/Cristobal Bonifaz	Date: March 13, 2024

CIVIL ACTION COVER SHEET INSTRUCTIONS — SELECT A CATEGORY THAT BEST DESCRIBES YOUR CASE*

AC Actions Involving the State/Municipality †*

AA1 Contract Action involving Commonwealth, Municipality, MBTA, etc.	(A)
AB1 Tortious Action involving Commonwealth, Municipality, MBTA, etc.	(A)
AC1 Real Property Action involving Commonwealth, Municipality, MBTA etc.	(A)
AD1 Equity Action involving Commonwealth, Municipality, MBTA, etc.	(A)
AE1 Administrative Action involving Commonwealth, Municipality, MBTA,etc.	(A)

CN Contract/Business Cases

A01 Services, Labor, and Materials	(F)
A02 Goods Sold and Delivered	(F)
A03 Commercial Paper	(F)
A04 Employment Contract	(F)
A05 Consumer Revolving Credit - M.R.C.P. 8.1	(F)
A06 Insurance Contract	(F)
A08 Sale or Lease of Real Estate	(F)
A12 Construction Dispute	(A)
A14 Interpleader	(F)
BA1 Governance, Conduct, Internal Affairs of Entities	(A)
BA3 Liability of Shareholders, Directors, Officers, Partners, etc.	(A)
BB1 Shareholder Derivative	(A)
BB2 Securities Transactions	(A)
BC1 Mergers, Consolidations, Sales of Assets, Issuance of Debt, Equity, etc.	(A)
BD1 Intellectual Property	(A)
BD2 Proprietary Information or Trade Secrets	(A)
BG1 Financial Institutions/Funds	(A)
BH1 Violation of Antitrust or Trade Regulation Laws	(A)
A99 Other Contract/Business Action - Specify	(F)

* See Superior Court Standing Order 1-88 for an explanation of the tracking deadlines for each track designation: F, A, and X. On this page, the track designation for each case type is noted in parentheses.

†* Choose this case type if ANY party is the Commonwealth, a municipality, the MBTA, or any other governmental entity UNLESS your case is a case type listed under Administrative Civil Actions (AA).

‡ Choose this case type if ANY party is an incarcerated party, UNLESS your case is a case type listed under Administrative Civil Actions (AA) or is a Prisoner Habeas Corpus case (E97).

ER Equitable Remedies

D01 Specific Performance of a Contract	(A)
D02 Reach and Apply	(F)
D03 Injunction	(F)
D04 Reform/ Cancel Instrument	(F)
D05 Equitable Replevin	(F)
D06 Contribution or Indemnification	(F)
D07 Imposition of a Trust	(A)
D08 Minority Shareholder's Suit	(A)
D09 Interference in Contractual Relationship	(F)
D10 Accounting	(A)
D11 Enforcement of Restrictive Covenant	(F)
D12 Dissolution of a Partnership	(F)
D13 Declaratory Judgment, G.L. c. 231A	(A)
D14 Dissolution of a Corporation	(F)
D99 Other Equity Action	(F)

PA Civil Actions Involving Incarcerated Party ‡

PA1 Contract Action involving an Incarcerated Party	(A)
PB1 Tortious Action involving an Incarcerated Party	(A)
PC1 Real Property Action involving an Incarcerated Party	(F)
PD1 Equity Action involving an Incarcerated Party	(F)
PE1 Administrative Action involving an Incarcerated Party	(F)

TR Torts

B03 Motor Vehicle Negligence - Personal Injury/Property Damage	(F)
B04 Other Negligence - Personal Injury/Property Damage	(F)
B05 Products Liability	(A)
B06 Malpractice - Medical	(A)
B07 Malpractice - Other	(A)
B08 Wrongful Death - Non-medical	(A)
B15 Defamation	(A)
B19 Asbestos	(A)
B20 Personal Injury - Slip & Fall	(F)
B21 Environmental	(F)
B22 Employment Discrimination	(F)
BE1 Fraud, Business Torts, etc.	(A)
B99 Other Tortious Action	(F)

RP Summary Process (Real Property)

S01 Summary Process - Residential	(X)
S02 Summary Process - Commercial/ Non-residential	(F)

RP Real Property

C01 Land Taking	(F)
C02 Zoning Appeal, G.L. c. 40A	(F)
C03 Dispute Concerning Title	(F)
C04 Foreclosure of a Mortgage	(X)
C05 Condominium Lien & Charges	(X)
C99 Other Real Property Action	(F)

MC Miscellaneous Civil Actions

E18 Foreign Discovery Proceeding	(X)
E97 Prisoner Habeas Corpus	(X)
E22 Lottery Assignment, G.L. c. 10, § 28	(X)

AB Abuse/Harassment Prevention

E15 Abuse Prevention Petition, G.L. c. 209A	(X)
E21 Protection from Harassment, G.L. c. 258E	(X)

AA Administrative Civil Actions

E02 Appeal from Administrative Agency, G.L. c. 30A	(X)
E03 Certiorari Action, G.L. c. 249, § 4	(X)
E05 Confirmation of Arbitration Awards	(X)
E06 Mass Antitrust Act, G.L. c. 93, § 9	(A)
E07 Mass Antitrust Act, G.L. c. 93, § 8	(X)
E08 Appointment of a Receiver	(X)
E09 Construction Surety Bond, G.L. c. 149, §§ 29, 29A	(A)
E10 Summary Process Appeal	(X)
E11 Worker's Compensation	(X)
E16 Auto Surcharge Appeal	(X)
E17 Civil Rights Act, G.L. c.12, § 11H	(A)
E24 Appeal from District Court Commitment, G.L. c.123, § 9(b)	(X)
E94 Forfeiture, G.L. c. 265, § 56	(X)
E95 Forfeiture, G.L. c. 94C, § 47	(F)
E99 Other Administrative Action	(X)
Z01 Medical Malpractice - Tribunal only, G.L. c. 231, § 60B	(F)
Z02 Appeal Bond Denial	(X)

SO Sex Offender Review

E12 SDP Commitment, G.L. c. 123A, § 12	(X)
E14 SDP Petition, G.L. c. 123A, § 9(b)	(X)

RC Restricted Civil Actions

E19 Sex Offender Registry, G.L. c. 6, § 178M	(X)
E27 Minor Seeking Consent, G.L. c.112, § 12S	(X)

TRANSFER YOUR SELECTION TO THE FACE SHEET

EXAMPLE:

CODE NO.	TYPE OF ACTION (specify)	TRACK	HAS A JURY CLAIM BEEN MADE?
B03	Motor Vehicle Negligence-Personal Injury	F .	☒ YES ☐ NO

STATEMENT OF DAMAGES REQUIRED BY G.L. c. 212, § 3A

DUTY OF THE PLAINTIFF — On the face of the Civil Action Cover Sheet (or on attached additional sheets, if necessary), the plaintiff shall state the facts on which the plaintiff relies to determine money damages. A copy of the completed Civil Action Cover Sheet, including the statement concerning damages, shall be served with the complaint. **A clerk-magistrate shall not accept for filing a complaint, except as otherwise provided by law, unless it is accompanied by such a statement signed by the attorney or self-represented litigant.**

DUTY OF THE DEFENDANT — If the defendant believes that the statement of damages filed by the plaintiff is inadequate, the defendant may file with the defendant's answer a statement specifying the potential damages which may result if the plaintiff prevails.

A CIVIL ACTION COVER SHEET MUST BE FILED WITH EACH COMPLAINT. IF THIS COVER SHEET IS NOT FILLED OUT THOROUGHLY AND ACCURATELY, THE CASE MAY BE DISMISSED.

BERKSHIRE COUNTY SUPERIOR COURT

PITTSFIELD, MASSACHUSETS

THE TOWN OF LEE, MASSACHUSETTS	CASE NO:
Plaintiff,	COMPLAINT FOR INTENTIONAL INFLICTION OF HARM TO HUMANS AND THE ENVIRONMENT, COMPENSATORY AND PUNITIVE DAMAGES.
v.	
MONSANTO COMPANY, SOLUTIA INC., PHARMACIA LLC., AND GENERAL ELECTRIC . ELECTRIC CORPORATION.	JURY TRIAL DEMANDED
Defendants.	

PLAINTIFF'S COMPLAINT FOR INTENTIONAL INFLICTION OF HARM TO HUMANS AND THE ENVIRONMENT,COMPENSATORY, AND PUNITIVE DAMAGES.

TABLE OF CONTENTS

TABLE OF EXHIBITS

EXHIBIT # TITLE OF THE EXHIBIT

TABLE OF EXHIBITS (CONTINUED).

I. INTRODUCTION

1. The tort of intentional infliction of harm encapsulates a basic moral principle – that if you injure someone intentionally and without just cause or excuse, then you should be liable for the commission of a tort—in addition to any crime you might commit.
2. Defendant Monsanto (including Defendants Solutia and Pharmacia) manufactured or marketed a toxic product (polychlorinated biphenyls or PCBs) from the 1930s to the late 1970s.The toxic product was sold to defendant General Electric "GE" for use in transformers.
3. Defendant GE profited from this product and discarded hundreds of thousands of pounds of no longer usable product into the Housatonic River in full expectation that the waste product will be carried by the River to the Atlantic.
4. In 1968 Monsanto discovered that the product would never be carried by rivers to the Atlantic but instead will become permanently imbedded in the sediments of rivers harming humans and the environment.
5. The toxicity of the product to humans and the environment became known word-wide by the 1960s and Monsanto decided to remove from the market the portion of the product sold as plasticizer.
6. Monsanto continued marketing the most profitable use of the product to GE **with a critical caveat.**
7. Monsanto told GE unequivocally that the product will harm humans and the environment and that GE could continue buying the toxic product only if it agreed to reimburse Monsanto for any claims filed against Monsanto:

"… without implied limitation, any contamination of or adverse effects on humans, marine and wildlife, food, animal feed or the environment by reason of such PCBs." DJ-20

8. GE continued buying the product from Monsanto after execution of the agreement and continued to dump waste product into the flowing waters of the Housatonic River.
9. The actions of Monsanto in not removing the product from the marked when it became a certainty the product will harm humans and the environment, and the actions of GE in continuing to profit from use the product even it caused harm to humans and the environment was an intentional act that could not be justified in any society. Intentional harm to humans is a crime whether or not prosecutors decide to prosecute or not to prosecute the actors of the intentional harm.
10. Earning money is not a justification for harming humans and the environment whether a governmental agency approves or disapproves of the action that causes the damages.
11. GE continuing use of the toxic product created a catastrophe to the Town of Lee and its residents for which both GE and Monsanto are responsible.
12. The Environmental Protection Agency "EPA" empowered by the Comprehensive Environmental Response, Compensation, and Liability Act "CERCLA" banned the manufacture and sales of the toxic product in 1979.
13. EPA after 40 years of study and litigation with GE ordered GE in 2022 to make an effort to minimize the presence of the toxic product—polychlorinated biphenyl's "PCBs" —from a 100-mile portion of the

Housatonic River "River" which flows through the City of Pittsfield "City" and the Massachusetts Towns of Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

14. EPA, GE, the City and the towns of Lee, Lenox, Stockbridge, Great Barrington, and Sheffield entered into a Settlement Agreement under which the City and towns agreed **only not to appeal** the EPA terms of the 2022 CERCLA Order to the courts in exchange for GE paying the City and Towns the sum of 62 million dollars to be divided among them.
15. The CERCLA Order was nevertheless appealed by citizens to the Court of Appeals of the First Circuit.
16. The First Circuit Court of Appeals dismissed the appeal on July 25, 2023.
17. The EPA Order is binding regardless of whether Lee agreed or disagreed with the Order, and cannot be overturned by municipal or local actions or by this Court as it has already been approved by the Court of Appeals of the First Circuit.
18. The Settlement Agreement does not prevent The Town of Lee from seeking monetary compensation from GE and Monsanto for the damages that PCBs have inflicted on the Town and its residents.
19. The 2022 CERCLA Order includes construction of a PCB dump in Lee the poorest town in the region.
20. The PCB dump could have been created within the confines of the other affected towns; Lenox, Great Barrington, Sheffield or Stockbridge, however these towns are wealthy and could afford to fight the issue in Courts for years, which Lee could not afford.

21. It is also evident that the moneys paid by GE as per the Settlement Agreement are not compensation for anything other than the towns not appealing the CERCLA Order—as per the content of the agreement—since of the 62 million paid by GE 25 million were allocated to Lee and 25 million were allocated to Lenox. Lenox the wealthy Town north of Lee does not have to suffer damages from a PCB dump like Lee.
22. The decision by EPA to order he construction of the PCB dump in Lee saves GE the expense of transporting dredged PCBs to an out of state accredited toxic dump as EPA's scientists and engineers recommended in an initial CERCLA Order issued by EPA in 2016.
23. Monsanto manufactured all PCBs currently in the River and is jointly liable with GE for PCB contamination of the River, and the consequences of the contamination.
24. This lawsuit against Monsanto and GE does not, cannot, and will not, interfere with the CERCLA Order or the Settlement Agreement.
25. The Town of Lee is seeking from Monsanto and GE adequate compensatory and punitive damages for the harm both companies intentionally caused to Lee by creating profits for their shareholders without justification.
26. Those damages include eliminating the use of the River for all Town's residents for years to come.
27. In the forthcoming 13 years two billion pounds of PCB contaminated muds and soil will be dredged from the River by GE–as ordered by EPA – transported in eighty-thousand-pound truck loads through the streets of Lee, and deposited within the confines of the Town of Lee in a dump projected to be 150 feet in height on a 20-acre base. Five hundred

thousand pounds of PCBs will be left in the sediments of the River by GE under EPA estimates under the CERCLA 2022 Order.

28. The sediments in the River will then be covered by a tarp with potential leakage of PCBs monitored for twenty years after completion of the partial dredging.
29. The Town Lee is seeking, as *parens patriae* on behalf of its residents adequate compensatory and punitive damages to be determined by a jury for the catastrophic disaster Monsanto and GE have caused to Lee.
30. The CERCLA Order of 2022 cannot and does not require Monsanto and GE to pay damages to the Town for the intentional actions of GE and Monsanto that have caused and will continue to cause harm to humans and the environment.
31. EPA has no jurisdiction over Monsanto as Congress restricted EPA jurisdiction to the immediate actor that contaminated the soil and the River– in this case GE.
32. Monsanto knew as far back as the 1930s that PCBs were toxic to humans and the environment.
33. The Town upon publication of the contamination of the Housatonic River by GE with PCBs in the 1980s and 1990s relied on EPA to force GE to restore the River and its banks to its original estate.
34. The task imposed on EPA by CERCLA turned out to be impossible given the nature of forever life of PCBs as Monsanto learned in 1968 from an admitted negligent event.

35. The CERCLA Order of 2022 is at best a weak compromise of what EPA could do under the circumstances to reduce the risks to humans and the environment.

36. In early 2023, cases filed across this country against Monsanto for contamination of water- ways made the Town of Lee aware for the first time that Monsanto was jointly liable with GE for PCB related damages.

37. Cases and settlements for contamination of water-ways mostly filed by attorney generals of states like Oregon and Pennsylvania against Monsanto provided The Town with a flood of internal Monsanto documents available in the dockets of the cases.

38. On November 10, 2023 the Town in good faith provided documentation to GE that would allow GE to seek compensation from Monsanto for all monies it had spent and was about to spend under CERCLA Orders for the dredging of the Housatonic and Hudson Rivers.(*DJ-22*).

39. The basis for GE's possible action against Monsanto was Lee's assumption that GE did not know that in 1968 Monsanto learned through a "negligent event"—Monsanto's words —that PCBs in the Hudson and Housatonic River did not flow with water currents to the Atlantic. (*Id.*)

40. GE's lack of response to Lee's generous letter generated the Town's interest and sought from lawyers associated with similar cases further documentation on the matter.

41. On December 15, 2023 the Town was provided with the afore mentioned contract between GE and Monsanto. (*DJ-20).*

42. The statute of limitation of the Town of Lee against Monsanto and GE for intentional infliction of harm to humans and the environment begins to run

on December 15, 2023 the date Lee obtained the Monsanto-GE contract. (*id*.).

II. II. PARTIES

43. The Town of Lee located in Western Massachusetts is the poorest of five towns through which the PCB contaminated Housatonic River flows. The Town is suing here as *parens patriae* on behalf of Town residents. Towns in Massachusetts can sue and be sued under Mass. G.L. ch. 40 § 2.

44. Old Monsanto is a limited liability company organized and existing under the laws of the State of Delaware. The sole member of Old Monsanto is Wyeth Holdings LLC. The sole member of Wyeth Holdings LLC is Anacor Pharmaceuticals, Inc., which is incorporated under the laws of Delaware and has its principal place of business in New York.

45. Through a series of transactions beginning in approximately 1997, Old Monsanto's business were spun off to form three separate corporations. The corporations now known as Monsanto operates Old Monsanto's agricultural business. Old Monsanto's chemical products business is now operated by Solutia. Old Monsanto's pharmaceutical business is now operated as Pharmacia.

46. Solutia was organized by Old Monsanto to own and operate its chemical manufacturing business. Solutia assumed the operations, assets, and liabilities of Old Monsanto's chemical business.

47. Although Solutia assumed and agreed to indemnify Pharmacia (then known as Monsanto Company) for certain inabilities related to the chemical business, Defendants Monsanto, Solutia and Pharmacia have entered into an agreement to share or apportion liabilities, and or indemnify one or more entity, for claims arising from Old Monsanto chemical business—including the manufacture of PCBs.
48. In 2003, Solutia filed a voluntary petition for reorganization under Chapter 11 of the U.S. Bankruptcy Code. Solutia's reorganization was completed in 2008. In connection with Solutia's Plan of reorganization, Solutia, Pharmacia and New Monsanto entered into several agreements under which Monsanto continues to manage and assume financial responsibility for certain tort litigation and environmental remediation related to the chemical business.
49. , Solutia was spun off from Old Monsanto. In connection with the spin off, Old Monsanto assigned certain rights to Solutia, including the rights to enforce the Special Undertaking Agreements. This Special Understanding Agreement is labeled throughout this Complaint as the Monsanto-General Electric Contract entered between Monsanto and General Electric executed on January 31, 1972. (Exhibit DJ-22). In particular, Old Monsanto assigned its "right, title, and interest . . . in and to all of the Chemical Assets" to Solutia, which were defined to include "all rights under insurance policies and all rights in the nature of insurance, indemnification or contribution." Solutia has the right to enforce the Special Undertaking Agreements.
50. Monsanto is a corporation organized and existing under the laws of the State of Delaware with its corporate headquarters and principal place of

business in St. Louis County, Missouri. Monsanto did not manufacture or sell PCBs. Monsanto was spun off from Old Monsanto in 2000. In 2008, Monsanto and Solutia entered into the Amended and Restated Settlement Agreement in connection with Solutia's Chapter 11 reorganization. As

51. part of that Amended and Restated Settlement Agreement, Monsanto agreed to assume financial responsibility for certain Legacy Tort Claims (which include claims for property damage, personal injury, products liability or premises liability or other damages arising out of or related to exposure to PCBs) and Environmental Liabilities related to Legacy Sites. Old Monsanto executed a Power of Attorney in favor of New Monsanto, which grants New Monsanto authority to take "all actions" over certain claims, including the PCB Lawsuits, and provides that Monsanto is Old Monsanto's "true and lawful agent and attorney." The Amended and Restated Settlement Agreement also obligated Solutia to use commercially reasonable efforts to assert indemnification rights (including the Special Undertaking Agreements) for the benefit of Monsanto and granted Monsanto the right to any benefits recovered by Solutia through its enforcement of those indemnification rights. Pursuant to the 2008 Amended and Restated Settlement Agreement and the Power of Attorney, Monsanto is and has been paying the costs incurred by Defendants to defend the PCB Lawsuits, and has also paid and/or agreed to pay amounts to settle some of the Food Chain cases and Water Cases, for the benefit of Defendants.

52. Defendant Pharmacia LLC (formerly known as "Pharmacia Corporation" and successor to Old Monsanto) is a Delaware LLC with principal place of

business at 100 Route 206 North, Peapack, NJ 07977. Pharmacia is now a wholly owned subsidiary of Pfizer, Inc.

53. Monsanto, Solutia and Pharmacia are collectively referred in this Complaint as Monsanto.

54. General Electric, a New York Corporation has headquarters and principal place of business in Boston Massachusetts.

III. JURISDICTION AND VENUE

55. This Court has jurisdiction over Defendants Monsanto, Solutia, and Pharmacia because 1) these defendants have transacted business and transact business in the Commonwealth of Massachusetts specifically in relation to the sale, distribution, procurement, shipments, use, discarding, research into assessment of risks, assessment of dangers, related to Defendants PCB products, 2) these Defendants have contracted to supply services or things in the Commonwealth of Massachusetts including PCBs, 3) these Defendants have caused tortious injury by acts of omissions in the Commonwealth of Massachusetts including the improper, intentional, reckless, and wrongful use, distribution, pollution, sales of PCBs in the Commonwealth of Massachusetts; and 4) these Defendants have caused tortious injury in the Commonwealth of Massachusetts by acts, or omissions outside the Commonwealth of Massachusetts where the Defendants have regularly done and solicited business in the Commonwealth of Massachusetts.

57. Defendants derived substantial amounts of revenue in the Commonwealth of Massachusetts through their persistent marketing of PCBs in the Commonwealth of Massachusetts.

58. This Court has jurisdiction over Defendant GE in Massachusetts because 1) GE has transacted business in the Commonwealth of Massachusetts specifically in relation to the sales distribution, procurement, shipping, discarding, assessment of risks, disposal assessment of dangers, dumping, remediation and removal of PCBs 2) GE has caused intentional harm to humans and the environment in Massachusetts from January 31 1971 the date of executing the Monsanto-GE contract (DJ-22) to 1979 when PCBs were banned by EPA.

59. Venue is proper in Berkshire County because the Plaintiff is a Town located in Berkshire County Massachusetts.

60. Venue is also proper in Berkshire County because Defendant GE has a regular place of business located in Massachusetts.

61. Venue is also proper in Berkshire County because defendants Monsanto, Solutia and Pharmacia have regularly conducted business in Berkshire County through their sale, distribution, shipment and placement of their products including PCBs into and throughout Berkshire County.

IV. FACTS

62. The EPA CERCLA Order of 2016 *(DJ-1)*:

> *The United States Environmental Protection Agency ("EPA") is charged with enforcing federal environmental laws to protect human health and the environment. Under this authority, EPA seeks to hold General*

Electric Company ("GE") accountable for contaminating over a hundred miles of the Housatonic River system (an area referred to as "Rest of River") with toxic polychlorinated biphenyls ("PCBs"). From 1998 to 2000, the United States, the Commonwealth of Massachusetts, the State of Connecticut, and GE negotiated a Consent Decree ("the Decree" or "CD") requiring GE to clean up its contamination. ***The Decree was approved by a federal court on October 27, 2000. GE committed to clean-up the Rest of River based upon the remedy selected by EPA through the process outlined in the Decree****. (Statement of Position of EPA, February 29, 2016. (Emphasis here only. Exhibit DJ-1. at page-1. Hereinafter DJ number at page number.)*

63. For the next sixteen years EPA used its scientific and technical expertise to address the contamination of the Housatonic River as it flows through the City of Pittsfield and the Towns of Lee, Lenox, Great Barrington, Stockbridge and Sheffield**.**

EPA has followed this exhaustive remedy selection process, which has included over a decade of expert information-gathering and technical analysis, to make its Intended Final Decision for the Rest of River remedy. EPA reached its Intended Final Decision based upon an analysis of the relevant criteria in the Decree and information in the Administrative Record. The remedy EPA selected includes a combination of excavation and capping of PCB contaminated material, and disposal of that material at a suitable ***off-site landfill****. In balancing the relevant factors under the Decree, the Intended Final Decision represents the* ***best alternative to protect human health and the*** *environment for the Housatonic River.* ***GE now challenges EPA's Intended Final Decision for one reason – to reduce its costs in cleaning up its PCBs****. (Id. p1. Emphasis here only).*

56. EPA made the substantive decisions on all human health related issues caused by the contamination of the Housatonic River and its floodplains which included burying the PCBs dredged from the River at an **off-site** location. (Id. at pages 15-27).

a. The Proposed Remedy Provides Long-term Protection of Human Health and the Environment. (Id. page 15).
b. EPA's toxicity values for PCBs are supported by scientific consensus and were vetted through public comment and peer review. (Id. pages 15-17).

c. *The proposed remedy is necessary to reduce human exposure to PCBs through consumption of fish. (Id. pages 17-19).*
d. *The direct contact exposure assumptions for sediment and floodplain soil in the HHRA [*Human Health Risk Assessment |EPA] *are reasonable estimates of risks to average and high-end users. (Id. pages 19-20).*
e. *The proposed remedy is necessary to reduce human health risks due to direct contact exposure to PCBs. (Id. pages 21-23).*
f. *PCBs pose unacceptable risks to the environment in Rest of River. (Id. pages 21-23).*
g. *The remedy's long-term benefits to human health and the environment outweigh any short-term ecological impacts which GE is required to mitigate. (Id. ps. 23-26).*

57. The position of the EPA as per DJ-1 was appealed by GE to the Environmental Appeals Board "EAB" who **reversed** the position of EPA on its restriction that PCBs dredged from the River must be buried at an **off-site** location.
58. GE submitted to EPA a Pre-Design Investigation of a projected PCB dump to be located in the Town of Lee "Lee" where the dredged PCBs would be buried. (*GE's Document DJ-2).*
59. EPA, forced by EAB's order to bury PCBs at an **on-site** location adopted GE's submission and issued a final Order to GE to move forward with the partial clean-up of the Housatonic River, its floodplains and other locations and to bury PCBs at the GE proposed location in Lee. (*EPA Document DJ-3).*
60. EPA was forced to agree to bury the dredged PCBS in Lee merely to lower the cots GE's clean-up. (S*upra ¶ 1.)*

V. MONSANTO'S JOINT LIABILITY WITH GE FOR THE ONTAMINATOION OF THE RIVER AND ITS FLODPLAINS

61. General Electric, a customer of Monsanto, used PCBs Aroclors 1254 and 1260 made by Monsanto on electrical transformers it manufactured and/or serviced in Pittsfield ("City") between 1930 and 1979.

62. PCBs used in electrical transformers lost its insulating properties after some usage, at which time GE collected and disposed of the PCBs by burying them in the City at various locations or by dumping the PCBs into the Housatonic River "River" that runs through the City and the towns of Lenox, Lee, Great Barrington, Sheffield and Stockbridge. (*DJ 1 and DJ-2)*

63. Dredging of the PCB from the River and depositing 50.5 tons (*AKA 101,100 pounds)* of PCBs *(DJ-15)* in a massive dump within the confines of Lee Has damaged, is damaging, and will damage the Town of Lee and its residents.

64. Dredging of PCBs imbedded in mud at 25 ppm concentration and transporting the two million tons of mud (AKA four billon pounds of mud) through the streets of Lee for the next 13 years is damaging to Lee and its residents. *(DJ-15).*

65. Leaving anywhere between 100,000 to 500,000 pounds of PCBs in the River covered by a tarp that will have to be monitored for the next 20 years–after the dredging is completed– has damaged, and will damage Lee and its residents. *(DJ-24 Fast Facts and DJ-3 pages 18 et seq.)*

66. Monsanto manufactured all the PCBs purchased by GE which have created the massive damages to Lee and its residents. referred to on supra *¶s 1-65.*

Monsanto knew at all times between the 1930s and 1979 that PCBs were toxic. (Monsanto's Statement of Material Facts. Document. DJ-4).

a. *Polychlorinated biphenyls (PCBs) are a class of 209 nonpolar chlorinated hydrocarbons with a biphenyl nucleus on which one to ten of the hydrogens have been replaced by chlorine. Commercial PCBs were manufactured and sold as complex mixtures containing multiple isomers (congeners) at different degrees of chlorination. Exhibit DJ-4 Monsanto's Statement of Facts in Town of Westport et al., v Monsanto C.A. 14-CV-12041. DJ-4 at p. 1. Citations Omitted).*
b. *Monsanto Company began the manufacture and sale of PCB mixtures in 1935 when it purchased the Swann Chemical Company. The Monsanto PCB mixtures were sold under the registered trademark of Aroclor. The Monsanto PCB-containing Aroclor numbers included 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. With the exception of 1016, the last two digits of the Aroclor series number correspond to the percent of chlorine. (Id at p 2 Citations Omitted).*
c. *Beginning in the 1930s, Monsanto commissioned hundreds of toxicological tests of PCBs from leading institutions such as the Harvard School of Public Health and the Kettering Institute of the University of Cincinnati. Those tests disclosed that PCBs, like all industrial chemicals, were capable of causing systemic toxicity at high doses, but could be safely manufactured, and, if recommended precautions are followed, can be used safely. At all times relevant to this case, Pharmacia [AKA Monsanto] supplied Aroclor product bulletins and warning labels to each of its customers. These bulletins contained then-known toxicological information regarding exposures to PCBs and information on their safe handling. These bulletins also provided physical and chemical characteristics for the Aroclors. Pharmacia also issued warnings on its labeling for barrels and tank cars. Pharmacia warned its customers: "Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects. This warning was repeated in a 1943 application data bulletin, in which Pharmacia warned: "Experimental work on animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects. Pharmacia provided the following warning: "The vapors emitted by Aroclor 1248 heated to elevated temperatures are injurious to the liver on prolonged exposure and should not be breathed. Pharmacia warned: "If these precautions are neglected acne may develop and excessive exposure may cause liver damage. (id. p-9-10.*

d. *PCB production in the United States began in response to the electrical industry's need for improved dielectric insulating fluids which would also provide increased fire resistance when used in transformers and capacitors.* ***As the unique functional characteristics of these materials became more fully understood additional uses were found. Their non-flammability made them an excellent choice in high pressure hydraulic applications associated with high risk of fire such as die casting and steel production. Their thermal stability and nonflammability were valuable in heat transfer systems.*** *Their non-flammability, thermal stability and viscosity characteristics made their use desirable in hot melt adhesives and other plasticizer applications.* ***PCBs therefore evolved as unique class of chemicals which met important needs for both industry and society****. In many instances fire and building codes required PCBs for the protection of life and property.(Id at ps. 4-5 Citations Omitted. Emphasis here only).*
e. ***In 1970, in response to growing information regarding PCB's environmental presence, Monsanto began to voluntarily phase out the sale of PCBs for various applications. Sales of PCBs for use as plasticizers were phased out as of August 1970. Monsanto had ceased the manufacture and sale of PCBs for all uses other than as a dielectric fluid for use in enclosed electrical equipment. Monsanto voluntarily ended the manufacture and sale of PCBs for all uses in 1977***

67. Monsanto's medical team knew in 1955 that PCBs are toxic and can cause liver disease in humans, yet it halted further evaluation of the limits of exposure. (*DJ-5 Monsanto's Document September 20, 1955).*

> *MCC's position can be summarized in this fashion. We know Aroclors are toxic but the actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an Individual develops any type of liver disease and gives a history of Aroclor exposure. I am sure the Juries would not pay a great deal of attention to MACs.[Minimum Allowed Concentrations](DJ-5 at p.-1).*
>
> *We, therefore, review every new Aroclor use from this point of view. If it is an industrial application where we can get air concentrations and have some reasonable expectation that the air concentrations will stay the same, we are much more liberal in the use of Aroclor. If, however, it is distributed to householders where it can be used in almost*

any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict. No amount of toxicity testing will obviate this last dilemma and therefore I do not believe any more testing would be justified. (Id at p-2).

68. The United States Navy rejected in 1956 a PCB (Pydraul 150 (AKA Aroclors 1254 mixture with 1260) marketed by Monsanto for usage as oil in the antenna of nuclear submarines as a toxic product in spite of Monsanto's protestations. (Monsanto's Document DJ-6 May 29, 1956 and Monsanto's Document DJ-7 January 21, 1957*).*

> *f. applications of Pydraul 150 caused death In all of the rabbits tested , (The amount Administered was not given.) …*
> *Vr: Inhalation of 10 milligrams of Pydraul 150 per Cubic meter or approximately 2 tenths of a part Of the Aroclor component per million for 24 hours A day for 50 days caused statistically definite Liver damage-.* ***No matter how we discussed the Situation, it was Impossible to change their minds.***
> *(Emphasis here only. Exhibits DJ 6 and 7).*

69. Monsanto's had internal dispute in 1957 as to whether Monsanto should recommend the use of Aroclor in agricultural products as an insecticide additive without approval of U.S.D.A-FDA. (Monsanto's Document DJ-8 August 30, 1957*).*

> *You may already know that since Aroclor are toxic and, according to your attached reference, may extend the residual life of the pesticide, the Federal Government would require the following before selling for use on food and feed crops:*
> *(1) Proof of benefits from the application .*
> *(2) Data to show whether or not residual Arozlor is present and whether it modifies the residual amount of Lindane or other active ingredient at harvest.*
> *(3) If Aroclor is present or if the residual quantity of Lindane or other active ingredient has been significantly changed, tolerances for the Aroclor and for the pesticide in*

> *question must be developed.*
> *(4) If a toxic quantity of Aroclor is present at harvest in food or feed crops a tolerance cannot be established until after two year chronic toxicity feeding tests have been completed for the Aroclor. (DJ-8).*

70. Monsanto discussed internally on March 6, 1969 the actions it could take in response of knowledge spreading around the world that Aroclors were an uncontrollable pollutant spreading widely by air-water. *(Monsanto Document DJ-9 March 6, 1969).*

> *Risebrough in a recent paper "Nature", Vol. 220, Dec. l4, 1968, has attacked chlorinated biphenyls in three ways:*
> *(1) a pollutant - widely spread by air-water; therefore an uncontrollable pollutant.*
> *(2) a toxic substance - with no permissible allowable levels causing extinction of peregrine falcon by induced hepatic enzymes which degrade steroids upsetting Ca metabolism leading to reproductive weakness, presumably through thinner egg shells.*
> *3) a toxic substance endangering man himself; implying that the peregrine falcon is a leading indicator of things to come.(Id. at page-1)*
> ****
> *Where does this leave us?*
> *Under identification and control of exposure - we will be able to identify and analyze residues as well or better than anyone in the world. We will probably find residues other than BBT and PCB's. We will probably wind up sharing the blame in the ppm to ppb concentration level.*
> *We can take steps to minimize pollution from our own chlorinated biphenyl plants, we can work with our larger customers to minimize pollution, we can continue to set up disposal and reclaim operations. Ve can work for minimum exposure in manufacture and disposal of capacitors, transformers and heat transfer systems, and minimize losses for large hydraulic users. (Id. p.-2)).*

71. Monsanto discussed a report on April 2, 1969 of comments on PCBs conducted at Industrial Biotest Laboratories in Chicago. *(Monsanto's Document DJ-10 March 21, 1969)*.

> *a. From the background data presented it appears that something of the order of 80 million pounds of polychlor biphenyls (PC3) are produced annually.(Id. p-1).*
> *b. At first thought it seems unlikely because of the major uses of PC3 in capacitors, transformer oils, heat transfer fluids in closed systems, that these materials could be the source of the substantial degree of environmental contamination reported. (id. p-1).*
> *c. Because of the apparent high stability of PCB, amounts entering the environment would be degraded very slowly and it seems possible that at least 10 million pounds annually may become environmental contaminants. Since the PCBs were introduced commercially in 1929 there have been 40 years of production. If this has averaged 50 million pounds per year, then about [2 billion] pounds have been made and perhaps {200 million pounds] have entered the environment. Because of the apparent stability of these compounds most of this amount nay still be circulating in the global ecosystem and this is suggested by the levels reported by Holmes et al. (1967) and Risebrough et al. (I968) in animal tissues which are quite comparable to those found for DDT.(Id.-p.1)*
> ***d.** It seems to the writer that the evidence regarding **PCB effects on environmental quality is sufficiently substantial, 0idespread, and alarming to require immediate corrective action on. the part of Monsanto.** (Id. p-2. Emphasis here only).*

72. Monsanto's Plasticizer Group sent a letter to its 661 US customers of Aroclors 1254 and 1260 on February 27, 1970 regarding published articles indicating that PCBs have been discovered at some points in some marine, aquatic and wildlife environments. … the quantities detected are said to be in the parts per million and parts per billion categories. *(Monsanto's Document and Attachments. DJ-11 January 27, 1970)*.

> *Dear Customer:*
>
> *Recently several newspaper and magazine articles have been published indicating that polychlorinated Biphenyls (PCBs have been discovered at some points in some marine, aquatic and wildlife environments. The*

quantities detected are said to be in the parts per million and parts per billion categories.

It is claimed that the PCBs found strongly resemble chlorinated biphenyls containing 54% and 60% chlorine by weight. Products sold by Monsanto under the trade names of Aroclor 1254 and 1260 containing chlorinated biphenyls.

As your supplier of Aroclor 1254 and 1260, we wish to alert you to the potential problem of environmental contamination is referred to In the newspaper and magazine articles.

We would like to point out the following additional facts.

1. Certain Monsanto products which are sold under the Aroclor trade mark, namely Aroclor 5060, 5442, and 5460 are not polychlorinated biphenyls.

2. PCBs with a chlorine chorine content of less than 54% have not been found in the environment and appear to present no potential problem to the environment.

We feel that all possible care should be taken in the application, processing and effluent disposal of these products to-prevent them becoming environmental contaminants. Of interest to you may be an article in Chemical Week , October 29, 1969 regarding water pollution standards set by each state of the Union. It is attached. ***This article reflect the view that good manufacturing practice in the-future may require that no products used by any company be lost or discharged in such a manner as to ultimately be found in waterways.***
(Id. at ps. ***1-2.*** *Emphasis here only).*

73. The warning sent to 661 customers of Aroclors 1254 and 1262 diluted the issue by incorporating the Chemical Week article, listing possible future regulatory work by each state, and stating that the warning was issued because of recent published articles **implying that was a**ll Monsanto knew about PCBs toxicity and its impact on humans, fish, birds and he environment. (*Id*).)

The Chemical Week article sent by Monsanto to its customers makes the following points:

a. "large chemical complexes now in vogue make water-and lots of it- a major site criterion. … That means locations on or near the big, drought-resistant rivers. … There are less than 200 rivers in the U.S. with minimum flows over 50 cu. ft per second."
b. The price tag for pollution control is high. … A recent WPCA study estimated that water waste treatment facilities can increase installed capital equipment costs 40% or more.
c. The article makes no suggestion to General Electric or any other customer not to dump PCBs in the Housatonic River, the Hudson River or any other river. Exhibit-DJ-11 Chemical Week Article. Exhibit-DJ-11).

74. Monsanto's Plasticizer Group sent the letter dated February 27, 1970 warning of contamination of the environment to 661 users of Aroclors 1254 and 1260 as plasticizers.

75. Three GE facilities received the letter: (*DJ-4).*

    a. Customer 248 GE Coshocton Ohio.
    b. Customer 249 GE 1430 E. Fairchild St. Danville Ill.
    c. Customer 250 GE 1 Plastic Avenue Pittsfield Mass. 01201

76. Monsanto's Plasticizer Group failed to notify GE's Transformer's Division of any possible problem with environmental contamination of the River.

77. Monsanto's letter suggested to its 661 plasticizer's customers "that all possible care should be taken in the application, processing and effluent disposal of these products to prevent environmental contamination."(*DJ-4, 2*).

78. Monsanto's Plasticizer Group's letter to its plasticizers customers dated February 27, 1970 was nothing more than an attempt to post facto protection of liability as five months letter in August of 1970 Monsanto ceased marketing Aroclors 1254 and 1260 as plasticizers. (Supra *¶ 66(e)*.

79. Monsanto knew much more about PCBs unique problems with PCBs contaminating rivers in 1968. This knowledge was unique to Monsanto. Monsanto kept this this information secret to prevent customers' like GE from terminating usage of Aroclors 1254 and 1260 as transformers' fluids which continued for ten more years.
80. Monsanto never told GE or any other of its 661 plasticizer's customers of Aroclors 1254 and 1260 that dumping PCBs into a River resulted **in permanent PCB contamination of the rivers due to the unique properties of PCBs (See Monsanto Documents that follow).**
81. Monsanto established in 1969 an Aroclor "Ad Hoc" Committee to set business objectives for the company and to discuss its current knowledge of the impact of Aroclors on humans, fish, birds and the environment. (*Minutes of Aroclor :Ad Hoc" Committee Monsanto's Document DJ-12 September 5, 1969.)*

MINUTES OF AROCLOR "AD HOC" COMMITTEE.).
First Meeting

Date: September 5, 1969
Present: M. W. Farrar
P. B. Hodges, Secretary
E. V. John
W. H. Richard .
E. P. Wheeler, Chairman

Objectives: (Agreed to by the Committee)
Submit recommendations Tor action which will:
1. Permit continued sales and profits, of Aroclors and
Terphenyls.
2. Permit continued development of uses and sales.
3. Protect image of Organic Division and of the Corporation.(Id-p-1).

Background Discussion of Problem:
1. Agreed that we should concentrate on Aroclor 1254 and

1260. …(Id at p-1)

2. - PCB has been found in:
a. Pish, oysters, shrimp, birds.
b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries. Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant.
3. PCB has been tied to DDT in effects on disappearance of wild birds which have fish diets. Ratio of PCB to ddt has been about 4o-50:1 generally. Dr. Reisboro (sic) reported almost 1:1 ratio. PCB may be contributing to or exaggerating the effects of other chlorinated aromatics. (Id.-p-1).

Escambia River Problem:

For a clearer understanding of the general problem, - the situation at Pensacola was reviewed. **From a relatively negligible discharge of 1-3 gal/day into a large river, 1/5 mile downstream levels of 42 ppb in water and 476 ppm in mud were found.** Although use of Aroclor was halted Immediately, **we can expect the water contamination to continue for a lengthy period by leaching from the contaminated mud.** No downstream samples have yet been taken to measure the decrease in contamination (as of 9/3/69). Id. at ps. 1-2. Emphasis here only) .

82. The "Escambia River Problem was not knew to Monsanto on September 5, 1969. In fact, it was problem that Monsanto understood would have devastating consequences for its 1254 and 1260 Aroclor business as early as 1968 or earlier when the Escambia River problem was discovered by Monsanto. (*Monsanto's* ***CONFIDENTIAL*** *Report of Aroclor "ADD HOC" Committee October 2, 1969 DJ-13*):

Losses from Monsanto Plants (DJ-13)

Efforts to reduce the losses of Aroclors in liquid wastes from Anniston and WGK plants are completed or underway. ***It is impossible to establish a limit as to what can be discharged "safely". Investigation has shown that the waters in receiving streams below the Anniston Plant contain significant (parts per million) concentrations of PCB.***

> ***More ominous perhaps is the fact that sediment in the bottom of these streams miles below our plants may contain as much as 2% Aroclor.*** *(Exhibit DG-13 at p. 8. Emphasis here only).*
>
> ***To prepare for the eventual publication*** *in the press of the discharge of PCB's (sic) in Alabama and to the Mississippi River, a significant an effort must be made to determine the present levels of contamination and more importantly, determine the levels of contamination as "clean up" procedures begin to show an effect. (Id. p. 8 Emphasis here only.).*
>
> ***The incident at the Monsanto plant at Pensacola indicates that all Monsanto Plants using Aroclors should be made aware of the potential problems and efforts made to eliminate any losses. The significance of "any losses" may be related to the one to three gallons per day which was being lost at the Pensacola Plant.*** *(Id. p. 8 Emphasis here only).*
>
> ***Hopefully research efforts will indicate what a "safe level " of losses would be higher in fresh water streams not adjacent to coastal estuaries. At the present time we know of no claims that the PCB's (sic) are "destroying" fish***. *(Id. at p.9. Emphasis here only).*

83. The Escambia River drains 425 square miles in Northwest Florida before flowing into Pensacola Bay at an average rate of 9,900 cubic feet per second.[1]
84. The Housatonic River flows through Pittsfield, Lenox, Lee, Great Barrington, Sheffield and Stockbridge at an annual average rate of 1,700 cubic feet for second.[2]

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1 https://www.google.com/search?client=safari&rls=en&q=ESCAMBIA+RIVER+AVERAGE+CFS&ie=UTF-8&oe=UTF-8

2 https://www.google.com/search?client=safari&rls=en&q=Housatonic+River+Average+CFS&ie=UTF-8&oe=UTF-8

85. Monsanto sold PCBs to GE from 1930 to 1977 for use in electrical transformers assembled and/or serviced by GE in Pittsfield Massachusetts.

86. Monsanto knew that the PCBs used in electrical transformers lost electrical properties after use and had to be discarded.

87. Monsanto never took back used PCBs for proper disposal.

88. Monsanto knew that GE's facility for refurbishing transformers was located in Pittsfield adjacent to the Housatonic River.

89. Monsanto knew or should have known that GE disposed of used PCBs by dumping them into the Housatonic River or by burying them in landfills created by GE in Western Massachusetts.

90. This is what Monsanto told its customers in 1970 summarizing the Chemical week Article:

> *This article reflect the view that good manufacturing **practice in the-future** may require that no products used by any company be lost or discharged in such a manner as to ultimately be found in waterways.(Monsanto's Letter to Customers 1970 DJ-11 Emphasis here only).).*

91. GE dumped into the Housatonic or buried in landfills more than 1.5 million pounds of PCBs between 1930 and 1979 according to Ed Bates of GE. (*See Documentary Good Things to Life: GE, PCBs, and Our Town, Mickey Friedman Director/Producer.* (Open Source You Tube Documentary*)*. EPA's estimate of the amount on the River sediments is between 100,000 and 600,000 pounds (*DJ-24 Fast Facts*).

92. Monsanto sold General Electric between 1972 and 1977 more than 59 million pounds of PCBs. (*Monsanto v. General Electric 4:23-cv-00204 Doc. #. 1-3 Filed 02/20/23 Page ID #.55-125*).

93. The discrepancy between Bates and EPA estimates and the 59 million pounds GE purchased from Monsanto between 1972 and 1977 are accounted for on a number of facts disclosed by Monsanto:

*a. "**Approximately five per cent of the transformers in service in this country contain PCBs; most transformers contain mineral oil instead of PCBs."** (Id. EPA's 1976 Document at at Page 4362 emphasis here only).*
b. "General Electric and its products have been a major source of environmental contamination and have released PCBs purchased both before and after the January 31, 1972 into the environment"(Id. Page ID # 88).
c. "General Electric facility in Oakland California served as a transformer manufacturing plant from 1930 to 1975. … The State of California … found that the soil and groundwater around General Electric's transformer manufacturing plant in Oakland California were contaminated with PCBs." Id.
d. "General Electric cause significant contamination of the Hudson River, now one of the largest superfund sites in the United States. … "GE facilities, one in Fort Edwards, New York, and one in Hudson Falls New York, used PCBs in the manufacture of electrical capacitors. PCBs from both facilities were discharged into the Hudson River. …" Id.
e. " From 1932 to 1977, General Electric manufactured and serviced transformers containing PCBs at its Pittsfield, Massachusetts Facility. EPA has determined that years of General Elecgtric's use and disposal of PCBs at this facility caused extensive contamination around Pittsfield as well as down the entire stream of the Housatonic River." Id. Page ID #s 88 and 89."
f. "General Electric is responsible for PCB contamination of Spokane Washington." Id. Page ID# 89.
g. "General Electric is responsible for contamination in Oregon. From 1952 until 2010 General Electric owned and operated an electrical equipment service and repair facility and warehouse in Portland Oregon–approximately 3,000 feet from the Williams River. … In 2003 testing by the City of Portland revealed that PCBs from sediments near the General Electric facility were discharged into the storm water system, and in turn, in the Willamette Riv." Id. Page ID # 89).
h. "General Electric also stored a variety of transformers and capacitors containing BCBs at a site at 2410 N. Columbia Blvd. in Portland Oregon. Officials subsequently discovered contamination at this site as well." Id. Page ID# 89.
i. "From 1970 until 1974, General Electric stored drums, transformer casings and other containers at a facility in Eugene Oregon. In 1995,

testing revealed PCBs persisted in the subsurface and sludge of water samples from a storm drain at the site." Id.

j. "From 1974 until 1993, General Electric had another facility in Eugene Oregon were employees washed and cleaned equipment including transformers. Water from these cleaning facilities was directed to tanks and sumps. In 1995, testing of groundwater sludge and water samples from the site revealed PCBs above regulatory levels. Id. Page ID #s 89 and 90

k. "General Electric is also responsible for PCB contamination in East Flat Rock, North Carolina. In 1994 EPA declared the 141-acre Geberaak Elecric Shepard Far Site a Superfund Site. EPA placed the site on its National Priority List because of contaminated groundwater and soil." Id. ID #s 89.

l. "General Electric is also responsible for extensive contamination of the soil and water surrounding its plant and other locations in Schectady New York." Id.

m. "Upon information and belief, General Electric is also responsible for PCB contamination around certain other facilities, both before and after 1972, including but not limited to facilities in Washington, West Virginia, Shepherdsville, Kentucky, Moreau New York, Rome, Georgia, Brandon, Florida, Anaheim, California." Id. Page ID#.91.

94. Monsanto introduced the following statement in a Federal Court as a Material Fact as to which there is no issued to be tried:

> *Monsanto voluntarily ended the manufacture and sale of PCBs for all uses in 1977 when members of the electrical industry identified alternative dielectric fluids. .. Before that time, the termination of sales for dielectric uses would have resulted in severe economic and social dislocation. … In 1971, an Interdepartmental Task Force made up of eight federal agencies and sub-agencies was convened to study the needs for PCBs. In a report issued the following year, the Interdepartmental Task Force concluded* ***that the continued use of PCBs for transformers and capacitors was considered "necessary*** *because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from ban on PCB use. (Monsanto's Material Facts as to Which There is no Issue to be Tried DJ-4 Material Fact No. 8 (citations omitted emphasis here only).*

95. In 2023 Monsanto filed in another Federal Court a 1976 EPA document that stated **that only 5% of the transformers in 1976 contain PCBs**. (*Monsanto v. General Electric 4:23-cv-00204 Doc. #. 1-3 Filed 02/20/23 Page ID #.*

4362). Clearly elimination of the 5% of the transformers manufactured in the United States in 1976 would not have disrupted electrical services in the United States as General Electric could easily have switched from PCBs to Mineral Oil on its 5% PCB transformer market as it did when Monsanto stopped selling PCBs to General Electric in 177 or in 1979 when PCBs were banned by EPA.

96. Monsanto's degree of malfeasance in not publicizing or communicating to the world and its customers that Aroclor 1254 and 1260 had the peculiar property of not simply flowing with the river to the sea, as did all other chemicals dumped into the rivers by manufacturing industries *(Monsanto's DJ-11 Chem. Week Article),* has to be measured in the context that Monsanto manufactured and profited from the sale of 1.4 billion pounds of PCBs from 1927 to 1977 and **only 0.1% of this amount** or 1.5 million pounds were dumped by GE into the Housatonic and its locally created dumps.

97. Monsanto was in the 1900s a sophisticated corporation with a legal department who knew a *canary in the coal mine* when it saw one. That legal department should have recommend to Monsanto's management to publicize its Escambia River Problem to the world in 1968 or before as soon as it learned of the problem.

98. Monsanto struggled for more than one year between 1968 and 1969 what to do with the information it had how the mud of the Escambia River became permanently contaminated with of PCBs and decided to do nothing.

99. Monsanto did act in August 1970 by suspending production of PCBs for plasticizer usage. *(Monsanto's Statement of Material Facts. Document. DJ-4 at ¶ 7).*

100. Monsanto fully aware that PCBs were harmful to humans and the environment agreed to continue selling PCBs to GE **provided that GE indemnify Monsanto for any damages to humans and the environment resulting from GE's continuing usage of PCBs**. *DJ-20.*

101. Monsanto as a result of its practices has ben found responsible for millions of dollars of Environmental damages in Oregon and Pennsylvania where Monsanto has settled cases in 2023 for 691 and 1100 million dollars respectively.

102. Monsanto has been found responsible in Washington State for a number of PCB illnesses cluster cases amounting to more than one billion dollars as to the date of the filing of this complaint.

103. Monsanto is currently suing General Electric for recovery of some of the paid-out funds on the basis of the contract entered into between Monsanto and General Electric dated January 31, 1972. (*Monsanto v. General Electric 4:23-cv-00204 Filed 02/20/23 Page ID#s 55 to 125*).

104. Monsanto in spite of its knowledge about the "Escambia River Problem" continued to sell Aroclors 1254 and 1260 to the electrical manufacturing industry. *(Monsanto's Statement of Material Facts. Document. DJ-4 at ¶ 8).*

105. Monsanto has to abide by its own advocated standards of foreseeability which Monsanto used in another case winning Summary Judgment Motion against Westport a Massachusetts Town in 2017.

(*Monsanto's Memorandum of Law in Support of its Motion for Summary Judgment in Town of Westport v. Monsanto et al., C.A. No. 14-CV 12041. DJ-14).*

> ***To establish a failure-to-warn claim, the plaintiff must establish that the product is unreasonably dangerous because foreseeable users were not adequately warned of the foreseeable risks of harm associated with its use. Evans, 465 Mass. at 439. Massachusetts has rejected any hindsight analysis of the duty to warn. Vassallo v. Baxter Healthcare Corp., 428 Mass. 1, 23 (1998). The manufacturer's duty is limited to warning of dangers that were reasonably foreseeable at the time of sale, or could have been discovered by way of reasonable testing prior to marketing the product. Id. at 22-23. The failure to warn under breach of warranty is judged by the reasonableness of the defendant's actions under the circumstances. Hoffman v. Houghton Chem. Corp., 434 Mass. 624, 637 (2001). Because the alleged harm at issue in this case was not reasonably foreseeable or discoverable in 1969, no duty to warn of the alleged risk arose as a matter of law.(DJ-14 at p. 6-7.)***

106. Monsanto's foreseeability standards establish that as soon as Monsanto learned that PCBs dumped in water ways did not flow with the water to the sea— **as all other chemicals did**— it had the immediate responsibility to notify all users of PCBs—and the entire world—of this unique property of PCBs.

107. Monsanto is jointly liable with GE for the consequences of PCBs dumped in the River by GE.

108. One consequence of the contamination of the River with PCBs is the massive PCB dump to be built in Lee.

109. The characteristics of the dump (Upland Disposal Facility "UDF") and how it will be constructed in the next 13 years is described by EPA in letter to counsel. *(Letter EPA's General Counsel to Attorney Bonifaz DJ-15 November 8, 2022):*

i. The landfill … shall have a footprint of 20 acres. (*Id., page 5 hereinafter Id., #)*
ii. *It will have an elevation of "1,099 feet above mean sea level.". (Id., 5)*
iii. "If seasonal high groundwater elevation is determined to be higher than 950 feet above sea level the maximum elevation of the landfill … may be increased". (*Id., 5*)
iv. "The bottom liner of the landfill will be installed at a minimum of 15 feet above …high groundwater elevation". (*Id., 5)*
v. "The Upland Disposal Facility shall have a maximum design of 1.3 million cubic yards" [AKA 1.3 million tons of mud and soil since one cubic yard of soil weights approximately one ton.] (*Id. 5).*
vi. "The 2020 remedy involves an estimated 47,000 truck trips of excavated materials to the UDF. " (*Id. 2*)
vii. "The cleanup is estimated to take 13 years, so there will be approximately 3,800 tuck trips per year. … the above numbers of truck trips do not count trips for importing clean material for capping, backfilling, or the construction of the UDF. They also do not account for return trips to the River after disposal at the UDF or trips taken by trucks to the River for disposal off-site." (*Id. 2, 3*).
viii. "The primary finding of the Desimone Report confirms what is already known and documented: … there are permeable soils underlying the UDF location. " (*Id. 2*).
ix. "The Notice also cites EPA guidance for the proposition that the liner system will eventually leak. 53 Federal Register 33345 (August 30,1988.) This guidance, however, does not recommend against properly designed and monitored landfills with low-permeable cover, double bottom liner, and leachate collection, such as the proposed UDF. The guidance actually recommends double bottom liners and groundwater monitoring longer than 30 years, which is what the permit requires." (*Id. 4).*
x. "Furthermore, the surface drainage from the UDF is generally away from the water supplies and towards the River. …**Thus, in sum, groundwater and surface water near the UDF flows towards the River** and away from the Town of Lee's water reservoirs." (Id. 4. Emphasis here only.).
xi. "The total mass of PCBs to be removed from the River is 50,500 pounds of PCBs*.(Id. 2).*

110. Ed Bates of GE has estimated that GE dumped 1,5 million pounds of PCBs into the River between 18930 and 1979. (*supra ¶ 69*). EPA's estimated in a 2020 publication that the River contains 600,000 pounds of PCBs.(*DJ-24)*. EPA in letter to counsel in 2022 estimates that GE will remove 50.5 tons (AKA 101,000 pounds) of PCBs from the River under the CERCLA Order, thus the poundage of PCBs that will be left on the

River after GE satisfies the requirements rages from 500,000 to 1.3 million pounds which are damaging to Lee and its residents

111. Regardless whether PCBs in the River amount to 1.5 million or 600,000 pounds the poundage to be removed from the River is merely 100,100 pounds.(*DJ-15 p. 2*).

112. Monsanto as per Monsanto as per Supra ¶s 21 to 111 will remain liable to the Town of Lee for the PCBs left in the River before and after the PCB dump is constructed for the damages that exists now, the damages that will remain after the CERCLA Order is compiled by GE, and the damages the dump will generate to Lee and its residents for years to come. (*See DJ-18 ballot Question, DJ-DJ-19 Decision of the Board of Health of Lee, DJ-21 Monsanto cancer compilation of is employees from 149 to 1970 and DJ-23 Letter from Lee to public officials.*

113. The dump was question 1 on the 2022 town election ballot. The residents rejected the UDF with a 665 Yes, 390 No, 47 Blanks. The ballot question read: "Shall the town require the elect board to rescind the town of Lee's approval of the rest of River Agreement". (*DJ-18 Communication Town of Lee to Counsel*). Given the CERCLA Order of 2022 the Town could not comply with the wishes of the majority of Town's residents.

114. The Board of Health of Lee found after an adjudicatory hearing that "By taking these concerns into consideration, The Lee Board of Health thereby considers that the proposed UDF may pose an increased risk to the health of the residents of Lee.(*DJ-19 Decision of the Board of Health of Lee in the matter of the PCB dump*).

115. Monsanto kept track of 608 cancer deaths of its PCB exposed employees between 1949 and the 1970s. This remarkable tabulation is ample proof that Monsanto had concerns of cancers caused by PCBs exposure. (DJ-21)

116. EPA concluded that leaving PCBs in the River or removing 285, 000 cubic yards (AKA tons) of sediments from Woods Pond and 60,000 cubic yards (AKA tons) in the River impoundments and moving them to Lee merely "**decreased risks to the health of Lee's residents".** In contrast it implied by its analysis that moving the PCBs to Lee eliminated the risks of health to the very wealthy residents of Lenox, Stockbridge, Great Barrington and Sheffield. *(Letter EPA to Counsel November 8, 2022 DJ-15).*

V. THE SETTLEMENT AGREEMENT NOT TO CHALLENGE THE CERCLA ORDER AND THE CONTRACT BETWEEN MONSANTO AND GENERAL ELECTRIC

117. EPA, GE, the City of Pittsfield and the towns of Lee, Lenox, Stockbridge, Great Barrington, Sheffield, the Audubon Society and others entered into an agreement **not to appeal** the CERCLA Order issued by EPA in 2022 in exchange for 62 million dollars to be paid by GE to the participants. (*DJ-16, DJ-17).*

118. There is nothing in the plain reading of Settlement Agreement that prevents Lee from filing this lawsuit for damages against GE and Monsanto for the damages these corporations have inflicted on the Town of Lee and its residents.

119. The afore mentioned Agreement was appealed by citizens groups to the District Court and eventually to the First Circuit Court of Appeals.

120. The Court of Appeals upheld the CERCLA Order. (*Housatonic River Initiative v. United States EPA, 75 F.4th 248; 2023 U.S. App. Lexis 18977 July 25, 2023).*

121. This action does not, cannot, and will not, interfere with the CERCLA Order or the Settlement Agreement.

122. The Town of Lee and its residents have suffered and will continue to suffer damages from the contamination of the River and its consequences including the massive PCB dump to be built in Lee to house the dredged PCB mud.

123. The compensatory and punitive damages Lee is seeking from Monsanto and GE are a consequence of the intentional tort committed by GE and Monsanto as per GE-Monsanto Contract of January 31, 1972.

124. Monsanto knew that PCBs were **toxic to humans and the environment** and communicated this fact to GE under the terms of the contract executed between GE and Monsanto *(DJ-20)*:

> *Buyer [GE] acknowledges that it is aware and has been advised by Monsanto that **PCB's tend to persist in the environment**; that care is required in handling, possession, use and disposition; that tolerance limits have been or are being established for PCBs in various food products.*
>
> *Monsanto has therefore adopted certain restrictive policies with respect to its further production, sale and delivery of PCB's (sic) including the receipt of undertakings from its customers as set forth below, and Buyer is willing to agree to such undertakings with respect to sale and/or deliveries of PCB's (sic) by Monsanto to Buyer.*
>
> *Accordingly Buyer thereby covenants and agrees that, with respect to any and all PCB's (sic) sold or delivered by or on behalf of Monsanto to*

Buyer after the date hereof and in consideration of any such sale or delivery, Buyer shall defend, indemnify and hold harmless Monsanto, its present, past and future directors, officers, employees and agents from and against all liabilities, claims, damages, penalties, actions, suits, losses, costs and expenses arising out of or in connection with the receipt, purchase, possession, handling, use, sale or disposition of such PCB's (sic) by, through or under Buyer, whether alone or in combination with other substances, including, ***without implied limitation, any contamination of or adverse effect on humans, marine and wildlife, food, animal feed or the environment by reason of such PCB's (sic).*** *(DJ-20 Emphasis here only).*

125. Monsanto sold PCBs under the terms of this contract and GE continued to profit from the use of PCBs knowing that PCBs were toxic to humans and the environment. Both companies carried this behavior without justification other than making money.

126. It was less expensive to GE to pay damage claims filed by humans and for themselves and their environment than to profit from the sale and use of PCBs.

127. Monsanto might have overreached, however, as evident from claims of fraud made by a customer, in identical position as GE, for Monsanto's lack of total disclosure under the terms of the afore mentioned contracts between Monsanto and Buyers. *(See Magnetek, Inc., v. Monsanto, Pharmacia and Solutia Superior Court of New Jersey Docket No.:BER -LE Complaint and Jury Demand. See also DJ-22 November 10, 2023 Letter of Counsel to GE.)*

128. The Town and its residents have suffered and will continue to suffer damages from their inability to use the Housatonic Rive as specified by EPA. (*DJ-24, DJ-3 pages 18 et seq*.)

129. The Town and its resident will suffer damages after GE complies with the 2020 CERCLA Order since the River bottom will be covered by a tarp

which GE will continue to monitor for leaks for 20 years after the 13 years of dredging have been completed.

130. The Town and its residents will suffer damages because in the forthcoming 13 years two billion pounds of PCB contaminated muds and soil will be dredged from the River by GE, transported in eighty-thousand-pound truck loads through the streets of Lee, and deposited within the confines of the Town of Lee in a dump projected to be 150 feet in height with a 20-acre base.

131. The presence of this massive PCB dump in Lee will cause severe damages to the Town and its residents for years to come. Lenox, Great Barrington, Sheffield and Stockbridge with their wealth would have litigated at infinitum any attempt by GE to locate this massive dump within their towns' boundaries. Lee the poorest town in the Berkshires could never have afforded such continuing litigation thus GE picked Lee as a place to dump the dredged mud.

132. The Town of Lee is seeking, as *parens patriae* on behalf of its residents, compensatory and punitive damages from Defendants.

VII. PRAYER FOR RELIEF

133. Plaintiff incorporates by reference paragraphs 1-132 of this Compliant as if fully stated here.

134. The Contract between Monsanto and GE (DJ-20 admits in writing the intentional unjustified infliction of harm to humans and the

environment Monsanto and GE have caused to the Town of Lee and its residents.

135. The contract between General Electric and Monsanto DJ-20 was executed by General Electric's Vice President and General Counsel and by Monsanto's Vice President thus it was a criminal corporate action that has caused damages to the Town of Lee and its residents.

136. The Town of Lee on behalf of itself and on behalf of the residents of Lee seeks compensatory damages to in an amount to be proven at trial plus all applicable and available prejudgment interest and post judgment interest.

137. The Town of Lee on behalf of itself and on behalf of the residents of Lee seek punitive damages in an amount to be proven at trial, plus all applicable and available prejudgment interest and post judgment interest.

138. The Town of Lee on behalf of itself and the residents of Lee seek attorney's fees and expenses.

139. Town of Lee on behalf of itself and of behalf of the residents of Lee seeks costs of suit.

JURY TRIAL IS DEMANDED

Respectfully submitted by
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DJ-1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1

Date: February 29, 2016

From: Bryan Olson, Director, Office of Site Remediation and Restoration

To: Carl Dierker, Regional Counsel

Subj: GE-Housatonic Dispute Resolution – EPA Statement of Position

Pursuant to the Consent Decree governing investigation and response at the GE-Pittsfield/Housatonic River Site, EPA notified General Electric Company ("GE"), the Settling Defendant in September of EPA's Intended Final Decision for the Rest of River response action. Per the Decree, Paragraph 22.o, GE invoked dispute resolution on that notification.

That dispute is currently in the formal dispute resolution stage under the Decree, and, on January 19, 2016, GE submitted its Statement of Position on the dispute. Attached is EPA's Statement of Position for your consideration. Under the Decree, GE now has an opportunity to file a Reply by March 15, 2016. Following those submittals, an EPA decision-maker is to resolve the dispute. Per his memorandum dated January 21, 2016, Regional Administrator Curt Spalding has designated you, per Paragraph 136.b. of the Decree, to issue a final administrative decision resolving the dispute in accordance with the procedures in the Decree. This administrative decision is not subject to further appeal under the Decree. CD ¶ 141(b)(i).

EPA has used its scientific and technical expertise to thoroughly consider GE's technical positions at multiple points in the Rest of River decision-making process. Moreover, EPA has subjected its own analyses to further scrutiny, including review by experienced EPA scientists and engineers nationally, and independent scientific peer review. Furthermore, EPA has afforded GE and the public with an extraordinary degree of participation and input on the Rest of River cleanup decision. Based on that substantive expertise and multiple process opportunities, EPA proposed a remedy that is best suited for the Rest of River.

GE challenges EPA's Intended Final Decision for one reason – to reduce its costs in cleaning up its PCBs. GE attempts to justify its challenge with three main claims: (1) GE allegedly knows better than EPA how to select a remedy in the public interest; (2) GE is allegedly entitled to virtually total certainty and finality in the cleanup, with uncertainties and additional costs all to be borne by the public; (3) EPA allegedly misinterpreted the Decree in requiring restoration of natural resources; and (4) EPA inappropriately applies ARARs. None of these claims are justified and should be rejected. EPA's decision thoroughly considered GE's and others' viewpoints, and fairly balances all the relevant factors under the Decree to produce a remedy that protects the overall public interest, not just GE's bottom line.

In short, our Statement of Position demonstrates that, contrary to GE's assertions, EPA correctly interpreted the Consent Decree, followed the appropriate process for selecting a remedy and made the right decision based on the relevant factors. Indeed, while GE objects that the remedy is too expensive, many others have commented that the remedy should go farther in removing contaminated PCB material even if it costs more to do so. At the end of the day, EPA has selected a remedy somewhere in the middle that is implementable and that provides GE with a level of certainty supported by the Consent Decree, RCRA, and CERCLA, without subjecting the public to unnecessary risks or costs. It should be clear that EPA – not GE – is in the best position to judge the appropriate level of analysis for selecting a remedy for the Rest of River that is in the public interest and protective of human health and the environment. The remedy outlined in our Intended Final Decision should be upheld so that we may move forward with this important decision to address the PCB contamination in the Housatonic River and floodplain. Now is the time for GE to step up and honor its commitment to proceed with this important cleanup.

We look forward to your decision on this dispute. Please contact me if you have further questions in this regard.

cc: (by email)
Susan Peterson, CT DEEP
Betsey Wingfield, CT DEEP
Betsy Harper, MA AG
Mike Gorski, MA DEP
Martin Suuberg, MA DEP
Ann Klee, GE
Tom Hill, GE
Mayor Linda Tyer, City of Pittsfield
Corydon Thurston, PEDA
Addie Fiske, DOJ
Dean Tagliaferro, EPA
Bob Cianciarulo, EPA
Tim Conway, EPA

STATEMENT OF POSITION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY

IN SUPPORT OF INTENDED FINAL DECISION ON THE MODIFICATION TO THE REISSUED RCRA PERMIT AND SELECTION OF CERCLA RESPONSE ACTION

REST OF RIVER REMEDY, GE-PITTSFIELD/HOUSATONIC RIVER SITE

February 29, 2016

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EXECUTIVE SUMMARY OF THE ARGUMENT

The United States Environmental Protection Agency ("EPA") is charged with enforcing federal environmental laws to protect human health and the environment. Under this authority, EPA seeks to hold General Electric Company ("GE") accountable for contaminating over a hundred miles of the Housatonic River system (an area referred to as "Rest of River") with toxic polychlorinated biphenyls ("PCBs"). From 1998 to 2000, the United States, the Commonwealth of Massachusetts, the State of Connecticut, and GE negotiated a Consent Decree ("the Decree" or "CD") requiring GE to clean up its contamination. The Decree was approved by a federal court on October 27, 2000. GE committed to clean-up the Rest of River based upon the remedy selected by EPA through the process outlined in the Decree.

EPA has followed this exhaustive remedy selection process, which has included over a decade of expert information-gathering and technical analysis, to make its Intended Final Decision for the Rest of River remedy. EPA reached its Intended Final Decision based upon an analysis of the relevant criteria in the Decree and information in the Administrative Record. The remedy EPA selected includes a combination of excavation and capping of PCB-contaminated material, and disposal of that material at a suitable off-site landfill. In balancing the relevant factors under the Decree, the Intended Final Decision represents the best alternative to protect human health and the environment for the Housatonic River. GE now challenges EPA's Intended Final Decision for one reason – to reduce its costs in cleaning up its PCBs.

GE attempts to justify its challenge with three main claims: (1) GE knows better than EPA how to select a remedy in the public interest; (2) GE is entitled to virtually total certainty and finality in the cleanup, with uncertainties and additional costs all to be borne by the public; (3) EPA misinterpreted the Decree in requiring restoration of natural resources; and (4) EPA inappropriately applies the statutorily required applicable or relevant and appropriate environmental requirements (ARARs). None of these allegations are justified and should be rejected. EPA's decision thoroughly considered GE's and others' viewpoints, and fairly balances all the relevant factors under the Decree to produce a remedy that protects the overall public interest, not just GE's bottom line.

a. EPA Followed the Consent Decree Process for Selecting a Remedy and made the Right Decision When Selecting the Remedy Based on the Relevant Factors

GE incorrectly contends that it knows better than EPA how to select an appropriate remedy for the Housatonic River to protect human health and the environment. This contention contradicts well-established principles of administrative law affording deference to environmental agencies based upon agency expertise in selecting corrective measures to benefit the public. Indeed, the Decree provides that EPA's Final Permit decision may only be overturned if it is arbitrary, capricious or otherwise not in accordance with the law. Here, EPA followed the process set forth in the Decree to reach the Intended Final Decision. Consistent with CERCLA and RCRA, this process included over a decade of gathering and analyzing information from: (1) independent third party scientists, including peer review of EPA's risk assessments and EPA's computer modeling work related to fate, transport and bioaccumulation of PCBs in the River; (2) citizens, neighborhood groups, non-governmental organizations, local government officials, and local businesses, including multiple opportunities for comment, public meetings, public workshops and a public hearing; (3) GE, including its submission of a Corrective Measures Study ("CMS") and a Revised CMS of remedy alternatives, its comments at every decision point, and its technical discussions with EPA during a more-than-one-year period; and (4) state environmental agencies, including multiple opportunities for comment and feedback at every decision point, and its technical discussions over many months regarding EPA's remedy proposal.

All this information was included in the Administrative Record and was considered and evaluated by EPA before reaching its Intended Final Decision. EPA weighed all the relevant information under the governing process set forth in the Decree, considering the nine criteria and all the relevant information in the Administrative Record, and reached its Intended Final Decision with significant input from the state environmental agencies. Therefore, the Intended Final Decision is a quintessential Agency decision entitled to deference under principles of administrative law. Moreover, the Intended Final Decision is the best suited alternative -- and is in the middle of the range of alternatives in terms of costs and intrusiveness - to address contamination in the River considering the multiple complexities and factors presented in the Administrative Record.

Two examples illustrate that GE is not in a better position than EPA to evaluate the remedy selection criteria and other relevant information in the Administrative Record to select a remedy: namely EPA's selection of off-site disposal for contaminated soils and sediments and the remedy for Woods Pond. GE objects because off-site disposal is more expensive than on-site disposal. However, EPA evaluated all disposal alternatives, including more expensive potential treatment technologies, which EPA rejected. Nonetheless, GE failed to establish that any of its proposed on-site disposal locations, although cheaper, would be equally suitable compared to established off-site landfills. For example, the Decree specifically provides that one of the selection decision factors for EPA's selection of a remedy is "implementability," which includes, among other things, coordination with other agencies, availability of suitable landfills, and consideration of regulatory and zoning restrictions. GE claims that the outpouring of public and governmental opposition to on-site disposal is irrelevant to EPA's decision making under the Decree. GE is mistaken because of these implementability concerns. On-site disposal is opposed by many local residents and community advocacy groups, every Berkshire County city or town along the Housatonic, and at least seven state offices within Massachusetts. Community members have already petitioned the Commonwealth successfully to designate the area as an ACEC, affording the area heightened protection under the law, including prohibitions on siting landfills. Several community advocacy groups have used legal action to oppose EPA's work at the Consent Decree site directly. EPA's experience at other cleanup sites supports the concern that coordinated opposition to on-site disposal at the Housatonic will unduly delay implementation and completion of the remedy. The Decree also directly refutes GE's claim that EPA's decision making process should have ignored local and state opinions. The Decree requires public comment on many aspects of EPA's remedy selection process and that these comments be part of the Administrative Record supporting EPA's Intended Final Decision. The Decree explicitly authorizes EPA to consider all "relevant information in the Administrative Record," including public comments. Public participation would be meaningless if EPA could not consider public comments when selecting a remedy.

Further contributing to the implementability difficulties associated with on-site disposal, GE seeks to permanently locate a PCB landfill along the River in an area with no known contamination, where such location, by GE's own admission, would require waiving permanently numerous environmental laws and regulations designed to protect the environment and natural resources, such as wetlands, floodplains, and a State-designated Area of Critical Environmental Concern ("ACEC"). GE's quest to permanently site a PCB landfill along the Housatonic cannot be justified because a practicable alternative – namely off-site disposal – already exists. While CERCLA and the Decree allow environmental requirements to be waived in certain prescribed situations, waiver for the sole purpose of saving costs for a responsible party is not such a situation.

Accordingly, EPA's approach balances the relevant criteria, including protectiveness, cost, short-term impacts and implementability, and concludes that compared to on-site disposal, off-site disposal is more likely to be promptly, properly and safely implemented, and is therefore more suitable, outweighing the higher costs. Indeed, at many other similar sites, EPA has also chosen off-site disposal. Nonetheless, GE seeks to construct a new PCB landfill in a potentially unsuitable location. This would save GE money, but would shift the burden and risks of PCB contamination onto the Berkshires.

Similarly, to save money, GE objects to the removal of over 285,000 cubic yards ("CY") of PCB contaminated sediment from Woods Pond. Instead of removing this material and permanently eliminating the risk of transport to downstream receptors in the event of Woods Pond dam breach or failure, GE seeks to shift the burden and risk onto the public through a shallower removal of the PCB contaminated material followed by capping. GE focuses entirely on the cost of properly remediating Woods Pond and ignores the benefits of source control. The mass of PCBs in Woods Pond at issue here represents approximately 25% of total PCB contamination in sediment in the entire River, in an area that does not provide priority habitat for any state-listed species, and that is amenable to traditional open water dredging technologies. There is no other area on the River where it is possible to remove over 285,000 CY of PCB contaminated material from a single location with fewer negative impacts to habitat. Based on the Administrative Record and the relevant factors under the Decree, EPA reached the proper conclusion that the benefits of permanently remediating Woods Pond by removing a significant mass of PCBs simply outweigh the additional cost.

b. EPA Selected a Remedy that Provides a Level of Certainty Supported by the Consent Decree, RCRA and CERCLA

GE also demands a level of certainty, detail, and finality regarding the ultimate *implementation* of the remedy that is unreasonable and is inconsistent with the Consent Decree. GE demands virtual certainty regarding its future obligations in cleaning up its contamination throughout a complex river system spanning over a hundred miles of river and floodplains, and in so demanding, seeks to shift uncertainty or risk related to the cleanup of its own contamination onto the public. However, nothing in the Decree, law, regulation, or EPA policy or guidance requires EPA to cabin GE's future risk at the expense of the environment or public interest.

c. EPA Correctly Interprets the Consent Decree and GE Cannot Shirk its Liabilities

GE also argues that EPA incorrectly interpreted the Decree and Permit by requiring GE to restore natural resources damaged during implementation of the cleanup. Yet GE's covenant not to sue for future liability for natural resource damages is not effective under the Decree until after GE has implemented the remedial action required by EPA's Intended Final Decision, including compliance with federal and state regulations that require restoration of certain natural resources. Clearly, the United States would not agree to a settlement that included the selection of a remedy for a complex hundred mile river system without requiring any natural resources that were damaged by the clean up to be restored. Such a hypothetical agreement would cost GE less but violates EPA practice, and the terms of the Decree.

d. EPA Correctly Designated ARARs and ARAR Waivers

CERCLA, the Decree and the Permit require the remedy to comply with all applicable or relevant and appropriate environmental requirements ("ARARs"), unless a reason for a waiver exists. Consistent with its efforts to minimize cleanup and costs, GE seeks to avoid its obligations regarding ARARs.

Overall, a remedy must be protective of human health and the environment. Because of GE's focus on its costs, GE cannot neutrally evaluate the merits of the multiple and complex factors under the Decree that shape and determine the selection of a remedy. Under sound principles of administrative law, EPA is best positioned to make such decisions and has done so here to protect health and the environment.

I. BACKGROUND

This Statement of Position responds to GE's arguments set forth in its January 19, 2016 Statement of Position for this dispute over EPA's proposed cleanup. The following background provides supporting background. This dispute is not subject to further review following the decision this dispute.

A. Consent Decree and RCRA Permit

The current dispute has arisen under the October 27, 2000 Consent Decree ("the Decree" or "CD"), entered into by the United States (through the U.S. Environmental Protection Agency or "EPA"), the State of Connecticut, and the Commonwealth of Massachusetts as Plaintiffs, and General Electric Company ("GE") as Defendant.[1] The Decree provides for investigation and cleanup of polychlorinated biphenyls ("PCBs")[2] that were released into the environment from GE's former facility in Pittsfield, Massachusetts and migrated to areas of the GE-Pittsfield/Housatonic River Site (see Site History and Background in Section I.C below). Amongst the jurisdictional bases for the Decree are the Resource

[1] The City of Pittsfield, Massachusetts, and the Pittsfield Economic Development Authority are also parties to the Decree, but not as Plaintiffs or Defendants.

[2] PCBs are classified as a known human carcinogen, a known carcinogen in animals, and have been linked to a number of other adverse health effects. See discussion below in Section III.B.2.a.

Conservation and Recovery Act ("RCRA") and the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"). CD ¶ 1.[3]

The Decree*, inter alia*, requires GE to complete response actions at over twenty-five separate areas contaminated by GE's PCBs, CD §§ VI-IX, to reimburse the Plaintiffs for their costs incurred in responding to the PCB threats CD § XX, and to provide compensation and perform activities to address natural resource damages. CD § XXI. The Decree also provides GE with covenants not to sue by the Plaintiffs, and recognizes the protection for GE from contribution actions based on GE's commitment to perform the cleanups. CD §§ XXVI (Covenants by Plaintiffs) and XXIX (Contribution Protection). The subject of this dispute is the "Rest of River" area, which is described below.

EPA and GE agreed that the Decree and the RCRA Corrective Action Permit, Appendix G to the Decree, would govern the Rest of River investigation, corrective measures alternatives analysis and remedy selection process. CD ¶ 22.[4] EPA and GE also agreed that, following remedy selection and any challenges to that selected remedy, GE is obligated to perform the selected Rest of River Remedial Action and operation and maintenance, pursuant to CERCLA and the Decree. CD ¶ 22.p.

B. Site History and Background

GE used PCBs at its 254-acre facility in Pittsfield, Massachusetts from 1932 to 1977. During this time, the Transformer Division manufactured and repaired transformers containing dielectric fluids, some of which included PCBs. PCBs and other hazardous substances were released to soil, groundwater, Silver Lake, the Housatonic River and were disposed of within and around the facility in landfills, former river oxbows, and other locations. The Decree for the GE-Pittsfield/Housatonic River Site ("the Site") was approved by the federal court in October 2000. The Decree segregated the Site into 28 separate cleanups. Twenty-seven of the Site cleanups (20 Removal Actions Outside the River, 5 Groundwater Management Areas, the Upper-½ Mile Reach of the Housatonic River, and the 1½-Mile Reach of the Housatonic River), are CERCLA removal actions. The remaining cleanup area in the Site is Rest of River, which is the subject of this dispute.

Rest of River includes approximately 125 miles of river in Massachusetts and Connecticut and the associated floodplain. Reaches 5 through 8 flow through the City of Pittsfield and the towns of Lenox, Lee, Stockbridge, and Great Barrington, Massachusetts. There are also approximately 100 acres of backwaters adjacent to Reaches 5 and 6. In addition, there are six dams with impoundments behind them in Reaches 5 through 8. The first dam is Woods Pond, also referred to as Reach 6, and is owned by GE. There are four privately owned dams in Reach 7, and GE owns Rising Pond Dam, which is also referred to as Reach 8. Reach 9 flows through Sheffield, Massachusetts. Reaches 10 through 16 are in Connecticut, from Canaan downstream to Derby. See Figures 1 and 2.

C. Statutory and Regulatory Background

[3] *Citing* CERCLA, 42 U.S.C. §§ 9606, 9607, 9613(b); RCRA – 42 U.S.C. §§ 6928, 6973.

[4] The RCRA Permit is incorporated into the Decree as Appendix G to the Decree. *See* Paragraph 212 of the Decree ("[t]he following appendices are attached to and incorporated into this Consent Decree… "Appendix G" is the Draft Reissued RCRA Permit.")

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"),[5] in response to the serious environmental and health risks posed by industrial pollution.[6] CERCLA was designed to promote the "'timely cleanup of hazardous waste sites'" and to ensure that the costs of such cleanup efforts were borne by those responsible for the contamination. *Consolidated Edison Co. of N. Y. v. UGI Util., Inc.*, 423 F.3d 90, 94 (2d Cir. 2005); *see also Meghrig v. KFC Western, Inc.*, 516 U. S. 479, 483 (1996); *Dedham Water Co. v. Cumberland Farms Dairy, Inc.*, 805 F. 2d 1074, 1081 (1st Cir. 1986), as stated in *Burlington Northern and Santa Fe Railway Company, et al., Petitioners v. United States et al.*, 556 U.S. 599 (2009). CERCLA is to be implemented by EPA.[7] CERCLA is essentially a remedial statute designed by Congress to protect and preserve public health and the environment.[8]

Enacted in 1976, the Resource Conservation and Recovery Act ("RCRA") empowers EPA "to regulate hazardous wastes from cradle to grave…"[9] *City of Chicago v. EDF*, 511 U.S. 328, 331 (1994). As part of RCRA, Congress established a permitting program for facilities that treat, store or dispose of hazardous waste and directed EPA to implement the program.[10] The 1984 Hazardous and Solid Waste Act amendments to RCRA added Section 3004(u) and (v) to RCRA, providing that any person seeking a RCRA permit must perform any "corrective action" necessary to clean up releases of hazardous wastes or hazardous constituents from any solid waste management unit at the facility.

D. Rest of River Process

As described in more detail below in Section III.A.1, the Decree established an extensive, thorough process for selecting a cleanup for Rest of River. This process that spanned over a decade included extraordinary efforts to solicit and respond to the views of the public, including GE. For more details on the specific public involvement steps, see Attachment A, Timeline for Opportunities for GE and the Public to Comment during Rest of River Process. Steps included EPA's computer river modeling, Human Health Risk Assessment and Ecological Assessment, and five independent peer reviews of the modeling and risk assessments. Also included were GE's analysis of the nature and extent of Rest of River contamination (RCRA Facility Investigation), its identification of preliminary cleanup standards (Interim Media Protection Goals), and, in 2008 and 2010, two versions of a Corrective Measures Study to analyze different alternatives for addressing GE's PCB contamination.

Based on that work and other information in the Administrative Record, EPA in 2011 presented a potential remedy for review by two national EPA advisory review boards. Following that review, and prior to soliciting public comment on a proposal, EPA entered into technical discussions with the States of Massachusetts and Connecticut (collectively the

[5] 94 Stat. 2767, as amended, 42 U. S. C. §§ 9601–9675.
[6] *See United States v. Bestfoods*, 524 U. S. 51, 55 (1998).
[7] 42 U.S.C. § 9621.
[8] "We are therefore obligated to construe its provisions liberally to avoid frustration of beneficial legislative purposes." *Dedham Water Co*., at 1081.
[9] *City of Chicago v. EDF*, 511 U.S. 328, 331 (1994).
[10] 42 U.S.C. § 6925

"States"). The EPA/States' discussions yielded, in May 2012, a Status Report of potential remediation approaches for Rest of River.[11] Following issuance of the Status Report, at GE's request, EPA and GE entered into over a year of remedy discussions, concluding those discussions in December 2013.

Based on that exhaustive set of information gathering, alternatives analysis and technical discussions, EPA, in May 2014, proposed a Rest of River remedy for public comment as set forth in the Draft Modification to the RCRA Permit.[12] The rationale for the Draft Permit is documented in EPA's Comparative Analysis of Remedial Alternatives ("Comparative Analysis") and the Statement of Basis for EPA's Proposed Remedial Action for the Housatonic River "Rest of River" ("Statement of Basis"). [13]

EPA evaluated a wide range of alternatives to address the unacceptable risks posed by GE's PCB contamination. The Permit describes nine criteria for consideration: three overarching "General Standards," including: (1) Overall Protection of Human Health and the Environment; (2) Control of Sources of Releases; and (3) Compliance with ARARs,[14] and six additional "Selection Decision Factors," including: (1) Long-Term Reliability and Effectiveness; (2) Attainment of Interim Media Protection Goals;[15] (3) Reduction of Toxicity, Mobility, or Volume of Wastes; (4) Short-Term Effectiveness; (5) Implementability; and (6) Cost. Permit II. G. EPA evaluated all the corrective action alternatives against these criteria, and any other relevant information in the Administrative Record. These factors are often referred to in short-hand as the "nine criteria" or the "nine criteria analysis."

E. EPA's Intended Final Decision

Following consideration of the public comments received on the Draft Permit Modification, further consultation with Massachusetts and Connecticut, and based on the same evaluation criteria as discussed immediately above, EPA modified its proposed remedy. To address GE's concerns on the Draft Permit Modification, EPA made several modifications to the remedy, including changing the Vernal Pool cleanup requirements to potentially less costly and intrusive measures, and eliminating certain obligations for GE to make direct payments to third parties that remove PCBs from their properties. With those modifications, EPA, in

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[11] EPA Status Report entitled "Potential Remediation Approaches to the GE-Pittsfield-Housatonic River Site 'Rest of River' PCB Contamination" ("Status Report"), released May 2012.

[12] Permit Section II.J. provides as follows: Based on the information that [GE] submits pursuant to this Permit and any other relevant information in the Administrative Record for the modification of this Permit, EPA will propose Performance Standards, and the appropriate corrective measures necessary to meet the Performance Standards, to address PCBs and any other hazardous waste and/or hazardous constituents that have migrated from the GE Facility to the surface waters, sediments, and floodplain soils in the Rest of River area. Permit II J. at 25. The Decree provides that all comments received on the CMS "and other documents considered or relied on by EPA will become part of the Administrative Record for the Rest of the River Remedial Action." CD ¶ 22.m.

[13] The Draft Modification to the RCRA Permit and the Statement of Basis were issued to the public June 2014. EPA held a public hearing, and a public comment period until October 27, 2014. The Comparative Analysis of Remedial Alternatives is in the EPA Administrative Record for the Rest of River.

[14] ARARs are Applicable or Relevant and Appropriate state and federal Requirements, ARARs are discussed in detail below, including in Section III.A.7, Section III.C.2, and Section III.D.

[15] Interim Media Protection Goals, or "IMPGs", are media-specific protection goals to be used in the Corrective Measures Study as part of the evaluation of remedial alternatives.

September 2015, notified GE pursuant to Paragraph 22.o of the Decree of EPA's Intended Final Decision on the modification of the RCRA Permit.

EPA's evaluation has yielded a balanced, reasonable approach to addressing the unacceptable risks posed by GE's PCBs in Rest of River. After a thorough evaluation of the Permit criteria, EPA's proposed remedy is best suited to meet the General Standards for Corrective Measures in consideration of the Selection Decision Factors, including a balancing of those Factors against one another.

The proposed remedy includes specific activities to address PCB contamination in river sediment, banks and floodplain soil, and biota, to reduce downstream transport of PCBs, allow for greater consumption of fish, and avoid, minimize or mitigate impacts to sensitive areas, species and habitats. The proposed remedy relies on a combination of cleanup approaches, as generally described below:

-Removing PCB-contaminated sediment and capping residual contamination.

-Monitoring natural recovery of the river.

-Removing PCB-contaminated erodible river banks that are a source of PCBs that could be transported downstream, focusing on the use of bioengineering techniques in restoring any disturbed banks.

- Removing PCB-contaminated material from the floodplain soil and replacing with clean backfill.

- Treating sediment in certain Vernal Pools, Backwaters and Reach 5B with activated carbon or other suitable sediment amendment.

- Restoring areas disturbed by the remediation.

-Transporting and disposing of all excavated contaminated soil and sediment off-site at existing licensed facilities approved to receive such soil and sediment.

- Establishing Performance Standards for the downstream transport of PCBs and the concentration of PCBs in biota.

-Reinforcing restrictions on eating fish, waterfowl and other biota where needed, as well as restricting other activities that could potentially expose remaining contamination.

-Establishing procedures to address PCB contamination associated with future work, and mechanisms for additional response actions if land uses change.

-Maintaining remedy components and monitoring over the long-term to assess the effectiveness of the cleanup and the recovery of the river and floodplain.

-Conducting periodic reviews post-cleanup to assess effectiveness and adequacy of the cleanup.

F. Current Dispute Resolution

After receiving EPA's Intended Final Decision, GE, on October 29, 2015, invoked its right to administrative dispute resolution under the Decree on EPA's Intended Final Decision. CD ¶ 22.o. In the current dispute resolution, EPA, GE, Massachusetts and Connecticut participated in mediation as part of informal dispute resolution pursuant to Paragraph 134 of the Decree. Per a letter agreement dated December 9, 2015, the parties agreed to extend the informal dispute resolution until March 15, 2016, and to proceed at the same time with formal Dispute Resolution under Paragraph 135 of the Decree. Per the formal Dispute Resolution procedures, GE filed its Statement of Position (GE "SOP") on January 19, 2016. In response, EPA is hereby submitting EPA's Statement of Position. GE may file a Reply by March 15, 2016.

II. STANDARD OF REVIEW

This dispute, governed by Paragraphs 22.o, 136, and 141(b) of the Decree, concerns the proposed remedy for the Rest of River site, as described in EPA's Intended Final Decision on the modification of the Reissued RCRA Permit. The Decree vests EPA with the authority to select the Intended Final Decision. CD ¶ 22.o.[16] Paragraph 136 of the Decree sets forth procedures for "disputes pertaining to the selection or adequacy of any response action[17] and all other disputes that are accorded review on the administrative record under applicable principles of administrative law."[18]

The Permit explains that EPA shall reach its decision based upon information that GE submits to EPA and any other relevant information in the Administrative Record. In accordance with Paragraph 136.a, the Administrative Record for this dispute contains all statements of position, including supporting documentation.[19]

The decision-maker[20] is charged, under Paragraph 136.b of the Decree, with issuing "after reasonable opportunity for review and comment by the State, a final administrative

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[16] Paragraph 22.o provides "Following the close of the public comment period, EPA will notify [GE] of its intended final decision on the modification of the Reissued RCRA Permit."

[17] Paragraph 136 defines "adequacy of any response action" to include, without limitation: "(1) the adequacy or appropriateness of plans, procedures to implement plans, or any other items requiring approval by EPA under this Consent Decree; and (2) the adequacy of the performance of response actions taken pursuant to this Consent Decree."

[18] To the extent this dispute on the Intended Final Decision for the selection of the remedy for the Rest of River on the Administrative Record involves any embedded question of contract interpretation, any such embedded question may be governed by governing principles of contract law.

[19] The Administrative Record for Rest of River is available on-line at https://semspub.epa.gov/src/collections/01/AR/MAD002084093 and all publically available documents for the entire Site are available on-line at https://semspub.epa.gov/src/collection/01/SC31186.

[20] On January 21, 2016, Curt Spalding, Regional Administrator of EPA Region 1, designated Carl Dierker, Region 1 Regional Counsel, per Paragraph 136.b of the Decree, to issue a final administrative decision resolving the dispute, in accordance with the procedures in the Decree.

decision resolving the dispute based on the administrative record[.]" *Under the Decree, the decision on this dispute based on the Administrative Record is not entitled to judicial review*.[21]

Following the final administrative decision, pursuant to Paragraph 22.p of the Decree, the next formal process step is for EPA to issue a modification of the Reissued RCRA Permit ("Final Permit Modification"), including a response to public comments received. Upon EPA's issuance of the Final Permit Modification, GE and any person who filed comments on the draft permit or participated in a public hearing on the draft permit may seek review of the modification by the EPA Environmental Appeals Board (the "EAB" or the "Board"). Decree, ¶ 141.b(ii) of the Decree; 40 C.F.R. § 124.19. Before the Board, the petitioner would bear the burden of demonstrating that EPA's decision is based on: (1) a finding of fact or conclusion of law that is clearly erroneous; or (2) an exercise of discretion or an important policy consideration that the Board should, in its discretion, review. 40 C.F.R. § 124.19(a). This standard of review is "applied stringently in practice" and the Board will grant review infrequently. *In re Knauf Fiber Glass, GmbH*, 9 E.A.D. 1, 6–7 (EAB 2000). "[W]hen a petitioner seeks review of a permit based on issues that are fundamentally technical in nature, the Board assigns a particularly heavy burden to the petitioner." *In re Peabody Western Coal Company*, CAA Appeal No. 04-01, 12 E.A.D. 22, 32 (Feb. 18, 2005) (citations omitted).

If the Board grants review of one or more petitions, GE or "any interested person" may seek review of that decision in the United States Court of Appeals for the First Circuit. Decree, ¶ 141.b(iii); RCRA § 7006(b). The Court of Appeals "may only overturn Board's [decision] . . . if it was 'arbitrary, capricious, an abuse of discretion or otherwise not in accordance with law.'" *City of Pittsfield, Mass. v. U.S. E.P.A.*, 614 F.3d 7, 10 (1st Cir. 2010) (citing 5 U.S.C. § 706(2)(A); *Adams v. EPA*, 38 F.3d 43, 49 (1st Cir.1994)). Under this narrow scope of review, the Court would defer to EPA on statutory interpretations and scientific matters within EPA's expertise and would uphold the decision unless it lacked a rational basis. *Adams v. U.S. E.P.A.*, 38 F.3d 43, 49 (1st Cir. 1994). Questions of contract interpretation, however, are subject to plenary review by the Court. *Farmers Ins. Exch. v. RNK, Inc.*, 632 F.3d 777, 783 (1st Cir. 2011).

If either the Board or the Court of Appeals vacates or remands all or part of EPA's permit modification, EPA may revise its decision. Decree, ¶ 22.t. To the extent consistent with 40 C.F.R. § 124.19, GE and other persons may seek review of the revised permit first before the Board and then before the Court of Appeals. Decree, ¶ 141.b(iv).

III. <u>ARGUMENT</u>

GE disputes the decision that EPA reached after EPA faithfully followed the extensive processes outlined in the Decree, including years of information gathering and consideration of scientific and public input. EPA's remedy will remove PCB contaminated soil and sediment from the River, and floodplain and dispose of the material in a pre-existing off-site suitable landfill, without prior treatment of the material. EPA considered and rejected more costly alternatives, such as treating PCB contaminated material prior to removal, as well as less protective and less costly alternatives. In the end, EPA proposes a remedy that appropriately

[21] Paragraph 141(b)(i) provides that GE "shall not have the right to seek judicial review of the administrative decision on EPA's notification of its intended permit modification pursuant to this subparagraph."

balances all the relevant factors, including GE's financial concerns, with EPA's obligation to assure protection of public health and the environment in and around the Housatonic River.

By contrast, GE's dispute of EPA's Intended Final Decision is driven only by GE's motivation to reduce costs and risks to GE. While GE claims willingness to clean up the River using a less expensive solution, it writes even of its own proposal: "this conclusion is subject to GE's reservations of rights, including its appeal rights, and thus *does not constitute a proposal to implement these alternatives*."[22] GE's dispute should be rejected because : (1) EPA, with its objectivity and technical expertise, is better positioned to select a remedy under the Decree to be protective of human health and the environment; (2) GE unfairly seeks to shift the risks of uncertainty and unknown expenses to the public and is not entitled to the level of detail, certainty and finality it unreasonably demands; (3) GE's bias to save costs renders a distorted interpretation of the Decree; and (4) EPA complies with its statutory obligations to comply with ARARs. Each of GE's challenges to each component of the remedy is resolved by these four points. .

First, EPA, as the Agency guided by scientific and technical expertise, is better positioned than GE to weigh and evaluate the host of complex scientific information and other relevant criteria in the Administrative Record -- including cost and consideration of public comments submitted to EPA during the remedy selection process -- that lead to the selection a remedy for the Rest of River under the Decree that is the public interest. This fundamental principle of administrative law applies to GE's dispute for the following components of the Intended Final Decision: EPA's risk assessments; EPA's selection of a remedy for Woods and Rising Ponds, Reach 7 impoundments, and backwaters; EPA's decisions regarding engineered caps; and EPA's selection of off-site disposal.

Second, in an effort to reduce its own risks, and shift risk to the public, GE demands a degree of certainty and finality that is inconsistent with the Decree and unreasonable in the context of selecting a cleanup for over a hundred miles of River and hundreds of acres of floodplains. EPA has already reduced GE's exposure to certain future liabilities by capping certain categories of response costs for which GE is liable. The Decree does not provide for GE to shift the risk of future PCB cleanup expenses to the public.

GE's unreasonable demands to reduce future uncertainties is shown for the following components of the Intended Final Decision: the PCB Downstream Transport and Biota Performance Standards; certain future floodplain activities and uses; inspection and maintenance of certain dams; and additional response actions for future dam failure or breach.

Third, GE misconstrues the Decree. This point is shown in GE's arguments to eliminate the responsibility and cost of restoring natural resources impacted by remediation. Under GE's theory, GE would have no obligation to return the Rest of River to pre-remediation condition and could simply leave the river, floodplains and vernal pools as open trenches.

Finally, GE's interpretation of ARARs is incorrect. .For simplicity, each component of GE's argument is organized by the above issues. Many of the issues overlap or are

[22] GE Revised CMS at 28 (emphasis added).

intertwined, but for the sake of simplicity and organization, the components of the remedy disputed by GE are grouped and organized by these four issues.

A. EPA Followed the Consent Decree Process for Selecting a Remedy and Made the Right Decision When Selecting the Remedy Based on the Relevant Factors.

After years of exhaustive study, public comment, and independent peer review, EPA determined, based upon the Administrative Record, that the Intended Final Decision best satisfies the relevant Decree criteria. EPA is the Agency vested with expertise and authority to select a remedy that is in the public interest based upon the Administrative Record. As shown below, EPA followed the process set forth in the Decree and made a remedy selection consistent with the Decree, Administrative Record, CERCLA, RCRA, and the relevant EPA guidance documents. GE's argument turns on the contention that EPA—after following the process set forth in the Decree—evaluated all the facts and allegedly reached the wrong conclusion. And that is exactly the kind of decision making that is vested squarely within EPA's expertise and that courts are reluctant to overturn, especially where the decision is the result of years of consensus building efforts among EPA and state regulators.

The following describes in more detail the process undertaken by EPA pursuant to the Decree to reach its Intended Final Decision based on the Administrative Record.

1. EPA Followed the Decree Process for Selecting the Remedy

a. Process for Gathering Scientific Information and Analysis under the Decree.

The Decree establishes an exhaustive process for EPA to study, gather, and analyze scientific information regarding the River. This near-decade-long process began with EPA and GE conducting additional studies from 1998 to 2002. The results of these studies were summarized in GE's 2003 RCRA Facility Investigation ("RFI") Report. CD ¶ 22.a. At that time, EPA also completed its initial Human Health Risk Assessment ("HHRA"), pursuant to CD ¶ 22.b, followed by independent expert peer-review, CD ¶ 22.c, and a revised HHRA, was completed in 2005. In 2003, EPA also completed its initial Ecological Risk Assessment ("ERA"), pursuant to CD ¶ 22.b, followed by independent expert peer review, CD ¶ 22.d, and a revised ERA in 2004. Similarly, from 2001-2006, EPA developed computer modeling documents to study fate, transport, and bioaccumulation of PCBs in Reaches 5 through 8 of Rest of River, CD ¶ 22.g, and this computer modeling work was subject to three rounds of peer review by a panel of independent modeling experts.[23] CD ¶ 22.h. Throughout this process GE submitted comments to EPA which EPA considered, accepted, modified, or rejected. Many of these same comments are rehashed in this dispute.

In 2008, GE submitted its CMS evaluating the alternative measures to be implemented as a remedial action under CERCLA to clean up the River. *See* Permit II. E-G. Following comment on the CMS, GE submitted a Revised CMS in 2010. Under the Permit, the Revised CMS was required to consider the corrective measures alternatives based upon nine Permit criteria described above in Section

[23] Modeling Documents and Peer Review consisting of 3 peer reviews—Modeling Framework Design; Model Calibration; and Model Validation (all are for Watershed, Fate & Transport, and Food Chain Models)

In 2011, EPA presented a potential proposed remedy to EPA's National Remedy Review Board ("NRRB") and Contaminated Sediments Technical Advisory Group ("CSTAG").[24] EPA considered comments from the NRRB and CSTAG and responded to those comments in August 2012.[25]

All this information and analysis gathered over the years is contained in the Administrative Record for the Rest of River Remedial Action. CD ¶ 22.m. GE cannot dispute that EPA followed *the process* set forth in the Decree for gathering scientific information and analysis for the Administrative Record.

b. Process for Gathering Community Input under the Decree

The Decree also establishes an exhaustive process for EPA to gather information from the community. For over a decade EPA has made extraordinary efforts to involve the public and to solicit and respond to the views of GE, other stakeholders, and the other members of the public on the Rest of River. The community has been provided the opportunity to comment upon EPA's draft permit modification decision as well as upon the RFI Report, CMS, Revised CMS, HHRA, ERA, each of EPA's river modeling documents, and other similar documents. CD ¶ 22.m, n, o. These Comments are part of the Administrative Record for the River. In addition, the Citizens Coordinating Council ("CCC") and community relations are both formal components of the Decree requiring cooperation and participation, including from GE. CD ¶ 213. The CCC is made up of over 30 environmental, business and community leaders from Berkshire County and Connecticut. In particular, EPA has supported the CCC since its formation in 1998, as a meaningful opportunity for citizens to keep involved in the Site cleanups. In addition, in 2011, EPA held a series of workshops and a meeting known as a "charrette" to further engage the community in the remedy selection process.

Community members have successfully petitioned the Commonwealth to designate certain portions of the Housatonic River as part of an ACEC. This designation affords the area heightened protection under the law.

EPA's actions taken under the Decree have also been consistent with CERCLA's and RCRA's statutory provisions contemplating consideration of community input through the comment process as well as regulation and guidance documents recognizing community acceptance as a factor in the remedy selection process. CERCLA, 42 U.S.C. § 9617; RCRA, 42 U.S.C. §6974; National Contingency Plan, 40 C.F.R. § 300.430(f)(3); RCRA Regulations, 40 C.F.R. 256.63; *see also RCRA Public Participation Manual*, EPA, EPA 530-R-96-007 (1996), *A Guide to Selecting Superfund Remedial Actions*, EPA, OSWER 9355 0-27FS.

GE cannot contend that EPA acted inconsistently with the process set forth in the Decree for gathering community input for the Administrative Record.[26]

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[24] EPA presents potential proposed remedy to EPA's National Remedy Review Board (NRRB) and Contaminated Sediments Technical Advisory Group (CSTAG)—June 2011.
[25] EPA issues regional response to NRRB/CSTAG Comments—August 2012.
[26] GE argues about the substantive impact of EPA's information gathering from the community, including that EPA allegedly provided too much weight to community input. This issue is addressed below in more detail at Section III.A.7, but such claims are different from arguing that EPA violated the process set forth in the Consent Decree for gathering information from the community and maintaining this information in the Administrative Record.

c. Process for Collecting Public Comment from GE, and State Regulators

Following EPA's submission of the proposed permit modification to the NRRB and CSTAG, in August 2011, the States requested facilitated discussions with EPA regarding the proposed Remedy. EPA and the States then engaged in a series of scientific/technical discussions in an effort to build consensus about a remedy that would be protective of human health and the environment under the relevant Decree criteria based on the Administrative Record. In May, 2012, EPA released a Status Report representing a potential approach to the remedy that would not be objectionable to the States or EPA, subject to completion of the public comment process set forth in the Decree.

In September 2012, GE requested a series of technical discussions with EPA to determine whether GE and EPA might resolve any differences regarding an appropriate remedy for the Rest of River ("Technical Discussions"). These Technical Discussions concluded in December 2013 without complete resolution of the issues.

GE cannot dispute that the process of considering public comment from itself and the States is consistent with the Decree, and represents an extraordinary effort by EPA to hear all viewpoints prior to proposing a remedy.

d. EPA's Substantive Decision is Entitled to Deference

Because GE cannot object to the lengthy and thorough process that EPA followed under the Decree, GE may only object to the conclusions that EPA reached after this process. Yet, it is clear that EPA is vested with authority and discretion in evaluating the relevant factors set forth in the Decree for selecting a remedy.[27] Here EPA's analysis of the relevant factors and its decision on the Administrative Record is entitled to deference, is supported by the States, and is a sound resolution of the multiple and complex factors that shape remedy determination under the Decree.[28] EPA considered and rejected more intrusive, more costly alternatives as well as less protective and less costly alternatives, and proposes a remedy that holds the right balance in weighing all the relevant criteria under the Decree.

As discussed below, EPA's technical determinations are science-based and in accordance with the Decree and applicable agency guidance. While GE disagrees with many of EPA's determinations, GE has not shown and cannot show any compelling reason to set EPA's determinations aside.

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[27] As noted in RCRA guidance, the exact emphasis placed on these decision factors, and how they will be balanced by EPA in selecting the most appropriate remedy for a facility, will necessarily depend on the types of risks posed by the facility, and the professional judgment of the decision-makers. 55 Fed. Reg. 30798, 30825 (July 27, 1990).

[28] *Adams v. U.S. E.P.A.*, 38 F.3d 43, 49 (1st Cir. 1994)("An agency is entitled to deference with regard to factual questions involving scientific matters in its own area of expertise"); *see also SEC v. Chenery Corp.*, 318 U.S. 80, 94 (1943)("If the action rests upon an administrative determination—an exercise of judgment in an area which Congress has entrusted to the agency—of course it must not be set aside because the reviewing court might have made a different determination were it empowered to do so."); *SEC v. Chenery Corp*., 332 U.S. 194, 209 (1947) (holding agency decisions are "entitled the greatest amount of weight" when they are the product of administrative experience, appreciation of the complexities of the problem, realization of the statutory policies, and responsible treatment of the uncontested facts").

2. EPA Made the Right Substantive Decisions When Selecting the Remedy

a. Health Basis for Overall Remedy and Ecological Issues:

i. The Proposed Remedy Provides Long-term Protection of Human Health and the Environment

The proposed remedy is necessary to protect human health and the environment from PCB contamination released by GE's Pittsfield facility. Peer-reviewed risk assessments have concluded that PCBs and other contaminants of concern pose unacceptable risks to human health and the environment at in Rest of River. The remedy employs a variety of mitigation tools to remove PCBs and reduce the exposure risks, including excavating contaminated soils and sediments and isolating contaminated materials under engineered caps. In some areas, construction of the proposed remedy will have unavoidable short-term impacts, but the design of the remedy limits those impacts, particularly in habitats of sensitive species. The remedy also requires GE to restore all disturbed areas. Due in part to this restoration requirement, the long-term benefits of the remedy far outweigh the short-term impacts.

Contrary to GE's arguments, the Human Health Risk Assessment ("HHRA") and Ecological Risk Assessment ("ERA") show that the PCB contamination in the Housatonic River poses unacceptable risks to human health and the environment. EPA performed the HHRA and the ERA using the best available science and the risk assessment process outlined in 40 C.F.R. Part 300, which are the Superfund regulations called the National Contingency Plan ("the NCP")[29] and agency guidance. The development processes that EPA employed for the Rest of River HHRA and ERA were more comprehensive, detailed, and inclusive of public input than is typical for hazardous waste sites.

Unlike most CERCLA/RCRA sites, the Rest of River HHRA and ERA were reviewed by review panels comprised of independent risk assessment experts. CD ¶¶ 22.c, d. The panel members were selected not by EPA but by a selection contractor mutually agreed upon by GE and EPA. Before the peer reviewers commenced their panel discussion at each peer review, GE and members of the general public, including the States, were provided opportunities to submit written comments and make oral presentations to both peer review panels. CD Appendix J, Step 1 and Step 3. While critical of some specific aspects of the assessments, the peer reviewers' comments were generally supportive of both the HHRA and the ERA.[30]

GE had many opportunities to review and comment on the risk assessments as they were developed. Based on its comments on the Draft RCRA Permit Modification and its SOP, GE plainly disagrees with the conclusions of those risk assessments, and it continues to re-argue many of the same points that received independent scientific review over ten years ago.

ii. EPA's toxicity values for PCBs are supported by scientific consensus and were vetted through public comment and peer review

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[29] 40 C.F.R. § 300.430(d).

[30] Responsiveness Summary to the Peer Review of the HHRA, USEPA, March 2004, and Responsiveness Summary to the Peer Review of the ERA, USEPA, June 2004.

GE disputes EPA's toxicity values for PCBs used in the HHRA. The HHRA uses published toxicity values for each contaminant of concern. These toxicity values quantify the relationship between the average daily doses calculated in the exposure assessment and the potential cancer risks and non-cancer health effects. GE claims that these values substantially overstate the cancer and non-cancer human health risks of PCBs. While GE may disagree with the values selected, it has not shown any credible evidence that EPA abused its discretion in setting these values or that the values lack a rational basis.

In fact, the HHRA PCB toxicity values are based on sound, peer-reviewed scientific inquiry. The HHRA used toxicity values published in EPA databases and reports.[31] Specifically, the HHRA used, where possible, toxicity values published in EPA's Integrated Risk Information System ("IRIS"). These IRIS values have undergone extensive scientific peer review. For contaminants of concern for which toxicity values are not published in IRIS, provisional values were obtained from the Health Effects Assessment Summary Tables (HEAST).[32] EPA derived these IRIS and HEAST toxicity values in accordance with all applicable EPA guidance.[33]

EPA issued its initial HHRA in June 2003 and in July 2003 GE submitted comments to the peer review panel that, *inter alia*, argued that EPA's toxicity values were overly conservative.[34] The initial HHRA and the comments on the HHRA received from the public (including GE) were subjected to peer review by a panel of independent risk assessment experts. The peer review panel was specifically charged with evaluating the toxicity assessment.[35] While the peer reviewers generally agreed with the toxicity assessment in the initial HHRA,[36] EPA chose to exercise its option to revise and reissue the document to explicitly address comments from the peer reviewers.

The revised HHRA, issued in February 2005, included an expanded discussion of toxicity values,[37] and summarized additional toxicity studies.[38] The revised HHRA also summarized an exposure study of Housatonic River area residents and a study comparing cancer rates in the Housatonic River area with the rest of Massachusetts.[39] EPA solicited a second round of public comments on the new information provided in the revised HHRA. GE's April 2005 comments asserted that EPA should clarify its summary of the study comparing cancer rates and criticized EPA's approach for calculating certain toxicity values.[40] EPA responded to these comments in June 2005 but determined that no additional revisions were necessary.[41]

[31] Initial HHRA, Vol. I at 2-4.
[32] U.S. EPA, Health Effects Assessment Summary Tables, 1997.
[33] *See* Attachment A. Response to GE's Comments on Toxicity Values Used to Evaluate Human Health Risks
[34] Comments of GE on USEPA's HHRA for the Housatonic River Site, Rest of River, GE, July 28, 2003. Section 6.
[35] Charge for HHRA Peer Review for Rest of Housatonic River, USEPA, June 2003, Page 2.
[36] HHRA Responsiveness Summary.
[37] Changes / Additions to the HHRA Report, USEPA, February 2005, at 2,
[38] *Id.*
[39] Changes / Additions to the HHRA Report.
[40] GE Comments on EPA's revised HHRA (April 5, 2005),
[41] Responsiveness Summary to Public Comments on New Information for the HHRA, USEPA, June 1, 2005,

Notwithstanding the studies cited by GE,[42] the overall scientific consensus remains: PCBs can cause cancer and many other health impacts.[43] Notably, EPA has not re-assessed the IRIS toxicity factors for PCBs at any point since the HHRA was issued. Additionally, since that time, the World Health Organization officially reclassified PCBs a known human carcinogen as opposed to a probable human carcinogen.[44] Thus, the Agency's toxicity values used in the HHRA remain well-supported.

iii. The proposed remedy is necessary to reduce human exposure to PCBs through consumption of fish

Of all the exposure pathways in the Rest of River, fish consumption poses the greatest risk to human health. To reduce PCB concentrations in fish tissue and the overall environment, the proposed remedy requires GE to remove a substantial volume of river sediments, install engineered caps, and take other actions. GE argues that these remedial actions are not necessary to protect human health.

The NCP directs EPA to select remedies that result in human cancer risks that fall within the risk range of 1 in 1,000,000 (expressed as 1×10^{-6}) to 1 in 10,000 (1×10^{-4})[45] and that do not pose unacceptable non-cancer risks. Where the cumulative risk to an individual exceeds this range, i.e., greater than 10^{-4}, action is generally warranted, and EPA's "point of departure" for remedy selection is at the more stringent, or protective, (*i.e.*, 10^{-6}) end of the risk range.[46] Under this approach, EPA favors the most stringent (10^{-6}) end of the range and will not as a matter of course select a remedy that barely achieves the least stringent (10^{-4}) requirement.[47] Fish consumption risks from PCBs exceed this risk range in the Rest of River, from the confluence downstream into Connecticut.[48] For persons at the high-end of exposure projections, the fish consumption risks range above 1 in 1,000 (1×10^{-3}) for PCBs, and are even higher for dioxin/furan toxic equivalent risk (up to 1 in 100).[49] Thus, the cancer risks

[42] Attachment J to GE's Comments on the RCRA Permit Modification contains several papers and reports that relate to toxicity and cancer risk in the Housatonic River area. Most of these documents were published after the HHRA was issued. EPA notes that researchers have written numerous studies on the toxicity of PCBs since the HHRA process completed in 2005. The conclusions of these studies vary, and it is unsurprising that GE was able to select several studies that purportedly minimize the risks posed by PCBs.

[43] PCBs have been demonstrated to cause a wide variety of adverse health effects, including cancer. PCBs also cause serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, endocrine system and other organs. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs. *See* EPA, Understanding PCB Risks at the GE-Pittsfield / Housatonic River Site, available at http://www.epa.gov/region1/ge/understandingpcbrisks.html#WhatArePCBs.

[44] In 2012, the World Health Organization's (WHO) International Agency for Research on Cancer (IARC), changed the carcinogenicity category of PCB-126, one of the 209 different PCB molecules, from Group 2A – Probably Carcinogenic to Humans, to Group 1 – Carcinogenic to Humans. And in 2013, IARC changed the category for PCBs in general and all dioxin-like PCB congeners to Group 1. Polychlorinated biphenyls and polybrominated biphenyls / IARC Working Group on the Evaluation of Carcinogenic Risks to Humans (2013: Lyon, France), as published in IARC Monographs On The Evaluation Of Carcinogenic Risks To Humans, Volume 107. 2015.

[45] 40 C.F.R. § 300.430(e)(2)(i)(A)(2); Preamble to the NCP, 55 Fed. Reg. 8666-01, 8718–19 (March 8, 1990).

[46] Role of the Baseline Risk Assessment EPA, 1991

[47] 55 Fed. Reg. 8666-01, 8718–19 (March 8, 1990).

[48] Statement of Basis at 15.

[49] Revised Human Health Risk Assessment, Rest of River, USEPA, February 2005, Volume IV, Appendix C, Consumption of Fish and Waterfowl Risk Assessment at page ES-15 and Table 5-1.

posed to people consuming fish from Rest of River are well beyond the risk threshold in the NCP.

Fish consumption also poses significant and unacceptable non-cancer human health risks. EPA utilizes a hazard index approach to evaluate systemic toxicants (non-cancer effects) and considers a response action to be generally warranted if the non-carcinogenic hazard index is greater than one.[50] For Rest of River, non-cancer hazard indexes are as high as 120 in some reaches.[51] GE's comments on the RCRA Permit Modification concede that, according to EPA's probabilistic risk model, the selected remedy will achieve a non-cancer Hazard Index of 1 for Adults with Central Tendency Exposure ("HI = 1 CTE adults") (which corresponds to 1.5 mg/kg in fish fillets) and achieve at least the cancer CTE of 1 in 10,000 in all Massachusetts reaches except one (Reach 5B) within the 52-year model projection period.[52] In fact, in most reaches, the proposed remedy achieves these particular Interim Media Protection Goals ("IMPGs") more rapidly than all but one other alternative.[53] Attainment of IMPGs is one of the six remedy selection decision factors in the Decree, and "the time period in which each alternative would result in the attainment of the IMPGs" is important to EPA's evaluation of this factor.[54]

Despite the risks posed by its contamination in Rest of River, GE argues that the amount of sediment remediation included in the proposed remedy is unnecessary, because it will not reduce PCB concentrations in fish to levels that would allow for fish consumption advisories to be discontinued.[55] In fact, under all alternatives, Institutional Controls (including but not limited to fish consumption advisories) would likely be needed to protect human health for a period of time following remediation. As documented in the Comparative Analysis, despite the need for continuing some level of Institutional Controls for some period of time after remedy implementation, the proposed remedy results in significant risk reduction.

GE argues that a less extensive remedy would also achieve a particular non-cancer IMPG (Hazard Index of 1 for an adult with Central Tendency Exposure, or "HI=1 CTE adult") for fish consumption in Massachusetts. In particular, GE asserts in its SOP that SED 5 would achieve this IMPG (HI=1 CTE adult) in all but one Massachusetts reaches within the model projection period, and would achieve other CTE IMPGs in more reaches than the proposed

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[50] *See*, *e.g.*, Rules of Thumb for Superfund Remedy Selection, OSWER Directive 9355.0-69, August 14, 1997; *see also* 40 C.F.R. § 300.430(e)(2)(i)(A)(1) ("For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety").

[51] Final HHRA, Volume IV, Appendix C, Table 8-2, page 8-5.

[52] GE Comments on EPA's Draft RCRA Permit Modification and Statement of Basis for Proposed Remedial Action for the Housatonic River - Rest of River, GE, October 27, 2014, Page 28.

[53] Comparative Analysis of Remedial Alternatives for the Housatonic River, Rest of River, USEPA, May 2014, Attachment 10. IMPGs are defined in the RCRA Permit as "media-specific protection goals for the Rest of River area, as established pursuant to . . . this Permit. The Interim Media Protection Goals shall be used in the CMS, as provided in this Permit". Permit at 6.

[54] RCRA Permit para. G.2.b.

[55] GE Comments on Draft RCRA Permit Modification at 28.

remedy.[56] But SED 5 employs thin-layer capping in backwaters and Reach 8. The many shortcomings of thin-layer capping, including uncertainty, long-term ineffectiveness, loss of flood storage capacity, and permeability, are discussed below, in Section III.A.2.c.[57]

GE also argues that EPA's predictions of future PCB levels in fish tissue in the Connecticut reaches are uncertain and unreliable, and that all of the alternatives would achieve similar reductions of the Connecticut PCB fish consumption advisory. In fact, GE developed a model (CT 1-D model) as part of the CMS to predict fish tissue concentrations in Connecticut in order to compare the effectiveness of remedial alternatives.[58] GE concluded that even given the large uncertainty in the CT 1-D methodology, the level of combined accuracy/precision was considered acceptable and that the model can be used to develop future predictions in the Connecticut portion of the river.[59] According to GE's CT 1 D model, the proposed remedy reduces PCB concentrations by a factor of ten compared to MNR.[60] Compared to GE's preferred alternative cited in its Revised CMS[61] (SED 10), the proposed remedy reduces fish tissue in Connecticut concentrations by a factor of five.[62] The model was used for its intended purpose, which is comparing between remedial approaches, and in this case was relevant to EPA proposing a remedy approach that was more likely to result in appropriate reductions in fish tissue contamination as compared with other alternatives preferred by GE.

iv. The direct contact exposure assumptions for sediment and floodplain soil in the HHRA are reasonable estimates of risks to average and high-end users.

GE asserts that exposure assumptions in the HHRA are unrealistic and overstate exposures and human health risks.[63] In fact, the exposure assumptions properly estimate levels of exposure for human populations, including persons most at risk. Under the NCP, "acceptable exposure levels" must "represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety."[64] In accordance with this regulation and Agency guidance, the HHRA evaluated the central tendency exposure

[56] GE Comments on Draft RCRA Permit Modification at 28–29. EPA notes that GE has not previously favored SED 5. In its 2010 Revised CMS, GE concluded that a combination of SED 10—not SED 5—and FP 9 is "best suited to meet the General Standards, including protection of human health and the environment, in consideration of the Selection Decision Factors." Revised CMS at 28.

[57] GE's support for SED 5 in this context is curious because GE objects to several aspects of SED 5, such as excavating and capping of the entirety of Reach 5B. In addition, SED 5 has other components that go well beyond EPA's proposed remedy, such as excavation and stabilization with hard armoring of all banks in Reaches 5A and 5B.

[58] GE Revised CMS at 3-45.

[59] GE Revised CMS, Appendix J at J-15.

[60] Statement of Basis for EPA's Proposed Remedial Action for the Housatonic River Rest of River, USEPA, June 2014, Page 33 and Table 4. and at Comparative Analysis at 22 & Table 4.

[61] In its 2010 Revised CMS, GE concludes that a combination of SED 10/FP9 is best suited to meet the General Standards, including the consideration of the Selection Decision Factors . Revised CMS at 28).

[62] EPA Statement of Basis at 33 & Table 4; Comparative Analysis at 22 & Table 4.

[63] GE Comments on Draft RCRA Permit Modification, at 30-32.

[64] 40 C.F.R. § 300.430(e)(2)(i)(A)(1) (emphasis added).

risks for persons with "average" exposure, as well as reasonable maximum exposure ("RME") for "high-end" or "maximally exposed" persons.[65]

The exposure assumptions used in the HHRA were established following the procedures outlined in EPA guidance.[66] The basis for and derivation of each exposure assumption used in the HHRA is described in detail in both the initial and revised Phase 2 Direct Contact Risk Assessment HHRA (Volume IIIA, Appendix B). All exposure assumptions, including assumptions about recreational use, dirt biking and sediment exposure scenarios, and soil ingestion rates, were derived from site-specific information when available or Agency guidance.[67]

The exposure assumptions used in the initial HHRA were among the subjects reviewed by the Peer Review Panel. As summarized on page 16 of the HHRA Responsiveness Summary, five of the seven members of the Peer Review Panel for the HHRA commented that the approach, including the selection of exposure scenarios, receptors, exposure parameters, and risk estimates used to estimate risk from direct contact, was reasonable and consistent with EPA policy.[68] EPA agrees with the majority of the Peer Review Panel members that the assumptions used to estimate risk from direct contact were reasonable and consistent with EPA policy.

v. The proposed remedy is necessary to reduce human health risks due to direct contact exposure to PCBs

GE argues that, even accepting EPA's exposure assumptions, a less disruptive remedy would still achieve acceptable cancer range levels and an acceptable non-cancer hazard index for direct contact exposure. In particular, GE asserts that alternative FP-9 would achieve the "RME IMPGs based on a 10-4 cancer risk and a non-cancer [hazard index] of 1 in all of the flood plain [exposure areas], and . . . based on a 10-5 cancer risk and a non-cancer [hazard index] of 1 in a majority (about two-thirds) of the direct-contact floodplain [exposure areas]."[69]

First, EPA notes that attainment of IMPGs, including direct contact IMPGs is only one of the decision factors that EPA balanced in selecting the remedy, and GE only discusses the

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[65] Final HHRA, Section 7.1.

[66] The Guidance for Risk Characterization (EPA, 1995) states that the "high end [RME] descriptors are intended to estimate the exposures that are expected to occur in small, but definable, "high end" segments of the subject population." The Guidelines for Exposure Assessment (EPA, 1992) defines the RME as "… a plausible estimate of the individual risk for those persons at the upper end of the risk distribution. The intent of this description is to convey an estimate of risk in the upper range of the distribution, but to avoid estimates which are beyond the true distribution." EPA's Risk Assessment Guidance for Superfund (EPA, 1990) notes that "The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures." The RME risk serves as the point of departure in remedy selection as outlined in the NCP. The CTE exposure was also evaluated consistent with EPA's Risk Characterization Policy and Handbook to provide the risk manager with additional information to consider while making decisions.

[67] *See* Final HHRA, Volume IIIA, Appendix B, Section 4. In particular, incidental ingestion rates and recreational exposure assumptions are based on information discussed in Subsections 4.5.2 and 4.5.3.

[68] One reviewer considered the selection of exposure parameters reasonable, but thought that the combination of exposure parameters resulted in overly conservative risk estimates for most of the scenario/receptor combinations. Another reviewer commented that individual exposure parameters were too high and the combination of exposure parameters resulted in extreme estimates of risk, rather than risk to an RME.

[69] Statement of Position (SOP) of General Electric Company In Support of Dispute of EPA's Notification of Intended Final Decisions on Rest of River Remedy, GE, January 19, 2016, at 13-14.

least stringent cancer risk IMPG for protection of human health from the direct contact pathway and completely ignores the attainment of ecological IMPGs. Second, GE argues in essence that EPA should select the least costly alternative that would achieve the least stringent human health risk levels allowable under the NCP, and that EPA erred in selecting a remedy that achieves more stringent levels.

The NCP provides that the most stringent cancer risk level (10^{-6}) is the "point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure."[70] The preamble to the NCP explains that this "point of departure,"

> expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range, but this does not reflect a presumption that the final remedial action should attain such a risk level. Factors related to exposure, uncertainty and technical limitations may justify modification of initial cleanup levels that are based on the 10-6 risk level. The ultimate decision on what level of protection will be appropriate depends on the selected remedy, which is based on the criteria described in § 300.430(e)(9)(iii).[71]

Thus, EPA begins its evaluation at the most stringent end of the risk range (10^{-6}), and adjusts that target downward only where necessary given site-specific factors.

With respect to the specific cancer risk IMPG raised by GE, which again is the least stringent, the SED 10/FP 9 proposal favored by GE achieves the 10^{-5} cancer risk level in fewer of the floodplain areas than the proposed remedy, which achieves the 10^{-5} risk level in all of the frequently used subareas and from 71% to 100% of the floodplain/sediment exposure areas, depending upon the extent of remediation conducted in NHESP Core Areas 2 and 3, to be decided on a case-by-case basis.

Other alternatives may achieve less stringent IMPGs as GE claims. But the proposed remedy best meets the Permit's general standards, in consideration of the selection decision factors, including a balancing of those factors against each other. The proposed remedy achieves a non-cancer hazard index of one, provides more protection against cancer risks, and ensures long-term protection of the environment from risks posed by PCBs.

This conclusion is supported by the Administrative Record, including without limitation the Comparative Analysis.

vi. PCBs pose unacceptable risks to the environment in Rest of River

GE incorrectly characterizes the ecological risks posed by PCBs in the Rest of River area as "tenuous and uncertain"[72] and argues that EPA overstates the impacts of PCBs on the local population of wildlife species.[73] In fact, PCBs pose significant risks to the health of local population of species, such as amphibians, insectivorous and piscivorous birds, and piscivorous

[70] 40 C.F.R. § 300.430(e)(2)(i)(A)(2).
[71] 55 Fed. Reg. 8666-01, 8718–19 (March 8, 1990).
[72] GE Comments on RCRA Permit Modification at 37.
[73] GE SOP at page 16, GE comments on RCRA Permit Modification at pages 38 and 39.

mammals.[74] The risks posed in the Primary Study Area ("PSA")—the roughly 11 mile portion of the river from the confluence, two miles below the GE facility, to Woods Pond Dam—and downstream areas between the PSA and the Derby-Shelton Dam in Connecticut were thoroughly evaluated in EPA'sERA.

The ERA characterized and, where appropriate, quantified the risks to biota that are exposed to PCBs and other contaminants of concern that are found in the sediment, surface water, riverbank and floodplain soil, and tissue in the Rest of River area.[75] Using a weight-of-evidence approach, EPA considered several lines of evidence and evaluated whether significant risk is posed to the environment.[76] Risks to several types of biota were assessed: benthic invertebrates, amphibians, fish, birds (including insectivorous and piscivorous birds), mammals (including piscivorous and omnivorous/carnivorous mammals), and threatened and endangered species.[77] Where possible and/or appropriate, three lines of evidence were evaluated for each species: field studies, site-specific toxicity studies, and a comparison of exposure and effects.[78]

The weight-of-evidence assessments indicated that aquatic life and wildlife in the PSA are experiencing unacceptable risks as a result of exposure to PCBs and other contaminants of concern.[79] Confidence in this conclusion is high for benthic invertebrates, amphibians, and piscivorous mammals, based on multiple lines of supportive evidence.[80] Downstream of the PSA, PCBs could potentially be causing adverse effects to benthic organisms in depositional areas as far as Reach 8, amphibians in floodplain areas as far as Reach 8, trout in Reaches 7 and 9, mink as far as Reach 10, and river otter as far as Reach 12.[81]

In July 2003, EPA issued the initial draft of the ERA and solicited comment from GE and the general public. GE's 2004 comments on initial ERA included arguments similar to those in GE's 2016 SOP. For example, GE asserted that "[o]verall, the evidence does not show adverse impacts on local populations and communities of ecological receptors despite 70 years of PCB exposure."[82] However, the risk assessment considered substantial evidence which showed that unacceptable adverse impacts were occurring and would continue to occur without remediation activities. This evidence includes the adverse effects observed in site-specific field and laboratory studies conducted for the ERA (*e.g.*, the mink feeding study) as well as the comparison of the numerous known adverse effect levels published in the scientific literature with site-specific contaminant concentrations.[83]

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[74] *See* Attachment C. Responses to GE's Comments on EPA's Ecological Risk Assessment and Development of IMPGS for Amphibians, Insectivorous and Piscivorous Birds, and Mink
[75] Charge for the Ecological Risk Assessment Peer Review for the Rest of the Housatonic River, USEPA, July 2003, at 1.
[76] Initial ERA, July 2003 at ES-12.
[77] ERA Peer Review Charge at 1–2.
[78] ERA Peer Review Charge at 1–2.
[79] Initial ERA at pages ES-43, ES-50.
[80] Initial ERA at ES-50
[81] Initial ERA at ES-50
[82] Comments of the General Electric Company on USEPA's Ecological Risk Assessment for the Housatonic River Site, Rest of River, January 13, 2004, at 76 of Presentation.
[83]Initial ERA, Risk Characterization Sections 3.4, 4.4, 5.4, 6.4, 7.4, 8.4, 9.4, 10.4, 11.4.

GE also argued in 2004 (and continues to argue) that the ERA improperly focused on effects to individual organisms instead of local populations and communities.[84] While EPA disagreed with GE's premise, it agreed to clarify that, in accordance with EPA guidance,[85] "impacts at lower levels of organization (*e.g*., adverse effects on survival of individuals) are often used to infer possible impacts at higher levels of organization (*e.g*., persistence of local populations)."[86] The final ERA, issued in November 2004, explained that "[a]lthough many of the endpoints[87] presented are linked to organism-level effects (e.g., survival and reproduction), these endpoints are expected to be strong indicators of potential local population-level effects," and "[e]xtrapolation from organism-level to population-level effects may be logically achieved based on the predictive nature of the endpoint and/or through the use of process-based models."[88]

The initial ERA and the public comments (including GE's 2004 comments) were subject to peer review by a panel of independent risk assessment experts. Although the peer reviewers did provide critical comments on some aspects of the ERA, their comments were generally supportive of the ERA's conclusions and methodology.[89]

In short, the ERA shows that GE's PCBs generate significant and unacceptable risks to the ecosystem and biota. Accordingly, the PCB contamination must be remediated to protect the environment.

vii. The remedy's long-term benefits to human health and the environment outweigh any short-term ecological impacts, which GE is required to mitigate.

Of all the alternatives, the proposed remedy best balances remediating the contamination with minimizing and mitigating the ecological impacts of constructing the remedy.[90] GE alleges, incorrectly, that the benefits of the proposed remedy are outweighed by the ecological harms associated with implementation. On this basis, GE argues that EPA's selection of the remedy is arbitrary and capricious, does not provide "overall protection of the environment" as required by the Decree, and does not properly balance short-term impacts and long-term harms as required by EPA guidance.[91] On the contrary, EPA has determined that the proposed remedy provides the best balance in terms of reducing residual risk and minimizing long-term ecological impacts.[92] As crafted, the proposed remedy limits short-term impacts to key habitats and ensures that disturbed areas will be restored after remediation. Thus, EPA's proposed remedy reasonably accepts some short-term impacts in favor of long-term protection of the environment.

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[84] GE 2004 ERA Comments Presentation at page 6, and restated in GE's SOP at 16.
[85] EPA 1997 Ecological Risk Assessment Guidance for Superfund
[86] Responsiveness Summary to the Peer Review of the ERA at 30 and 31.
[87] Endpoints refer to the Assessment and Measurements Endpoints identified during the Problem Formulation stage of the ERA development.
[88] Final ERA at page 2-68.(citing Ecological Risk Assessment and Risk Management Principles for Superfund Sites. OSWER Directive 9285.7-28P; EPA (U.S. Environmental Protection Agency). 1992. Framework for Ecological Risk Assessment. Risk Assessment Forum, Washington, DC. EPA/630/R-92/001).
[89] Responsiveness Summary to the Peer Review of the ERA.
[90] Statement of Basis at 31.
[91] GE Dispute Letter (Jan. 19, 2016) at 14.
[92] Statement of Basis at 31.

There are specific provisions in the proposed remedy to avoid impacts to key habitats designated as "Core Area 1" by the Massachusetts Division of Fish and Wildlife. Core Area 1 includes the "highest quality habitat for species that are most likely to be adversely impacted by PCB remediation activities."[93] GE must avoid excavation in Core Area 1 habitat except in limited areas where necessary to meet Secondary Floodplain Performance Standards.[94] Additionally, no excavations shall occur in Vernal Pools or backwaters (unless PCBs are greater than 50 ppm) in Core Area 1.[95] In addition, bank excavation is significantly limited in Reach 5B and limited in Reach 5A to a lesser extent.[96] Furthermore, in Core Areas 2 and 3[97] impacts will be minimized and, on a case-by case basis, avoided.[98] Phasing the work will also disperse the effects of the construction activities over time (the remedial action period is estimated to be 13 years) and space (a distance of over 30 miles).[99] These and other restrictions will limit the short-term ecological impact of implementing the remedy.

In the long-term, the reduction in PCB exposures and the active restoration that will occur after implementing the proposed remedy ensure that the permanent benefits of remediation will far exceed the short-term harm. Performance Standards set forth in Paragraph II.B.1.c(1) of the modified permit require GE to:

> (a) Implement a comprehensive program of restoration measures that addresses the impacts of the Corrective Measures on all affected ecological resources, species and habitats, including but not limited to, riverbanks, riverbed, floodplain, wetland habitat, and the occurrence of threatened, endangered or state listed species and their habitats, and,
>
> (b) Return such areas to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements.

Paragraph II.B.1.c.(2) requires GE to follow a four-step restoration process. GE must assess pre-remediation conditions; develop restoration criteria for Corrective Measures; develop a restoration coordination plan to be performed during the implementation of the Corrective Measures; and, finally, design and implement a Restoration Plan for all areas disturbed by the remediation activities.

Remediating and restoring Rest of River is necessary to ensure the long-term health of the ecosystem. As discussed above, PCBs pose significant risks to aquatic life and wildlife in the Housatonic River, particularly in the PSA. While elements of the ecosystem that are unaffected by PCBs continue to function (*e.g.*, the plant community), pollution from GE's Pittsfield facility has significantly degraded many aspects of the Housatonic River

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93 Mass. DFW, Core Habitat Areas in the Primary Study Area (2012) at 1-2.
94 Intended Final Decision at 47.
95 Intended Final Decision at 28, 50.
96 Intended Final Decision at 24.
97 Core Area 2 and 3 are defined in the 7/31/12 Letter from Jon Regosin (MADFW) to Robert G. Cianciarulo (USEPA), Re: Housatonic River, Core Habitat Areas in the Primary Study Area.
98 Intended Final Decision at footnote 11.
99 Statement of Basis

environment. Left alone, the ecosystem will not repair itself for several decades or even centuries. [100] The restoration component of the remedy will support and accelerate natural ecosystem recovery processes.[101] While remediation of the river and floodplain at this scale cannot be accomplished to any meaningful level without impacts to the present state of the river and floodplain, the restoration activities will mitigate impacts caused by the remediation.[102] Over the long-term, restoration activities will return the processes sustaining diverse river and floodplain communities.[103]

Ecosystem restoration is an emerging science that has been practiced successfully at many large riverine sites.[104] EPA has published specific guidance on aquatic restoration.[105] In addition, several federal agencies, including the National Research Council, Natural Resources Conservation Service and the Fish and Wildlife Service have published guidelines for river restoration projects.[106] Additional guidelines are available from non-profit organizations, such as the Society for Ecological Restoration—a non-profit organization comprised of individuals and organizations from around the world representing the public, private, and non-profit sectors. Scientific literature and the work of restoration practitioners provides additional information and specific technical guidance.[107] In recent years, the number of river restorations has grown exponentially, and restoration techniques are used to achieve a wide array of goals, such as removing contaminants, and supporting fisheries and wildlife.[108]

Examples of riverine restoration projects include a 35-acre contaminated wetland and stream remediation and restoration project at Loring Air Force Base in Maine. After only 6 years, large areas of remediation were virtually indistinguishable from the areas prior to disturbance.[109] Another example is the remediation of the Clark Fork River in Montana, where hazardous mining waste contaminated 43 miles of river bed sediments and the floodplain. The state developed a restoration plan to restore river and floodplain habitats, maximize the long-term beneficial effects and cost-effectiveness of restoration activities, and improve natural aesthetics. Remediation and restoration activities have begun, with contaminated soil being removed and replaced with clean soil, and streambanks stabilized and replanted with native vegetation.[110] While rivers are unique and restorations vary depending on the setting, these and other example projects show that restoration on the scale of the Rest of River ecosystem is feasible.

It is important to note that the Commonwealth of Massachusetts supports the proposed remedy, despite the short-term impacts to the environment. Throughout its 2014 comments and SOP, GE misleadingly suggests that the Commonwealth does not support EPA's proposed

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[100] Comparative Analysis, Attachment 12 at 1.
[101] Comparative Analysis, Attachment 12, at 6.
[102]Comparative Analysis, Attachment 12, at 6.
[103] Comparative Analysis, Attachment 12, at 6.
[104] Comparative Analysis, Attachment 12 at 8.
[105] USEPA, 2000. Principles for the Ecological Restoration of Aquatic Resources. EPA841-F-00-003. Office of Water (4501F), United States Environmental Protection Agency, Washington, DC. 4 pp.
[106] *See* NRRB Site Information Package (Att. 12 to Comp. Analysis) at 4, *e.g.*, NRCS, 2001; NRCS, 2007; USFWS, 2008.
[107] *See, e.g.*, Fischenich and Dudley (2000) (river hydraulics).
[108] Comparative Analysis, Attachment 12, at 5.
[109] Comparative Analysis, Attachment 12, at 9.
[110] Comparative Analysis, Attachment 12, at 9–10 (citing CFRTAC, 2009).

remedy. While in 2011 the Commonwealth did express concerns about potential impacts of the remediation on the ecosystem when commenting on GE's Revised CMS, EPA and Massachusetts subsequently addressed those concerns through a series of technical discussions culminating in the 2012 status report that outlined a conceptual framework for the remedy, which explicitly focuses on avoiding, minimizing and mitigating impacts to Core Areas.[111] In its 2014 comments, the Commonwealth—specifically the Executive Office of Energy and Environmental Affairs and its Department of Environmental Protection ("MA DEP") and Department of Fish and Game—expressly stated its support for the proposed remedy, which is "protective of human health while employing a remediation framework developed in consultation with the Commonwealth and the State of Connecticut that is directed at preserving the dynamic character of the river ecosystem and avoiding, minimizing and mitigating remedy impacts to the affected wildlife and their habitats, with a particular focus on protecting state-listed species."[112]

The Massachusetts Fisheries and Wildlife Board ("MA FWB"), which oversees the Division of Fisheries and Wildlife (the largest landowner in the Rest of River area), also supports the proposed remedy.[113] The FWB recognizes that the PCB contamination at Rest of River "poses a public health risk that must be addressed."[114] While noting that there is no "silver bullet solution" for sites contaminated with PCBs and that crafting the Rest of River remedy has been a "difficult balancing act," the FWB acknowledged that the proposed remedy "has been crafted to responsibly address the public health risks while responsibly maintaining the natural and recreational values of this section of the Housatonic."[115]

Finally, none of GE's specific technical criticisms[116] demonstrate that EPA acted unreasonably in selecting the remedy for the Rest of River site. EPA's responses to these specific criticisms are presented in Attachment C.

As described above, EPA carefully crafted the proposed remedy to address the ecological risks posed by PCBs and to balance short-term harm to the environment with substantial long-term benefits. Despite temporary disruption of some ecosystems, in the long-term the remedy will provide overall protection of the environment in Rest of River.

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[111] Commonwealth of Massachusetts' Comments on EPA's Proposed Cleanup Plan for Rest of River. October 27, 2014, at 4.
[112] Commonwealth of Massachusetts Comments, at 2.
[113] Comment Letter from Joseph S. Larson (Mass Fisheries and Wildlife Board) from the Public Hearing conducted by EPA for Draft RCRA Permit Modification. Lenox Memorial Middle/High School, Lenox, MA. September 23, 2014.
[114] Comments of Joseph Larson, Mass. Fisheries and Wildlife Board (2014).
[115] Comments of Joseph Larson, Mass. Fisheries and Wildlife Board (2014).
[116] *See* GE SOP at 12-16; GE Comments on the Draft RCRA Permit Modification (2014) at 34-37 and Attachments C, D and E.

b. Woods Pond

Requirement: The Intended Final Decision requires removal of approximately 285,000-340,000 cubic yards ("CY")[117] of PCB contaminated sediment and placement of an engineered cap in Woods Pond (Reach 6) . [118]

GE Position: The intended remedy for Woods Pond requires unnecessary removal and provides insufficient risk-based benefits compared to a smaller, less disruptive, and less costly alternative.

EPA Position: At issue here is the opportunity to permanently remove the risks posed by approximately 285,000-340,000 CY (depending upon EPA's or GE's respective calculations)[119] of PCB-contaminated sediment. Woods Pond sediment contains approximately 25% of the mass of PCBs present in the Housatonic River,[120] and does not provide priority habitat for state-listed species.[121] Accordingly, the remedy in the Intended Final Decision for Woods Pond represents the opportunity to remove a significant mass of PCBs from the river system, thereby reducing the potential for downstream transport of PCBs, and significantly reducing the bioavailability and exposure of PCBs to human and ecological receptors (including but not limited to the consumption of contaminated fish) with minimal short- or long-term impacts to the environment from the remediation itself. EPA's remedy selection for Woods Pond is supported by the Administrative Record, and falls within EPA's expertise in evaluating all the relevant factors in selecting a remedy for the Rest of River.

In terms of procedure, EPA followed the decision-making process outlined in the Decree and Permit in reaching its proposal for Woods Pond, and GE is not in a better position than EPA to evaluate the relevant considerations. EPA evaluated the relevant criteria based upon the Administrative Record, including comments received from GE and other members of

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[117] The removal volume estimates are based on the requirements of the Intended Final Decision, which generally calls for removal of sediment throughout the pond and an Engineered Cap placed to result in a residual depth of 6 feet, except in shallower areas.

[118] For each remedy component, the Statement of Position provides a general description of the remedy requirements. For the specific requirements, consult EPA's September 30, 2015 Intended Final Decision.

[119] GE and EPA differ on the volume of material required to be excavated from Woods Pond under the Intended Final Decision. EPA based its calculations of 285,000 CY on a minimum water depth of six feet, not an average depth of six feet as GE mistakenly claims. Comparative Analysis, Attachment 6; GE SOP at 16, n. 17. GE provided no support for its 340,000 figure so it is difficult to comment upon its accuracy. Further, GE's "preferred remedy" as briefly described in its SOP would likely involve the removal of approximately 100,000 CY or more. The 100,000 CY estimate is based on a 1.0 to 1.5 foot excavation (not 9 inches, which was not contemplated in GE's Revised CMS – See Table 6-1) in both the shallow and deep portions of Woods Pond. Excavation in the deep part of Woods Pond may be necessary to avoid the loss of flood storage capacity in the Woods Pond area. Therefore, the difference between EPA's Intended Final Decision and GE's SOP preferred remedy is 185,000 CY, a smaller differential than portrayed by GE. But even if GE's figures were correct, EPA's analysis would not change for all the reasons set forth herein. GE's SOP position was not included in the series of remedial options evaluated by GE in its Revised Corrective Measures Study ("Revised CMS"), so GE's SOP position has not been fully evaluated by EPA against the remedy selection criteria. Significantly, GE in its Revised CMS, opined that the alternative known as SED 10 best met the permit criteria. For Woods Pond, SED 10 required the removal of 169,000 CY in the top 2.5 feet of sediment without the placement of an Engineered Cap.

[120] GE's RCRA Facility Investigation Report for the Rest of River, 2003. Table 4-11. This does not include the PCB mass in the floodplain.

[121] Commonwealth of Massachusetts' Comments (2014) at 6.

the public in selecting the proposed remedy for Woods Pond. In doing so, EPA relied upon its technical expertise to evaluate the merits of the multiple and complex factors that shape and determine the selection of remedy that is in the public interest to protect human health and the environment. The soundness of EPA's decision is contrasted with GE's bias favoring its own bottom line as shown below.

GE ignores or discounts the many benefits of removing significant quantities of PCB contaminated sediment from Woods Pond.[122] For example, the Woods Pond represents a significant percentage of the total PCB contamination, in an area that does not provide priority habitat for any state-listed species, and that is amenable to traditional open water dredging technologies. Therefore, there is an opportunity at Woods Pond to remove a significant source of PCBs without impacting the state Core Habitats and by using relatively straightforward engineering methods. Once dredging of the Pond is initiated, continuing deeper dredging to remove a significant mass of PCB contaminated material from the Pond will result in minimal additional natural resources being disrupted while providing the benefit of greater removal. There is no other point on the River where it is possible to remove over 285,000 CY of PCB contaminated material from a single location with fewer negative impacts to habitat.[123]

GE claims that a shallow removal followed by capping would provide almost the same level of protection to human health and the environment, in part because it is the owner of Woods Pond dam and therefore there is unlikely to be any dam breach or failure resulting in significant releases of PCBs. EPA does not disagree with GE's assertion that sediment removal sufficient to place a properly designed, constructed, operated and maintained Engineered Cap in perpetuity might achieve the same reductions as this greater PCB removal for certain risks, such as fish consumption, direct contact, and ecological risk in Woods Pond itself. However, this conclusion assumes that such a cap will be achieved and be properly maintained and operated to resist floods and ice-scour in perpetuity and that there is no breach or failure of Woods Pond Dam. In making these arguments, GE discounts the benefits of more effective source control through the permanent reduction in the bioavailability of PCBs to human and ecological receptors through removal. Here the more extensive source control – removal – leads to the twin benefits of risk reduction, including reduction of the risk of downstream transport, and increased long-term effectiveness. In Woods Pond, there is a significant benefit to removal of the large amount of PCBs in the event of breach or failure of Woods Pond Dam.[124] After all, even with the best intentions and significant resources, it is impossible to guarantee that there will never be a dam breach or failure in perpetuity,[125] even if GE remains the Dam owner in perpetuity, including unknowns or uncertainties associated with potential climate change. In contrast, removing sediment from behind the dam and disposing of it in a secure landfill guarantees that such sediment cannot be reintroduced into the environment and transported downstream in the event of cap or dam breach or failure. GE simply fails to account for the benefits provided by the finality in risk reductions and source

[122] This position contradicts its earlier view as set forth in its Revised CMS that the best alternative for Woods Pond was removal of 169,000 CY of sediment. Revised CMS at 28 and table 6-1.
[123] This is not to say that other portions of the River do not also require cleanup to address the ongoing risks posed to the River and floodplains.
[124] *Also see* EPA SOP III. B.5.
[125] The PCB contamination caused by the 1992 partial breach of the Rising Pond dam, described further in Section III.A.2.e, is a relevant example.

control related to actually removing 285,000-340,000 CY of PCB-contaminated material from the River.

In its SOP, for the first time,[126] GE also attempts to discount the value of removing Woods Pond sediment as EPA proposes by suggesting that most of the deeper sediments (more than two feet below the sediment surface) contain PCB concentrations less than 1 mg/kg. Even if most of the deeper concentrations (more than two feet below the sediment surface) are less than 1 mg/kg more than two feet below the sediment surface, which is uncertain,[127] far higher levels of PCB concentrations are also present more than two feet below the sediment surface. For example, PCB concentrations as high as 273 mg/kg are located from 2 to 2.5 feet deep; as high as 152 mg/kg from 2.5 to 3 feet deep; as high as 21.5 mg/kg from 3 to 3.5 feet deep; and as high as 146 mg/kg from 5.5 to 6 feet deep.[128] In addition, GE ignores the fact that, according to the data presented in Table 4-10 of GE's RFI Report, approximately 75% of the PCB mass in Woods Pond is contained in sediment from one to six feet deep.[129] Thus, removing sediment from one to six feet deep beneath the current pond bottom results in the removal of a significant mass of PCBs from the Pond, and thereby reduces future risks of PCBs becoming bioavailable and/or being transported downstream.

In addition, GE exaggerates the downsides of the EPA proposal for Woods Pond, by arguing that other remedies would be almost as good and cost far less. EPA believes that GE's cost discrepancies are inflated. While GE infers a cost difference of approximately $130 million, EPA believes a more accurate cost difference is likely to be approximately $80 million.[130] Regardless of the exact figures, EPA considered the magnitude of any additional cost when evaluating all the relevant factors for its Intended Final Decision.[131]

Similarly, GE argues that the benefits provided by a deeply dredged Woods Pond in its capacity to serve as a PCB trapping mechanism to prevent PCB transport downstream are allegedly immaterial. GE acknowledges that the proposed deepening increases the PCB trapping efficiency compared to remedies that do not deepen the Pond. Accordingly, at issue is the significance of the increased trapping. GE's own modeling shows that as a result of the increase in trapping efficiency, the incremental reduction in downstream transport, or flux, over Woods Pond is 0.1 kg/year and over Rising Pond is 0.2 kg/yr. GE SOP at 18. These reductions in flux are significant relative to the Downstream Transport Performance Standards.. If these trapping related reductions were not achieved it would decrease the likelihood of GE achieving the Downstream Transport Performance Standard. Furthermore, the pond and dam have historically been an effective trap as a significant amount of PCB mass

[126] First, it should be noted that GE's latest proposed remediation is to a depth of only nine inches (in the shallow areas of the Pond only), and GE's comment refers to sediment more than *two* feet below the surface.
[127] For information on sediment heterogeneity, see 2004 ERA, Appendix D, Sections D.2.4.4 and D.2.4.6 and Model Calibration Report, Appendix B, Pages B.1 to 10.
[128] Rest of River Site Investigation Data Report.
[129] GE RFI Report, Table 4-10. In Table 4-10, GE does not present the estimate of the average pounds of PCB mass for each depth interval. The percentage calculated is based on GE's +2 Standard Error estimate.
[130] If the volume of material is only 285,000 CY as EPA believes, the cost of excavation and disposal will be proportionately reduced compared to 340,000 CY. EPA believes the cost difference between the Intended Final Decision and a GE's proposed shallow remedy in its SOP is around $80 million.
[131] Even if GE's cost figures and assumptions are accurate, EPA's proposal for Woods Pond would remain the preferred alternative based upon a full evaluation of all the relevant factors, including the objective of eliminating risks related to source control and downstream transport.

has been retained in the pond. Increased trapping combined with future periodic removal of PCB-contaminated sediment from the pond, as required by the Intended Final Decision, at 29-30, will reduce downstream flux of PCBs in two ways. One, removing future sediment accumulation will eliminate the opportunity for PCBs to dissolve off the solids and into the water column, and two, will prevent the PCBs attached to the solids from migrating downstream due to erosional forces and/or dam breaches or failure. Accordingly, the benefits of additional trapping efficiencies favor the Intended Final Decision.

Pursuant to the process set forth in the Decree, EPA considered all public comment on the proposal, including those from GE, Massachusetts, and Connecticut. As stated in its October 27, 2014 letter expressing support for the Proposed Cleanup Plan, the Commonwealth strongly favors the proposed remediation approach to Woods Pond for the reasons identified by EPA. GE suggests that the Commonwealth favors the Intended Final Decision to improve the pond's capacity as a recreational fishery. This is not accurate. While the Commonwealth noted, after summarizing the remediation objectives and benefits of the proposal, that it will also have the *secondary* benefit of enhancing the public's safe, recreational use of the Pond: the latter was not the basis for the Commonwealth's support or a factor in EPA's decision. Statement of Basis; Comparative Analysis. Similarly, GE cites additional truck traffic for deeper removal of PCB contamination from Woods Pond as a negative issue due, in part, to its impact on the community. However, the Commonwealth and, in general, the community support the Intended Final Decision for Woods Pond, including willingness to accept any additional truck traffic for deeper removal of PCB contamination from the Pond, and this support contributes to the implementability of the alternative.[132]

Finally, the proposal to remove 285,00-340,000 CY of PCB contaminated sediment from Woods Pond cannot be considered in isolation from the other components of the Rest of River response action proposal. In evaluating all the relevant factors for all the relevant components of the Rest of River, including floodplains, vernal pools, individual reaches, EPA considered the totality of the proposal from a holistic perspective. For example, EPA's initial proposal before the National Remedy Review Board included considerably more removal of contaminated PCBs from other portions of the River and floodplains, resulting in the total removal of approximately 1,080,000 CY of contaminated sediment or soil with the approximate cost of $677 million.[133] In contrast, the Intended Final Decision is somewhat less costly overall, and while it includes far less removal from other portions of the River and floodplains, especially Reach 5B, where the reduction is 88,000 CY, it does require the removal of additional PCB contaminated sediment from Woods Pond. The net change represented by the Intended Final Decision involves removal of approximately 90,000 CY less material than originally recommended to the NRRB and a savings of over approximately $50 million.

Overall, as the Comparative Analysis demonstrates, EPA considered all the relevant factors, and for Woods Pond, proposed an alternative best suited to addressing these criteria based on all the information in the Administrative Record. EPA's decision to remove a

[132] To the extent that any additional truck traffic contributes to additional greenhouse gas emissions, even if rail cannot be utilized, EPA believes that any negative impacts of such emissions are offset by other relevant factors including the value of removing significant quantities of PCBs from the River.
[133] Submittal from EPA Region 1 to NRRB, June 2011, at ES-21.

significant portion of PCB contaminated sediment from Woods Pond and control the sources of PCB releases is a sound decision under the Decree and in the public interest.

c. Reach 7 Impoundments:

Requirements: Reach 7 consists of an approximate 18 mile stretch of free-flowing River interspersed with impoundments behind the Columbia Mill, Eagle Mill, Willow Mill and Glendale dams. GE's PCB contamination has been deposited in sediment, and is posing unacceptable risks to human health and the environment, at these impoundments (collectively, the "Reach 7 Impoundments").

EPA's proposed approach to the Reach 7 Impoundments employs a combination of excavation of contaminated sediment and the placement of an Engineered Cap to isolate the remaining PCBs.[134] EPA's proposal also provides GE with significant flexibility in how the PCB contamination is addressed, including excavating sediment to achieve an average of 1 mg/kg PCBs without capping and alternatives in the event of parties seeking removal of one or more Reach 7 dams. In addition, it requires that there be no net loss in flood storage capacity or an increase in water surface elevation.

GE Position: GE argues that EPA's proposal is unjustified, claiming that a less extensive and less costly remedy can achieve similar results. First, in its SOP, GE primarily focuses on its proposal for thin-layer capping ("TLC") in the Reach 7 Impoundments, namely the placement of a 6-inch layer of clean material with no removal.[135] Second, in its 2010 Revised CMS and its 2014 Comments, GE had focused on its proposal for Monitored Natural Recovery (MNR), which uses naturally occurring processes to reduced bioavailability or toxicity, and monitoring of contaminant levels over time, with no current excavation or containment of PCBs.

EPA Position: Neither TLC nor MNR would be suitable for the Reach 7 Impoundments. TLC is different from Engineered Capping.[136] Engineered Capping reduces risks posed by contaminants by physically isolating the contaminated sediments from human or animal exposure, by chemically isolating the contaminated sediments from being transported up into the water column, and by stabilizing contaminated sediment to protect it from erosion, particularly in high-flow situations.[137] On the other hand, TLC is not designed to provide long-term isolation of contaminants, but rather is a form of Enhanced Monitored Natural Recovery

[134] For the flowing subreaches of Reach 7, the Intended Final Decision provides for use of Monitored Natural Recovery. II.B.2.h.
[135] *See* GE SOP at 19-20. In its SOP, GE also references that there is more detailed support in Section IV.B.2 of GE's October 2014 comments on EPA's Draft RCRA Permit. Section IV.B.2 focuses primarily on MNR being GE's preferred remedy for the Reach 7 Impoundments. Also, SED 10, which GE identified as the remedy that best meets the Permit criteria in its 2010 Revised CMS, calls for MNR in these impoundments.
[136] Engineered Capping is discussed below in Section III.A.2.f of this Statement of Position.
[137] *See* EPA's Contaminated Sediment Remediation Guidance at Section 5.1, December 2005,

("Enhanced MNR") in which a thin layer of clean material mixes with or dilutes the existing contaminated sediments to help the natural sedimentation processes.[138]

In response to EPA comments on GE's 2008 CMS, GE appears to acknowledge this distinction. In its October 2010 Revised CMS, GE defines TLC as the "Placement of a thin-layer (e.g., 3 to 6 inches) of clean material over PCB containing sediment to provide an immediate reduction of PCB concentrations in the biologically active zone and to accelerate natural recovery."[139] However, despite this acknowledgement, GE, in its SOP and comments, continues to claim, based solely on model runs, that TLC is equivalent to Engineered Capping.

In its September 9, 2008 letter responding to GE's Corrective Measures Study submittal, EPA expressed concern regarding GE's characterization of TLC, its applicability for use in the conditions present in Rest of River, the uncertainty of model predictions of its effectiveness, and the lack of evaluation of boat traffic and biota on the stability of material.[140]

More recently, in its analysis of alternatives and its review of public comments, EPA considered the use of TLC in the Reach 7 impoundments.[141] However, EPA continues to have serious reservations about the overall suitability for TLC under the conditions in these impoundments[142] as well as how GE evaluated TLC, and therefore discounted GE's projected model results due to uncertainty in its effectiveness in this scenario. Specifically:

- GE essentially modeled TLC under that assumption that it would effectively isolate and contain PCBs, when in reality, by definition, it is Enhanced MNR or dilution. That is why the modeling results are almost identical. If GE modeled TLC as dilution, the results would be significantly different.
- Although GE used EPA's model to evaluate the physical stability of the placement of a six-inch layer of material, the model only addresses large-scale hydrodynamic erosional forces and shear stresses, and does not account for the variation in shear stresses in smaller-scale areas. Furthermore, the model does not evaluate the effects of the following, all of which need to be evaluated as part of an Engineered (or isolation) Cap:[143]
    - Mixing of the placed material with underlying sediment;
    - Inclusion/effects of a chemical isolation layer;

[138] EPA's Contaminated Sediment Remediation Guidance at Section 4.5, states, "Thin-layer placement [capping] normally accelerates natural recovery by adding a layer of clean sediment over contaminated sediment. The acceleration can occur through several processes, including increased dilution through bioturbation of clean sediment mixed with underlying contaminants. Thin-layer placement is typically different than the isolation layer caps discussed in Chapter 5, In-Situ Capping, because it is not designed to provide long-term isolation of contaminants from benthic organisms."
[139] GE Revised CMS at 1-18
[140] September 9, 2008 letter from Susan Svirsky to Andrew Silfer, RE: EPA comments on GE's March 2008 Corrective Measures Study report, at 5-7.
[141] Moreover, EPA's proposed remedy includes Enhanced MNR for Reach 5B sediments and for the Vernal Pools, proposing the use of Activated Carbon or a comparable sediment amendment to promote the natural recovery processes.
[142] EPA September 9, 2008 letter on GE's March 2008 CMS Report, at 6.
[143] Intended Final Decision, at Section II.B.2.1.

  - Effects of bioturbation, wind-generated waves, motor boat wakes and ice impacts;
  - The geotechnical stability of caps (e.g., bearing capacity, slope stability, ebullition)

- TLC is not Engineered Capping, so there can be no inspection and maintenance requirements to ensure its long-term effectiveness.
- TLC does not include any sediment removal, and could result in the loss of flood storage capacity in each of the Impoundments.

Furthermore, there has been preliminary interest in removing at least one of the dams in Reach 7.[144] Adding six inches of material to the existing system without any sediment removal would only add to the volume of material to be removed should future dam removal occur.

In essence, in its SOP, GE is agreeing with EPA's remedy for capping these impoundments to isolate the PCBs (although GE concurrently incorrectly equates TLC with Engineered Capping) and GE's disagreement is really with (a) the need to remove sufficient sediment for an Engineered Cap prior to capping and (b) the requirement to follow the design criteria, specifications, and long-term inspection and monitoring requirements for Engineered Caps (as discussed below in Section III.A.1.f of this Statement of Position)

With respect to MNR,GE argues in its Revised CMS in 2010 and in Section IV.B.2 its October 2014 comments, which are referenced in its SOP[145], that the model projections show only small incremental reductions in fish PCB concentrations in the Reach 7 Impoundments compared to MNR. GE then argues that MNR would achieve similar reductions in PCB concentrations in the impoundments and downstream, as well as an equivalent reduction in downstream PCB transport.

EPA does not agree that the results of the modeling carried out by GE indicate "only small incremental reductions" when the proposed alternative is compared with MNR. On the contrary, GE's modeling results (fish fillet PCB concentrations at the end of the 52-yr modeling period) clearly indicate the markedly lower fish tissue concentrations achieved by the proposed remedy as opposed to an MNR-only approach. At the Columbia Mill impoundment, fish tissue concentrations achieved by the proposed remedy are projected by the model to be 0.6 mg/kg while MNR achieves a concentration of 2.0 mg/kg, over three times higher. In the Eagle Mill and Glendale impoundments, the concentrations projected to be achieved through MNR are over double those achieved by the proposed remedy. Only in the Willow Pond impoundment do these two alternatives achieve similar concentrations, but even there fish tissue concentration projected with MNR is still over 10% higher than the concentration achieved by the proposed remedy.

These differences matter. The current PCB concentrations in the edible tissues (fillet) of fish inhabiting these impoundments are significantly elevated and the concentrations achieved by MNR in 52 years would be cause for concern if they were encountered in other

[144] Columbia Mill Dam Sediment Management Study, by Tighe and Bond, For the Commonwealth of Massachusetts, June 2011. Also, Lee, Lenox Assessment Report and & recommended Action Plan Housatonic River, Lee Lenox Stream Team 2014 by the Housatonic Valley Association, at 9 and 10.

[145] By responding to this comment from the 2014 Comment letter, EPA is not waiving its ability to argue that GE's including in its Statement of Position a blanket reference to another documents warrants a response from EPA on such documents in this dispute.

water bodies. Not only are the concentrations achieved by MNR projected to be above or close to the Short-Term Biota Standard of 1.5 mg/kg in all but one impoundment, but more importantly, the proposed remedy makes it clear that the goal is to achieve a PCB concentration of 0.064 mg/kg in Massachusetts, or at a minimum, monitor progress towards those goal. EPA's proposed remedy achieves significantly more progress towards this goal. Furthermore, the added reduction can be very significant for purposes of whether a consumption advisory needs to be maintained by the Massachusetts Department of Public Health, which is set at 1 mg/kg.[146] In addition, as shown in Attachment F to GE's Comments on the Draft RCRA Permit, EPA's proposed remedy achieves several more IMPGs compared to MNR in the Impoundments.[147] Lastly, the proposed remedy achieves concentrations below 1 mg/kg in all four of the Reach 7 impoundments while MNR barely achieves this level in only a single impoundment (Willow Mill). These are not "small incremental reductions" and they have important implications for public health as they significantly reduce the health risk associated with the consumption of fish in these reaches, as well risk to ecological receptors.

GE also claims EPA's proposed remedy does not show a significant incremental decrease in the PCB flux over Rising Pond compared to MNR. GE's own analysis does not support this conclusion. GE estimates that when EPA's upstream remedy is combined with MNR in the Reach 7 Impoundments, the PCB flux is projected to be 2.6 kg/yr. This compares to a projected flux of 2.3 kg/yr for EPA's proposed remedy.[148] The difference -- a greater than 10% reduction in flux -- is indeed significant.

Furthermore, regardless of the uncertainty of the model in predicting absolute values, GE acknowledges that the model can be used to compare remediation alternatives. Comparing the model results, it is clear that EPA propose remedy of sediment removal followed by the placement of Engineered Capping performs better than MNR with regard to fish tissue concentrations, regardless of whether or not it performs exactly three times higher or twice as high as GE claims[149], and it performs better in reducing the downstream flux of PCBs.

In sum, for Reach 7 Impoundments, EPA properly analyzed the suitability of different alternatives (including requiring removal of contaminated sediment above 1 mg/kg) considering the risks posed by the high concentrations of PCBs in the Reach 7 sediment, and an evaluation of the relevant permit criteria, including the long-term reliability and performance of different options. EPA considered the increase in greenhouse gases, truck traffic and cost of its proposed remedy compared to TLC (or MNR). In its evaluation of the Permit criteria, EPA concluded that the benefits of the proposed remedy outweigh these considerations and the best suited remedy based on an evaluation of all of the remedy selection criteria is excavation sufficient to allow for Engineered Capping, along with flexibility for GE to propose different excavation approaches or to respond to proposals for dam removal.[150]

[146] *See* September 9, 2008 letter from Susan Svirsky to Andrew Silfer, RE: EPA comments on GE's March 2008 Corrective measures Study report, at 5, footnote 1

[147] Attachment F to GE's Comments, Figures F2a through F2d. For example, at the Glendale impoundment, an additional three IMPGs are achieved with EPA's proposed remedy compared to MNR in Reach 7.

[148] GE's October 2014 comments on EPA's Draft RCRA Permit at IV.B at 49.

[149] GE 2014 Comments, at 46 (Table).

[150] Intended Final Decision, Section II.B.2.f.

d. Rising Pond:

Requirements: Rising Pond is approximately 32 miles downstream from the confluence of East and West Branches, immediately downstream of Reach 7. Rising Pond Dam is the last significant dam in Massachusetts prior to the River flowing into Connecticut. GE's PCB contamination has been deposited in sediment behind the Rising Pond dam, is posing unacceptable risks to human health and the environment, and is contributing to the downstream transport of PCBs.

EPA's proposal for addressing GE's PCB contamination in Rising Pond (which is known also as Reach 8) includes a combination of sediment excavation and Engineered Capping to achieve average concentrations of 1 mg/kg; the option for GE to excavate sediments to a 1 mg/kg average level without capping; ensuring protectiveness through monitoring and potential excavation if over time sediments accumulate in Rising Pond; and ensuring that remediation activities do not result in a loss of flood storage capacity or increase in water surface elevation.[151]

GE Position: GE argues that the remedy does not have significant risk-based benefits compared to a remedy that removes less sediment than proposed by EPA. In its SOP, GE suggests an alternate remedy of sediment removal of six inches in the shallow area of the Pond followed by placement of an Engineered Cap over the entire Pond.[152] With respect to fish consumption risks and downstream transport of PCBs, GE argues that the proposed remedy is not significantly better than GE's suggested alternative, has more short-term impacts, and higher costs. GE also questions EPA's asserted concern about the potential breach or failure of Rising Pond dam.

EPA Position: EPA concurs that GE's alternative of partial dredging and installation of an Engineered Cap performs similarly to EPA's proposed remedy of dredging sufficient sediment to place an Engineered Cap back to existing grade. This is because they are essentially the same remedy, with the only differences being that (a) GE wants to lock in an Engineered Cap thickness of six inches in the Permit, as opposed to determining the cap thickness in accordance with the Engineered Cap Performance Standards during design,[153] and (b) GE resists removing sediment prior to capping, which would increase potential for flooding.

EPA disagrees with both of these concepts. Placing the Engineered Cap on top of existing sediment could change the hydrodynamics of the system, result in the loss of flood storage capacity and increase water surface elevations and associated flooding. With regard to

[151] Intended Final Decision, II.B.2.g. Description in this Statement of Position is general; see Intended Final Decision for precise details.
[152] GE SOP, at 21, with additional information at 50-51 of Section IV.C of GE's October 2014 comments on EPA's Draft RCRA Permit. However, note that in GE's 2010 Revised CMS, GE stated that it believed SED 10 best met the Permit Criteria. SED 10 calls for MNR in Reach 8, not the capping remedy GE mentions in its SOP.
[153] In estimating volumes and cost for its proposed remedy, EPA estimated cap thicknesses, and associated sediment removal depths, of 1 foot low shear stress areas and 1.5 feet in high shear stress areas. (Attachment 6 of Comparative Analysis). However, as required by the permit, actual cap thicknesses will be determined during design.

locking in Engineered Cap thicknesses as part of the Permit, see EPA's response in this Statement of Position in Section III.A.2.f (Engineered Cap).

GE also downplays the potential for dam breach or failure due to its current ownership of Rising Pond. But Rising Pond Dam itself, in 1992, had a significant release of PCBs downstream into Connecticut. This event, demonstrates that dam breach or failure is a serious risk that EPA was correct to consider.[154] While the dam was not under GE ownership at the time of the breach, it was subject to management under the terms of the Massachusetts dam regulations which GE has claimed prevent such an event. In fact, there have been subsequent issues regarding the stability of the dam since GE became the owner.[155] Given the catastrophic and unexpected infrastructure failures observed during Hurricanes Katrina and Sandy as well as other concerns regarding climate change, this is not the unrealistic concern that GE claims.

GE also points to potential adverse effects of the proposed remedy, such as greenhouse gas emissions, truck traffic and cost. Admittedly those are higher for the proposed remedy than other, less active alternatives. At the same time, those adverse effects and costs are even higher for other alternatives that EPA has analyzed and not proposed. EPA evaluated those effects, and other relevant Permit criteria in proposing a remedy to address the risks of PCB contamination in Rising Pond. EPA's proposal includes significant reduction in PCB risks in Rising Pond and in the downstream transport of PCBs, in combination with flexibility for GE to propose an alternative approach to remediation, and without the drawbacks associated with locking in cap thicknesses prior to a design evaluation, and lack of accounting for flood storage capacity water elevation.

To address the risks posed by the high concentrations of PCBs in Rising Pond sediments, EPA properly analyzed the suitability of different alternatives in its Comparative Analysis, including alternatives requiring removal of considerably more or considerably less sediments than the proposal. The remedy proposed by GE in its Statement of Position is new, and therefore it has not been analyzed to the same degree as the alternatives reviewed by EPA in the remedy proposal. However, as described above, the unique components of the GE approach ("locking in" cap thicknesses now, and placing a cap on top of sediments without taking flood storage capacity or water elevation into account), while likely making the approach cost less, also make it less well suited as a potential remedy. Based on its evaluation, EPA continues to believe that the proposed remedy is the best suited remedy based on an evaluation of all of the remedy selection criteria.

e. Backwaters adjacent to Reaches 5, 6, and 7:

Requirements: The PCB contamination from GE's facility extends into the backwaters of the Housatonic River ("Backwaters"), resulting in unacceptable human health and ecological risks. EPA's proposed remedy includes three main elements: excavation and capping of Backwaters to achieve a Surface Weighted Average Concentration (SWAC) of 1.0 mg/kg; limited excavation and capping of Core Area 1 habitat coupled with use of Activated

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[154] *See* discussion in this Statement of Position regarding Rising Pond Dam breach, at 21.
[155] Right Embankment Sinkhole Investigations and Test Pit Explorations, prepared by GZA for GE, 2009.

Carbon to reduce risks; and ensuring that the remedy activities cause no net loss of flood storage capacity.

GE Position: GE seeks a less costly remedy that provides fewer risk-based benefits than EPA's proposal. GE argues as follows: (1) that the fish habitat in the Backwaters is poor, including an argument that EPA's model results show similar fish PCB concentrations in the main stem regardless of whether Backwaters sediment is remediated; (2) that EPA should have proposed a less extensive removal and capping alternative (i.e., removal and Engineered Capping to achieve a SWAC of 3.3 mg/kg)[156] that would achieve Short-Term Biota Performance Standard, would be protective of human direct contact with sediments, and provides for protection of amphibians, with fewer adverse impacts and at less cost.

EPA Position: Overall, EPA's remedy is a reasonable solution to addressing the PCB risks posed by GE's PCBs in the Backwaters, with significantly greater risk reduction than GE's approach while concomitantly minimizing adverse impacts. More specifically, EPA disagrees with GE's assertions.

First, EPA disagrees with GE on the quality of the Backwaters as a fish habitat based on fish collections and other field work conducted during the course of the Housatonic River Project. In 2000, EPA conducted a study to determine fish biomass in the various subreaches of the river between the Confluence of the East and West Branches (the starting point for the "Rest of River" area) and Woods Pond Dam.[157] The study used standard fish capture methods and established statistical techniques to estimate biomass by species and size (fish length; largemouth bass estimates were made by age class) for Reaches 5A, 5B, 5C, Backwaters (subsequently designated Reach 5D) and Reach 6 (Woods Pond). Two field collections were made, one of which was conducted at the end of August, a period of annually elevated temperatures and associated low dissolved oxygen levels in the Backwaters. The results of the study clearly indicated that the Backwaters support substantial species richness and biomass (per unit area, expressed in grams per square meter [g/m^2]) of fish species. For example, largemouth bass biomass in the Backwaters was estimated at 1.88 g/m^2, which was more than Reach 5A (1.65 g/m^2) and nearly triple the largemouth bass biomass per unit area found in Woods Pond (0.71 g/m^2). Highest densities of largemouth bass, both of which were less than double the biomass supported in the Backwaters, were in Reaches 5B (2.28 g/m^2) and 5C (2.89 g/m^2).

The Backwaters were similarly shown to support considerable biomass of yellow perch (1.51 g/m^2); lower than the biomass in Reach 5B (2.7 g/m^2), but comparable to the biomass in Reach 5C (1.9 g/m^2) and Woods Pond (1.61 g/m^2), and higher than Reach 5A (0.92 g/m^2). For sunfish (bluegill and pumpkinseed combined), the Backwaters supported the highest biomass of all reaches (3.91 g/m^2), greater than Woods Pond (2.45 g/m^2) and all of Reach 5 combined. The Backwaters also provide habitat for brown bullhead (0.97 g/m^2) – less than the biomass supported by Woods Pond for this species (1.68 g/m^2) but much greater than all of Reach 5 which is generally not good habitat for brown bullhead. These survey results clearly indicate

[156] Note that in GE's Revised CMS, GE's selected alternative SED 10 as the remedy that best meets the permit Criteria. SED 10 called for Monitored Natural Recovery in Backwaters. GE's remedy of 3.3 mg/kg with Engineered Capping was not included in GE's Revised CMS, so was not evaluated along with the other alternatives in the Revised CMS.

[157] Woodlot Alternatives. 2002. *Fish Biomass Estimate for Housatonic River Primary Study Area*.

that, far from not providing good habitat for fish, the Backwaters provide very good habitat and support significant biomass of the species typically sought by anglers, and therefore the species most likely to be consumed.

GE performed its own study during June and late-July/August 2000 of the distribution and characteristics of the largemouth bass population throughout the Upper Housatonic River. The report states that:

> "As discussed in Section 4.2, a detailed aquatic habitat assessment was conducted in 2000 for the mainstem Housatonic River and its associated Backwaters, the three main branches to the upper Housatonic River, and the major tributaries. This assessment focused in particular on evaluating the suitability of the habitats for largemouth bass.…This assessment showed that, within the mainstem Housatonic River, suitable largemouth bass habitat is abundant in Woods Pond, *in shallow backwater areas*, and in the ponds and wetlands that are hydrologically connected to the river (Figure 5-1) …The distribution of largemouth bass was consistent with our delineation of identified largemouth bass habitat. Largemouth bass were found throughout the mainstem habitats and in the study sites in the East and West branches of the Housatonic River (Appendix D, Table D-2). Largemouth bass were most abundant within these sites *in shallow backwater areas* and near or in accumulations of downed wood…Overall, CPUE [catch per unit effort] of young-of-year *largemouth bass in backwater habitats* was greater than 6 times the CPUE in main channel habitats." [158] (Emphases added).

Furthermore, even if temperature and dissolved oxygen conditions result in the Backwaters becoming unacceptable habitat during some small portion of the year, an assessment that EPA does not necessarily agree with, fish are free to move from the Backwaters to the main stem and then return to the Backwaters when conditions improve. Remediation of the main stem alone, therefore, would not be sufficient to adequately reduce the exposure of fish to PCBs.

In addition, the EPA model alone is not determinative on the fish tissue concentrations. The model does not simulate migration of fish to and from the Backwaters. Thus, the only effect on tissue concentrations of fish resident in the main stem that would be seen in a model simulation would be from movement of PCBs from the Backwaters into the adjacent sections of the main stem, which would not be expected to affect the fish tissue concentrations significantly. Therefore, because fish do in fact spend time in the Backwaters and move back and forth into the main stem, the model projections for the main stem would underestimate the PCB concentrations in fish if Backwaters were not remediated.

In response to GE's second argument, EPA disagrees with GE's characterization. EPA's proposal provides significantly improved protection from fish consumption risks, while at the same time including multiple measures to reduce adverse effects.

[158] R2 Resource Consultants, Inc. 2002. Evaluation of Largemouth Bass Habitat, Population Structure, and Reproduction in the Upper Housatonic River, Massachusetts.

The comparison in average fish fillet concentrations between EPA's proposal and GE's alternative is 0.3 ppm versus 0.8 ppm, respectively,[159]which is very significant in terms of risk to human health from fish consumption as well as to ecological receptors. That comparison shows that GE's alternative would result in almost three times the concentration of PCBs in fish compared to EPA's alternative. In addition, while both alternatives meet the Short-Term Biota Performance Standard of 1.5 mg/kg, EPA's proposal makes much more progress toward achieving the Long-Term Biota Monitoring Performance Standard levels of 0.064 mg/kg in Massachusetts and 0.00018 mg/kg in Connecticut. (Intended Final Decision, at II.B.1.b.(1)(b)),

Admittedly, achieving those significant risk-based benefits does require more truck traffic and more cost than a less protective remedy. However, EPA's evaluation of remediation alternatives,[160] including more extensive remediation approaches, against the Permit decision-making criteria was not limited to those two items. Based on that reasoned evaluation, EPA has proposed an approach that leads to significant reduction in fish consumption risks and significant progress toward the Permit's Long-Term Biota Monitoring Performance Standards, while demonstrating a sensitive approach toward reducing adverse effects of the cleanup.

f. Engineered Cap:

Requirements: Properly designed and constructed Engineered Caps reduce risks posed by contaminants by physically isolating the contaminated sediments from human or animal exposure, by chemically isolating the contaminated sediments from being transported up into the water column, and by stabilizing contaminated sediment to protect it from erosion, particularly in high-flow situations.[161] In the Intended Final Decision, for each remedy component that calls for Engineered Capping, EPA requires that GE design and construct all Engineered Caps consistent with the Performance Standards, including the principles presented in pertinent EPA or U.S. Army Corps of Engineers guidance such as EPA's 2005 "Contaminated Sediment Remediation Guidance for Hazardous Waste Sites", and the U.S. Army Corps of Engineers' 1998 "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments."

The Intended Final Decision further provides that GE's design include a set of layers or functions commonly part of cap designs, including the following: a Mixing Layer; a Chemical Isolation Layer; an Erosion Protection Layer; a Geotechnical Filter Layer; a Bioturbation Layer; a Habitat Layer; and other consider design considerations.[162]

[159] EPA cannot independently verify the accuracy of GE's model runs, however, since GE ran the model consistently for both alternatives, the relative performance of EPA's proposed remedy vs. GE's alternative is likely accurate, even if the predictive fish tissue results vary from GE's figures.

[160]As noted above, GE's remedy of 3.3 mg/kg with Engineered Capping was not included in GE's Revised CMS, so was not evaluated along with the other alternatives in the Revised CMS. However, as discussed in the text, EPA continues to believe the proposed remedy for Backwaters is still the best suited alternative.

[161] EPA Contaminated Sediment Remediation Guidance, Section 5.1, December 2005.

[162] Intended Final Decision at II.B.2.i.(1) and (2). This Statement of Position provides a general description of the Intended Final Decision Performance Standards and corrective measures; for precise requirements, see Intended Final Decision.

GE Position: GE argues that EPA's proposal is deficient because of the following: (1) EPA failed to account for GE information that thinner caps than EPA estimated could be sufficient, and (2) EPA failed to agree with specified target thicknesses that GE has proposed.[163]

EPA Position: EPA disagrees. EPA did consider the information GE presented, however, it chose not to incorporate GE's proposal to lock in thinner cap layers or set target cap thicknesses in the Permit. EPA believes, and has consistently held, that it is critical that the decisions on the thicknesses of different cap components take place during the design of the remedy. The design phase is the appropriate time for determining Engineered Cap thicknesses because it is expected that the design will occur in phases, thereby providing sufficient time to collect additional data. Additional data will contribute to an adaptive management approach that can be used to incorporate lessons learned, and/or new materials, techniques, and/or equipment that become available in the future to improve the cap design.

EPA noted in its September 9, 2008 comments on GE's CMS that "EPA recognizes that it was appropriate to evaluate remedy components on a reach-wide basis in the CMS but notes that it will be necessary and appropriate in the final design to implement different remedies for smaller sections of a floodplain area or reach with unique characteristics." Further, EPA noted that

> the thickness of an engineered cap (and associated depth of excavation, if required), whether placed with or without prior removal, should be determined in final design based on site-specific requirements using factors such as described in White Paper No. 6B – In-Situ Capping as a Remedy Component for the Lower Fox River (Palermo et al, 2002) and other applicable guidance. The design should consider the underlying sediment PCB profile and associated needs for chemical isolation as well as the need for physical stability. GE shall provide a description of the design process (such as that described in Palermo et al, 2002) that will be used to determine the appropriate cap materials and thickness of materials to be placed.

In addition, in May 2012, EPA's Status Report on potential remediation approaches to the Rest of River provided: "In any proposed remedial approach, EPA would tend to specify certain cap design principles and performance standards, but not a particular material thickness."[164]

Thus, EPA has been clear throughout the CMS and remedy selection process of its expectations regarding the appropriate time and scale for the details of cap designs. GE

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[163] In its 2014 Comments on the Draft Permit Modification, GE advocated for its target thicknesses, and implied that EPA also had proposed target cap thicknesses in its proposed remedy. While GE acknowledges in that submittal that "[t]he Region indicates that the actual design and thickness of caps would be determined during remedial design", GE suggests that EPA has its own target thicknesses in the Comparative Analysis. However, EPA only included any thicknesses "for purposes of this comparative analysis" to compare alternatives and to develop cost estimates. Comparative Analysis at 2. In any event, the Intended Final Decision does not include any suggested or target cap thicknesses.

[164] EPA 2012 Status Report at 6.

essentially acknowledged this approach in its Revised CMS. Various parameters for Engineered Capping were described by GE in Section 3.1.3 of the Revised CMS, and values for cap thickness and cap composition (materials) were assumed for the caps in various reaches of the river and for various alternatives evaluated to provide the basis of comparison of the alternatives. These assumptions, which included cap thickness ranging from 1.5 to 2 feet, were used to estimate sediment removal volumes, cap material volumes, costs, construction timelines, and other considerations for comparison of the alternatives. At the feasibility stage of evaluation, it is standard procedure to use assumptions regarding the cap design in order to evaluate the feasibility and potential cost of capping components of a remedy. This feasibility evaluation provides the basis for comparing the alternatives against the criteria and selecting a proposed plan. During the technical discussions between GE and EPA in 2012/2013, GE raised the issue of potentially establishing thinner caps in the Permit, including potential caps as thin as six to nine inches, as opposed to making cap thickness decisions during the design stage.

During design, it will be necessary to include the timely collection of information on an appropriate scale for the detailed engineering evaluations needed to support the design. For example, in a given mile or two stretch of the river there can be significant variation in sediment bottom topography and substrate type, water depth, PCB concentrations, and aquatic habitat that currently exist and which may also change over the course of remedy implementation. These fine-scale details need to be identified, researched through data collection, and then the appropriate engineering considerations need to be applied to derive a cap design for each area that best meets the Engineered Cap Performance Standards for those conditions.

EPA also disagrees on the appropriateness of setting ‘target thicknesses” in the Permit for “confirmation” during remedial design. That approach would establish expectations that would not be consistent with performing an unbiased review during remedial design of the important considerations for protective and functioning Engineered Caps. The target thickness approach would likely “anchor” or skew the resulting remedial design toward those “target” levels for confirmation, rather than allowing for an unbiased analysis.

Additionally, the target thickness approach is misguided here because technical reviews raised serious questions about GE’s “targets”. As stated above, EPA did consider GE’s input. During the 2012-2013 technical discussions between EPA and GE, when GE requested that EPA perform a technical review of a proposal similar to GE’s current proposal for caps with defined thicknesses. In May 2013, EPA obtained review by a number of experienced persons from academia, EPA and the U.S. Army Corps of Engineers. The technical reviews generated many questions regarding the protectiveness of the approach favored by GE.[165] Examples of concerns with GE’s approach include the following:

[165] Documents include: May 31, 2013, EPA, “Initial Review of GE’s Conceptual Design”, summarizing reviews from U.S. Army Corps of Engineers, Paul Schroeder and Trudy Estes, ERDC; University of Texas, Dr. Danny Reible; EPA (Region 1 and OSWER/OSRTI); May 28, 2013, “Technical review of Housatonic River conceptual cap design”, Trudy J. Estes, and Paul R. Schroeder, Research Civil Engineers, US Army Engineer Research and Development Center; May 29, 2013, “Review of Capping Design Proposal for GE/Housatonic River”, Danny D. Reible, PhD, PE.

- there was concern that GE's proposed bioturbation layer cannot also serve as the key component of the chemical isolation layer;
- GE's proposed 6-inch cap includes a 2-inch mixing layer and a 4 inch bioturbation layer, but no specific chemical isolation layer;
- a separate isolation layer of 7-9 inches is needed to ensure cap effectiveness.
- there are areas where the conceptual design is not appropriately conservative,
- concerns over improper evaluation of habitat layer restoration;[166]
- focusing attention on the need for additional design-level data prior to making a decision, such as: erosional forces issues need to be evaluated in Woods Pond and other areas with significant fetch; site-specific data be collected prior to final cap design; and GE's use of average velocities over large-scale areas underestimates the erosional forces.[167]

Those third party concerns reinforce EPA's judgment that the design of Engineered Caps at the Rest of River should be undertaken during the remedial design process, unbiased by preconceived notions of particular target thicknesses.

EPA has long recognized the significance of cap thickness to the amount of removal of contaminated soils and sediments, and the resulting impact on disposal costs. To reiterate EPA's 2012 Status Report, EPA expects that during remedial design GE will seek to optimize cap design to reduce the amount of PCB-contaminated material that requires disposal. Anticipating that scenario, EPA's Engineered Cap Performance Standards represent a reasonable technical approach to ensure that the eventual design, construction and operation of the caps is protective of human health and the environment. It avoids potentially biasing the design and affords GE the opportunity to propose, subject to EPA approval, a cap design consistent with the Engineered Cap Performance Standards.

g. Off-Site Disposal

Requirement: The Intended Final Decision requires that GE dispose of all sediment and soil removed as part of the remedy at licensed off-site disposal facilities.

GE Position: GE argues that the requirement violates the Decree and is unlawful because it would cost more than on-site disposal and would be no more protective of human health and the environment.

EPA Position: For the Rest of River, off-site disposal is more protective of human health and the environment for several reasons, and is less costly than other alternatives considered and rejected by EPA. It is a sound decision under the Decree, was developed according to the process set forth in the Decree, and is based upon an analysis of the relevant

[166] May 31, 2013, EPA, "Initial Review of GE's Conceptual Design", summarizing reviews from U.S. Army Corps of Engineers, Paul Schroeder and Trudy Estes, ERDC; University of Texas, Dr. Danny Reible; EPA (Region 1 and OSWER/OSRTI).
[167] *Id.*

criteria and the administrative record. For example, without limitation, (1) permanent on-site disposal at one of GE's preferred locations would not meet TSCA landfill siting requirements and/or require waiver of ARARs designed to protect wetland habitat and/or an ACEC; (2) unlike on-site disposal, off-site disposal does not entail the potential siting of a new landfill in an area that may not meet all the suitability requirements for such a landfill, such as proximity to drinking water sources, hydrology, and soil permeability; (3) on-site disposal would require the creation of a new landfill in an area with no known contamination whereas off-site disposal will place contamination in a pre-existing area licensed to accept hazardous substances; (4) on-site disposal faces significant state and local opposition that threatens the implementation of the remedy; and (5) while off-site disposal is more expensive than on-site disposal, it is less expensive than other alternatives requiring the treatment of contamination. In sum, based on EPA's review of the relevant criteria and the Administrative Record, off-site disposal is best suited to meet the general standards outlined in the Permit, in consideration of the Permit's decision factors, including a balancing of those factors against one another.

i. EPA's selection of off-site disposal is supported by the nine permit criteria and the administrative record.

GE claims that EPA concedes that off-site disposal would be no more protective to human health and the environment than on-site disposal. GE SOP at 6. On the contrary, EPA does favor off-site disposal in terms of protectiveness. In addition, and even more significantly, GE treats cost and protectiveness as the sole criteria for decision-making, when they are only two of the nine Permit criteria that EPA evaluated. When viewed in that context, off-site disposal is clearly the best suited disposal option.

One of the Permit factors EPA considered in selecting the remedy is its implementability, including coordination with other agencies, regulatory and zoning restrictions, and availability of suitable facilities. Long-standing and active opposition to on-site disposal threatens the Rest of River remedy with lengthy litigation and community resistance. By proposing off-site disposal, EPA avoids these road-blocks, rendering the entire remedy more likely to be promptly implemented and in that respect more protective of human health and the environment. EPA acted in a manner consistent with the Decree in considering public and governmental objections to on-site disposal because these objections are relevant to the implementability criterion listed in the Permit. In addition, the Decree allows EPA to consider any relevant evidence in the administrative record, including the overwhelming number of public comments opposing on-site disposal. Moreover, the Decree offers multiple public participation opportunities, and these would be meaningless if EPA could not consider the views of the public in remedy selection.

Apart from implementability, EPA also considered the other relevant Permit criteria, including cost. For example, in evaluating long-term reliability and effectiveness, EPA evaluated the suitability of the proposed on-site landfill locations, considering the fact that GE did not establish that the proposed locations were suitable in light of soil permeability, hydrology, and proximity to potential drinking water sources and the Housatonic River. Similarly, EPA recognized that the Woods Pond and Forest Street locations would require the waiver of ARARs designed to protect an ACEC and/or wetlands habitat. EPA further considered the suitability of a pre-existing licensed off-site disposal location in comparison with creating a new on-site landfill and potentially disturbing the habitat in an area with no known contamination. EPA also considered disposal alternatives that might have reduced PCB mobility, volume, or toxicity -- one of the nine criteria -- but these treatment alternatives were more expensive than off-site disposal and were rejected. Overall, EPA determined that off-site disposal is the best alternative under the relevant criteria because it will provide improved implementability, increased long-term reliability and effectiveness, compliance with ARARs, and be more protective of human health and the environment. Collectively these benefits outweigh off-site disposal's higher cost and the increased short-term impacts from the remedy.

ii. EPA's consideration of public and state opposition was well within the legal framework for the remedy selection process.

GE argues that EPA's off-site disposal requirement "conflicts with the Consent Decree's remedy selection criteria and is unlawful." In fact, EPA appropriately considered public and government opposition to on-site disposal. First, the text of the Decree and Permit authorize EPA to consider public and State views in evaluating alternatives, and second, the community and State views are a significant part of the Administrative Record that the Permit directs EPA to consider.

a.. *Consideration of Public and State Views Fits Squarely within the Permit Criteria*

EPA's consideration of public or governmental comment is supported by the Permit and Decree. The procedures outlined within those documents encompass consideration of community, local government, and state views. The Permit directs GE to consider each remedial alternative according to nine criteria that provide the standards for corrective measures.

Within the nine criteria set forth in the Permit, it is permissible to consider state and local opposition because they fall within the "implementability" criterion, Permit Section II.G.2.e. GE argues that EPA is reading state and community opposition into the "implementability" remedy selection criterion. But to implement means to "put into effect," or "to carry out."[168] The public and legal opposition to on-site disposal is squarely within the plain meaning of the term "implementability" because it will jeopardize EPA and GE's ability to carry out the entire remedy.

Those who oppose on-site disposal have several mechanisms to severely delay or block implementation of the remedy. The Decree itself recognizes the Commonwealth's right to appeal the remedy pursuant to 40 C.F.R. § 124.19 before the EAB and Section 7006(b) of RCRA before the 1st Circuit.[169] But the Commonwealth is not the only party with this right. In fact, any party that commented on the draft permit or participated in a public hearing on the draft permit may petition for review of the permit before the EAB. 40 C.F.R. § 124.19. Similarly, under Section 7006(b) of RCRA, "any interested person" may seek review of a permit modification under the Administrative Procedures Act in the relevant Circuit Court of Appeals. Even after these appeals were exhausted, the Commonwealth or local governments could pass new legislation or regulations to bar on-site disposal, which may have to be defeated through litigation before the remedy could proceed.

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168 Pocket Oxford American Dictionary and Thesaurus, Third Ed., 2010, at 403.
169 Decree Paragraph 22.bb.

EPA's reading of the term "implementability" is further informed by several of the subsections listed in the permit under implementability. Subsection 6, "coordination with other agencies," would include the many comments from Massachusetts agencies, and local municipalities and towns opposing a local landfill. The ACEC designation and the solid and hazardous waste site restrictions fall within Subsection 3, "regulatory and zoning restrictions." Finally, public and governmental opposition bears upon Subsection 7, the availability of "suitable on-site or off-site treatment, storage, and disposal facilities and specialists," because if all on-site landfills are strongly opposed by the community, the suitability of those sites is compromised.

EPA's interpretation of the nine permit criteria takes into account its CERCLA and RCRA guidance documents. These guidance documents call for EPA to consider state and local acceptance in remedy selection. The National Contingency Plan, which is the set of regulations governing Superfund cleanups, includes "state and community acceptance" as "modifying criteria that shall be considered in remedy selection."[170] In accordance with this regulation, EPA's Superfund Community Involvement Handbook notes "The agency may alter the preferred alternative or shift from the preferred alternative to another if public comments or additional data indicate that these modifications are warranted."[171]

As in CERCLA, EPA's regulations for issuing RCRA permits (along with other types of permits) require public comment and public hearing opportunities on draft permits, allowing EPA to alter the final permit in response to public views.[172] EPA's RCRA Public Participation Manual states, "Public participation plays an integral role in the RCRA permitting process."[173] A guidance document for RCRA corrective action decision documents notes that the response to comments accompanying the final permit decision should include any changes made to the proposed remedy due to public comments.[174]

b. *GE Overstates Potential Limit on Consideration of Community and State Concerns*

As shown above, the Permit criteria explicitly support the consideration of public and State views. Beyond that, even if the Permit criteria did not do so, the Permit does not limit EPA to these criteria in selecting its remedy. When EPA is selecting the corrective measures and performance standards for the Rest of River, the Permit directs EPA to consider the submissions from GE, such as the nine criteria analysis in the Corrective Measures Study report, along with "any other relevant information in the Administrative Record for the modification of this Permit."[175]

Public and governmental comments, minutes of the Citizens Coordinating Council, and other information relating to the many public engagement sessions sponsored by EPA are within the Administrative Record for the modification of the Permit. The Administrative Record also includes EPA regulations and guidance documents, including guidance documents for selection of CERCLA remedies and RCRA corrective actions. As explained below, these

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[170] 40 C.F.R. § 300.430(f)(1)(i)(C).
[171] USEPA, Superfund Community Involvement Handbook, April 2005 at 36.
[172] 40 C.F.R. §§ 124.10 through 124.14.
[173] 1996 Edition, at 2-1.
[174] US EPA, 1991, Guidance on RCRA Corrective Action Decision Documents.
[175] Permit Section II.J.

guidance documents call for consideration of community and state acceptance in remedy selection. [176]

The Decree envisions active public and state participation in the remedy selection process. This public participation would be empty if, as GE asserts, EPA cannot consider the wishes of the community in remedy selection. For instance, Decree Paragraph 22.n calls for EPA to propose the draft permit modification pursuant to EPA's RCRA regulations, "including the provisions requiring public notice and an opportunity for public comment . . ." Similarly, Paragraphs 22.j and 22.k require GE to submit a CMS Proposal and CMS Report to Massachusetts and Connecticut. Comment periods and opportunities for coordination with the states would be meaningless if public and state opinions were irrelevant to remedy selection. EPA's consideration of public or governmental comment is required by the Decree and Permit and the procedures outlined within those documents encompass consideration of community, local government and state views.

Additional support for the need for state and community concerns to be considered comes from EPA's 1996 RCRA Advanced Notice of Preliminary Rulemaking ("Notice"). [177] At that time, EPA's national RCRA corrective action program championed strong public participation at the same time as proposing use nationally of Corrective Action Permit criteria similar to those being used in the Rest of River permit. The 1996 Notice stated that "EPA is committed to providing meaningful public participation in all aspects of the RCRA program, including RCRA corrective action" and that among EPA's key goals and implementation strategies for corrective action was to "Continue to involve the public in all stages of the corrective action process."[178] In that same Notice, EPA proposed to implement RCRA corrective action remedy selection through use of ten remedy selection criteria, none of which were Community Acceptance or State Acceptance.

Admittedly, the Permit does not explicitly list public and state acceptance as individual stand-alone remedy selection criteria. Nonetheless, the Permit's detailed description of the Implementability criterion, such as its specific subsections on coordination with other agencies, regulatory and zoning restrictions, and availability of suitable on-site or off-site treatment, storage, and disposal facilities and specialists, clearly is meant to accommodate public and State views. Moreover, to interpret the nine criteria otherwise leads to a result totally inconsistent with EPA guidance, the clear direction of the Decree, and RCRA and CERCLA desire for public participation. Moreover, it cannot be considered arbitrary for EPA to follow its own RCRA and CERCLA guidance in interpreting the permit criteria, and to follow the Permit direction to factor in any relevant information in the Administrative Record, in selecting the remedy. If GE intended for EPA to depart from this longstanding EPA practice codified in EPA's RCRA and CERCLA regulations, GE should have negotiated for an explicit prohibition in the Decree or Permit, but there is no prohibition in these documents. In short, far from being "arbitrary," EPA's decision to consider public and state views on the disposal alternatives was

[176] The National Contingency Plan includes "state and community acceptance" as modifying criteria. 40 C.F.R. § 300.430(f)(1)(i)(C).
[177] The negotiations on the Decree and Appendix G, the RCRA Corrective Action Permit, began in 1998, and the Decree was lodged in U.S. District Court in 1999.
[178] 61 Fed. Reg. 19432.

authorized by the text of the Decree, CERCLA's regulations, RCRA guidance, and overall EPA policy.

iii. Opposition to a new local PCB landfill has been persistent and vigorous.

GE stands alone in its advocacy of on-site disposal. Local communities and governments strongly oppose on-site disposal of PCB-contaminated material in Berkshire County. EPA has encountered this opposition from numerous Berkshire County residents, community groups, municipalities along the Housatonic, and from Massachusetts government agencies. Many residents worry about the risks posed by a PCB landfill in Berkshire County, and public opposition only intensified after GE's disposal of PCBs at the "Hill 78" landfill near a Pittsfield elementary school. Community groups have historically taken legal action to contest EPA's choices related to the cleanup. Citizens nominated, and the Commonwealth designated, the Upper Housatonic as a protected area, which activated a state prohibition on permanent landfills. EPA has encountered similar levels of resistance in other site cleanups across the country; such intense public and governmental opposition to on-site disposal threatens to delay and/or altogether block completion of the Rest of River Remedial Action. Berkshire County residents have expressed their objections to siting a new PCB landfill in their community in hundreds of public comments, protests at public meetings, and letters to newspaper editors over the last decade. For example, residents submitted comments to EPA identifying this widespread sentiment, saying that creating a landfill in Berkshire County "is unacceptable to the people of this county,"[179] And "will not be tolerated by its populace."[180]

A common theme among commenters has been a concern about the ongoing negative environmental effect of a dump or landfill in Berkshire County, which has already endured decades of impacts from GE's contamination. The Planning Board for the town of Great Barrington wrote that it "believes that there is tremendous potential for serious and long-lasting environmental and economic damage to the Town of Great Barrington if this [PCB landfill] is forced on the Town."[181] Tim Gray, Executive Director of the Housatonic River Initiative, wrote, "Toxic hazardous waste dumps will be dangerous to residents, [affect] property values, and be terrible for our tourism industry."[182] Ann Gallo asked pointedly, "GE continues to be unaware of, or are deliberately overlooking the impact of their thoughtless, offensive choices. […] Why, yet again, do they leave behind their waste on a struggling county?"[183]

In some cases, public comments were informed by the Hill 78 controversy. As part of the non-Rest of River cleanup, the Decree allowed GE to use a pre-existing landfill located on the former GE facility to dispose of soil and sediment excavated in remediating the Site. This historic landfill, called "Hill 78," was across the street from Allendale Elementary School. Residents turned out in force to voice their concerns about placement of additional material at Hill 78. Nearly 85 residents attended a public meeting at the Allendale School[184] Community

[179] Comment from Jeffrey Leppo, M.D. to US EPA (Apr. 10, 2008), SDMS 289634.
[180] Comment from John Messerschmitt to US EPA (Apr. 9, 2008), SDMS 289634.
[181] Comment from Town of Great Barrington Planning Board to US EPA (Jan. 29, 2011), SDMS 477441.
[182] Comment from Tim Gray to US EPA (Jan. 30, 2011). SDMS 477441.
[183] Comment from Ann Gallo to US EPA (Dec. 4, 2010), SDMS 477441.
[184] Jack Dew, *PCB Dump Looms Over Allendale Elementary School,* Berkshire Eagle, Oct. 23, 2005. Dew describes the scene at this meeting: "Dozens raised their hands and several shouted questions, asking 'Would you let your children play here?' 'Would you live next to the dump?'"

groups arranged independent testing of the school's air filters.[185] All 11 Pittsfield pediatricians signed a letter to the Pittsfield mayor noting concern over airborne PCBs reaching Allendale students from Hill 78 disposal activities and stating, "We urge the community to aggressively pursue options that will further reduce or eliminate the risk to our children."[186]

The "Hill 78" controversy galvanized citizens to oppose any future PCB landfills in the region. For instance, William and Christine Coan, Pittsfield residents, "strongly urge[d]" EPA to oppose an upland disposal facility in Berkshire County: "In light of the community uproar generated by the disposal dump located behind Allendale School in Pittsfield, we would suggest that the project would be delayed for years as communities utilized all political and legal means available to keep such a dump out of Berkshire County."[187] Similarly, Peter Lafayette wrote that he has "fierce opposition to GE's proposal to create another toxic landfill in Pittsfield or Berkshire County. The recently created Hill 78 contains PCB waste and has become a battleground for residents. To suggest that another PCB landfill is to be considered for Pittsfield or Berkshire County is outrageous."[188]

Massachusetts has also declared vigorous disapproval of a new local landfill in public comments and meetings with EPA officials. From 2007 through 2014, EPA received comments from seven offices within the Commonwealth of Massachusetts, including the Departments of Fish and Game, Environmental Protection, Conservation and Recreation, and Public Health, advocating against disposal within Massachusetts. For example, the Commissioners of three Commonwealth offices wrote that "[t]he Commonwealth vigorously opposes two disposal options outlined in the revised CMS that call for disposal of removed material to be sited within Berkshire County" because:

> Installation of a disposal facility in Berkshire County would also have extremely negative impacts to the communities surrounding the facility including economic aesthetic, recreational,and potential health impacts should the facility fail. Further, construction of yet another such facility just expands the number of locations that would be affected by PCB-contamination, requiring additional long-term monitoring, operation and management beyond what is already a long-term burden on the community, and which runs counter to the concept of the anti-degradation provisions incorporated into the Massachusetts site cleanup regulations. [189]

In addition, every Berkshire city or town along the Housatonic (Pittsfield, Lee, Lenox, Stockbridge, Great Barrington, Sheffield, and Tyringham) submitted at least one comment against any additional landfills. For instance, the chair of the Lenox Board of Selectmen wrote: "We find it unacceptable that there could be a new, permanent hazardous waste landfill constructed in our community. We wish to state in very clear terms that such a facility will be vigorously opposed."[190] In 2008, Pittsfield's city council unanimously passed a resolution

[185] Jack Dew, *Allendale Parents Upset at Agencies over PCBs,* Berkshire Eagle, Jan. 22, 2006.
[186] Letter from Siobhan McNally, M.D. *et. al.* to Mayor James Ruberto (May 1, 2006).
[187] Comment from William and Christine Coan to US EPA, (Apr. 3, 2008).
[188] Comment from Peter Lafayette to US EPA, (Apr. 8, 2008).
[189] Letter from Richard Sullivan, Secretary of the Massachusetts Executive Office of Environmental Affairs, et al, to US EPA (Jan. 31, 2011).
[190] Letter from Stephen Pavlosky, Chair Lenox Board of Selectmen, to US EPA (May 15, 2008).

stating its opposition to any upland disposal facility for dredged sediments in the city of Pittsfield or Berkshire County.[191]

In addition to voicing disapproval, the Commonwealth and public have taken action to protect the unique ecosystem of the Upper Housatonic. For example, 43 community members, including several members of the Massachusetts legislature, nominated the Upper Housatonic for designation as an ACEC, in 2008.[192] Nearly 1000 area residents signed petitions supporting this nomination.[193] In response, the Secretary of the Executive Office of Energy and Environmental Affairs designated the Upper Housatonic River as an ACEC in March 2009. [194] This designation automatically activated State-wide environmental protections provided for ACECs to the 13-mile corridor of riverbed, riverbank, floodplain and riverfront land running from Pittsfield to Lee, including the prohibition of siting permanent Solid Waste facilities within or adjacent to ACECs.[195] The Commonwealth later amended its statewide Hazardous Waste Facility Location Standards to prohibit permanent hazardous waste facilities in or adjacent to any ACEC in the Commonwealth.[196]

Several community advocacy groups and the Schaghticoke Nation have sought to shape the Housatonic River remedy, and have opposed on-site disposal. A Citizens Coordinating Council has been meeting since 1998, with participation from groups including Mass Audubon, Berkshire Natural Resources Council, and the Schaghticoke Nation. A community group called the Housatonic River Initiative has sponsored "No More Dumps" conferences and meetings for more than five years. Several of the groups have used legal action to oppose EPA's work at the Site. When EPA moved to enter the Decree in 2000, Housatonic River Initiative, Housatonic Environmental Action League, and the Schaghticoke Nation, among other entities, moved to intervene to overturn the Decree, in part because they opposed the Hill 78 landfill.[197]

EPA's experience at other sites lends credence to its fear that opposition to on-site disposal at the Housatonic will bar completion or timely completion of the remedy. In Bloomington, Indiana, a 1985 consent decree called for the construction of an incinerator to treat the PCB wastes from six area Superfund sites, all contaminated by Westinghouse industrial activities.[198] The public opposed the consent decree but it was entered despite this

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[191] *Politicians Vow to Fight Second PCB Dump*, Pittsfield Gazette, Apr. 10, 2008.
[192] Commonwealth of Massachusetts, Designation of the Upper Housatonic River Area of Critical Environmental Concern, March 30, 2009 ("March 2009 ACEC Designation").
[193] March 2009 ACEC Designation.
[194]March 2009 ACEC Designation.
[195] *Id.*
[196]310 CMR 30.708; also see Proposed Action on Regulations, July 19, 2013; and Regulations Filed with the Secretary of State, Dec. 20, 2013, Massachusetts Register Number 1250. In addition to the normal public hearings on changes to MADEP Regulations at MADEP regional offices, two additional public hearings were arranged for Lenox and Pittsfield. This regulation applies specifically to facilities that manage wastes containing PCBs at concentrations at or above 50 ppm. A potential waiver of these regulations is discussed *infra* at Section C.
[197] Memorandum by Housatonic River Initiative in support of Motion to Intervene, Dkt. No. 20, Feb. 29, 2000; Memorandum by Housatonic Environmental Action League and Schaghticoke Nation in support of Motion to Intervene, Dkt. No. 77, May 19, 2000. Housatonic River Initiative eventually withdrew its Motion to Intervene after it reached a settlement with the US.
[198] United States v. Westinghouse Electric Corp. et al, Civ. Action No. IP83-9-C and IP 81-488-C (S.D. Ind. 1985).

opposition in 1985. At that point, the public successfully lobbied the Indiana legislature to pass laws that delayed construction of the incinerator, in part by forbidding local disposal of the incinerator ash. In 1994 the parties to the decree began to explore alternative remedies. Consent decree amendments memorializing agreements for alternative remedies were entered in 1997, 1998, 1999, and 2008. In the end, cleanup was delayed for over a decade.

Similarly, in New Bedford, Massachusetts, a 1990 Record of Decision selected dredging, on-site incineration, and on-site disposal of incinerator ash for the PCB hotspot in New Bedford Harbor.[199] In response to strong local opposition including a letter-writing campaign and other community activism, in 1993 New Bedford passed a city ordinance banning transportation of the incinerator within city limits in an attempt to prevent the cleanup. Congressional involvement from Representative Barney Frank, Senator John Kerry, and Senator Ted Kennedy, as well as the Massachusetts Department of Environmental Protection convinced then EPA administrator Carol Browner to direct EPA Region 1 to plan a new remedy with community support.[200] The new remedy, selected in a 1999 ROD amendment, included dredging and off-site disposal of hot spot sediments without incineration.[201] In the end, cleanup of this most contaminated area of New Bedford harbor was delayed for nine years.

Having learned from these experiences, EPA takes community opposition seriously in its remedy selection process. In part due to strong public opposition, EPA has chosen off-site disposal at some of the nation's largest PCB-contaminated sediment sites, such as the Hudson River site. There, more than 2.7 million cubic yards of contaminated sediment have already been disposed off-site.[202] EPA has proposed off-site disposal for the anticipated 4.3 million cubic yards of contaminated soil and sediment at the Passaic River Diamond Alkali Site after the public and state of New Jersey expressed opposition to on-site confined aquatic disposal.[203] And at the Lower Fox River site, more than 3.6 million cubic yards of dredged sediments were disposed at off-site licensed and regulated landfills.[204] Taken together, the volume of sediments disposed off-site at these three sites alone exceed the volume of sediments disposed on-site at other sites around the country.[205]

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[199] US EPA, Record of Decision Amendment, New Bedford Harbor Site, Hotspot OU, at 4-7, Apr. 27, 1999.
[200] Troy W. Hartley, How Citizens Learn and Use Scientific and Technical Information in Environmental Decision Making, 10 J. of Higher Ed. Outreach and Engagement, 153, 159-161 (2005).
[201] US EPA, Record of Decision Amendment, New Bedford Harbor Site, Hotspot OU, Apr. 27, 1999.
[202] Telephone Interview with Michael Cheplowitz, EPA Remedial Project Manager (August 2015); EPA First Five Year Review for Hudson River PCBs Superfund Site, June 1, 2012.
[203] Telephone Interviews with Alice Yeh, EPA Remedial Project Manager (August 2015 and January 2016); EPA Proposed Plan for Lower Eight Miles of the Lower Passaic River, Part of the Diamond Alkali Superfund Site, April 2014; Letter from Bob Martin, Commissioner of New Jersey Department of Environmental Protection, to Amy Legare, National Remedy Review Board Chair, Dec. 6, 2012.
[204] Telephone Interview with Jim Hahnenberg, EPA Remedial Project Manager (August 2015); Telephone Interview with Susan Pastor, EPA Community Involvement Coordinator (January 2016); Five Year Review Report for Fox River NRDA/PCB Releases Superfund Site, July 17, 2014.
[205] Based on the volume of on-site sediment disposal identified in Exhibit A to GE's Statement of Position.

iv. **EPA evaluated all the relevant remedy selection factors, not just the factors related to implementability, in proposing off-site disposal.**

It should be understood that EPA considered all the relevant remedy selection factors in proposing off-site disposal, not just the factors related to implementability. For example, EPA considered factors related to cost, protectiveness, control of sources, short-term impacts, compliance with ARARs, and the long-term reliability and effectiveness of GE's proposed upland disposal locations. These points are discussed below.

In EPA's view, GE's proposed upland disposal facilities may be less effective at containing waste than an off-site disposal facility, because the locations selected by GE do not meet TSCA's siting requirements for PCB landfills. [206] GE admits this.[207] For instance, GE acknowledges that none of the three proposed landfill sites meet TSCA's requirements for soil characteristics including permeability[208]. Even more troubling, it notes that none of the three sites meet all of TSCA's requirements for a landfill site's hydrological characteristics, all three sites are located within close proximity to the Housatonic River.[209] By contrast TSCA requires that the bottom of the landfill liner be more than 50 feet above the historical high water table, that groundwater recharge areas be avoided, and that there is no hydraulic connection between the site and a surface waterbody.[210] Similarly, the Forest Street Site would not meet the TSCA requirement that a landfill be located in a relatively flat area to minimize erosion or landslides.[211]

These TSCA criteria are meant to be protective of human health and the environment in the event of leaks or failure in the landfill technology. As explained in EPA's Statement of Basis, "there is the potential for PCB releases to the Housatonic watershed if the landfills are not properly operated, monitored and maintained." Statement of Basis at 36. Moreover, the potential extended duration of the operation of the proposed on-site landfills, given the range of sediment and soil volumes at issue here and the length of remedy implementation, likely necessitates that the proposed on-site facilities operate for an extended period of time.[212] These factors increase the risks of potential future releases to the Housatonic watershed, compounded by the poor suitability of the proposed locations given such factors as soil permeability, proximity to the Housatonic watershed, and/or drinking water sources. Accordingly, use of on-site landfills would "rel[y] heavily on proper long-term operation, maintenance, and monitoring activities." [213]

By contrast, an off-site disposal facility would pose no risk of release to the Housatonic watershed, would be fully licensed and regulated under TSCA and/or other applicable federal and state requirements. Such facilities are generally constructed in the area best suited to that use considering the hydrology and soil characteristics. Here, GE has not been able to identify any on-site locations that would meet the TSCA PCB landfill siting requirements. In addition,

[206] 40 CFR § 761.75(b)(1).
[207] GE's Revised CMS at 9-48 to 9-49.
[208] *Id.*
[209] *Id.*
[210] 40 CFR § 761.75(b)(3).
[211] GE's Revised CMS at 9-49.
[212] Comparative Analysis at 64.
[213] Comparative Analysis at 65.

an off-site disposal landfill will already contain hazardous substances whereas none of the proposed locations identified by GE are known to be contaminated, making them a less suitable alternative.

Compliance with ARARs is also one of the nine criteria, in fact one of the three general standards to be met in a remedy decision. EPA can waive ARARs only under certain specific circumstances, including where compliance is technically impracticable. GE claims that it is arbitrary for EPA to waive ARARs in situations involving the *temporary* storage of hazardous substances on-site but not to do so for the creation of permanent on-site landfills. However, the two situations are not analogous as discussed below.

Excavated PCB-contaminated sediments and soils will likely need to be temporarily stored on-site while awaiting transport to an off-site facility. In terms of temporary storage on-site, under some scenarios, as described more fully in Attachment C to the Intended Final Decision[214]off-site disposal may require a waiver of the Massachusetts regulations that prevent hazardous and solid waste facilities within ACECs, in order to implement the remedy and allow *temporary* storage areas where the waste would be prepared for long distance transport. As discussed in more detail below in Section III.D.7.of this Statement of Position, if those conditions occur and the regulations are applicable to temporary storage, a waiver for temporary storage is appropriate because it is technically impracticable to perform the remedy without temporary stockpiling. All alternatives for disposal and transport of the dredged sediments involve temporary storage. These waivers for temporary storage would not defeat the purpose of the waste facility siting regulations because the storage areas will not result in a permanent landfill, and EPA has established Restoration Performance Standards to ensure the temporarily-used storage areas are restored effectively.

In contrast, permanent on-site disposal at GE's Woods Pond landfill location would require waivers of these waste facility siting regulations because that location is within the ACEC and GE is seeking to place a permanent landfill there. Because the Forest Street landfill location is within a regulated wetland area a waiver may also be required of regulations or requirements designed to protect such areas including: EPA's and the Corps of Engineers' regulations under Section 404 of the Clean Water Act (40 CFR Part 230, 33 CFR Parts 320-323); the federal Executive Order for Wetlands Protection (E.O. 11990); the Massachusetts water quality certification regulations for discharges of dredged or fill material into waters of the U.S. (314 CMR 9.06); and the Massachusetts Wetlands Protection Act regulations (310 CMR 10.53(3)(q)). Likewise, the Rising Pond landfill abuts 25 acres of Priority Habitat for the state-listed Wood Turtle. As a result, further confirmation would be needed to conclude if there are any effects on priority habitat of rare species in the operational area of the landfill, and depending on the significance of such effects, compliance with, or a waiver of, the Massachusetts Endangered Species Act would be required. As another example, GE's proposed sites may not meet the potentially applicable Massachusetts hazardous waste landfill siting criteria, namely its prohibition on siting disposal facilities within 1000 feet of an existing private drinking water well. 310 CMR 30.704, 703(4) 30.010. The Woods Pond location is within 1000 feet of a drinking water well. GE did not investigate whether the other locations were within 1000 feet of drinking water wells.

[214] Intended Final Decision, Attachment C, at pages 11-12.

Since off-site disposal is a practicable alternative, technical impracticability does not provide a basis for these waivers, and there is no other valid basis for a waiver. Furthermore, Massachusetts would likely challenge all waivers related to on-site disposal under CERCLA Section 121(f)(2)(B), as authorized by Decree paragraph 22.bb.i.. During this challenge, the revised permit is stayed, causing significant delay. Decree paragraph 22.bb.ii. All-in-all, the numerous ARAR waivers required by on-site disposal, and the associated implementability challenge associated with Commonwealth appeals of those waivers, weigh against selecting on-site disposal under the nine criteria analysis based on the administrative record.

GE objects to the added cost of approximately $200 to $300 million associated with off-site disposal compared to on-site disposal, depending on the assumed location of the landfill, the transport method for off-site disposal and the rates charged by an off-site landfill at the time of disposal. However, GE fails to recognize that EPA also considered alternative options involving treatment of PCB contamination. While these alternatives included positive aspects such as controlling sources of releases and reduction of toxicity of the contamination – two of the nine Permit criteria -- these treatment alternatives are more costly than off-site disposal, and were rejected. In other words, EPA has hardly selected the most expensive or the most aggressive remedy under consideration.

GE notes that some of the short term impacts from the disposal process itself, namely transporting the waste, are likely to be somewhat higher for off-site disposal. There will be higher greenhouse gas emissions from long-distance transport, and statistics suggest that there could be an increase in injuries or fatalities from traffic accidents. However, GE fails to observe that EPA's modified permit includes a preference for rail transport, which will mitigate greenhouse gases as compared to truck transport.

In addition, community impacts of truck traffic will probably be lower for off-site disposal as compared to on-site disposal for two of the three potential on-site disposal facilities (Forest Street and Rising Pond). Only miles driven on local roads (whether on-site or off-site), as opposed to miles driven on major highways such as the Massachusetts Turnpike, should be considered to impact the local community.[215] As a result, trucks will travel fewer miles on local roads to reach a rail loading facility or the Massachusetts Turnpike, in the off-site disposal scenarios, as opposed to traveling to GE's more distant landfill locations.[216] The Forest Street location in particular, is several miles off any main road and would result in traffic through a relatively remote area, over roads that cannot support the loading. Also, as shown in the attached table, the impacts for truck traffic for the Woods Pond on-site disposal

[215] The "short-term effectiveness" Permit criterion specifically mentions "impacts to nearby communities." Permit at 22.

[216] The location of the rail loading facility has not yet been determined, but GE assumed a location immediately upstream of Woods Pond in its 2014 comments. Using this location, EPA estimates local miles traveled under each scenario. The estimated mileage includes estimates for construction of the disposal facilities and transport of waste on local roads:

	Upland Disposal Facility			Off-site by Truck	Off-site by Rail
	Woods Pond	Forest Street	Rising Pond	Travel to Massachusetts Turnpike	Rail loading Facility
EPA Estimate	955,350	4,868,700	3,147,800	1,110,200	860,950

facility and off-site disposal would be similar assuming a rail loading facility is close to the Woods Pond disposal facility.

v. The Administrative Record and the relevant remedy selection factors support EPA's decision to require off-site disposal.

EPA weighed the host of relevant factors under the Decree based on the Administrative Record after years of study and information gathering. Selecting off-site disposal would enable prompt completion of the remedy through a suitable well established landfill in an appropriate location. By contrast, allowing GE to build a new landfill adjacent to the Housatonic River would delay or bar completion of the remedy and result in a potentially unsuitable landfill location in an area with no known contamination. During any delay associated with on-site disposal, the public health and environment would be unprotected. PCBs would continue to migrate downstream, including into Connecticut, and to wash up on floodplains during storm events. Fish in the Housatonic would continue to bioaccumulate PCBs from food web exposure pathways and direct uptake pathways that will continue until the remediation of the river, and unacceptable risks would remain in the floodplain. Off-site disposal protects the public health and environment better than on-site disposal because it allows for the remedy (and corresponding risk reduction) to be implemented with a minimum of delay, and in an established suitable landfill location.

Even if GE is correct that the federal government, through Court orders and other coercive means, could eventually impose the landfills on the community against their will, after establishing that such locations are otherwise suitable and protective, this would only occur after a long, drawn out process, substantially delaying the cleanup. Further, GE is requesting that EPA waive environmental regulations or requirements to create a new landfill near the Housatonic River and/or potential drinking water sources in areas of unsuitable geology and permeable soil to save GE money, without considering the multiple benefits of promptly implementing the remedy through existing off-site established locations. GE fails to adequately account for the uncertainties and risks associated with long term operation and maintenance of a new landfill within the Housatonic River and watershed.

GE provided a table of 24 sites where it asserts that PCB-contaminated sediments and soil were disposed on-site or at local landfills, included as Exhibit A to its Statement of Position. More complete and accurate information for each of the sites listed in GE's table is provided in Table 2 to this Statement of Position. While it is true that EPA has successfully implemented on-site disposal of dredged sediments at several sites around the country, GE's table is misleading because it lumps local landfills together with true on-site disposal. For instance, GE cites 250,000 cubic yards of non-TSCA sediment locally disposed at the Ottawa River Site. These non-TSCA sediments were actually disposed at an off-site landfill owned and operated by the City of Toledo, while the TSCA-regulated sediments from that site were disposed out of state at a hazardous waste landfill. This "local disposal" at a fully-regulated municipal landfill is not comparable to on-site disposal, where regulations may be waived.

GE also stretches the term "on-site disposal" beyond its logical limits. For instance, GE calls the disposal of roughly 100,000 cubic yards of less-contaminated sediment at the River Raisin Site "on-site disposal," but this sediment was actually disposed at an off-site pre-existing confined disposal facility two miles away operated by the US Army Corps of Engineers for disposal of contaminated sediments unearthed during navigational dredging.

This disposal in a pre-existing federally-managed facility outside site borders cannot be considered "on-site disposal," and is not comparable to GE's proposal to build a new upland disposal facility outside the area of contamination, adjacent to the Housatonic River site, where GE has argued that EPA should waive relevant and applicable regulatory requirements.

For nearly half of the Sites listed in GE's table, only a portion of the wastes was disposed on-site while the remainder was shipped off-site to a licensed and regulated landfill.[217] For instance, at Lower Fox River more than 95% of the contaminated sediment and soils were disposed off-site at TSCA and municipal landfills, but GE mentions only the small amount disposed at an off-site landfill owned by a PRP. Similarly, at the Fields Brook Site, the vast majority of contaminated sediment and soil was disposed off-site: roughly 700,000 cubic yards out of a total of roughly 750,000. But GE mentions only the first Operable Unit, where 14,000 cubic yards of contaminated sediment and soils were treated on-site or disposed on-site.

GE cites the on-site disposal of contaminated soil and sediment in the prior non-Rest of River Decree removal actions as its principal example of on-site disposal. The Decree allowed GE to dispose of dredged contaminated soil and sediment in two consolidation areas: the first on top of an existing landfill, the "Hill 78" discussed above, and the second adjacent to the existing landfill, in an area called "Building 71." GE fails to mention that Hill 78 was a pre-existing landfill, not an area with no known contamination such as GE's new proposed landfill sites. Moreover, the Decree limited the footprint for Hill 78 and Building 71 and required off-site disposal of remaining wastes. As a result, GE could only dispose approximately 245,000 cubic yards of soil, sediment and building debris at these facilities, far less than the volume anticipated for Rest of River. GE and EPA have to date transported approximately 100,000 cubic yards of material from non-Rest of River areas off-site for disposal. Any additional material generated by GE in completing the non-Rest of River cleanups will also be transported off-site for disposal.

Moreover, public opposition to this on-site disposal was resolved during Consent Decree negotiations. As a component of the Decree that authorized the GE Pittsfield facility landfills, GE provided the City of Pittsfield with an economic redevelopment package (referred to as the Definitive Economic Development Agreement, or DEDA) valued at $45,000,000.[218] This in part, led to the City of Pittsfield supporting the Consent Decree, and its on-site landfilling, at the time of entry, thus facilitating implementation. There is no such "host benefit" package proposed for the municipalities in Berkshire County that would bear GE's proposed on-site landfill. Furthermore, as discussed above, the public's experience with the Hill 78 and Building 71 landfills has now informed and provoked heightened opposition compared to that present during the lodging of the Decree.

GE also claims in its SOP that "EPA concluded [in the earlier Housatonic cleanup] that the use of on-site disposal facilities for PCB-containing material was appropriate and consistent with the use of such on-site containment as the 'presumptive remedy' for similar situations and types of waste," citing the United States' response to comments on the proposed

[217] See Table 2 to this Statement of Position, Sites included in Exhibit A of GE's Statement of Position that had Off-site Disposal of PCB-Contaminated Sediments/Soils.
[218] Definitive Economic Development Agreement, Exhibit 6 to Memorandum in Support of Motion to Enter Consent Decree,

Decree.[219] GE mischaracterizes EPA's comments. In fact, EPA noted that containment is the presumptive remedy for *pre-existing landfill* sites, citing guidance that called for containment at municipal landfill sites and military landfills.[220] This guidance is inapplicable to the landfill proposed for the Rest of River, which would not be a pre-existing landfill and would be located in an area with no prior known contamination. EPA has not been able to locate any EPA statement that on-site disposal is the presumptive remedy for large dredged sediment sites. As discussed above, EPA frequently chooses off-site disposal for the sites most similar to the Rest of River, and even used off-site disposal as a component at 11 of the 24 sites identified by GE as examples of on-site disposal.

In sum, EPA was well within its discretion to choose off-site disposal from the range of alternatives given the severe challenges and likely delay associated with implementing a remedy that includes on-site disposal in a potentially unsuitable location, and the resulting inability of the remedy to protect human health and the environment. In considering all the relevant remedy selection factors, the benefits of having an implementable, permanent, compliant remedy acceptable to the community at an established off-site landfill outweigh the higher cost and short-term impacts associated with off-site disposal. EPA evaluated the alternative approaches, and is proposing selection of the alternative best suited to meet the Permit's General Standards, in consideration of the decision factors, including a balancing of those factors against each other. Ultimately, in proposing to select off-site disposal in an established suitable landfill, EPA has chosen the remedy that is likely to be promptly implemented and protective of human health and the environment, rather than mired in litigation and controversy for years. In doing so, EPA follows the Decree, including the Permit criteria, but it also fulfills its duty to protect the public, and upholds the purpose of CERCLA and RCRA.

B. EPA Selected a Remedy that Provides a Level of Certainty Supported by the Consent Decree, RCRA, and CERCLA.

In this dispute, GE demands a level of detail and certainty that is inconsistent with the Decree and impossible to achieve. Nonetheless GE makes these demands in an effort to reduce its costs, even though the United States has already limited GE's exposure to future expenses by capping certain categories of response costs for which GE would otherwise be liable. GE's

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[219] GE SOP, p. 6.

[220] EPA's specific comment in the Response to Comment is as follows: "Under the NCP, the Agency's expectation is to use engineering controls, such as containment, for wastes, such as PCB-contaminated soil, that pose a relatively low long-term threat. Moreover, under Agency Directive No. 9355.0-49FS, Presumptive Remedy for CERCLA Municipal Landfill Sites, September 1993 and Agency Directive No. 9355.0-67FS, Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills, December 1996, the presumptive remedy for CERCLA (i.e. Superfund) municipal landfills and military landfills, respectively, is containment." United States' Response to Comments on Proposed Consent Decree, July 20, 2000, at 68-69. In the second paragraph that GE cites, EPA writes "In fact, EPA has more recently prescribed contaminant as the presumptive remedy for Superfund municipal landfills, Agency Directive No. 9355.0-49FS, Presumptive Remedy for CERCLA Municipal Landfill Sites, September 1993 and Agency Directive No. 9355.0-67FS, Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills, December 1996." *Id.*

demand for even greater limitations on future expense unfairly and improperly shifts the risks of uncertainty away from GE, the responsible party, and onto the general public.

GE claims that virtually all its future obligations should be known at the time of selection of the remedy. This demand is not supported by the Decree or the uncertainties related to any future work. While the Administrative Record demonstrates the significant effort by EPA over many years to solicit and consider extensive input from all stakeholders, including GE, to ensure an appropriate remedy for Rest of River, the Decree contains several provisions that specifically recognize that EPA's chosen corrective measures may nevertheless fail to achieve and maintain Performance Standards. Indeed, the Decree is explicit that there is no guarantee or "warranty or representation of any kind" that the chosen corrective measures will achieve and maintain the Performance Standards. CD ¶ 40.[221] Further, if, during implementation of the corrective measures, the work is not achieving and maintaining the Performance Standards, EPA may require GE to incorporate "such modification" to the work that is necessary to achieve and maintain Performance Standards, or to carry out and maintain the effectiveness of the response action. CD ¶ 39.a.[222] Decree Paragraphs 39 and 40 reflect the fundamental principle that no innocent party should bear the risk that selected cleanup measures fail to protect human health and the environment. This principle is codified in CERCLA's statutory provisions on covenants not to sue, and the limitations and reservations—known as the "reopeners"—for those covenants, 42 U.S.C. § 9622(f), set forth in the reopener provisions of the Decree, CD ¶¶ 162, 163, and mirrored in EPA's model settlement document. Likewise, there is nothing in the case law that suggests that GE is entitled to the certainty it demands.[223]

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[221] Paragraph 40 provides:

> Nothing in this Consent Decree, the SOW, the Rest of the River SOW, … constitutes a warranty or representation of any kind by Plaintiffs that compliance with the work requirements set forth in the SOW, the Rest of the River SOW, … which requirements are not part of or included within the Performance Standards, will achieve the Performance Standards.

[222] Paragraph 39.a. applies to the Rest of the River SOW and provides:

> For each Removal or Remedial Action required under this Consent Decree, if EPA determines that modification to the work specified in the … the Rest of the River SOW, … is necessary to achieve and maintain the Performance Standards or to carry out and maintain the effectiveness of a particular Removal or Remedial Action, EPA may require that such modification be incorporated in the … the Rest of the River SOW; provided, however, that a modification may only be required pursuant to this Paragraph to the extent that it is consistent with the scope of the response action for which the modification is required and does not modify the Performance Standards (except as provided in Paragraph 217 (Modification) of this Consent Decree).

In any conflict between Paragraph 39.a. of the Decree and the Permit, the provisions of the Decree control. CD, definition of Consent Decree.

[223] Cases interpreting CERCLA and RCRA support the conclusion that some uncertainty at the time of remedy selection is acceptable. For example, in *United States v. Hooker Chemicals & Plastics Corp.,* 540 F. Supp. 1067 (W.D.N.Y. 1982), the court upheld the settlement of a RCRA corrective action complaint even though the final remedy had not been selected. The Consent Decree provided that the defendant would conduct sampling, analysis, and then implement the remedy to be chosen based upon this additional information. The court found the approach "wise" in that the "parties have chosen to proceed cautiously." *Id.* 1073.

Similarly, in *United States v. Akzo Coating,* 719 F. Supp. 571, (E.D. Mich. 1989), the court upheld a CERCLA settlement over objections that the proposed pilot testing was ill-defined and unreliable. *Id.* at 585. The court concluded that

To the extent that GE objects that certain response action obligations are not sufficiently specific, those details will be developed in the next phases of the remedy implementation process through the Rest of River Statement of Work ("SOW") and Work Plans—phases that occur after remedy selection, and in which GE will be heavily involved. CD ¶ 22.x. In fact, per the Decree, GE negotiated the ability to submit the first draft of the SOW, which is typically done by EPA. CERCLA guidance recognizes that the amount of information that is developed in selecting a remedy need only be set at "a level of detail *appropriate to the site situation*."(emphasis added).[224] Even the major components of the remedy, including the treatment technologies and/or engineering controls that will be used, as well as any institutional controls, may be presented in "bullet form." [225] Bullet form is all that is required because, according to EPA guidance:

> the ROD is only intended to provide the framework for the transition into the next phase of the remedial process, namely Remedial Design. Remedial Design is the engineering phase during which additional technical information and data identified are incorporated into technical drawings and specifications developed for the subsequent implementation of the remedial action. The specifications in the Remedial Design are based upon the detailed description of the Selected Remedy and the cleanup criteria provided in the ROD.[226]

Here, the major components of the selected remedy are described in considerably more detail than "bullet form." The Decree contemplates that additional details required for the design and implementation of the remedy will be provided during the SOW and Work Plans phases for the Rest of River—and are not required at the remedy selection stage—otherwise there would be no need for Work Plans or the SOW. GE is wrong to claim that, at the remedy selection phase, it is entitled to detail well beyond "bullet form."

Finally, GE is wrong to suggest that it is entitled to more certainty than is provided in the Intended Final Decision. Although GE may wish that it had struck a different bargain, both

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> **It is legally acceptable to leave aspects of a remedial action plan open for further determination**…. Moreover, there are sound justifications for leaving aspects of a remedy open for future determination. The science of remedying and evaluating toxic waste, like all sciences, is constantly evolving. To require the defendants and the EPA to select a remedy if soil flushing proves to be ineffective, without the aid of knowing how the soil conditions have changed, is unreasonable and would preclude the implementation of new methods of clean up that are not yet discovered.

Id. at 585 (emphasis added). The decision was affirmed. 949 F.2d 1409, 1434 (6th Cir. 1991).

[224] National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. § 300.430(f)(5)(i) (emphasis added). "The Agency will then evaluate potential remedies against the five decision factors listed in proposed section 264.525(b), as appropriate to the specific circumstances of the facility…. In practice, the relative weights assigned to these five factors will vary from facility to facility according [sic] the site characteristics…." 55 Fed.Reg. No. 145, 36824-5 (July 27, 1990).

[225] EPA, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (July 1999), 6-41.

[226] Id. At 6-42. Here, the Intended Final Decision is the RCRA equivalent of a CERCLA ROD, and the Decree requires the remedy to be implemented as a CERCLA remedial action. CD ¶¶ 22.p, 22.z.

sides must accept and fulfill their obligations. EPA has already compromised over $100 million in response costs as a result of the Decree's limitation on EPA's right to recover certain categories of capped response costs. EPA negotiated these capped cost categories at GE's request to limit GE's uncertainty and exposure to costs. Any further EPA compromise regarding GE's obligations to clean up of the River is neither required by the Decree nor is it in the public interest.

1. PCB Downstream Transport and Biota Performance Standards

Requirement: The Downstream Transport Performance Standard specifies annual average values for PCB movement, or flux, over Woods Pond Dam and Rising Pond Dam (Section III.B.1.a). The Short-Term Biota Performance Standard sets an average PCB concentration of 1.5 mg/kg in fish fillets to be achieved within 15 years of completion of remedial activities in the applicable reach of the River. (Section III.B.1.b). (For simplicity, the Short-Term Biota Standard is referred to herein as the "Biota Performance Standard" as distinguished from the Long-Term Biota Standard).[227] If the PCB Downstream Transport Performance Standard is exceeded at either dam in three or more years within any five-year period after the completion of Rest of River construction-related activities and/or if the Biota Performance Standard is exceeded in two consecutive monitoring periods after that 15-year period, GE must identify the potential cause(s) of the exceedance and propose additional actions necessary to achieve and maintain the relevant Standard, and EPA will determine any such additional actions in accordance with the Decree.

GE Position: GE generally objects to these Performance Standards on the following grounds: (1) the PCB Downstream Transport Standard is allegedly not related to any perceived risk to human health or the environment; (2) the computer model predicting the effectiveness of the remedy is an insufficiently reliable basis upon which to establish the Standards; and (3) each Standard allegedly exceeds EPA's Consent Decree and statutory authority.[228]

EPA Position: As discussed below in more detail (1) the PCB Downstream Transport Standard is based upon PCB source control, and reducing the risk of ongoing PCB contamination; (2) the computer model has been subject to multiple phases of peer review and evaluation and is supported by the Administrative Record; and (3) each Standard is well within Consent Decree and statutory authority.

a. The Standards are supported by PCB source or risk control objectives.

[227] In its 2014 Comments, GE requested clarification that a failure to achieve and maintain Long-Term Biota Performance Standards requires only monitoring and maintenance of institutional controls. GE Comments at 63. Accordingly, the Intended Final Decision clarifies the obligations regarding Long-Term Biota Performance Standards. Section II.B.1.b.(1)(b). Further, EPA considered GE's 2014 Comments and concludes the Long-Term Biota Performance Standard for fish fillet in Connecticut remain, based on CT DEEP's consumption calculations assuming 365 fish meals per year and a 1×10^{-6} cancer risk. Section II.B.1.b. (1)(b). footnote 3.

[228] GE also claims that these Performance Standards are not "proper Performance Standards." GE SOP at 24 n.28. GE offers no explanation as to why these Performance Standards fail to satisfy the Consent Decree definition of a Performance Standard, which includes "cleanup standards, design standards and other measures and requirements set forth in …the final modification of the Reissued RCRA Permit to select the Rest of River Remedial Action …"CD ¶ 4. These standards clearly set forth clear requirements to promote the remedy's reduction in risks and control of the source of PCB contamination. That being the case, GE's claim may be disregarded.

GE claims the PCB Downstream Transport Standard is arbitrary because it is allegedly not related to risk reduction to protect human health and the environment. Yet, one of the General Standards for the remedy is to reduce the bioavailability of PCBs through "control of sources of releases," Permit II.G.1.b, p. 20. Here the Performance Standard measures the effectiveness of the remedy in achieving this objective by measuring the levels of PCBs transported downstream. PCBs traveling downstream are an uncontrolled source. They are bioavailable to human and ecological receptors and cause recontamination of the floodplains.[229] Therefore the Performance Standard is related to risk reduction because it measures the effectiveness of the remedy in achieving source control objectives. Contrary to GE's argument, this Standard includes a clear human health or environmental risk-based justification.

b. EPA exercised sound judgment in relying on the model work to develop the Performance Standards.

GE next claims that EPA's method for developing the PCB Downstream Transport and Biota Performance Standard was faulty because the model was designed to measure the comparative effectiveness of remedies rather than to establish an absolute measure for Performance Standards. GE SOP at 26. EPA's technical and scientific analysis of the facts, considerations of the model, and other information in the record, however leads to the opposite conclusion – and such EPA conclusions are entitled to deference as discussed below.

First, GE argues that EPA was required to establish the measure of the effectiveness of the remedy "based on an analysis of risk," and by making a showing "that the specified values [in the measure] are tied to reductions in risk or are otherwise justified under the remedy selection criteria." GE SOP at 25. Yet nothing in the statutes or Consent Decree prescribes the particular quantitative method by which EPA is to set Performance Standards measuring the effectiveness of the remedy, nor do the statutes or Consent Decree include the hypothetical demands for EPA's selection of such Performance Standards.[230] To the contrary, the Decree requires EPA to develop the model, subject to multiple stages of peer review, as a first step in evaluating alternatives for cleaning up the River. CD ¶¶ 22.g. h. and i.[231] The Decree also requires EPA to set Performance Standards, and does not preclude EPA, in its expert judgment, from relying on the peer-reviewed model – including comments from GE -- to establish Performance Standards. This is all the more true, where EPA has already considered and addressed any valid concerns regarding the model as shown below.

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229 Without question a Performance Standard may be developed to measure the effectiveness of the remedy. Permit definition of Performance Standards.

230 GE cites to RCRA § 3004(v) and CERCLA §§ 101(24), 121(d)(1) to imply that Performance Standards may only be set after undertaking certain kinds of risk analysis as measured by certain criteria dictated by GE. GE SOP at 25. Yet nothing in these statutory provisions require the use of a particular form of risk analysis or decision making in setting Performance Standards. Further, the Consent Decree grants EPA the authority to set Performance Standards necessary to protect human health and the environment, without the theoretical and hypothetical constraints or limitations GE now demands. CD and Permit definitions of Performance Standards.

231 Pursuant to the Decree, EPA Region 1 retained a consultant, HDR (formerly Hydroqual), to develop the required computer model to analyze the anticipated impact of remedy alternatives on PCB downstream fate and transport, bioaccumulation, and other factors. The model was subject to multiple independent peer reviews, resulting in changes to the model framework.

Specifically, a more stringent Performance Standard for general downstream transport was initially proposed by EPA in its August 2012 response to the National Remedy Review Board comments: namely achieving and maintaining a maximum of 2.0 kg/year PCB flux rate (mass per time) over Woods and Rising Pond Dams. This initial more stringent proposal was based upon the model work, but was ultimately adjusted after EPA and its consultant, HDR evaluated comments received by GE during the 2012/2013 Technical Discussions. In particular, during the Technical Discussions, EPA, CT DEEP, and GE worked together to craft the structure of the Performance Standard presented in the draft permit and now included in the Intended Final Decision. As a result, the approach set forth in the Intended Final Decision now accounts for variation in average annual flows and applies an uncertainty factor to predicted results.[232] Had EPA relied on the absolute values of the model predictions, the Downstream Transport Standard would be more stringent.

Similarly, the Biota Performance Standard would be more difficult to achieve, if EPA had relied on absolute values allegedly derived from the model as claimed by GE. To the contrary, the Biota Performance Standard does not become effective until 15 years after the completion of remediation activities in each entire reach. If EPA were to consider the model to be predictive of absolute concentrations as GE claims, then the Biota Performance Standard would be effective far earlier than the 15 year period. For example, in Reach 5A, the model predicts that the remedy will achieve the Biota Performance Standard approximately 8 years after completion of the remediation in Reach 5A. Yet the Performance Standard is only triggered 15 years after completion, when the modeled concentration is approximately 0.6 mg/kg, or 60 percent lower than the Performance Standard of 1.5 mg/kg. Similarly, for Woods Pond, the projected fish tissue concentration is approximately 1.0 mg/kg 15 years after remediation, approximately one-third lower that the Standard. Therefore, by applying the Biota Performance Standard in a given reach 15 years after remediation is completed, EPA accounts for uncertainties in remedy performance, including those associated with model predictions of performance.[233]

EPA's reliance on this modeling work to develop Performance Standards is supported by the Administrative Record, EPA guidance, and case law.[234] EPA is best positioned to consider and evaluate scientific information in developing a remedy that is in the public interest, including reliance upon information and analysis developed through computer modeling work – especially when EPA has already considered, addressed and/or rejected GE's

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[232] Namely, "to account for uncertainty in setting a compliance value given the variability in the flux verses flow values, a regression was fit to the flux vs. flow values and prediction intervals were calculated." Memorandum from Ed Garland, HDR to Scott Campbell, Performance Standard Flow-Based Annual Average PCB Flux Methodology, April 25, 2014.

[233] Because it is anticipated that the Biota Standard will be achieved in the short-term, EPA established the complimentary Long-Term Biota Standard to measure the remedy's long-term success at achieving additional risk reduction and measuring progress towards long-term risk reduction goals in Massachusetts and Connecticut. Section II.B.1.b. (1)(b). footnote 3.

[234] *E.g., Sierra Club v. US Forest Service*, 878 F. Supp 1295, 1310 (D.S.D. 1993) ("as long as an agency reveals the data and assumptions upon which a computer model is based, allows and considers public comment on the use or results of the model, and ensures that the ultimate decision rests with the agency, not the computer model, then the agency use of a computer model to assist in decision-making is not arbitrary and capricious."); U.S. EPA OSRTI OSWER Directive 9200.1-96FS, *Understanding the Use of Models in Predicting the Effectiveness of Proposed Remedial Actions at Superfund Sediment Sites (2009).*

concerns regarding use of the model. It is within EPA's expertise to establish Performance Standards measuring the effectiveness of the remedy based upon information in the Administrative Record, including computer modeling.

c. The Performance Standards do not exceed EPA's Consent Decree or statutory authority.

GE claims that the PCB Downstream Transport and Biota Performance Standards exceed EPA's Consent Decree and statutory authority because they (1) impose potential additional unspecified response action obligations; (2) constitute an allegedly impermissible contingent remedy; and (3) allegedly violate the covenants of the Decree. None of these criticisms have merit as discussed below.

It is undisputed that EPA has authority to issue Performance Standards, as it is intended that the Permit include Performance Standards. CD ¶¶ 23, 24; Permit II.J. And it is undisputed that there are consequences under the Decree for failure to achieve and maintain and achieve Performance Standards. For example, in such cases, the Decree specifically provides for modification of the Rest of River SOW to include modified work to achieve and maintain Performance Standards, CD ¶ 39.a, or to seek additional response action if certain covenant reservation, or "reopener" conditions are met. CD ¶¶ 162, 163. Thus, even though the Permit calls for EPA to set forth "the *appropriate* corrective measures necessary to meet the Performance Standards," Permit II.J. (emphasis added), the controlling Consent Decree recognizes that it will not always be possible or *appropriate* to identify all corrective measures necessary to meet and maintain the Performance Standards at the time of the Intended Final Decision. CD ¶39.a. Indeed, the Decree specifically recognizes that there is no "warranty or representation of any kind" that compliance with the selected corrective measures will achieve Performance Standards. CD ¶ 40.

GE argues that certain provisions of the Decree and Permit imply that together they were "intended to provide GE with certainty and finality at the time of the Rest of River remedy selection." GE Comments at 61. In fact, no provision of the Decree or Permit explicitly or implicitly provides the certainty and finality now demanded by GE. Indeed, the Decree directly contradicts GE's strained interpretation by explicitly providing for additional response actions to achieve and maintain Performance Standards:

> if EPA determines that modification to the work specified in the … the Rest of the River SOW, … is necessary to achieve and maintain the Performance Standards or to carry out and maintain the effectiveness of a particular Removal or Remedial Action, ***EPA may require that such modification [of the work] be incorporated in the … the Rest of the River SOW***.

CD ¶39.a (emphasis added).[235]

[235] If there is any conflict between the Decree and Permit, the Decree controls. The definition of the term "Consent Decree" provides that "in the event of conflict between this document and any appendix, this document shall control." CD definition of "Consent Decree."

In claiming that these Performance Standards violate the Decree's covenants, GE ignores the provisions of Paragraph 39.a. GE SOP 26. GE only points to the Decree's provisions regarding reopener conditions or five year review, CD ¶¶ 43.c, 44, 46, 161-3, while ignoring the authority to require additional response actions to achieve and maintain Performance Standards set forth in Paragraph 39.a of the Decree. As a result, GE is wrong to claim that a provision in the Intended Final Decision "that allows EPA to require GE to conduct additional response actions (not specified in the remedy decision) in the future without satisfying the reopener conditions would violate the Decree." GE SOP at 26. That is exactly what Paragraph 39.a. allows.[236] In short, these Performance Standards, like any other Performance Standard, are not a violation of the Decree's covenants.

GE also claims that no additional new or modified work can be required for the Rest of River because any such work would not have been subject to the "nine criteria analysis required"[237] for other corrective measures at the time of the permit modification. GE SOP 26, Comments at 61. If this flawed interpretation of the Decree were correct, it would render Decree Paragraph 39.a and the Operation and Maintenance (O&M) provisions[238] superfluous – neither modified work pursuant to Paragraph 39.a nor O&M work could ever be required because such work can never be subject to the allegedly relevant analysis -- it is unknowable at the time of remedy selection what modified work or O&M will be necessary to achieve and maintain Performance Standards.[239] It is well settled that contractual terms should not be interpreted to render any provisions superfluous, and GE's argument is incorrect.[240] In addition, as discussed above at Section III.B, not all components of the remedy require the level of analysis demanded by GE. In short, neither the Decree nor the Permit requires that all work required for the Rest of River Remedial Action be subject to a fixed analysis at the time the permit is issued.

Finally, GE argues that any additional work required by an exceedance of a Performance Standard would constitute an allegedly impermissible "contingency remedy" that has not been fairly evaluated under the relevant criteria in breach of the Decree or law. GE

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[236] GE also claims that these Performance Standards conflict with the Certification of Completion provisions of the Decree. CD ¶ 88; Comments at 62. However, these Performance Standards function like any other Performance Standard. If at the time of completion of Remedial Action for the Rest of River, the Performance Standards have been attained and there is no violation of the Performance Standard, GE is entitled to a Certification of Completion. The ongoing obligation of maintaining any Performance Standard is established through O&M following Certification of Completion.

[237] Note that while the "nine criteria" are significant to remedy selectionthe Decree and Permit provide that EPA may select the remedy based upon the CMS (which includes an evaluation of the alternatives under the nine criteria) and the information in the Administrative Record. CD ¶ 22.p; Permit II. J..

[238] The Decree defines O&M to include "all activities required to maintain the effectiveness of the Remedial Action for the Rest of the River as required under an Operation and Maintenance Plan developed for the Rest of the River Remedial Action." CD ¶ 4. For example the O&M program requires "other response actions necessary to achieve and maintain compliance with Performance Standards." Intended Final Decision II.C.

[239] Moreover, the question whether the "nine criteria analysis" applies during Paragraph 39.a. modification of work need not be resolved today. This question should be resolved during dispute resolution under the Decree, if and when EPA ever determines that modification of the work is necessary under Decree Paragraph 39.a., and if and when GE disputes that determination.

[240] *U.S. v. Melvin*, 730 F. 3d 29, 37 (1st Cir. 2013)(contracts should be interpreted to give force to all provisions); *Crowe v. Bolduc*, 365 F. 3d 86, 97 (1st Cir. 2004)(" . . . an inquiring court should, whenever possible, avoid an interpretation that renders a particular word, clause, or phrase meaningless or relegates it to the category of mere surplusage.").

SOP at 27. In arguing that the "contingent remedy" here is impermissible, GE relies upon an EPA guidance document relating to the selection of contingent remedies in CERCLA RODs, describing some of the situations in which it is permissible or acceptable to include contingent remedies in a ROD.[241] Indeed, the Decree itself contains several permissible conditional response action obligations. For example, the Decree authorizes Performance Standards for a Conditional Solution, including as may be identified for the Rest of River: for example, when a property owner declines a land use restriction offer from GE, then GE may need to undertake additional cleanup if the land use changes. CD ¶ 34. Similarly, in certain circumstances when the selected remedy fails to achieve and maintain Performance Standards, the Decree also obligates GE to undertake additional response actions to achieve and maintain those Performance Standards. CD ¶39.a. Those additional response actions contribute to the effectiveness of the cleanup, but necessarily cannot be defined at the time of the remedy decision. Likewise, in certain emergency situations, GE must "take all appropriate action to prevent, abate, or minimize" the release or threat of release. CD ¶91. Thus, the Decree contemplates that not all work, contingent or otherwise, required for the Rest of River, such as O&M, can or need be subject to a fixed analysis at the time of the Final Intended Decision. Thus, the requirement here to undertake additional work in response to failure to maintain and achieve Performance Standards is no different than failure to meet and achieve any other Performance Standard, and does not constitute an impermissible contingent remedy.

In conclusion, GE simply does not like the fact that it may someday be required to undertake additional or modified work to achieve or maintain these Performance Standards according to the provisions of the Decree. None of these requirements are unusual or outside the bounds of EPA's contractual or statutory authority. EPA must choose a remedy that is in the public interest and that protects human health and the environment, even if there is some uncertainty in the process.

2. Requirements Regarding Legally Permissible Future Projects or Work in Sediment and Banks

Requirement: In the event that a third party plans to conduct any Legally Permissible Future Project or Work[242] that requires handling or disturbance of sediments or riverbank soils with PCB concentrations greater than 1 mg/kg in certain stretches of the River, GE must conduct response actions, including material handling and off-site disposal, engineering controls, etc., to maintain Performance Standards, and/or the effectiveness of the remedy, and to be protective of such project or work.

GE Position: GE objects to the Performance Standards and corrective measure requirements regarding Legally Permissible Future Projects or Work on the grounds that these provisions allegedly exceed EPA's Consent Decree and statutory authority for three reasons: (1) the provisions allegedly constitute an open-ended impermissible contingent remedy that has allegedly been inadequately evaluated under the relevant criteria; (2) the provisions are allegedly an impermissible end-run around the statutory and Decree re-opener provisions; and

[241] EPA, *EPA 540-R-98-031, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (1999) at 8-3.

[242] This term is defined to include "construction and repair of structures; utility work; flood management activities; road and infrastructure projects; dam removal, maintenance, repair, upgrades, and enhancement activities; and activities such as the installation of canoe/boat launches and docks." Intended Final Decision, Definitions, at page 4..

(3) the provisions allegedly unlawfully deprive GE of defenses to hypothetical 3rd party actions.

EPA Position: The Performance Standard and corrective measures regarding Legally Permissible Future Project or Work are well within Consent Decree and statutory authority. Given the amount of PCB contamination remaining following remediation, these provisions are essential to maintaining the effectiveness of the cleanup as conditions or uses change. Each of GE's arguments is rebutted below.

(1) **The provisions are not an impermissible open-ended contingent remedy selected without adequate evaluation under the relevant criteria**.

The record refutes each of the issues embedded in GE's claim that these provisions constitute an open-ended impermissible contingent remedy selected without adequate analysis. By this objection, GE seeks an unreasonable level of certainty that is inconsistent with other provisions of the Decree, and with the realities of dealing with PCB contamination. The requirement for GE to undertake work necessary to be protective of a Legally Permissible Future Project or Work is analogous to the previously approved Performance Standards for Conditional Solutions for the Rest of River and the right to identify similar Conditional Solutions for the Rest of River. CD ¶ 34, and ¶ 34(d)(iii). As set forth in Decree Paragraph 34, Performance Standards for Conditional Solutions require GE to use best efforts to obtain institutional controls in the form of Environmental Restriction and Easements ("EREs") for certain properties. If GE is unsuccessful in obtaining EREs, GE must then undertake a clean up to be protective of the current use, including, in certain circumstances, undertaking further response actions to be protective of future projects or work. CD ¶ 34(d)(iii). [243] The Decree authorizes EPA to select similar Performance Standards for Conditional Solutions for the Rest of River. *Id.*

Not only are the Performance Standards for Legally Permissible Future Projects or Work not impermissibly "open-ended," these requirements serve as a limit on the scope of required corrective action. GE is required only to undertake response actions to achieve and maintain the Performance Standard for Legally Permissible Future Projects and Work. These requirements are also in keeping with the additional work required to achieve and maintain any Performance Standard as set forth in Decree Paragraph 39.a and are consistent with the requirement to undertake Operation and Maintenance, including "other response actions necessary to achieve and maintain compliance with Performance Standards." Intended Final Decision II. C. GE is unreasonably demanding more certainty in the process of addressing the

[243] These Performance Standards include the requirement to undertake additional response actions in the event of implementation of projects, or certain changes in the legally permissible future uses related to certain properties, including "for any activities that would involve any off-property disposition of soils or excavation of soils, response actions to ensure the proper excavation, management and disposition of such soils and the protection of workers and other individuals during such excavation activities, in accordance with applicable laws and regulations." CD ¶ 34.d (ii)(C). And these Performance Standards include all the Performance Standards for a Conditional Solution "*that may be identified as Performance Standards for a Conditional Solution in the Rest of River SOW*" including response actions related to implementation of future projects or changes in use. CD ¶ 34 (emphasis added). Accordingly, the Decree authorizes EPA to identify Performance Standards for Conditional Solutions in the revised Permit for the Rest of River, and the Performance Standards identified in the Intended Final Decision regarding conditional solutions for legally permissible future work or projects are within the authority of the Decree. *Id.*

hundreds of acres of contaminated River and floodplain. This is especially true when GE is not being required to remove all the PCB contamination, or even impose EREs for riverbed and banks – GE is simply tasked with managing its residual contamination during Legally Permissible Future Projects or Work in a way that is protective of human health and the environment and meets Performance Standards, thus reducing costs to GE.

GE also objects that EPA has allegedly not adequately analyzed alternative corrective measures under the nine criteria for Performance Standards and other requirements related to Legally Permissible Future Projects or Work. This is not true. EPA guidance documents on selecting either RCRA or CERCLA remedies only require "appropriate" analysis of the remedy under the relevant criteria, and recognize that the ultimate weight given to the factors, and how they will be balanced, depends on the risks posed by the facility "and the professional judgment of the decision-makers."[244]

Nothing in the Decree requires EPA to undertake a more rigorous analysis of any particular factor than is required by regulation or guidance. As is the case with many of GE's objections, EPA—not GE—is in the best position to judge the appropriate level of analysis for selecting a remedy for the Rest of River that is in the public interest and protective of human health and the environment.

Here EPA considered the relevant information in the record including information regarding EREs, Conditional Solutions, Intuitional Controls, and PCB contamination in the Rest of River. For example, GE's analysis included a cost estimate for "Institutional Controls and EREs."[245] EPA considered these alternatives and the alternative of requiring a full cleanup of all third party property, or requiring ERE's on all property with residual contamination. In the end, EPA proposed an alternative that is less expensive than requiring complete removal of all PCBs, or even imposing EREs on the properties at issue here. Given the potential health risks posed by the PCB contamination that will remain after remediation, EPA rightly determined that the remedy should contain certain restrictions to such exposure. EPA concluded that it had sufficient information upon which to make a proposal according to the relevant criteria and information in the Administrative Record, and it is unreasonable for GE to argue that it is in a better position than EPA to determine whether further analysis is necessary.

GE's objection that these provisions constitute an impermissible "contingent remedy" is also wrong for the same reasons discussed above at Section III.B.1.. In addition, the conditional framework for Legally Permissible Future Project or Work is authorized by, or is analogous to, the Performance Standards for Conditional Solutions endorsed under similar circumstances in GE's Revised CMS,[246] and the Decree. CD ¶¶34-38.

Although GE argues that the conditional solutions for Legally Permissible Future Project or Work selected in the Intended Final Decision are not specifically endorsed by the Conditional Solution provisions of the Decree, CD ¶ 34, these provisions are nonetheless

[244] 55 Fed.Reg. No. 145, 36824-5 (July 27, 1990)(" The exact emphasis placed on these decision factors, and how they will be balanced by EPA in selecting the most appropriate remedy for a facility, will necessarily depend on the types of risks posed by the facility, and the professional judgment of the decision-makers.").
[245] The cost estimate was submitted by GE under a claim of confidential business information, as part of the supporting material for the Revised CMS. EPA is handling the information in accordance with CBI claims.
[246] *See* GE's Revised CMS 4-29 to 4-30, endorsing the use of Conditional Solutions at certain floodplain properties where EREs are not obtainable.

within the broader authority of the Decree authorizing EPA to select a remedy to be protective of human health and the environment. To address residual levels of PCB contamination within portions of the floodplain, conditional solutions, such as the Performance Standards for Legally Permissible Future Projects or Work, are an acceptable alternative to requiring complete and costly cleanup of all contamination on all properties, or even the imposition of EREs on all such property. Source and risk control objectives are being met through protective measures to respond to residual contamination. For example, in lieu of total cleanup, to address residual contamination, the MCP establishes an analogous "Temporary Solution," that requires inspection protocols for residual contamination and precludes certain changes in use. 40 MCP 40.1000. These MCP Temporary Solutions have been implemented by GE in certain portions of Pittsfield.[247] In short, the Performance Standards for Legally Permissible Future Project or Work are not an impermissible open-ended contingent remedy selected without adequate analysis.

(2) – (3) **The provisions are lawful and consistent with the reopener provisions.**

GE also claims that the Performance Standards and related requirements regarding a Legally Permissible Future Project or Work violate the reopener provisions of the Decree, because certain "additional" future work may be required to be protective of the Legally Permissible Future Project or Work. However, the work is not "additional" within the meaning of the reopener provisions, because the Intended Final Decision provides that GE shall undertake such work. Just as none of the Performance Standards and related requirements in the Decree and SOW for Conditional Solutions, CD ¶ 34, trigger the reopener provisions, neither do the Performance Standards regarding a Legally Permissible Future Project and Work for the Rest of the River. In either case, the work at issue is necessary to achieve and maintain the Performance Standards as set forth in the Decree, SOW, and/or Intended Final Decision. GE's obligations are simply part of the remedy and not "additional" work. These future work provisions are a rational response to PCB contamination in the River short of requiring massive investigation on all potentially contaminated property, EREs, and/or complete clean-up.

Third, GE contends the requirements are "unlawful" because they deprive GE of certain defenses in a hypothetical third party suit against GE for the same relief. If GE's argument were correct, EPA could never settle disputes involving contamination of third party property, yet such settlements are a common EPA practice, including in this case. Here, GE agreed to cleanup certain third party properties, and waived certain defenses that GE might have had against third parties suing GE for the same relief. For example, the Conditional Solution provisions of the Decree provide that GE will undertake cleanup work on certain third party property including if such third party undertakes a Legally Permissible Future Project or Work. CD ¶ 34(d).[248] GE now claims such requirements are "unlawful." *Id.*[249] But in resolving the

[247] See, for example, GE's seventh annual inspection report of certain Temporary Solution properties at the Dalton Avenue Site, Pittsfield, Mass.

[248] To quote GE, these requirements "make GE entirely responsible to perform, at its sole cost, the response actions associated with whatever project or work the property owner or project proponent selects, regardless of its scope of costs and without the need for the owner or proponent to consider the necessity of the costs, their consistency with the NCP or the Massachusetts Contingency Plan (MCP), and whether there are more reasonable and cost-effective alternatives that would involve less PCB handling or impacts." GE SOP at 29.

[249] In making this argument GE relies upon the inapposite case, *Kelley v. EPA*, F.3d . *Kelley* involved comment on EPA rule-making not interpretation of a public interest Consent Decree.

United States' claims, GE agreed to these terms. CD ¶34. GE also agreed that EPA could identify such terms for the Rest of River, as the alternative could require EREs or complete cleanup on all these properties at far greater expense. *Id.* This is not unlawful, but inherent in the settlement of the United States' claims requiring cleanup of GE's contamination on third party property.

In sum, EPA considered the alternative of selecting a remedy for the Rest of the River to require GE to immediately clean up all the PCBs on all third party property, or even impose EREs on riverbank and riverbed. Instead EPA chose a more limited response, which simply required GE to properly manage and handle PCB material if there is a Legally Permissible Future Project or Work on certain third party property with PCB contamination above 1 mg/kg. Shifting the responsibility and costs of managing and disposing of GE's PCBs to innocent landowners or to the United States would not be in the public interest, and would be contrary to the bargain struck by the Parties years ago.

3. Requirements Regarding Future Floodplain Activities and Uses

Requirement: For properties within designated Exposure Areas (EAs) that do not meet the residential Performance Standard (2 mg/kg at surface and at depth), GE must: (i) record Grants of Environmental Restrictions and Easements (EREs) on GE properties and Notice EREs on Commonwealth properties; (ii) offer compensation for EREs on all other properties; and (iii) for properties where the owner declines an ERE, implement Conditional Solutions under which GE must undertake any response actions for any Legally Permissible Future Project or Work at the property (including material handling and off-site disposal, engineering controls, etc.) and any response actions for any change in use to a Legally Permissible Future Use to meet certain specified Performance Standards for future floodplain uses For any other floodplain properties in Massachusetts and Connecticut in Reaches 5 through 16 where sampling data indicate that PCB concentrations exceed 1 mg/kg in the floodplain portion, GE must conduct response actions for any Legally Permissible Future Project or Work (including material handling and off-site disposal, engineering controls, etc.) and response actions for any change in use to a Legally Permissible Future Use to meet the specified Performance Standards for future floodplain uses .

GE Position: GE objects to the Performance Standards and corrective measure requirements regarding future floodplain activities and uses on the grounds that the Standards and requirements are overbroad and conflict with EPA guidance. In particular, GE alleges that EPA guidance requires a change in use to be reasonably anticipated before requiring GE to record or seek EREs or implement Conditional Solutions. GE also objects to the requirements related to any Legally Permissible Future Project or Work that requires proper management and disposal of PCBs above 1 mg/kg but below 2 mg/kg on the grounds that this requirement is allegedly inconsistent with imposing a general residential clean-up standard of 2 mg/kg.

EPA Position: The Standards and requirements are consistent with the law, the NCP, the Decree, EPA guidance, and sound remedy selection decision-making. In the face of residual potential PCB contamination within certain areas of the floodplains, EPA could have chosen to require GE to sample and clean up all such property to residential standards, which would have been the most protective, and most costly, remedy. Instead, EPA has proposed a cleanup to be protective of current uses while only requiring GE to manage potential residual PCB contamination through a combination of more limited obligations, including: notification to land owners of residual contamination; responsibility for addressing PCB contaminated material in certain exposure areas through EREs and Conditional Solutions; responsibility for addressing PCB contaminated material in portions of Reaches 5-16 through sampling and, *if necessary based upon sampling results*, additional response actions to be protective of legally permissible future uses and activities. The following addresses GE's comments regarding (a) EREs/Conditional Solutions, and (b) Legally Permissible Future Project or Work and/or Changes in Use.

a. EREs/Conditional Solutions

GE claims the obligation to seek EREs (or alternatively Conditional Solutions) on properties with no reasonably anticipated change in use is arbitrary and capricious and inconsistent with EPA guidance. Contrary to GE's claims, however, the EPA guidance cited by GE explicitly recognize that institutional controls are required to be protective of even *unanticipated* changes in future use.[250] explains that, if residual contamination remains on site, "institutional controls will generally have to be included in the alternative to prevent an *unanticipated* change in land use that could result in unacceptable exposures to residual contamination, or, at a minimum, alert future users to the residual risks and monitor for any changes in use." *Id*. at 9 (emphasis added).[251] This is all the more true because institutional controls serve multiple purposes including prevention of changes of use (even if unanticipated), notice of contamination, and/or safe handling instructions for contaminated soil during future excavations onsite. For instance, even on properties where there may be no reasonably anticipated change in use, notice and safe soil handling instructions are appropriate to be protective of utility work, or in the case of Audubon property, trail maintenance or development. Indeed, GE agreed to such institutional control provisions in the model ERE

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[250] *Land Use in the CERCLA Remedy Selection Process,* OSWER Directive 9355.7-04.

[251] Most recently, EPA guidance established that "if any cleanup alternative being evaluated leaves residual contamination in place, ICs should be considered to ensure that unacceptable risk from residual contamination does not occur." Institutional Control s: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites, December, 2012. Indeed, unless all contamination is removed, Institutional Controls are a "typical" component of a remedy. *Remedy Selection guide* (EPA, 1995) at 13 ("Institutional controls typically will be used in conjunction with engineering controls when the remedy results in long-term waste management onsite."). And to the extent the guidance documents discuss institutional controls in the context of consideration of reasonably anticipated land use, such consideration of reasonably anticipated land use does not limit the scope of appropriate institutional controls. *Considering Reasonably Anticipated Future Land Uses and Reducing Barriers to Reuse at EPA-Lead Superfund Remedial Sites* (EPA, 2010) at 11 ("Regions should take into account reasonably anticipated future land uses when selecting ICs and drafting the specific IC requirements and evaluating which instruments may be best to achieve the IC objectives."). If hazardous substances remain on site, institutional control objectives should be established to be protective of human health and the environment regardless of whether a change in use is reasonably anticipated, or not.

attached to the Decree.[252] CD Appendix O. These kinds of protections are just as appropriate for third party owned property or state-owned property in the Rest of River.[253]

If EREs cannot be obtained following best efforts, implementation of Conditional Solutions is appropriate for all the foregoing reasons, regardless of whether the change in use is reasonably anticipated.[254] Whether a change in use is reasonably anticipated or not, is no reason to shift responsibility away from GE for addressing its residual contamination to third parties or the United States. Further, GE is not being asked to address all its residual contamination on all property at this time, only if the property owner declines an ERE after best efforts, and upon the occurrence of a Legally Permissible Change in Use or Future Project or Work to protect human health and the environment.

b. Legally Permissible Future Project or Work and/or Changes in Use

GE argues that requiring any additional response action for properties with PCB levels below the residential cleanup standard of 2 mg/kg is allegedly inconsistent with the Decree. GE SOP at 32. Contrary to GE's implication, however, EPA has not set an unqualified universal standard of 2 mg/kg as protective throughout the entire Rest of River, including floodplains, with limited or no sampling history. The residential standard rests upon the requirements for adequate sampling and characterization of the property followed by response action to achieve the standard.

The properties at issue in the Rest of River cited by GE (Permit Section II.B.6.c. -- portions of the floodplains in Reaches 5-16), however, have not been sampled or have limited sampling and are not subject to any initial cleanup or response action measures as part of the

[252] GE assumes that if land is cleaned up to a standard that is generally protective of that current use, such as commercial, or industrial, then no further action is required at the property to address any residual contamination even if there is future excavation of contaminated material. This is wrong. For example, even if a property may be generally safe for commercial use, the level of PCBs remaining would still pose an unacceptable risk if the property use changed to a scenario with more potential PCB exposure, such as to a recreational or residential use, or if the property owner decided to excavate or otherwise handle any of the remaining PCB contamination. Accordingly, the levels of remaining PCBs make it essential that excavation and handling of PCB contaminated material requires additional response actions to remain protective of human health and the environment.

[253] GE claims there is no need to provide such protections on state-owned property where there is no reasonably anticipated change in use. GE SOP 32. But the Notice ERE provides notice of residual contamination and/or instruction for handling residual contamination. These requirements remain relevant for any potential change in use (even if unlikely) and whether the property is owned by a third party or the Commonwealth.

[254] GE also argues that Conditional Solutions are not Institutional Controls because Institutional Controls cannot include affirmative obligations. GE SOP at 32, n. 36. However, GE previously agreed that the model ERE, an Institutional Control that is attached as an Appendix to the Decree, imposes affirmative obligations regarding contaminated soil management and handling. CD, Appendix O. Similarly, EPA Institutional Control Guidance, December 2012 provides that EREs may "require the performance of specific activities." *Id.* at 4. Nevertheless, this issue need not be resolved here. The only relevant question is whether EPA properly selected conditional solutions as components of the Intended Final Decision. As noted above, this selection was a well-chosen alternative to requiring GE to cleanup all its contamination on all property. Instead, GE need only implement certain response actions in the event of certain Legally Permissible Changes in Use or Project or Work on contaminated property.

remedy.[255] In other words the extent of contamination is unknown or uncertain. In such areas, EPA has determined that additional sampling must be undertaken in certain circumstances to determine if additional response actions is such area are necessary to be protective of human health and the environment. Moreover, GE is not required to conduct any sampling in such areas unless: (1) there is a Legally Permissible Change in Use or Future Project or Work, and (2) there is sampling data showing PCB levels are above 1 mg/kg. Only if the sampling establishes levels above 1 mg/kg, must GE undertake response actions to be protective of any Legally Permissible Future Project or Work, for example, ensuring the proper excavation, management, and off-site disposal of such sediment or soil.[256] Similarly, only if additional sampling establishes levels above 2 mg/kg (or above the applicable Performance Standards in Tables 3 and 4) must GE undertake response actions to be protective of any change in a Legally Permissible Future Use. Accordingly, EPA determined that the risk of unknown PCB levels, including potentially high PCB levels, requires that certain properties with any Legally Permissible Future Project or Work or change in Use be subject to additional sampling and, if necessary, additional response action. The Intended Final Decision is not inconsistent with the Decree in treatment of property with no or limited history of PCB sampling or other response action measures, because there are no such areas outside of Rest of River under the Decree. The alternative would require GE to extensively sample all the Rest of River properties at issue to confirm that such properties are safe for all future uses and activities. Such an alternative would have been far more expensive than the Intended Final Decision.

The remainder of the objections to the requirements here are the same as GE's objections to the requirements for Performance Standards and Corrective Measures regarding Legally Permissible Future Projects or Work. For the same reasons as stated above, these requirements here are an appropriate remedy for addressing GE's contamination.

4. Inspection, Monitoring, Maintenance at Non-GE-Owned Dams

*Requirement***:** In the Intended Final Decision, EPA includes requirements to ensure that future PCB releases from dams are minimized, including that GE "shall minimize PCB releases related to dams and Impoundments by inspecting, monitoring and maintaining such dams and Impoundments, and operating the Woods Pond and Rising Pond Dams," and that such activities shall include: maintaining the integrity of the dam to contain contaminated sediments, and conducting materials handling and off-site disposal, and engineering controls.[257]

*GE Position***:** GE asserts that EPA's requirements would impose obligations on GE that are the responsibility of dam owners under federal and state law. Specifically, GE argues: (1) that this requirement would interfere with existing federal and state dam regulatory programs, by creating conflicts between GE and the dam owner on repairs and upgrades; (2) that EPA does not have authority to impose obligations or liabilities on GE that go beyond what is

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[255] To the extent that the Intended Final Decision is not clear on this point, it can be modified to clarify that the obligation to address a Legally Permissible Change in Use or Future Project or Work at properties with PCBs contamination less than 2 mg/kg in these reaches will no longer apply if such properties are remediated to residential standards. Similarly, EPA can clarify in Sections 6.b.1.b that for properties in EAs that are remediated to residential standards, then GE does not need to seek EREs or implement a CS

[256] After all, disposing of PCBs above 1 mg/kg in Massachusetts is subject to regulation. 310 CMR 40.0000.

[257] Intended Final Decision, at II.B.2.j.(1)(a), and II.B.2.j.(2)(b). The description in this Statement of Position of the Intended Final Decision requirements is general; for specific details, see the Intended Final Decision.

necessary to protect human health and the environment from GE's PCB releases, such as potential liability as the "operator" of the dams; and (3) that EPA's proposal is in conflict with the Decree requirement that EPA evaluate this requirement under the remedy selection criteria in the Permit.

EPA Position: As an initial point, there is no absolute requirement for GE to perform inspection, monitoring and maintenance requirements on dams they do not own. GE can elect, as part of the Performance Standards for the Reach 7 Impoundments, to remove the PCBs impounded behind the dams, thus eliminating the inspection, monitoring and maintenance requirements.[258] However, depending on the approaches that GE recommends in its remedy design proposals, if risks remain under GE's approach, then the inspection, monitoring and maintenance requirements in the Intended Final Decision represent a rational approach to ensuring protectiveness.

Further, to address GE's specific arguments, first, there is no interference or conflict with existing requirements on dam owners. GE's responsibilities under the Intended Final Decision are in connection with minimizing releases of the PCBs that are located behind the dams.[259] The requirements of the Intended Final Decision are not meant to relieve the dam owner of its statutory obligations. If GE believes that the dam owner is currently performing inspections of the dam in a frequency and a manner that will ensure minimization of releases of PCBs located behind the dam, and GE receives approval from EPA that the activities by the dam owner are protective to minimize releases of PCBs located behind the dams, GE does not have to perform duplicative inspection, maintenance and monitoring activities at that dam. [260] Beyond that, based on EPA's review of GE's Statement of Position, EPA would be willing to clarify in the Final Permit decision that if GE uses best efforts to fulfill these obligations but cannot fulfill them without a conflict occurring, GE may submit to EPA for review and approval a plan that includes, without limitation, any proposed actions GE will take to remediate the PCB contamination behind the dams, any further actions to be taken to obtain agreement from the dam owner, and whether the Engineered Caps will maintain effectiveness without GE having fulfilled its obligations regarding dam inspection, monitoring and maintenance.

If however, the activities performed by the dam owner are not sufficient to minimize releases of PCBs behind the dams, GE has the responsibility in the proposed remedy to ensure that the release of PCBs is minimized. In fact, GE's own experience at Rest of River is

[258] Intended Final Decision, at II.B.2.f.(1)(d).

[259] In Reaches 5-9, there are six dams which currently have impoundments that contain GE's PCBs at unacceptable levels: Woods Pond Dam in Reach 6, the Columbia Mill Dam, Eagle Mill Dam, Willow Mill Dam and Glendale Dam in Reach 7, and Rising Pond Dam in Reach 8. GE currently owns the Woods Pond Dam and Rising Pond Dam, and only two other dams are currently in active use (Willow Mill and Glendale). Presently in Reach 7, the Eagle Mill dam is already partially breached and the owner of the Columbia Mill Dam vacated the dam/mill complex and is no longer operates the dam.

[260] *See* Intended Final Decision, II.B.2.j.(2)(b): Permittee may seek EPA approval for another party to implement some or all of the Permittee's inspection, monitoring and maintenance activities.

inconsistent with its arguments. GE took ownership of Rising Pond Dam in 2008.[261] However, even as far back as 1989, GE had performed an inspection of Rising Pond Dam.[262]

Moreover, as to GE's second argument, these requirements are clearly necessary to protect human health and the environment, and EPA is not exposing GE to further liability as an operator. First, EPA's concern toward minimizing releases of PCBs from dams is not theoretical, but based in recent history on this same stretch of the Housatonic. In 1992, releases of contaminated sediment occurred when water behind the Rising Pond Dam was released to facilitate repairs to the dam. According to the Connecticut Department of Environmental Protection's Bureau of Water Management, no apparent measures were employed to contain PCB contaminated sediment in Rising Pond during this work.[263] Following the dam repair, benthic and fish tissue samples collected and analyzed for PCBs downstream of Rising Pond showed an increase in PCB concentrations.[264] Additionally, per Connecticut DEP, GE informed CT DEP that March 1993 data collected at a downstream location during high flow events in April, May and June 1992 exhibited atypically high PCB levels.[265]

Ensuring the effectiveness of the dams at minimizing PCB releases is also important to the protectiveness of the Engineered Cap called for in the proposed remedy. Were there to be a significant dam opening or failure, the Engineered Cap would also fail to be effective in isolating the PCBs. It is not logical to construct Engineered Caps behind a dam and then not ensure that the dams are properly inspected, monitored and maintained.

If EPA had chosen to require GE to remediate all PCBs behind the dams, then the emphasis on protecting Engineered Caps, would not be as important. Moreover, GE has the flexibility in the Intended Final Decision to propose to excavate more sediment as a way of eliminating the need for an Engineered Cap behind a dam. If GE does not choose that approach, GE must take other actions like a Cap to keep remedy protective.

As to "operator" liability, initially, EPA points out that the Intended Final Decision allows GE to reach agreements with each dam owner on responsibilities, and that GE may seek EPA approval for another party to implement some or all of GE's activities. Furthermore, GE has already agreed that it will not contend that PCB contamination in the Rest of River did not migrate from the GE facility.[266] Furthermore, in past actions by EPA under CERCLA for River cleanup, EPA determined that GE is a liable party for PCB contamination in the River under CERCLA.[267] GE does not subject itself to additional liability by performing the

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[261] Berkshire Eagle, "GE buys former Fox River dam", Sunday July 13, 2008.
[262] April 12, 1989, memorandum from Harza Engineering Company to GE, re: Rising Pond Dam, Assessment of Planned Breaching of Dam; June 12, 2006.
[263] Connecticut Bureau of Water Management Interdepartmental Message from Charles Fredette (Supervising Sanitary Engineer) to Michael Harder (Director) Regarding Summary of 1992 CT DEP Housatonic PCB Monitoring Re: Rising Dam, Great Barrington, MA. May 18, 1993. ("Fredette Memorandum").

[264] Connecticut Post, "Higher level of PCBs in Housatonic feared", May 23, 1993.
[265] Fredette Memorandum.
[266] Decree Appendix G, Reissued RCRA Permit, at Section I.P (Interpretation of Migration from GE Facility).
[267] E.g., June 3, 1998, EPA, Second Unilateral Administrative Order for Removal Action, CERCLA Docket No. I-98-1040, Paragraph 9.

necessary actions needed to minimize PCB releases from behind the dams. In fact, by performing the actions, GE is minimizing its liability for future releases.

Regarding GE's argument that EPA should have evaluated these requirements separately under the remedy selection criteria, the record is clear that EPA has fulfilled its responsibility to perform a thorough evaluation of multiple alternative remedies pursuant to the nine Permit criteria. At the same time, EPA is not required to perform that same level of evaluation on each element within an alternative. For example, to address the risks posed by PCBs behind the Reach 7 Impoundments, EPA evaluated a number of remedial options, including an alternative to remove all PCBs at levels posing unacceptable risks. Instead of requiring such a full-scale removal, EPA has proposed to reduce the risks with an alternative that excavates some PCBs and reduces exposure to the remaining PCBs through use of an Engineered Cap behind the Impoundments. However, as with other remedy components that seek to isolate or reduce exposure to PCBs, the approach must also include long-term monitoring/maintenance elements to ensure the proposed approach remains protective. Each of these elements within a proposed alternative is not required to undergo the same level of evaluation. In that respect, these obligations are more similar to the requirements for inspection, monitoring and maintenance in Section II.B.4, as well as the Operation and Maintenance requirements at Section II.C of the Intended Final Permit.

In summary, as demonstrated above, GE's arguments are without merit. However, in the interest of resolving this dispute based on GE's Statement of Position, EPA is willing to modify this provision as follows: (1) clarify in the Final Permit decision that if GE uses best efforts to fulfill these obligations but cannot fulfill them without a conflict occurring, GE may submit to EPA for review and approval a plan that includes, without limitation, any proposed actions GE will take to remediate the PCB contamination behind the dams, any further actions to be taken to obtain agreement from the dam owner, and whether the Engineered Caps will maintain effectiveness without GE having fulfilled its obligations regarding dam inspection, monitoring and maintenance; (2) place these requirements in the Final Permit decision within the Reach 7 provisions of Section II.B.2.f, the Inspection, Monitoring and Maintenance provisions at Section II.B.4, and/or the Operation and Maintenance provisions at Section II.C; and (3) revise the responsibilities in the Final Permit decision to be that GE will ensure performance of inspection, monitoring and maintenance instead of performing inspection, monitoring and maintenance.

5. GE Responsibilities Regarding Catastrophic Failure or Material Breach of a Dam

Requirement: If there is a catastrophic failure or breach of a dam causing a materially greater than normal release of PCBs, GE must propose a response to maintain the Performance Standards or to maintain the effectiveness of the remedy Upon EPA approval of such plan, GE is to implement the plan.[268]

GE Argument: GE objects as follows: (1) for non-GE dams, repair or removal of a dam is the responsibility of the dam owner, not GE; (2) the requirements for GE to conduct response actions have not been evaluated under remedy selection criteria and thus conflict with the Decree, and that such actions "constitute a contingent remedy under EPA guidance"; and

[268] Intended Final Decision, II.B.2.j.(2)(b)

(3) these future contingent requirements conflict with the CD covenants, which allow EPA to require such additional response actions only if EPA determines that there is new information or conditions indicating that the remedy is no longer protective.

EPA Position: As stated above, PCBs from GE's facility have contaminated the River sediments, bank soils, floodplain, and biota for many miles, including in impoundments behind the dams in Rest of River, including into Connecticut. The Intended Final Decision allows for PCB contamination to remain behind the Rest of River dams at a significant cost savings to GE. That residual PCB contamination could still pose an unacceptable risk if a breach or failure of a dam occurs. That being the case, in conjunction with preventative requirements,[269] if a dam fails or has a material breach, GE must propose and implement a protective response.

First, regulatory requirements on dam owners do not prohibit GE from taking action to address GE's PCBs migrating downstream from a failed or breached dam. Given the large concentrations of residual PCBs behind the dams, it is very reasonable to expect that if a dam that was holding back GE's PCBs becomes compromised, GE should be held responsible for ensuring that the Performance Standards, and the effectiveness of the cleanup, are maintained. As for GE's specific objection about not being required to repair or remove a dam, EPA is not mandating in this proposed remedy the specific actions that would be most appropriate; what is most appropriate depends on the circumstances. Instead, EPA is requiring GE to submit a plan, and upon approval by EPA, to implement that plan. If at that point GE disagrees with EPA's response to its submittal, GE may avail itself of the Decree's Dispute Resolution provisions. Also, if GE does not want the uncertainty of long-term maintenance, EPA included in the Performance Standards for the Reach 7 Impoundments the option for GE to remove sufficient PCBs sequestered behind the dams to avoid that responsibility.[270]

Second, as to specifying and evaluating the response activities in the Permit, GE is seeking unreasonable and infeasible specificity. The specific actions required after a release of GE's PCBs have not been identified, and will necessarily depend on the circumstances of the PCB contamination, the plan submitted by GE, and the EPA response. EPA guidance for RCRA or CERCLA remedies only require "appropriate" analysis of the remedy under the relevant criteria, which EPA has performed very thoroughly for Rest of River. It cannot be considered "appropriate" to force EPA and GE to identify *now* the specific activities that may or may not take needed in response to a *future* dam failure. Moreover, it is consistent with the Decree and Permit for the response to an unplanned event during remedial action or O&M to be unknown at the time of Permit issuance. As discussed in Section III.B.1 above, the Decree includes several response action obligations that are not appropriate to define at Permit issuance, but which are important for maintaining Performance Standards and the effectiveness of the remedy. In many respects, this requirement for the dams is similar to the obligation to maintain an Engineered Cap or the obligation to maintain the cap of a landfill.[271]

[269] EPA Statement of Position, Section III.B.4..
[270] Intended Final Decision, II.B.2.f(1)(d).
[271] Under the Decree, GE is responsible for long-term maintenance of the caps for the On-Plant Consolidation Areas established at the former GE Plant Area. Decree ¶ 15.

That being said, EPA has bounded the potential responses by GE by making clear in the Intended Final Decision that GE's responsibilities for dam failure are limited to responses to maintain Performance Standards or remedy effectiveness.

Further, the fact that it is virtually impossible to foresee the specifics of each and any such occurrence years prior to the event does not constitute a "contingency remedy". As is discussed above in Section III.C.1,c. regarding the Downstream Transport and Biota Performance Standards, such a remedy applies where EPA selects an alternative remedy in a ROD in case the preferred ROD remedy fails. Here EPA cannot predict a specific "contingency remedy" to use because EPA cannot predict the circumstances or the specific response activities, if any, following a future failure or breach.

Third, EPA disagrees with GE's claim that EPA's response authority is limited to a demonstration that there is new information or conditions indicating a lack of protectiveness.[272] EPA's ability to require such work is not so limited. First, distinct Decree authority for such work is not necessary. The Intended Final Decision provides for achieving and maintaining the Performance Standards and the remedy's effectiveness. The required responses of GE to a material release of GE's PCBs from a dam are precisely measures to maintain Performance Standards and remedy effectiveness. That being the case, they are not separate, additional response actions that require additional Consent Decree authority can be required by EPA under the response action.

Finally, even if EPA needed to invoke the Decree separate from carrying out the response action, the Decree provides a less limited threshold. Paragraph 39 of the Decree provides that if EPA determines that modification to the work specified in the Rest of River Statement of Work ("Rest of River SOW"), and/or in work plans developed pursuant to the Rest of River SOW and/or the Decree is necessary to achieve and maintain the Performance Standards or to carry out and maintain the effectiveness of the response action, EPA may require that such modification be included in the Rest of River SOW and/or such other work plans; provided however, that a modification may only be required under Paragraph 39 to the extent that it is consistent with the scope of the response action for which the modification is required and does not modify the Performance Standards of the response action (except as provided in the Decree provision on mutually-agreed modifications). If EPA did not have the direct ability to require the work pursuant to the Intended Final Permit, Paragraph 39 allows for such work to proceed with fewer limitations than GE seeks.

C. EPA Correctly Interprets the Consent Decree and GE Cannot Shirk its Liabilities.

GE argues that EPA incorrectly interpreted the Decree and Permit by requiring GE to restore natural resources damaged during implementation of the cleanup or to comply with ARARs that require restoration. These arguments are directly refuted by the terms of the Decree: the covenant not to sue GE for natural resource damages is not effective until after GE has implemented all the work required by EPA's Intended Final Decision, including compliance with ARARs. Clearly, the United States would not agree to a settlement that

[272] GE cites to Decree Paragraphs 162-163, which are the Pre- and Post-Certification Reservations of Rights, or "Reopeners" to GE's liability covenants. Such reopeners are one method to require additional response actions, but are not necessary in this situation where EPA may require the actions in a more straightforward way.

included the selection of a remedy for a complex hundred mile river system without requiring any natural resources that were damaged by the clean up to be restored. Such a hypothetical agreement would cost GE less but runs counter to public policy, EPA practice, and the terms of the Decree.

1. Restoration Requirements for Areas Disturbed by Remediation Activities.

a. Restoration and Compensatory Mitigation

Requirement: GE must develop and implement a plan for restoration of affected habitats disturbed by remediation activities to the extent feasible and consistent with remediation requirements.

GE Position: GE argues that any obligation to restore natural resources damaged by implementation of the remedial action and/or to comply with ARARs allegedly violates the Decree covenants and/or otherwise exceeds EPA's Consent Decree and statutory authority.

EPA Position: Both types of restoration activity required by the Intended Final Decision are within EPA's Consent Decree and statutory authority, including (1) requiring GE to restore resources disturbed by remediation activities; and (2) requiring GE to comply with ARARs that provide for restoration work. Each of these points is discussed below.

GE advances a novel argument to suggest that EPA does not have the authority under CERCLA or RCRA to require the restoration of impacted habitats disturbed by remediation activities. GE SOP at 33-34. Such authority is vested in EPA pursuant to: Section 106 of CERCLA, providing the power to "issue such orders as may be necessary to protect public health and welfare and the environment," 42 USC § 9606; Section 3004(u) of RCRA granting broad authority to issue "corrective action for all releases of hazardous waste," 42 USC § 6924(u); and Section 3005(c)(3) of RCRA providing that each permit under this section "shall contain such terms and conditions as the Administrator (or the State) determines necessary to protect human health and the environment." 42 U.S.C. § 6925(c)(3). Nothing in the Decree limits this authority, and GE's past implementation of the Decree recognizes EPA's authority to require GE to restore natural resources disturbed by response action to pre-remediation condition. For example, when GE compared the alternatives for remediating the Rest of River in its Revised CMS, GE considered potential restoration activities to restore disturbed areas[273] and estimated the costs of restoring areas disturbed by the response actions to pre-remediation condition, including the cost of restoring forested wetland, shrub and shallow emergent habitat, backwater, deep emergent marsh, and other habitat.[274] GE and EPA considered restoration as a component of the evaluated remedial alternatives, separate and apart from settlement of natural resource damage ("NRD") claims. Similarly, in other areas of the GE Pittsfield/Housatonic River Site outside the Rest of River, such as Unkamet Brook, Silver Lake, and portions of the floodplains, where GE has undertaken removal action work, GE is restoring, or has restored, portions of the Brook, Lake and floodplains to at least pre-remediation condition pursuant to the applicable Work Plans.[275] For example, pursuant to the Work Plan for Phase 4 Floodplain

[273] Revised CMS, Chapter 5, Approach to and Considerations in Evaluating Adverse Impacts from Remedial Alternatives, Means to Avoid or Minimize those Impacts, and Potential Restoration.
[274] Revised CMS, Appendix Q, Submitted as Confidential Business Information.
[275] *See* Work Plans for Unkamet Brook, Silver Lake, and Phase 3 and Phase 4 properties adjacent to the 1 ½ Mile Reach.

Properties, GE conducted inventories of pre-existing conditions, including trees, shrubs, and other features to ensure that restoration of conditions to pre-remediation conditions would be achieved. Accordingly, this work to restore the Brook, Silver Lake, and portions of the floodplain to pre-remediation condition is independent of GE's obligations to also create additional habitat improvements in other separate areas of the Brook and Lake to resolve its natural resource damages liability to the natural resource trustees.[276]

Under CERCLA, cleanups must also comply with all ARARs. 42 U.S.C. § 9621(d).[277] Here, the Clean Water Act and the Massachusetts Endangered Species Act constitute ARARs and, under certain circumstances, these ARARs require the restoration of natural resources disturbed by remediation. GE argues, however, that EPA does not have authority to require restoration of disturbed areas even as part of CERCLA's mandate to comply with ARARs, because ARARs may allegedly only apply to hazardous substances that remain "onsite." GE SOP at 34. No court has ever adopted GE's interpretation and it is refuted by the Decree: the Decree establishes ARARs that are not limited to hazardous substances remaining "onsite." Decree, Appendix E, Attachment B. Likewise, EPA's guidance makes clear that federal and state statutes and regulations that are directed at protecting locations (e.g. resource areas, including habitats) can also be ARARs. For example EPA guidance on such location-specific ARARs states that substantive compliance with the federal Endangered Species Act ("ESA") means:

> that the lead agency must identify whether a threatened or endangered species, or its critical habitat, will be affected by a proposed response action. If so, the agency must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat.[278]

Indeed, the ESA is an ARAR that GE does not dispute, including the obligation to "take mitigation measures so that action does not affect species/habitat." Intended Final Decision, Attachment C at 7.

Thus, contrary to GE's claims, it is well settled that the natural resources disturbed by remediation must be restored and mitigated as part of the remedial process in accordance with the substantive requirements of ARARs, such as the ESA, the Massachusetts Endangered Species Act, the Massachusetts Wetlands Protection Act, and the Clean Water Act. Indeed, in other areas of the Site outside the Rest of River, the Clean Water Act and the Massachusetts Wetlands Protection Act constitute ARARs for the Removal Actions Outside the Rest of River and respectively require that River banks will be restored, habitat will be improved, and "disturbed vegetation will be restored." Decree, Appendix E,*Id*. Table 3 at 2, 4, 5. Similarly, GE does not dispute that the National Historic Preservation Act and the Mass. Historical Commission Act serve as ARARs, including for the Rest of River. *Id.* at 7; Intended Final Decision, Attachment C at 6, 13.

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[276] *See* Work Plans for Unkamet Brook, Silver Lake, and Phase 3 and Phase 4 properties adjacent to the 1 ½ Mile Reach.

[277] The statute requires the remedy to be conducted in accordance with all ARARs unless specific waiver requirements are met. CERCLA §121(d).

[278] EPA's CERCLA Compliance with Other Laws Manual: Part II, Clean Air Act and Other Environmental Statutes and State Requirements (August, 1989), p. 4-12

In addition, GE claims that any restoration to return disturbed areas to pre-remediation condition or to comply with ARARs would conflict with the Decree's covenants regarding natural resource damages ("NRD"). The future liability covenants related to NRD for the Rest of River, however, are not triggered until the Rest of River Remedial Action is complete. CD ¶¶ 112.a., 161. Indeed Paragraph 161(d) is explicit on the timing of the covenant:

> With respect to future liability, the covenant not to sue shall be effective for each Removal or Remedial Action to be performed by [GE] … upon EPA's Certification of Completion for that individual Removal or Remedial Action....

CD ¶ 161(d). Indeed, the statute prohibits the Natural Resource Trustees from providing a covenant for NRD until the responsible party "agrees to undertake appropriate actions necessary to protect and restore the natural resources damaged by" releases of hazardous substances. 42 U.S.C. § 9622(j)(2).[279] As discussed earlier, other provisions of the Decree, in turn, require that GE's implementation of response actions comply with ARARs, which include those requiring that natural resources disturbed by the remedy be restored or mitigated: Specifically, GE is required to comply with any ARAR set forth in the documents selecting the Rest of River Remedial Action and/or in the Rest of River SOW, unless waived by EPA pursuant to CERCLA and the NCP. CD ¶ 8. Here, GE agreed to implement the remedy for the Rest of River, and the NRD covenant for the Rest of River applies once this Remedial Action is complete. CD ¶¶ 112.a., 161(d).

GE relies on Decree Paragraph 114.b, a payment provision to the Natural Resources Trustees, to argue that it precludes EPA from requiring compliance with ARARs or restoration of areas disturbed by remediation activities. But this provision merely provides that GE pay the Trustees: "$600,000 as mitigation for wetlands impacts associated with PCB contamination and with response actions at the Site." CD ¶ 114.b. GE ignores the other relevant Decree provisions that state that GE's *satisfaction of the natural resource damage claims* is subject to GE's "[p]erformance of the response actions required under the Decree." CD 112(a). In short, until GE performs the Rest of River response actions in accordance with the requirements of the Decree, which include compliance with ARARs, GE has not satisfied the Governments' claims for natural resource damages. Accordingly, the payment provision in Paragraph 114.b is not a covenant not to sue from the United States. As noted above, that covenant is set out in Paragraphs 112(a) and 161, and is not triggered until completion of all Work required in the Rest of River SOW.[280]

GE also includes a few summary arguments regarding the level of detail and likelihood of success of restoration. SOP at 33, incorporating Comments. To the extent GE objects that the specifics of restoration are not sufficiently developed, those details will be set forth in the

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[279] GE suggests that because the *Natural Resource Trustees* have authority to recover for NRD, GE SOP at 34, that the United States, through EPA, may not require restoration of resources damaged by response action work or compliance with ARARs requiring restoration of natural resources. This interpretation is inconsistent with the covenants and with the statute. 42 U.S.C. §9622(j)(2). Satisfaction of the *Trustees'* claim is triggered by completion of all work required by the Decree, including the work set forth in EPA's Intended Final Decision.

[280] GE is wrong to claim that "restoration and acquisition of equivalent resources are part of NRD, not remedial action." GE SOP at 34. The Trustees and EPA have overlapping interests and jurisdiction and worked together here to draft a settlement in the public interest. As noted above the covenant not to sue for NRD does not apply until all the work is completed in the Rest of River, including restoration of resources disturbed by remediation and/or in compliance with ARARs.

Rest of River SOW or the Work Plans for the Rest of River SOW as is contemplated by the Decree. CD ¶¶ 22.x. To the extent GE further questions the likelihood of success of restoration efforts, information in the record does not support GE's position, and as noted above at Section III.B of this Statement of Position additional detail or certainty is not required at the remedy selection phase of remedy implementation. Finally, the restoration requirements in the Intended Final Decision reflect the expertise and input of EPA and the States in this area.

2. Massachusetts Endangered Species Act

Requirements: PCB contamination from GE's facility has been deposited widely throughout the Rest of River, including in areas designated by the Division of Fisheries and Wildlife ("DFW") in the Massachusetts Department of Fish and Game ("DFG") as habitat for endangered, threatened and species of special concern (collectively, "State-listed species") pursuant to the Massachusetts Endangered Species Act ("MESA") and the MESA regulations.[281] In evaluating remedial approaches for Rest of River, EPA has worked extensively with DFW's Natural Heritage and Endangered Species Program ("NHESP") over many years to identify potential approaches that balance remediation of the risks posed by GE's PCBs with the protection of State-listed species, and the Intended Final Decision reflects agreements reached between EPA and NHESP in this regard.[282, 283] The integration of MESA concerns into the Intended Final Decision is not limited to a particular provision, but is part of many different components for addressing the River, riverbanks, and floodplains.[284]

GE Position: GE argues three things: (1) that the net benefit requirement is inapplicable to species for which the "take" would impact a significant portion of the local population and that the requirement cannot be applied to those species; (2) that the requirement is not an ARAR as defined by CERCLA because of, GE claims, the amount of discretion in the decision maker; and (3) that the requirement is an attempt to recover natural resource damages in violation of the Decree's covenants not to sue for natural resource damages (NRD).

EPA Position: First of all, the dispute is speculative and need not be decided at this time. During the design of the remedy, if EPA determines that a "take" that would impact a significant portion of the local population occurs, EPA will identify that to GE, and GE would have the right, as with any design/implementation dispute, to pursue Dispute Resolution under the Decree, including review by U.S. District Court. CD Section XXIV. Beyond that, EPA will clarify the position below.

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[281] M.G.L. c. 131A and 321 CMR 10.00.

[282] See EPA's May 2012 Status Report; and NHESP's July 31, 2012 letter to EPA, Attachment B to the Intended Final Decision.

[283] The Intended Final Decision is similar to the June 2014 Proposed Cleanup Plan EPA issued for public comment. The Commonwealth, in its October 27, 2014 letter expressing support for the Proposed Cleanup Plan, stated, [T]he Commonwealth wishes to express our appreciation of EPA's willingness to consider and address many of the Commonwealth's concerns and priorities for the remediation of this unique ecosystem that … includes one of the richest and most diverse array of state-listed species protected under [MESA] and the MESA regulations at 321 CMR 10.00".

[284] Attachment B to the Intended Final Decision provides a description of the Core Habitat Area concepts used to assist EPA and the Commonwealth in identifying the remedy most suited to the circumstances of Rest of River.

With respect to the Net Benefit provision, EPA's Intended Final Decision includes a table of the applicable or relevant and appropriate environmental requirements for the Rest of River remedy (the "ARAR Table").[285] The ARAR Table has the following Synopsis for this provision of MESA:

> A proposed activity in mapped Priority Habitat for a state-listed rare, threatened, endangered species or species of special concern, or other area where such a species has occurred may not result in a "take" of such species, unless it has been authorized for conservation and management purposes that provide a long-term net benefit to the conservation of the affected state-listed species. A conservation and management permit may be issued provided an adequate assessment of alternatives to both temporary and permanent impacts to State-listed species has taken place, an insignificant portion of the local population would be impacted by the project or activity, and an approved conservation and management plan is carried out that provides a long-term Net Benefit to the conservation of the State-listed species.[286]

Similarly, the ARAR Table includes the following as the Actions to be Taken to Achieve this requirement:

> To the extent that unavoidable impacts result in a take of state-listed species, EPA would follow the regulatory requirements with respect to implementing a conservation and management plan providing for a long-term net benefit to the affected state-listed species.[287]

GE argues that if there is a "take" of a species which results in a "significant" portion of the local population being impacted by the project or activity, the requirement to submit a Conservation and Management Plan providing for a Net Benefit to the species would not apply, because the "take" is prohibited outright.

DFW has affirmed for EPA that under the MESA regulations, if a determination of a take is made, the project or activity must either be modified to eliminate the take or the proponent must obtain a conservation and management permit ("CMP") pursuant to 321 CMR 10.23. More specifically, in addition to showing that the impacts from the remedial action have been avoided, minimized and mitigated, the MESA regulations at 321 CMR 10.23(2)(a)-(c) set forth three separate, distinct and substantive performance standards that must be met in order to obtain a CMP authorizing a take under MESA:

a) there has been an adequate assessment of alternatives to both temporary and permanent impacts;

b) only an insignificant portion of the local population of the affected state-listed species will be impacted, and

[285] See Attachment C to the Intended Final Decision, at 14.
[286] Intended Final Decision, Attachment C, at 14.
[287] Ibid.

c) an approved conservation and management plan provides for the long-term Net Benefit for the conservation of the state-listed species. The term "Net Benefit" is defined in the MESA regulations at 321 CMR 10.01 to mean (1) an action(s) that contribute significantly to the long-term conservation of a state-listed species, and (2) that conservation contribution exceeds the harm caused by the proposed project or activity.

As noted above, DFW has affirmed for EPA that the insignificant impact on local population and the Net Benefit performance standards in 321 CMR 10.23(2)(b) and (c) are separate and distinct substantive requirements applicable to the permitting of a take. More specifically, in order to authorize a take, 321 CMR 10.23(2)(b) requires that there be an "insignificant impact" to the *local* population of the affected state-listed species. In comparison, 321 CMR 10.23(2)(c) requires that a Net Benefit be provided to the affected state-listed species *as a whole* (i.e., beyond the geographic location of the local population of that species).

If a take will have a significant impact on the local population of the affected species, in order to move forward, such an activity would need to be redesigned or coupled with a form of mitigation that would result in an insignificant impact on the local population. In that regard, there are certain forms of mitigation designed to enhance the local population, thereby lessening the overall impact of a project. For this reason, DFW typically requires an applicant to evaluate whether a Net Benefit can be provided, even in cases where there is a preliminary assessment that the activity will impact a significant portion of the local population. This approach is appropriate because after-the-fact habitat management and habitat restoration could off-set remediation impacts in certain cases, which should be considered in evaluating the level of impact on the local population resulting from a particular remedial alternative in site-specific locations.

During design and implementation of the proposed remedy, if, despite that evaluation and potential mitigation, a significant impact on the local population remains, EPA, in consultation with DFW, will evaluate whether it is appropriate to waive the requirement of an insignificant impact on local population pursuant to CERCLA Section 121(d)(4), such as if it is technically impracticable to comply with that requirement. GE remains obligated under the MESA regulations to comply with the separate, distinct and substantive Net Benefit performance standard in 321 CMR 10.23(2)(b) to compensate for the resulting take through the implementation of a conservation and management plan.

GE also argues that MESA provides too much discretion to the decision maker on determining whether to permit a "take", and that amount of discretion does not satisfy CERCLA 121(d)'s requirement for that an ARAR be "standard, requirement, criteria or limitation".

EPA disagrees. The DFW Director's authority to permit a take of a State-listed species is subject to and limited by several specific standards established in the MESA regulations. First, as outlined above, the DFW's Director's authority to authorize a take is subject to the performance standards at 321 CMR 10.23(2), unless in a situation such as GE's implementation of the Rest of River remedy, such MESA performance standard(s) is waived by EPA. Furthermore, the MESA regulations at 321 CMR 10.23(7) ("General Mitigation Standards Applicable to Individual and General Conservation and Management Permits Issued by the Director") specifically address the general mitigation standards to be applied by the

DFW Director in issuing CMPs[288]. This regulation directs the Director to apply the areal habitat mitigation ratios specified therein that correspond to the affected category of state-listed species: 3:1 for endangered species; 2:1 for threatened species; and 1.5:1 for species of special concern.

While the regulation reserves the right to deviate from the applicable mitigation ratio or allow an alternative mitigation approach, discretion to do so is subject to the process and criteria specified therein. Specifically, the decision-maker is required to determine in writing that the alternative mitigation ratio or mitigation approach is either sufficient or required to meet the Net Benefit standard. In making such determination, the decision-maker must also consider, at a minimum, the 5 factors identified in the regulation, which involve specific conservation management considerations such as the threats to and population density of the affected state-listed species, the size and configuration of both the habitat impact and quality of the habitat proposed to be protected.

With respect to GE's argument on the MESA-required activities being precluded by the Natural Resource Damage covenants in the Decree, EPA disagrees with GE's characterization and has responded to GE's arguments in Section III.C.1 of this Statement of Position.

D. EPA Correctly Designated ARARs and ARAR Waivers

1. Water Quality Criteria:[289]

Requirements: The relevant National Recommended Water Quality Criteria establish PCB limits for the Housatonic River. EPA identified the requirements for the Intended Final Decision.

GE Position: GE argues that EPA should not attempt to meet the human health criterion based on human consumption of water and organisms of 0.0000064 micrograms per liter (ug/L) in Connecticut because of difficulties in measuring the 0.000064 ug/L standard, and

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[288] 321 CMR 10.23(7) includes the following habitat mitigation ratios that are to be generally applied: The Director, in determining the appropriate nature and scope of mitigation necessary for an applicant for an individual or general conservation and management permit to achieve the long-term Net Benefit performance standard in 321 CMR 10.23(1), will generally apply the following areal habitat mitigation ratios, based on the category of State-listed Species:
1. Endangered Species: 1:3 (i.e., protection of three times the amount of areal habitat of the affected Endangered Species that is impacted by the Project or Activity);
2. Threatened Species: 1:2 (i.e., protection of two times the amount of areal habitat of the affected Threatened Species that is impacted by the Project or Activity).
3. Special Concern Species: 1:1.5 (i.e., protection of one and one half times the amount of areal habitat of the affected Species of Special Concern that is impacted by the Project or Activity).

[289] For each of the ARARs discussed in this Statement of Position, more specific information, including a synopsis of the requirements, the status of the requirement, and the action(s) to be taken to attain the ARAR, can be found at Attachment C of the Intended Final Decision, Summary of Applicable or Relevant and Appropriate Requirements.

that given uncertainties in extrapolating model results to CT, there is no reliable method to predict the attainment of this criterion in CT. [290]

EPA Position: EPA disagrees. Current modeling shows that the remedy will achieve attainment of the 0.000064 ug/L level in 3 of the 4 Connecticut impoundments.[291] In its Revised CMS submittal, GE evaluated alternative SED 9, which, of the alternatives evaluated in the Revised CMS, is the alternative most similar to the proposed remedy (one difference is that the proposed remedy has less excavation of sediment in Reach 5B, which could cause its estimates to be slightly higher than those for SED 9.) In GE's Revised CMS evaluation of SED 9, GE stated that for the Connecticut impoundments, the water column concentrations estimated by the model exceed the criterion in one of four impoundments. Given those estimates, the remedy is intended to meet this standard.

As GE has stated, the Connecticut modeling provides a means of generally estimating the impact of different sediment alternatives on the major four Connecticut impoundments.[292] However, EPA does recognize that there is inherent uncertainty in this modeling based on the nature of the analysis. Accordingly, EPA will consider a waiver of the ARAR in the future should it become apparent that these criteria are technically impracticable to meet.[293] However, until there is further information indicating that the chances for attainment in CT impoundments is not as likely as currently modeled, EPA believes it is reasonable to continue to seek attainment of this standard.

2. Clean Water Act Section 404 Regulations:

Requirements: The regulations are to address dredging and filling of waterbodies. As EPA states in the Intended Final Decision's ARAR Table,[294] the remedy is designed to reduce human health and environmental risks posed by PCBs and includes actions to excavate riverbed sediments, bank soils and floodplain soils, with backfilling and capping.

To comply with the CWA 404 ARAR, the remedy will include excavation technology and multiple engineering controls to minimize resuspension of any PCB-contaminated water,

[290] GE in its Statement of Position makes a blanket reference to the arguments made in its 2014 comments on this issue on EPA's 2014 remedy proposal. To the extent that a response to those 2014 comments is required for this Statement of Position, it is as follows. First, GE claims that continued input of PCBs from atmospheric sources decreases the likelihood of ever attaining 0.000064 ug/L. In response, EPA's stands by its modeling efforts as being appropriate for this decision-making. The modeling efforts, prescribed by the Consent Decree, included for Massachusetts sections of the River independent scientific peer reviews on three different components of the modeling process, and the ability for GE to provide comments to the peer review panel at each of the three junctures (which GE availed itself of). For Connecticut, GE used the outputs from the peer reviewed Massachusetts model as inputs for its modeling effort in Connecticut. The model is sufficient for the purposes of Rest of River decision-making. Second, GE argues that EPA erred in stating that all remedial actions in the waterway will be conducted so as not to contribute to an exceedance of the water quality criteria. EPA disagrees. Overall, the remedy components are designed to reduce the PCB levels in the riverbed, bank soils and floodplain soils, not to contribute to exceedances. As noted above, modeling results indicate that the PCB concentrations in water will be reduced significantly due to the Intended Final Decision. Implementation of the proposed remedy will significantly improve the likelihood of achieving the water quality criteria.

[291] GE Revised CMS, Section 6.9.4, at 6-300 (2010).

[292] GE Revised CMS, Section 3.2.5, at 3-45 (2010).

[293] 2014 Statement of Basis, at 40.

[294] Intended Final Decision, Attachment C, at 4.

including any from wetlands. The remedy will proceed from upstream to downstream, with capping to follow in parts of the river.

Any remedy activities that will alter wetlands, including excavation of contaminated wetland soils and sediments, backfilling and capping, will be conducted in accordance with these standards.

GE Position: GE argues three points: (1) That there are practicable alternatives that would be protective and have less adverse impacts than the proposed remedy; (2) That the proposed remedy would cause or contribute to exceedance of a water quality criterion; and (3) That the regulations include the "compensatory mitigation" regulations, and that attempt to recover compensatory mitigation would violate the covenants not to sue that GE received for natural resource damages under the Decree. CD ¶ 161.

EPA Position: EPA disagrees with GE's assertions. EPA has evaluated each of the alternatives from GE's Revised CMS, and has reviewed the public comments on the June 2014 proposed remedy. EPA has determined that there are no practicable alternatives with lesser effects on the aquatic ecosystem than the proposed remedy. The EPA regulations provide that "an alternative is practicable is it is available and capable of being done after taking into consideration costs, existing technology, an logistics in light of overall project purposes."[295] Additionally, the Preamble to the Clean Water Act Section 404(b)(1) Guidelines states "… [w]e consider implicit that, to be practicable, an alternative must be capable of achieving the best purpose of the proposed activity." [296] The proposed remedy, which EPA has determined to be best suited under the circumstances, is designed to reduce the unacceptable risks posed by GE's PCB contamination, while at the same time to avoid, minimize and mitigate risks to habitat. No other practicable alternative has less adverse impact on the aquatic ecosystem. EPA's proposed remedy includes extensive efforts to reduce the impacts of the remediation. See the description in the discussion of the Massachusetts Water Quality Certification regulations and the Massachusetts Wetlands Protection Act, at Sections III.D.4.and III.D.5 of this Statement of Position, for more details.

Second, the remedy will not cause or contribute to violation of any applicable water quality standard, violate an applicable toxic effluent standard, jeopardize existence of endangered or threatened species, or contribute to significant degradation of waters of the United States. In fact, the remedy is designed to reduce the health risks, reduce the levels of contamination in the riverbed sediments, bank soils and floodplain soils, and to isolate and stabilize the remaining PCB contamination. The remedy also includes substantial safeguards to protect endangered and threatened species.[297]

Third, with respect to GE's argument about compensatory mitigation activities being precluded by the NRD covenants in the Decree, there is currently no specific dispute for resolution at this time because no compensatory mitigation measures have been required.[298] Moreover, based on its comments on the 2014 remedy proposal, GE appears to acknowledge

[295] 40 C.F.R. § 230.10.
[296] 45 Fed. Reg. 85,339 (Dec. 24, 1980).
[297] See Section II.B.1.c of the Intended Final Decision.
[298] EPA's ability to require restoration activities for areas disturbed by remediation activities and/or to achieve ARARs is also discussed above in Section III.C.1 of this Statement of Position.

that requirements directed to "attempting to address the impacts of the release by returning affected areas to their pre-remediation condition" [299] would not be covered by GE's NRD covenant. The future liability covenants related to NRD for the Rest of River, however, are not triggered until the Rest of River Remedial Action is complete. CD ¶¶ 112.a., 161. Indeed Paragraph 161(d) is explicit on the timing of the covenant:

> With respect to future liability, the covenant not to sue shall be effective for each Removal or Remedial Action to be performed by [GE] … upon EPA's Certification of Completion for that individual Removal or Remedial Action....

CD ¶ 161(d) (emphasis added). Indeed, the statute prohibits the trustees from providing a covenant for NRD until the responsible party "agrees to undertake appropriate actions necessary to protect and restore the natural resources damaged by" releases of hazardous substances. 42 U.S.C. §9622(j)(2). Here, GE agreed to implement the remedy for the Rest of River, and the NRD future liability covenant for the Rest of River applies once this Remedial Action is complete. CD ¶¶ 112.a., 161(d)

Finally, if during implementation of the proposed remedy, EPA makes a specific determination as to the necessary measures to accomplish compensatory mitigation, and GE interprets such action as being covered by the Decree NRD covenant, GE may at that time avail itself of the dispute resolution provisions under the Decree. CD § XXIV.

3. Executive Orders on Wetlands and Floodplains:

Requirements: Wetlands and floodplains of the Housatonic River are among the areas where GE's PCBs have come to be deposited, and those PCBs are posing unacceptable risks to human health and the environment. To address those risks, the Intended Final Decision includes activities such as excavation and capping of GE's PCBs in wetlands and in floodplains. To accomplish those activities and other remedy components, support activities are proposed to take place in the floodplain, such as use of temporary access roads and temporary areas for staging excavated material prior to disposal. The proposed remedy also requires GE to complete restoration of areas disturbed by the cleanup implementation, per the Restoration Performance Standards discussed above at Section III.C.1. Throughout the remedy implementation, EPA will comply with the Executive Orders for Protection of Wetlands[300], and for Floodplain Management[301].

GE Position: GE argues as follows: (1) that activities in the floodplain will result in occupancy or modification of the floodplain, and (2), that the proposed remedy would not meet the requirements of the Floodplain or Wetlands Executive Orders because, GE asserts, there are practicable alternatives with less impact on the floodplain and wetlands.

EPA Position: First, with respect to occupancy or modification of the floodplain, EPA's proposal mandates a number of different requirements to ensure there is no long-term occupancy or modification of the floodplain. The Restoration Performance Standards state clearly that, for all areas disturbed by remediation activities under this Permit, GE shall:

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[299] October 27, 2014, GE letter to EPA, "GE's comments on EPA's Draft RCRA Permit Modification and Statement of Basis for Proposed Remedial Action for the Housatonic River – Rest of River", at 66.
[300] Executive Order 11990.
[301] Executive Order 11988.

> (a) Implement a comprehensive program of restoration measures that addresses the impacts of the Corrective Measures on all affected ecological resources, species and habitats, including, but not limited to, … floodplain, wetland habitat …, and
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> (b) Return such areas to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements.[302]

Plainly, the proposed remedy is designed to not have long-term impacts on the floodplain. However, to the extent that the limited activities to remove PCB contamination from the floodplain, and the support activities for other proposed remediation activities are considered occupancy and modification of the floodplain, EPA has determined that there is no practicable alternative to it.

EPA disagrees with GE's second argument. Based on EPA's extensive evaluation of alternatives to remediate GE's PCBs, there is no practicable alternative with less adverse impacts on either the floodplains or wetlands. As described elsewhere in this Statement of Position, the proposed remedy is a balanced, reasonable approach to address the unacceptable risks posed by GE's PCBs while also emphasizing protection of sensitive habitat.

With respect to the floodplain, GE's PCB contamination is causing unacceptable risks throughout the Rest of River floodplain, as well as in the riverbed, riverbanks, Backwaters, and related Rest of River areas. That being the case, activity in the floodplain is necessary to address the floodplain risks and to support the activities to clean up GE's PCBs in other Rest of River areas. These remediation activities in the floodplain will be temporary, and they will be restored after remediation. In addition, the proposed remedy is designed to minimize impacts on flood storage capacity from cleanup activities. For example the Engineered Caps used in several remedy components will be designed and placed so that they will not decrease flood storage capacity. In addition, the remedy will comply with regulatory standards on floodplain management.[303]

Regarding wetlands, significant levels of contamination exist in wetlands within the Rest of River. EPA has determined that its proposed remedy is the least environmentally damaging practicable alternative. [304] EPA will minimize potential harm and avoid adverse impacts on wetland resources, to the extent practical, by using best management practices to minimize harmful impacts on the wetlands, wildlife and habitat. The Restoration Performance Standards cited above include wetland habitat among those areas for which GE must implement a comprehensive program of restoration measures, and return such areas to pre-remediation conditions to the extent feasible and consistent with the remediation requirements. [305]

4. Massachusetts Water Quality Certification Regulations:

Requirements: These regulations govern the discharge of dredged or fill material, dredging, and dredged material disposal in waters of the United States within the

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[302] Intended Final Decision, at II.B.1.c(1).
[303] Statement of Basis, at 40.
[304] Statement of Basis, at 40.
[305] Intended Final Decision, at II.B.1.c.

Commonwealth. They are applicable to the proposed remedy, and EPA has stated that all activities will be conducted in accordance with these regulations.[306]

GE Position: GE argues that EPA cannot show that there is no practicable alternative with less adverse impact on the aquatic ecosystem, that the proposed remedy would necessarily have an adverse effect on the estimated habitats of rare wildlife species, and that application of the 1:1 restoration/replication requirements to acquisition or construction of new wetlands as compensatory mitigation would be unauthorized.

EPA Position: First, EPA evaluated many alternatives to address the criteria in the Permit, and determined that the proposed remedy is the alternative best suited to satisfy the Permit criteria. The proposed remedy is designed to reduce the unacceptable risks posed by GE's PCB contamination, while at the same time to avoid, minimize and mitigate risks to habitat. There is no other practicable alternative that reduces unacceptable PCB risks while protecting habitat with less adverse impact on the aquatic ecosystem.

Although GE is correct in that 314 CMR 9.06(2) generally prohibits any project involving the discharge of dredged or fill material that will have any adverse effect on specified habitat sites of Rare Species, GE's argument ignores other pertinent aspects of the regulations that allow the remedy to go forward. Even with that general prohibition, projects that involve the discharge of dredged or fill material in protected resource areas are otherwise permissible under 314 CMR 9.06(2) if appropriate and practicable steps are taken, such as a minimum of 1:1 restoration or replication, to avoid and minimize potential adverse impacts. Furthermore, the prohibition in 314 CMR 9.06(2) may be overcome by meeting the criteria at 314 CMR 9.08 applicable to variances, including taking all reasonable measures to avoid, minimize, and mitigate adverse effects on the environment and demonstrating the action is justified by an overriding public interest.

The Commonwealth has affirmed that there exists an overriding public interest in waiving the prohibition in 314 CMR 9.06(2) because the proposed remedy is designed to reduce the unacceptable risks posed by GE's PCB contamination while at the same time avoiding, minimizing, and mitigating the risks posed to the habitat of Rare Species. In addition, to meet the criterion for a variance of the prohibition in 314 CMR 9.06(2) on projects that will have any adverse effect on specified habitat sites of Rare Species, the proposed remedy provides for taking all reasonable measures to avoid, minimize, and mitigate adverse effects on the environment. Massachusetts Department of Environmental Protection ("MassDEP") generally seeks to coordinate implementing its regulations regarding the protection of habitat of Rare Species with the Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Program in the Massachusetts Department of Fish and Game ("Natural Heritage Program"). This criterion is met through the development and implementation of a Conservation and Management Plan to provide for a long-term Net Benefit to such habitat sites in accordance with the Massachusetts Endangered Species Act regulations.[307] Finally, MassDEP has determined that the proposed remedy is otherwise permissible under 314 CMR 9.06(2) because appropriate and practicable steps will be taken,

[306] Attachment C to the Intended Final Decision, at 8.
[307] *See* EPA's Statement of Position at Section III.C.2 on the application of the MESA Conservation Plan/Net Benefit Requirement in the context of GE's implementation of the Rest of River remedy.

including a minimum of 1:1 restoration or replication, to avoid and minimize potential adverse impacts on protected resource areas.

As EPA addresses in Section III.D.2 of this Statement of Position, EPA disagrees with GE's characterization of the requirements for potential compensatory mitigation projects.

5. Massachusetts Wetlands Protection Act Regulations:

Requirements: These regulations govern activities in wetlands. EPA has stated that all remedy activities will be conducted in accordance with these standards.[308] As EPA describes in Attachment C to the Intended Final Decision, the proposed remedy satisfies the criteria for a "limited project", per 310 CMR 10.53(3), where there are no practicable alternatives to the response action that would be less damaging to resource areas, and where impacts to resource areas are minimized.

GE Position: GE asserts that (1) there are practicable, protective and less damaging alternatives, and (2) that (a) Section 10.59 of the regulations prohibits projects that would have short-or long-term adverse effects on the habitat of a local population of a state-listed species, without mention of a MESA Conservation and Management Plan, and (b) that EPA's remedy would have such impacts.

EPA Position: EPA has evaluated thoroughly many different alternative approaches to addressing the risks posed by GE's PCB contamination in the wetlands of Rest of River. In its review, there was no practicable remedy that addresses the unacceptable risks to human health and the environment that included less adverse impacts on wetlands. EPA has considered alternatives to avoid adverse impacts, and has required specific steps to minimize harm to the floodplain and to ensure that no practicable alternative has less adverse impact on the wetlands. EPA's proposed remedy includes specific Performance Standards on Restoration of Areas Disturbed by Remediation Activities, which require GE to:

> 1. Implement a comprehensive program of restoration measures that addresses the impacts of the Corrective Measures on all affected ecological resources, species and habitats, including but not limited to, riverbanks, riverbed, floodplain, wetland habitat, and the occurrence of threatened, endangered or state-listed species and their habitats; [309], and
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> 2. Return such areas to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements.[310]

GE is correct that Rest of River response actions are "limited projects" within the meaning of 310 CMR 10.53. 310 CMR 10.53(3) states that "no [limited] project may be permitted which will have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.59[]." Since 2006, MassDEP has continued to maintain a written policy entitled "DWW Policy 06, Procedures for Coordinated review Under the Endangered Species and Wetlands Protection Regulations for State-Listed

[308] Attachment C to the Intended Final Decision, at 10.
[309] Intended Final Decision, at Section II.B. 1.c.
[310] Intended Final Decision, at Section II.B.1.c..

Wildlife in Wetlands" (the "Policy") that is applied in determining whether a project will have any adverse effect on such sites. As MassDEP explains in the Policy:

> Pursuant to 321 CMR 10.00, the Natural Heritage Program reviews any project proposed for state-listed species habitat. When a project is proposed in estimated habitat in wetland resource areas, it is also subject to MassDEP's wetlands regulations. In fulfilling its responsibilities under 321 CMR 10.00, the Natural Heritage Program considers whether a take will occur under 321 CMR 10.18 and whether it can be permitted under 321 CMR 10.23. A set of conditions that avoid a take under 321 CMR 10.18, will be presumed to not have an adverse effect on the habitat of state-listed wildlife species pursuant to 310 CMR 10.37 and 10.59. It makes sense for the Natural Heritage Program to make these determinations at the same time as it fulfills its obligations under MassDEP's wetlands regulations.
>
> As provided in 310 CMR 10.37 and 10.59, when a project is proposed in estimated habitat, the issuing authority relies on the Natural Heritage Program's opinion as to whether a proposed project has any short or long-term effect on the habitat of the local population of any state-listed wildlife species. Accordingly, when the Natural Heritage Program makes a determination pursuant to 321 CMR 10.23, that a project may proceed pursuant to a conservation and management permit, this determination shall be presumed to satisfy the standard for no short or long-term adverse effect pursuant to the wetlands regulations (310 CMR 10.37 and 10.59.)

MassDEP has affirmed for EPA that consistent with the above MassDEP's written policy as applied in the context of GE's implementation of the Rest of River remedy pursuant to CERCLA[311], an EPA determination, made in consultation with the Natural Heritage Program, that a response action with an adverse effect on a specified habitat site of Rare Species will be mitigated through a Conservation and Management Plan providing a Net Benefit to the affected State-listed species as a whole will satisfy MassDEP's substantive standards under 310 CMR 10.53(3) and 10.59.

6. Massachusetts and Connecticut Dam Safety Regulations:

Requirements: The Rest of River includes six dams in Massachusetts, and six dams in Connecticut. Many of those dams are in areas where PCB contamination has been found, in some instances at highly elevated levels. The EPA Intended Final Decision includes several project components dealing with PCBs in relation to the dams, such as addressing PCB-contaminated sediment in impoundments behind dams,[312] ensuring inspection, monitoring and maintenance,[313] and responding to a PCB release due to a dam breach or failure.[314] In EPA's listing of ARARs,[315] EPA listed the two states' dam safety regulations as "potentially applicable".

[311] For relevant background, see EPA's Statement of Position on the MESA Conservation Plan/Net Benefit Requirement at Section III.D.2.
[312] Intended Final Decision, Section II.B.2.e, f, g.
[313] Intended Final Decision, Section II.B.2.j.
[314] Intended Final Decision, Section II.B.2.l.
[315] Intended Final Decision, Attachment C, ARAR Table, at 11, 14

GE Argument: GE does not dispute that the Massachusetts Dam Safety Standards constitute ARARs for the dams currently owned by GE, Woods Pond Dam and Rising Pond Dam. For other dams, GE asserts that the Federal Energy Regulatory Commission (FERC) preempts state jurisdiction on some dams, and that for others, the regulations clearly establish responsibilities of non-party dam owners, not GE.

EPA Position: As noted above, EPA listed these as "potentially applicable" requirements. EPA recognizes that if responsibilities for a particular dam are subject to preemption by FERC, the state dam safety ARAR would not be applicable. Other than Woods Pond and Rising Pond Dams, if in the future, GE becomes owner or operator of any Rest of River dam for which FERC does not preempt dam safety regulations, the ARAR would be applicable for such dam(s). Finally, as described above in Section III.B.4-5 of this Statement of Position, these ARAR requirements are in addition to the other responsibilities related to dams in the Intended Final Decision, which, unless specifically provided, are not dependent on the dam safety regulations being applicable.

7. Massachusetts Location Standards for Hazardous Waste Management Facilities

Requirements: These requirements provide locational requirements for hazardous waste management facilities, including restrictions on hazardous waste facilities in an ACEC.

The Intended Final Decision includes excavation of PCB-contaminated soil and sediment and the off-site disposal of such excavated soil and sediment. The Intended Final Decision does not require disposal at a hazardous waste disposal site in the ACEC. However, prior to transportation of the excavated soil and sediment to its off-site disposal location, the Intended Final Decision provides for temporary management of excavated soil and sediment at locations near the River, some of which would be within the ACEC. The temporary management may include temporary stockpiling or accumulation of materials, and may include locations related to railroad transport of excavated materials. Also, the remedy includes restoration of the temporarily used areas -- for each area disturbed during remedy implementation, including those within the ACEC, the remedy includes provisions for restoration of what is disturbed by the temporary management of the excavated material.

These regulations prohibit permanent disposal locations within an ACEC. As specified in Attachment C to the Intended Final Decision, to the extent that the provisions of 310 CMR 30 apply to temporary management of excavated materials prior to disposal off-site, and if the temporary management occurs within or in close proximity to the ACEC, and the materials being temporarily managed are subject to these regulations, EPA, in consultation with the Commonwealth, considers as waived, pursuant to CERCLA 121(d)(4)(c), the requirements of 310 CMR 30 that prohibit such temporary management locations during remedy implementation.

GE Position: GE argues that if EPA waives the ARAR relating to temporary management of materials, EPA should also select on-site disposal and extend that ARAR waiver analysis to permanent, not temporary, disposal of hazardous waste within the ACEC.

EPA Position: EPA disagrees. Placement of a permanent disposal facility is clearly within the scope of the regulations. Moreover, the temporary and permanent effects on the resources of the ACEC are very different. With temporary management of waste, followed by restoration of disturbed areas, there will be only short-term impacts on the resources of the ACEC. Such short-term impacts are dramatically different than the impacts on the resources of the ACEC associated with construction of a hazardous waste disposal facility, which will impact the resources of the ACEC in perpetuity. In addition, removal of GE's PCBs to reduce the unacceptable health risks cannot be implemented without temporary impacts to the resources of the ACEC, whereas the remedy can be implemented without allowing permanent impacts to the resources of the ACEC that would result from construction of a hazardous waste disposal facility. Permanent on-site disposal within the ACEC at GE's preferred Woods Pond landfill location, would require waivers of these waste facility siting regulations. Since off-site disposal is a viable alternative, technical impracticability does not provide a basis for this waiver, and there is no other basis for a waiver.

8. Massachusetts Site Suitability Criteria for Solid Waste Facilities:

Requirements: These requirements provide criteria for placement in Massachusetts of solid waste facilities, including restrictions for placement of a solid waste facility in an ACEC.

The Intended Final Decision includes excavation of PCB-contaminated soil and sediment and the off-site disposal of such excavated soil and sediment. The Intended Final Decision does not require disposal at a solid waste disposal site in the ACEC. However, prior to transportation of the excavated soil and sediment to its off-site disposal location, the Intended Final Decision provides for temporary management of excavated soil and sediment at locations near the River, some of which would be within the ACEC. The temporary management may include temporary stockpiling or accumulation of materials, and may include locations related to railroad transport of excavated materials. Also, the remedy includes restoration of the temporarily used areas -- for each area disturbed during remedy implementation, including those within the ACEC, the remedy includes provisions for restoration of what is disturbed by the temporary management of the excavated material.

These regulations prohibit permanent disposal locations within an ACEC. As further described in Attachment C to the Intended Final Decision, to the extent that the provisions of 310 CMR 16 apply to temporary management of materials after excavation and prior to off-site disposal, and if the temporary management occurs within or in close proximity to the ACEC, and the materials being temporarily managed are subject to these regulations, EPA, in consultation with the Commonwealth, considers as waived, pursuant to CERCLA 121(d)(4)(c), the requirements of 310 CMR 16.40 that prohibit such temporary management locations during remedy implementation.

GE Position: GE makes three arguments: (1) that these requirements should be waived because the State has not applied the requirements to on-site waste management/disposal facilities at other sites in Massachusetts, or at the GE-Housatonic Site; (2) that EPA should waive the requirements for permanent disposal under the same analysis as EPA proposes to waive the ARAR for temporary stockpiling of solid waste; and (3) that if the regulations do apply, the prohibition on siting a solid waste handling facility in a Riverfront Area (within 200 feet of a flowing waterbody) would need to be waived as technically impracticable from an engineering perspective.

EPA Position: As to the application of requirements by the State, CERCLA Section 121(d) requires each remedial action to achieve the ARARs, unless a specific reason for a waiver of the ARAR exists. One basis for a waiver is if a State has not consistently applied (or demonstrated the intention to consistently apply) the regulations in similar circumstances at other remedial actions within the State.

The Commonwealth timely identified 310 CMR 16 as an ARAR for this remedial action. Moreover, contrary to GE's implication, the Commonwealth has in fact cited 310 CMR 16 as an ARAR at prior remedial action sites.[316]

With respect to the other response actions at the GE-Housatonic Site, none of the response actions were performed as CERCLA remedial actions and therefore the ARAR provisions did not apply. Moreover, for the GE-Pittsfield/Housatonic River Site Removal Action cited by GE in its 2014 Comments, the Building 71 On-Plant Consolidation Area, listing the Site Suitability Criteria as an ARAR was not necessary. Specifically, the Building 71 Consolidation Area: was designed to handle hazardous waste, not solid waste: was not within or adjacent to an ACEC; was in an area with existing groundwater contamination and at or adjacent to areas with soil contamination: and included capping to meet RCRA and TSCA requirements.

For other Massachusetts sites, there are several reasons why the 310 CMR 16 regulations were not listed as ARARs. Specifically:

- For New Bedford Harbor, the disposal areas: were not located within or adjacent to an ACEC; consisted of Confined Disposal Facility or Confined Aquatic Disposal, not an upland landfill; were constructed in areas already contaminated; and were designed to meet RCRA and TSCA requirements.
- At Sullivan's Ledge: the disposal area was not located within or adjacent to an ACEC; the remedy did not expand the footprint of the existing disposal area or create a new disposal facility; the remedy required the consolidation of all excavated material into an existing disposal area; and the remedy required a cap designed to meet RCRA and TSCA requirements.
- At Silresim Chemical Corporation, the remedy called for all excavated material to be disposed of under a RCRA-equivalent cap; the disposal area was not located within or adjacent to an ACEC; the remedy did not expand the footprint of the existing disposal area or create a new disposal facility; and the remedy required the consolidation of all excavated material into an existing on-site disposal area.
- At the Norwood PCBs Site, the remedy called for all excavated material to be disposed of on-site in a manner that met TSCA requirements; the disposal areas were not located within or adjacent to an ACEC; the remedy did not expand the footprint of the existing disposal area or create a new disposal facility; and required capping that met TSCA requirements.

Decisions not to list 310 CMR 16 as an ARAR at these sites were because application of those regulations was not necessary.

GE claims that if the ARAR is legitimate for this action, the ARAR waiver proposed by EPA should be extended not just to temporary management of materials prior to disposal off-

[316] *See*, e.g., Norwood PCBs Site, 1996; Fort Devens Operable Unit 2 Decision, 1999.

site, but to the permanent disposal within the ACEC of solid waste generated in the cleanup. EPA disagrees. Placement of a permanent disposal facility is clearly within the scope of the regulations. Moreover, the temporary and permanent effects on the resources of the ACEC are very different. With temporary management of waste, followed by restoration of disturbed areas, there will be only short-term impacts on the resources of the ACEC. Such short-term impacts are dramatically different than the impacts on the resources of the ACEC associated with construction of a hazardous waste disposal facility, which will impact the resources of the ACEC in perpetuity. In addition, removal of GE's PCBs to reduce the unacceptable health risks cannot be implemented without temporary impacts to the resources of the ACEC, whereas the remedy can be implemented without allowing permanent impacts to the resources of the ACEC that would result from construction of a hazardous waste disposal facility. Permanent on-site disposal within the ACEC at GE's preferred Woods Pond landfill location would require waivers of these waste facility siting regulations. Since off-site disposal is a viable alternative, technical impracticability does not provide a basis for this waiver, and there is no other basis for a waiver.

Finally, as to GE's argument about a waiver of the Riverfront Area requirements, the provision would be potentially applicable like other provisions in 310 CMR 16. To the extent that (1) the provisions of 16.40 apply to the temporary management of materials during implementation of the remedy after excavation and prior to off-site disposal; (2) the materials temporarily managed on-site during implementation of the remedy constitute solid waste under the regulation; and (3) the locations for management of materials include Riverfront Area(s) pursuant to the regulations, EPA, in consultation with the Commonwealth, considers as waived, pursuant to CERCLA 121(d)(4)(C), the requirements of 16.40 that prohibit or restrict such temporary management locations during implementation of the remedy.

9. MESA:

In its reference to the MESA ARAR in the Statement of Position (pages 40-41),, GE has raised the same arguments as it makes regarding MESA at pages 34-35 of its brief. That being the case, EPA's position regarding the MESA ARAR dispute is the same as EPA's position at Section III.C.2 above.

IV. CONCLUSION

As the foregoing demonstrates clearly, the arguments in GE's Statement of Position should be rejected, and EPA's Intended Final Decision affirmed. For over a decade, EPA has followed faithfully the remedy decision-making process provided in the Consent Decree and Permit, including scientific information gathering and technical analysis, multiple reviews by independent peer-review panels, and an extraordinary number of process opportunities for both GE and the public. EPA relied upon its technical expertise and objectivity, along with input from GE and the public, in analyzing alternatives in light of the relevant criteria in the Permit and information in the Administrative Record. Based on that analysis, EPA proposed a balanced, reasonable remedial approach, rejecting more costly and intrusive alternatives, as well as alternatives with less health protection and less cost.

EPA has carefully considered GE's arguments, and has identified herein particular modifications or clarifications that EPA is willing to make in the final Permit to address GE's concerns. For example, see the clarification as to the obligation to address a Legally

Permissible Change in Use or Future Project or Work at properties with PCBs contamination less than 2 mg/kg in Section III.B.2 above, the Section III.B.4 statement of three potential modifications to Inspection, Maintenance and Monitoring of non-GE-owned dams, the Section III.C.2 clarification regarding the MESA regulations, and Section III.D.8's clarification regarding the Riverfront Area requirements in 310 CMR 16.

However, the great majority of GE's arguments, are premised on a skewed evaluation that focuses almost exclusively on minimizing GE's costs and shifting environmental risks and additional costs to the public. That distorted approach should be rejected. The record is clear that the Intended Final Decision is the remedy best suited to meet the Permit's general standards in consideration of the decision factors, including a balancing of those factors against one another.

For the reasons stated above, EPA's Intended Final Decision should be upheld consistent with this Statement of Position.

TABLE 1

ABBREVIATIONS

ACEC	Areas of Critical Environmental Concern
ARARs	Applicable or Relevant and Appropriate Requirements
CAA	Clean Air Act
CCC	Citizens Coordinating Council
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
CMP	Conservation and Management Permit
CMR	Code of Massachusetts Regulations
CPUE	Catch Per Unit Effort
CSTAG	Contaminated Sediments Technical Advisory Group
CT DEEP	Connecticut Department of Energy and Environmental Protection
CTE	Central Tendency Exposure
CY	Cubic Yards
DEDA	Definitive Economic Development Agreement
EA	Exposure Area
EAB	Environmental Appeals Board
EO	Executive Order
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ERE	Environmental Restriction and Easements
FERC	Federal Energy Regulatory Commission
GE	General Electric
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
IMPG	Interim Media Protection Goal
IRIS	Integrated Risk Information System
LOAEL	Lowest Observed Adverse Effect Level
MA DEP/MassDEP	Massachusetts Department of Environmental Protection
Mass FWB	Massachusetts Fisheries and Wildlife Board
Mass NHESP	Massachusetts Natural Heritage and Endangered Species Act
MATC	Maximum Acceptable Threshold Concentration
MCP	Massachusetts Contingency Plan
MESA	Massachusetts Endangered Species Act
MNR	Monitored Natural Recovery
NCP	National Contingency Plan
NRD	Natural Resource Damages
NRRB	National Remedy Review Board
O&M	Operation and Maintenance

PCB	Polychlorinated biphenyls
PSA	Primary Study Area
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
ROR	Rest of River
SOP	Statement of Position
SOW	Statement of Work
SWAC	Surface Weighted Average Concentration
TLC	Thin Layer Capping
TSCA	Toxic Substance Control Act.

Table 2.

Sites Included in Exhibit A of GE's Statement of Position that had Off-site Disposal of PCB-contaminated Sediment/Soils

Site	Information Cited in GE's Exhibit A (On-site Disposal Volume/Type of Disposal)	Actual Total Volume Sediment/Soils Disposed <u>On</u>-site	Actual Total Volume Sediment/Soils Disposed <u>Off</u>-site	Source/Basis
GE Housatonic, including Upper ½ Mile and 1 ½ mile reaches R1 / MA	245,000 yds^3 / Placement in two on-site consolidation areas at GE Plant – a new one for TSCA and RCRA regulated material and an existing one for other material.	245,000 yds^3 disposed on-site.	Approximately 125,000 to 135,000 yds^3 to be disposed off-site (excluding Rest of River).	CD (2000) Interview with Dean Tagliaferro, EPA RPM, January 2016
New Bedford R1 / MA	up to 550,000 yds^3 / Disposed in on-site CAD in Lower Harbor.	19,000 yds^3 disposed in on-site Pilot Study CDF. 300,000 yds^3 projected to be disposed in CAD cell in Lower Harbor.	As of 12/4/15, 384,421 yds^3 disposed off-site. 229,579 yds^3 projected additional to be disposed off-site.	OU 2: 1990 ROD 1992 ESD 1995 ESD 1999 Amended ROD OU 1: 1998 ROD 2001 ESD 2002 ESD 2010 ESD 2011 ESD 2015 ESD Interview with Elaine Stanley, EPA RPM 1/12/16-1/20/16
Norwood PCBs R1 / MA	20,000 yds^3 / Consolidation of soils and sediments into portion of site to be covered with TSCA-compliant multi-layer cap.	20,000 yds^3 consolidated and capped on-site.	Approximately 500 yds^3 disposed off-site (1983 removal action).	ROD Amended (1996) Interview with Dan Keefe, EPA RPM, 1/19/16
Grand Calumet River R5 / IN	~800,000 yds^3 / On-site disposal of sediments in a RCRA CAMU.	Approximately 800,000 yds^3 disposed on-site in RCRA CAMU as part of U.S. Steel site remediation.	150,000-200,000 yds^3 disposed off-site.	AOC under RCRA (1998) CD under CWA (1998) Interview with Dianna Mally, EPA Project Mgr 1/21/16

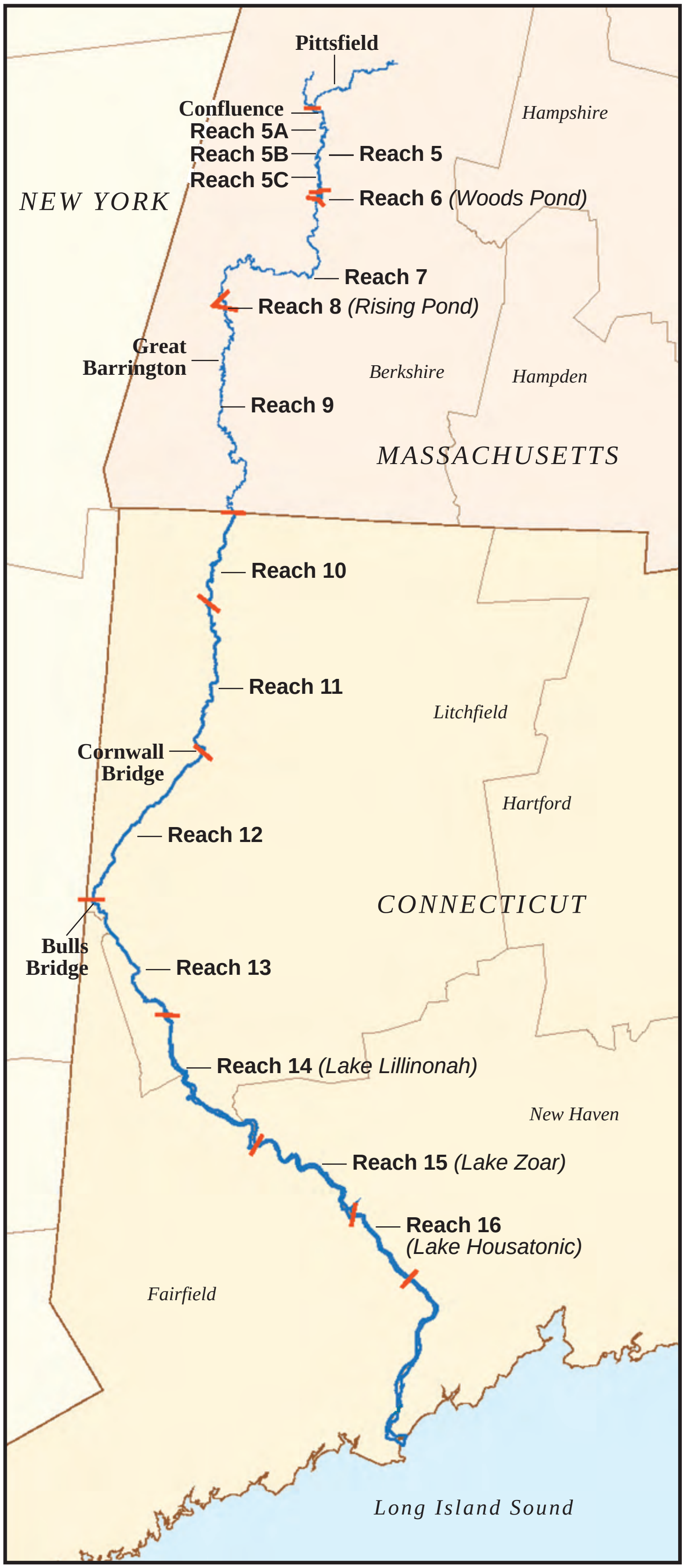
Site	Information Cited in GE's Exhibit A (On-site Disposal Volume/Type of Disposal)	Actual Total Volume Sediment/Soils Disposed <u>On</u>-site	Actual Total Volume Sediment/Soils Disposed <u>Off</u>-site	Source/Basis
Lower Fox River R5 / WI	81,000 yds^3 /disposal at local industrial landfill owned by PRP located approximately 6 miles away.		3,694,000 yds^3 as of 8/1/15 disposed off-site. Volume includes 81,000 yds^3 from 2000 removal action disposed off-site in Greenbay, WI landfill owned by PRP Fort James Corp. The additional dredged volumes were disposed at facilities in Whitelaw, WI (TSCA), Chilton, WI (non-TSCA), and at two facilities in Michigan.	AOC (2000) see also final report on project (2000) NPL Fact Sheet (2015) Interview with Jim Hahnanberg, EPA RPM in August 2015 and with Susan Pastor, EPA Community Involvement Coordinator, January 2016
Ashtabula River R5 / OH	500,000 yds^3 /On-site disposal on PRP's property.		509,000 yds^3 sediment pumped through a 2.5 mile pipeline to a sediment confinement facility on the Fields Brook site in Ashtabula, OH (owned by a PRP).	Fact Sheet (May 2008) Interview with Owen Thompson, EPA Project Manager for Fields Brook site, 1/27/16
Ottawa River R5 / OH	250,000 yds^3 / disposal of sediments (except from limited hotspots) in nearby landfill.		239,877 yds^3 disposed off-site (includes 220,000 yds^3 non-TSCA regulated disposed at Hoffman Road Landfill, Toledo, OH; 19,877 yds^3 TSCA-regulated disposed out-of-state).	Ottawa River Legacy Act Cleanup (2010) Interview with Scott Cieniawski, EPA Project Mgr., August 2015
River Raisin R5 / MI	109,000 yds^3 / On-site disposal of less contaminated sediment (106,000 cy) at CDF 2 miles north of river mouth. Off-site disposal of the most contaminated sediment (3,000 cy).		72,250 yds^3 (includes 70,000 yds^3 non-TSCA regulated disposed at USACE Sterling State Park CDF approx. 2 miles north of River Raisin mouth; 2,250 yds^3 TSCA regulated disposed at Wayne Disposal, Belleville, MI).	River Raisin Legacy Project (2012) Interview with Scott Cieniawski, EPA Project Mgr., August 2015
Outboard Marine Corporation Site / Waukegan Harbor R5 / IL	OU 2: 124,000 yds^3 / On-site disposal at Outboard Marine Corporation Plant 2 property at newly constructed sediment consolidation facility.	126,000 yds^3 from Waukegan Harbor consolidated in on-site containment cells including approximately 12,000 yds^3 that were thermally treated prior to placement in cells, resulting in 30,000 gallons of removed PCBs, being disposed off-site.	Approximately 46,000 yds^3 from Outboard Marine Corp. Plant 2 property disposed off-site under 2006 removal action and 2007 ROD.	ROD (2009) ROD (2007) Fourth Five-Year Review (2012) ESD (2012) Interview with Timothy Drexler, EPA RPM, January 2016
Allied Paper / Portage Creek (including Bryant Mill Pond) / Kalamazoo River R5 / MI	OU3: 4,000 yds^3 / Consolidation of soil/sediment into existing on-site landfill to be capped. Bryant Mill Pond: ~150,000 yds^3 / Disposal in on-site former dewatering lagoons on PRP property.	154,000 yds^3 disposed on-site in Allied Landfill.	166,127 yds^3 disposed off-site from various removal actions. 30,800 yds^3 projected to be disposed off-site under 2015 ROD for Kalamazoo River.	Bryant Pond Time Critical Removal Action (1999) RODs (1998, 2015) Interview with Jim Saric, EPA RPM, January 2016

Site	Information Cited in GE's Exhibit A (On-site Disposal Volume/Type of Disposal)	Actual Total Volume Sediment/Soils Disposed <u>On</u>-site	Actual Total Volume Sediment/Soils Disposed <u>Off</u>-site	Source/Basis
Fields Brook R5 / OH	14,000 yds^3 / Off-site thermal treatment of most contaminated sediment (3,000 cy). Disposal of other excavated sediments (11,000 cy) at on-site TSCA-equivalent landfill.	Approximately 41,514 yds^3 disposed on-site.	Over 729,079 yds^3 disposed off-site.	ROD (1986) ESDs (1997, 1999, 2001) Third Five-Year Review (2014) Interview with Owen Thompson, EPA Project Manager, 1/27/16
Twelve Mile Creek R4 / SC [Sangamo Weston / Twelve Mile Creek/Lake Hartwell)	Volume not specified / On-site disposal of sediments dredged from behind dams at upland SMU proximate to site.		450,000 yds^3 non-TSCA regulated disposed in off-site landfill constructed on parcel purchased by PRP located adjacent to the site.	ESD (2009) Interview with Craig Zeller, EPA RPM, 1/25/2016
Reynolds Metal / St. Lawrence River R2 / NY	77,600 yds^3 /On-site disposal of sediments with PCBs < 50 ppm at industrial landfill on PRP property with RCRA cap. Off-site disposal of sediments with PCBs > 50 ppm.	69,000 yds^3 non-TSCA regulated disposed on-site.	16,655 yds^3 TSCA- regulated disposed off-site.	Decision Document Amend (1998) Interview with Pam Tames, EPA RPM 1/20/16
Commencement Bay: Thea Foss/Wheeler-Osgood Waterways R10 / WA[1]	620,000 yds^3 / Disposal of contaminated sediments in on-site near-shore fill area (St. Paul near-shore fill area).	422,535 yds^3 disposed in a CDF at the head of the St. Paul Waterway.	Approximately 5,000 yds^3 from Thea Foss disposed in permitted off-site, upland facility located in Pierce County, WA.	ESD (2004) Five-Year Review (2004) Remedial Action Construction Report (2006) Third Five-Year Review (2009) Fourth Five-Year Review (2014) Interview with William Ryan, EPA RPM, February 2016

[1] The Commencement Bay Superfund site has several operable units. Only those for which PCBs were a major constituent of dredged sediment were included in this table. The CDFs which received sediment from the operable units discussed above also received sediment from other operable units/projects.

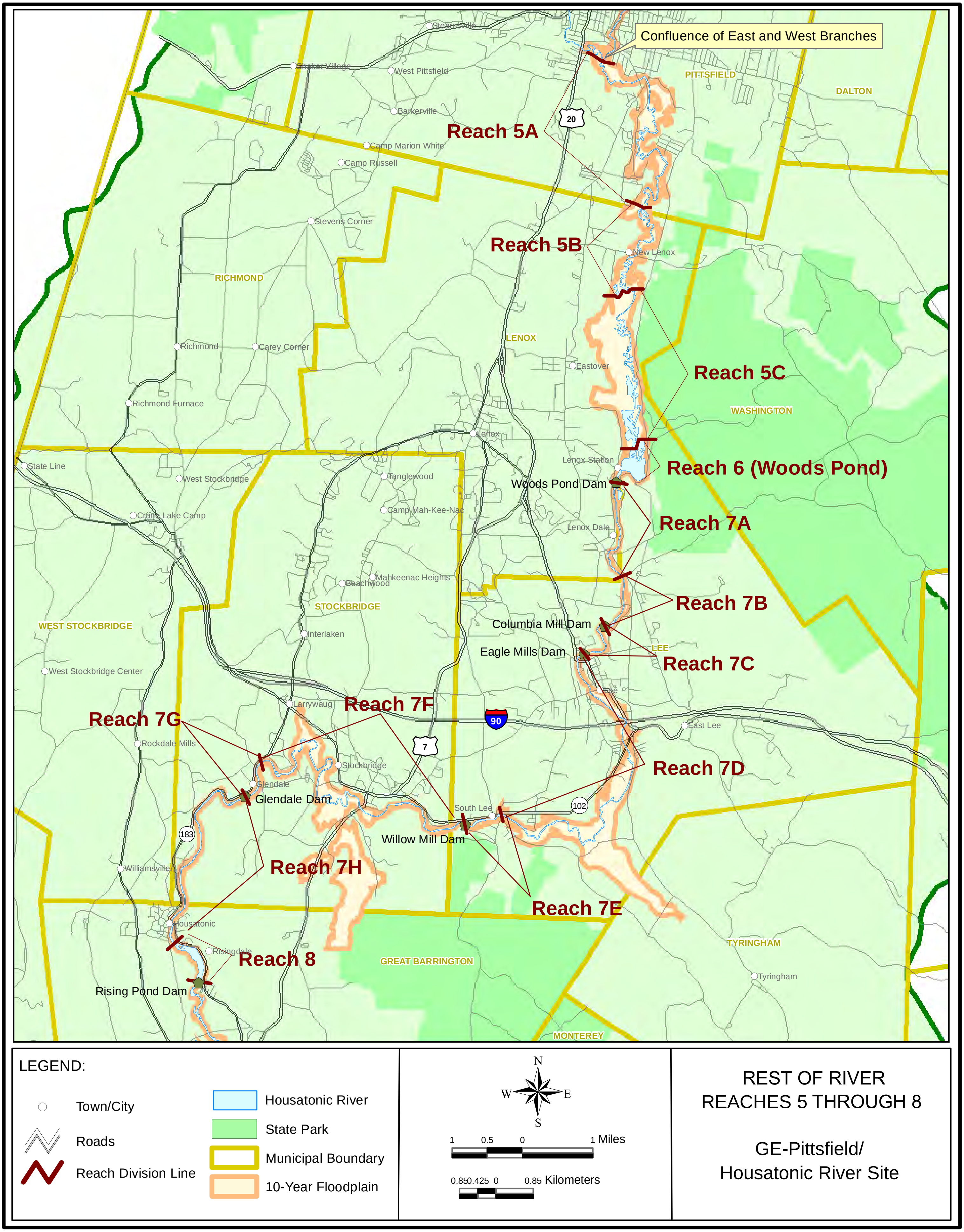
Site	Information Cited in GE's Exhibit A (On-site Disposal Volume/Type of Disposal)	Actual Total Volume Sediment/Soils Disposed On-site	Actual Total Volume Sediment/Soils Disposed Off-site	Source/Basis
Commencement Bay / Hylebos Waterway R10 / WA	940,000 yds^3 / Disposal of contaminated sediments at local near-shore man-made slip (Blair Slip 1) converted to CDF and at upland regional landfill.	493,000 yds^3 disposed in the Blair Slip 1 Nearshore Confined Disposal Facility (NCDF) created by the Port of Tacoma, a PRP, as a dual purpose use: a shipping terminal has been constructed on top.	135,000 yds^3 less contaminated sediment disposed in Dredged Material Management Program (DMMP) which is located in open water in Commencement Bay, but manages material dredged to maintain navigational waterways and berth depths in the state of Washington. 405,000 yds^3 dredged from the head of the Hylebos disposed at Roosevelt Regional Subtitle D Landfill in central Washington (located over 200 miles from Commencement Bay).	Third Five-Year Review (2009) Fourth Five-Year Review (2014) Interview with Jonathan Williams, EPA RPM, 2/5/2016
Commencement Bay/ Olympic View Resource Area R10 / WA			2002 Non-Time Critical Removal Action: Approximately 11,000 yds^3 of contaminated sediment and debris were removed from the nearshore area and disposed of in an off-site upland landfill.	Third Five-Year Review (2009) Fourth Five-Year Review (2014)

FIGURE 1



REST OF RIVER (REACHES 5 THROUGH 16)

FIGURE 2


Confluence of East and West Branches
PITTSFIELD
DALTON
Reach 5A
Reach 5B
Reach 5C
Reach 6 (Woods Pond)
Reach 7A
Reach 7B
Reach 7C
Reach 7D
Reach 7E
Reach 7F
Reach 7G
Reach 7H
Reach 8
RICHMOND
LENOX
WASHINGTON
STOCKBRIDGE
WEST STOCKBRIDGE
LEE
TYRINGHAM
GREAT BARRINGTON
MONTEREY
West Pittsfield
Barkerville
Camp Marion White
Camp Russell
Stevens Corner
New Lenox
Richmond
Carey Corner
Eastover
Richmond Furnace
Lenox
Lenox Station
State Line
West Stockbridge
Tanglewood
Woods Pond Dam
Crane Lake Camp
Camp Mah-Kee-Nac
Lenox Dale
Mahkeenac Heights
Beachwood
Interlaken
Columbia Mill Dam
Eagle Mills Dam
West Stockbridge Center
Larrywaug
East Lee
Rockdale Mills
Stockbridge
Glendale
Glendale Dam
South Lee
Willow Mill Dam
Williamsville
Housatonic
Risingdale
Rising Pond Dam
Tyringham
20
90
7
102
183
LEGEND:
Town/City
Roads
Reach Division Line
Housatonic River
State Park
Municipal Boundary
10-Year Floodplain
N
W
E
S
1 0.5 0 1 Miles
0.85 0.425 0 0.85 Kilometers
REST OF RIVER
REACHES 5 THROUGH 8
GE-Pittsfield/
Housatonic River Site

Attachment A

Timeline for Opportunities for GE and the Public to Comment during Rest of River Process

For nearly two decades, EPA has made extraordinary efforts to solicit and respond to the views of GE, other stakeholders, and the rest of the public throughout the Rest of River process.

-In 1998, a year prior to EPA lodging the Decree, EPA established a Citizens Coordinating Council ("CCC") made up of over 30 environmental, business and community leaders from Berkshire County and Connecticut. The CCC provides a participatory forum for the governments, and sometimes GE, to discuss with the public the status of cleanup, and other activities at the Site, and to obtain feedback from the CCC, and to answer questions. For many years, during periods of most active remediation, the CCC met monthly. Currently, the CCC meets four times a year.

-EPA subjected its human health and ecological risk assessments, and three of its modeling documents, to independent peer review. As part of these independent peer reviews, all stakeholders were invited to present their views to the peer reviewers. Following hearing the positions of the peer reviewers, EPA adjusted its work products if necessary.

-From 2000-2005, EPA conducted human health and ecological risk assessments of the Rest of River, and submitted those risk assessments to peer review by panels of independent risk assessment experts. GE and other members of the public were provided the opportunity to present their views to the scientific peer review panels. GE also performed its own studies as part of the risk assessment processes. CD ¶ 22.b-e.

-From 2001-2006, EPA conducted modeling of the fate, transport and bioaccumulation of PCBs in the Rest of River down through Reach 8, and submitted three different modeling documents to peer review by panels of independent modeling experts. In each of the three independent modeling peer reviews, GE and other members of the public were provided the opportunity to present their views to the scientific peer review panels. CD ¶ 22.g-i.

-In 2003, GE submitted, and EPA approved, a RCRA Facility Investigation Report that included data on the scope and concentrations of PCB contamination in Rest of River;

-In 2005-2006, GE developed and submitted, and EPA approved, Interim Media Protection Goals for the Rest of River. CD ¶ 22.f.

-In 2007, GE submits its Corrective Measures Study Proposal (or Work Plan for the CMS)

-In 2008, GE developed and submitted a Corrective Measures Study ("CMS"), and in 2010 a Revised CMS, each of which included an analysis of alternative approaches to addressing the unacceptable risks posed by the PCBs in the Rest of River.

- In April and May 2011, after reviewing GE's Revised CMS and the public comments received on the Revised CMS, and before EPA made a proposal to its National Remedy Review Board and Contaminated Sediments Technical Advisory Group, EPA held an extraordinary set of public sessions known collectively as a "Charrette." EPA designed and carried out the Charrette to fully inform and involve the overall public, including GE, about EPA's Rest of River remedy decisionmaking. Over the course of three evening sessions in April 2011, EPA and its experts presented information about the Rest of River, PCBs, and sediment remediation to nearly 200 citizens. EPA offered a second full-day Charrette in May 2011, at which citizens weighed remedial alternatives using the Permit's evaluation factors.

-In June-July 2011, EPA Region 1 (the "Region") submitted EPA's proposed remedy to EPA's internal advisory National Remedy Review Board ("NRRB"), and Contaminated Sediments Technical Advisory Group ("CSTAG"). GE and the public presented their views to the NRRB/CSTAG.

-From September 2011 to May 2012, EPA, Massachusetts and Connecticut jointly engaged in remedy discussions, and in May 2012 issued to GE and the public a Status Report of Potential Remediation Approaches for the Rest of River. EPA followed up with multiple public meetings in both Connecticut and Massachusetts to hear public comments on the governments' Status Report.

-From August 2012 – December 2013, at GE's request EPA and GE engaged in technical discussions regarding the proposed remedy.

-In June 2014, pursuant to the procedures in the RCRA Corrective Action Permit, EPA, in consultation with Massachusetts and Connecticut, issued for public comment a Draft Modification to the RCRA Permit, and Statement of Basis ("Draft Permit Modification"). The public comment period, which included a formal public hearing, continued until October 27, 2014. EPA received over 2,100 pages of comments from more than 140 commenters.

In addition to the formal public comment steps called for by RCRA or CERCLA, EPA informally solicited public comments at many steps in the process, including on GE's Interim Media Protection Goals submittals, and GE's CMS proposal, CMS and Revised CMS.

As demonstrated above, in recognition of the broad impact that this remedy will have on the communities lining the Housatonic River, EPA has afforded GE and the public with a virtually unprecedented number of process opportunities. These interactions with the public and GE have assisted EPA in selecting the alternative best suited to satisfy the Permit's remedy selection criteria.

Attachment B

Response to GE's Comments on Toxicity Values Used to Evaluate Human Health Risks

EPA's process for evaluating human epidemiological and animal evidence to determine the carcinogenicity and cancer potencies of chemicals, including PCBs, is set forth in Agency guidelines (USEPA, 1976, 1984, 1986c, 1994, 1996a). The guidelines were developed within the Agency, published in the Federal Register for external comment, and peer reviewed by a panel of expert scientists in the fields of carcinogenesis, toxicity, exposure, and related scientific disciplines from universities, environmental groups, industry, labor, and other governmental agencies. EPA responded to comments on the draft guidelines and made changes based on a review of the comments submitted by these groups and individuals. The guidelines were also submitted for review to EPA's Science Advisory Board, an external scientific review panel. Agency guidelines for assessing carcinogens are consistent with the scientific approaches that are used by national and international agencies (e.g., the National Toxicology Program [NTP, 1984] and the International Agency for Research on Cancer (IARC, 1987) for evaluating the carcinogenicity of chemicals.

EPA's process for evaluating human epidemiological and animal evidence to determine the noncancer toxicity of chemicals, including PCBs, is set forth in the Agency's guidelines (USEPA, 1986a-b, 1991, 1992, 1993a, 1996b, 1998) and the background document on non-cancer toxicity provided on IRIS (USEPA, 1993b). The guidelines cover a variety of health endpoints, including Developmental Toxicity (USEPA, 1986b, 1991); Reproductive Toxicity (USEPA, 1996b); Neurotoxicity (USEPA, 1998); Female Reproductive Risk (USEPA, 1986a); and Male Reproductive Risk (USEPA, 1986a). The guidelines were developed within the Agency, published in the Federal Register for external comment, and peer reviewed by a panel of expert scientists from universities, environmental groups, industry, labor, and other governmental agencies working in various fields associated with non-cancer toxicity, including developmental toxicity, neurological toxicity, endocrine effects, etc. EPA responded to comments on the draft guidelines and made changes based on a review of the comments submitted by these groups or individuals. The guidelines were also submitted for review to EPA's Science Advisory Board, an external scientific review panel.

References

International Agency for Research on Cancer (IARC, 1987). "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Supplement 7, Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs Volumes 1-42." Lyon, France.

NTP. 1984. Report of the Ad Hoc Panel on Chemical Carcinogenesis Testing and Evaluation of the National Toxicology Program, Board of Scientific Counselors. Available from: US Government Printing Office, Washington, D.C. 1984-421-132:4726.

USEPA 1976. Interim procedures and guidelines for health risk and economic impact assessments of suspected carcinogens. Federal Register 41:21402-21405.

USEPA. 1984. Proposed guidelines for carcinogen risk assessment. Federal Register 49:46294. November 23.

USEPA. 1986a. The Risk Assessment Guidelines for 1986. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-89/043, July

USEPA. 1986b. Guidelines for the Health Assessment of Suspect Developmental Toxicants. Federal Register 51 (185) 34028-34040, 24 September 1986.

USEPA. 1986c. Guidelines for carcinogen risk assessment. Federal Register 51:33992-34003.

USEPA. 1991. Guidelines for Developmental Toxicity Risk Assessment. Federal Register 56 (234) 63798-63826, 5 December 1991

USEPA. 1992. Guidelines for Exposure Assessment. Federal Register 57 (104) 22888-22938, 29 May 1992

USEPA. 1993a. Workshop Report on Developmental Neurotoxic Effects Associated with Exposure to PCBs. U. S. EPA, Risk Assessment Forum, Office of Research and Development, Washington, D.C. EPA/630/R-92/004, May, 1993.

USEPA. 1993b. Reference Dose (RfD): Description and Use in Health Risk Assessments. Background Document 1A. USEPA, National Center for Environmental Assessment (NCEA), Office of Research and Development, Washington, D.C. March 15, 1993.

USEPA. 1994. "Report on the Workshop on Cancer Risk Assessment Guidelines Issues." Office of Research and Development, Risk Assessment Forum, Washington, D.C. EPA/630/R-94/005a.

USEPA. 1996a. Proposed guidelines for carcinogen risk assessment. Federal Register 61 (79) 17960-18011. April 23.

USEPA. 1996b. Guidelines for Reproductive Toxicity Risk Assessment. Federal Register 61 (212) 56274-56322. 31 October 1996.

USEPA. 1998. Guidelines for Neurotoxicity Risk Assessment. Federal Register 63 (93) 26926-26954, 14 May 1998.

Attachment C

Responses to GE's Comments on EPA's Ecological Risk Assessment and Development of IMPGs for Amphibians, Insectivorous and Piscivorous Birds, and Mink

GE's Statement of Position had discrete arguments regarding the Ecological Risk Assessment ("ERA") and Interim Media Protection Goals ("IMPG") development for amphibians, insectivorous and piscivorous birds, and mink. EPA's specific technical responses are below on each topic. Overall, EPA's work on the ERA and IMPGs was a thorough, reasoned approach using generally accepted practices, as well as establishing an independent, peer-reviewed process, while at the same time soliciting GE and public input.

Amphibians

GE, in its SOP and in Section III.C.2 of its October 2014 comments, criticizes EPA's risk assessment and derivation of the lower-bound IMPG for amphibians. EPA agrees with GE that the derivation of the lower bound IMPG for amphibians (3.3 mg/kg PCB) was based on EPA's field study of wood frogs (calculated using the methodology recommended by the Peer Review Panel) summarized in the ERA,[1] however EPA disagrees with GE's characterization of the amphibian risk assessment and the IMPG.

It is accepted practice in a typical assessment of ecological risk[2] to conduct studies using surrogate or representative species (e.g., wood frogs and leopard frogs) to estimate risks to the larger taxonomic group (e.g. amphibians), as it is impossible to study all effects to all taxa within a group as a practical matter. As discussed in Appendix E of the ERA, this procedure was followed for the amphibian portion of the ERA, in which the results of field studies of wood frogs and leopard frogs were combined with other lines of evidence to reach the conclusion that there is significant risk to local populations of amphibians in the Housatonic River.[3] The majority of the Peer Review Panel agreed with EPA's conclusion.[4]

EPA also disagrees with GE's statement in the SOP that EPA's demonstration of risk to this taxonomic group was overstated and based solely on a site-specific wood frog field study. In fact, risk to amphibians was demonstrated using three lines of evidence (field studies, laboratory studies, and review of the effects of PCBs on amphibians documented in the scientific literature) as documented in the ERA, not solely the site-specific field study for wood frogs. EPA also modeled the effect of the metamorph sex ratio and malformations on local population dynamics for wood frogs. The modeling supported the weight of evidence of risk to amphibians from PCBs, specifically, that PCBs have an impact on wood frog population growth and abundance and hasten population decline, reduce population numbers, and increase the likelihood of local extinction.[5]

EPA does recognize that populations of frogs and other amphibians have reproductive strategies that can withstand losses of individuals during development. EPA's wood frog study was designed to assess the potential impact of PCBs on different amphibian life stages, including

[1] Final Ecological Risk Assessment, Appendix E, at E-145
[2] EPA 2002 Framework for Ecological Risk Assessment EPA/630/R-92/001
[3] Final Ecological Risk Assessment, Appendix E
[4] Responsiveness Summary to Peer Review of the ERA, at 184.
[5] Final Ecological Risk Assessment, at 4-66.

reproduction, growth, and maturation, based on known or expected toxicological effects of PCBs on amphibians documented in the scientific literature. However, many of those effects (or combinations of effects) from PCB exposure are biologically relevant at the local population level. The lower-bound IMPG for amphibians was based on two sensitive and biologically relevant endpoints (metamorph malformation and sex ratio), which act in concert to limit the viability of local wood frog populations.[6] The sediment lower-bound IMPG of 3.3 mg/kg PCB was established, which corresponds to a 20% incidence of malformation (which would lead to either death or sterility in the adult, among other issues), rather than the more conservative 20% incidence rate for metamorph sex ratio observed at the lower PCB concentration of 0.61 mg/kg.[7] It should be noted that the objective of the IMPG,[8] while derived from data on one species, is to provide adequate protection for all amphibian species, including those that may be more sensitive to PCBs than the wood frog (e.g. leopard frogs, salamanders).

Therefore, based on the weight of evidence available for the amphibian risk endpoint, EPA disagrees with GE's assertion that wood frogs can tolerate a 20% or greater effect level, and maintains that EPA is correct in using this IMPG in the Performance Standard for Vernal Pools.

Insectivorous Birds/Piscivorous Birds

GE states in its SOP and in Section III.C.2 of GE's October 2014 comments that EPA overstates the risks to insectivorous and piscivorous birds and that EPA derived IMPGs based on inappropriate methods in the ERA. Regarding the ecological risk assessments for insectivorous birds and piscivorous birds, GE again mischaracterizes the risk assessment process that was followed for the Rest of River. First, EPA did not "require" that any specific effect level be used for any of the endpoints examined in the final ERA[9], nor did EPA "require" that any IMPG be based on a particular modeled food intake rate. EPA's only requirement was that the risk assessment follow sound scientific procedure and established EPA guidance. Effects and exposure levels used for any of the endpoints were selected by the risk assessors and subsequently peer-reviewed by an independent panel of risk assessment experts. In their review of the July 2003 ERA, Peer Review Panel members commented favorably on the decision criteria used to select effects metrics for wildlife, which included the two bird endpoints.[10]

Laboratory studies were not available to characterize effects of PCBs to the surrogate species used in the avian risk assessments, and the field studies had significant limitations which prohibited their use for deriving an IMPG. Therefore, a threshold range was derived using toxicity data from the scientific literature, in accordance with the decision criteria established in the ERA. A threshold range provides a range of doses that would be protective of the most sensitive bird species (the lower end of the range) as well as the most tolerant bird species (the upper end of the range). The threshold range for insectivorous and piscivorous birds selected for the assessment conducted in the ERA was 0.12 to 7.0 mg/kg body weigh/day based on

[6] The term used in the ERA was the MATC; the IMPG was developed based on the MATC.
[7] The metamorph sex ratio 20% incidence rate was 0.61 mg/kg. EPA selected the IMPG of 3.27 mg/kg based primarily on metamorph malformations. A Peer Review Panel member noted that Ouellet (2000) suggests that malformation rates greater than 5% are biologically relevant. The stochastic population modeling conducted by EPA and presented in the ERA supports the conclusion that these effects are biologically relevant.
[8] This IMPG of 3.3 mg/kg was used in the Performance Standard for Vernal pools in EPA's Intended Final Decision
[9] Final Ecological Risk Assessment
[10] Responsiveness Summary to the Peer Review Comments on the ERA

reproductive studies conducted on white leghorn chickens[11] and American kestrels,[12] respectively. The Peer Review Panel members were supportive of the approach and the data used to derive the threshold range for these endpoints.[13]

With regard to piscivorous birds, EPA acknowledges the fact that the dataset from which the modeled food intake rate used to calculate the piscivorous bird IMPG was derived did not include the osprey. As noted in the final ERA (Volume 6, page H-25), there were insufficient data to generate an allometric equation for Falconiformes, of which osprey are members, so the equation for Charadriiformes was used. However, this latter group includes many piscivorous birds, and was therefore deemed by EPA to be acceptable, lacking an alternative. Again, the ERA Peer Review Panel did not express concerns with this accepted approach to establishing effect levels for groups with limited experimental data.

Lastly, on page 40 of GE's October 2014 comments, GE states that, despite EPA's assertion that the remedy will reduce ecological risks, the proposed remedy does not include remediation directly related attaining IMPGs for the insectivorous and piscivorous bird receptors. The analysis of how the proposed remedy (as well as the other alternatives) attains the ecological IMPGs is documented in EPA's Comparative Analysis. Even though EPA did not include specific Performance Standards requiring attainment of IMPGs for these receptors, the remedy will reduce risks[14] by significantly reducing exposure of these receptors to PCBs in sediment, surface water and biota.

Mink

GE states in its SOP in Section III.C.2 of GE's October 2014 comments that EPA overstates the risks to mink and that EPA derived IMPGs based on inappropriate methods. GE, as it has in the past, attempts to cast doubt upon the validity of the study of PCB toxicity to mink that was conducted as part of the ERA. These same points were raised over a decade ago in GE's comments on the ERA and were thoroughly refuted.[15, 16]

As was the case with amphibians, a Maximum Acceptable Threshold Concentration (MATC) was derived from effects on one species of the taxonomic group (i.e. mink) that must be protective for all species in the group, including those that may be more sensitive (i.e. river otter). The MATC of 0.984 mg/kg PCB corresponds to a concentration that would be expected to cause 20% reduced survival (LC20) of mink kits from 0 to 6 weeks of age, an effect judged by EPA to be biologically relevant. This PCB concentration is higher than the Lowest Observed Adverse Effect Level (LOAEL) of 0.72 mg/kg determined from studies conducted regarding PCB contamination in Saginaw Bay, and nearly four times higher than the LC20 (0.248 mg/kg)

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[11] Lillie, R.J., H.C. Cecil, J. Bitman, and G.F. Fries. 1974. Differences in response of caged white leghorn layers to various polychlorinated biphenyls (PCBs) in the diet. Poultry Science 53:726-732.
[12] Fernie, K.J., J.E. Smits, G.R. Bortolotti, and D.M. Bird. 2001. Reproductive success of American kestrels exposed to dietary polychlorinated biphenyls. Environmental Toxicology and Chemistry 20:776-781.
[13] Responsiveness Summary to the Peer Review Comments on the ERA, multiple locations
[14] Comparative Analysis, at 39-41.
[15] Responsiveness Summary to the Peer Review Comments on the ERA, at 69-70, (Response O-RS-25), by Weston/EPA
[16] Responsiveness Summary to Public Comments on New Information on the ERA, at 52 to 60, (Responses GE-23 to GE-27)

derived from those studies.[17] The consensus among the Peer Review Panel members regarding the overall scientific validity of the design, conduct, and interpretation of the mink feeding study.[18]

With regard to the lack of necropsies performed on kits that died prior to six weeks of age, this question was also clearly explained in Response GE-27 and O-RS-25 in the ERA Responsiveness Summary. In summary, it is standard operating procedure in conducting these studies at Michigan State University to not necropsy young mink kits because of the cannibalistic behavior of maternal mink and other kits toward dead offspring, leaving no carcass to necropsy; other studies reported in the scientific literature also did not necropsy young mink kits. This lack of data in no way invalidates the results of this study, as clearly indicated by the Peer Reviewers' remarks. As discussed in the ERA, the conclusion that these kits died as a result of PCB exposure is supported by data on kit weight, which is known to be depressed by PCB exposure, and the negative relationship between PCB concentration and kit survival. If other contaminants were responsible for the observed kit deaths, the results would be expected to be random with respect to PCB concentration.

Lastly, on page 40 of GE's October 2014 comments, GE states that, despite EPA's assertion that the remedy will reduce ecological risks, the proposed remedy does not include remediation directly related attaining IMPGs for mink. The analysis of how the proposed remedy (as well as the other alternatives) attains the ecological IMPGs is documented in EPA's Comparative Analysis. Even though EPA did not include Performance Standards for attainment of IMPGs for piscivorous mammals, the remedy will reduce risks[19] by significantly reducing exposure of these receptors to PCBs in sediment, surface water and biota.

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17 Bursian, S. J., Sharma, C., Aulerich, R. J., Yamini, B., Mitchell, R. R., Orazio, C. E., Moore, D. R. J., Svirsky, S. and Tillitt, D. E. (2006), Dietary Exposure Of Mink (Mustela Vison) To Fish From The Housatonic River, Berkshire County, Massachusetts, USA: Effects On Reproduction, Kit Growth, And Survival. Environmental Toxicology And Chemistry, 25: 1533–1540. doi:10.1897/05-406R.1

18 Responsiveness Summary to the Peer Review Comments on the ERA, at 290 - 292.

19 Comparative Analysis, at 41-42.

Attachment D

Responses to GE's Arguments on Potential Harm from EPA's Proposed Remedy

GE, in its Statement of Position ("SOP") (pages 14 and 15) and on pages 34-37 of Section III.C.1 and Attachments C, D and E of its October 2014 comments, claims that EPA's Proposed Remedy would cause severe and enduring harm to the Rest of River's unique ecosystem. GE's concerns, and EPA's responses are as follows:

GE Argument: Remedy would impact the entire channel in Reaches 5A and 5C, harming ecosystem and species

As GE correctly notes in its comments at 34 para. 4, the proposed remedy would remediate the entire river bed in Reaches 5A and 5C and would impact limited river banks in Reach 5A, or 35% of the approximately 10 linear miles of bank in that most upstream subreach. After sediment removal (sufficient to construct the appropriate Engineered Cap), the river bed will be returned to its former grade by placing the Engineered Cap to contain any residual PCB contamination.[1] EPA recognizes that removal of the sediment in these reaches of the Housatonic River will create a significant short-term disruption to the ecosystem (e.g.to benthic invertebrates, fish populations, substrate composition, and colonization by invasive species), however, sediment removal is necessary to mitigate the significant threat to human health and environment caused by GE's PCBs.

In recognition of these short-term impacts, EPA included measures in the proposed remedy to mitigate them to the extent possible. First, the remediation will be conducted using a phased approach, thus an entire reach will not be affected at any single time. Phasing the remediation (and restoration) will provide many species with areas adjacent to the construction for refugia. The Restoration Performance Standards and corrective measures also include provisions for the management of impacts to state-listed species as necessary.[2]

Second, the proposed remedy requires that the Engineered Cap include in its design a habitat layer approximating the natural sediment characteristics.[3] Therefore, there should be minimal long-term effect on substrate composition. Furthermore, as shown following the remediation of the Upper 2-Mile Reaches, there will be significant redeposition of sediment from upstream sources and reworking of surficial sediment, which will further assist in returning the natural characteristic of the riverbed.

Third, the extent and timing of recovery of benthic invertebrates and fish populations in these reaches following remediation would be considerably more rapid than GE claims. There is an excellent example of the recovery that can be expected which was documented in the studies conducted upstream in the East Branch of the Housatonic River following the extensive remediation in the ½-Mile and 1½-Mile Removal Reaches (these actions included remediation of

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[1] The actual remediation amounts will be determined during remedial design pursuant to the process described in the Intended Final Decision. Intended Final Decision at 24.
[2] Intended Final Decision at 21-22
[3] Intended Final Decision at 38

the river bed, all banks, and much of the floodplain immediately adjacent to the river). In 2007, approximately one year following completion of remediation of these two miles of river, EPA conducted a quantitative survey of benthic invertebrate populations and a semi-quantitative survey of fish populations at three transects in the 1½-Mile Removal Reach.[4] The results of the investigation showed that benthic invertebrate populations had recolonized the sediment bed as measured by species richness, density, and diversity, and that the benthic community had higher diversity, increased abundance, and increased presence of pollution-intolerant taxa than before the remediation occurred. The fish species composition and numbers also were observed to meet expected conditions. In addition, tissue PCB concentrations in the invertebrates, which form the base of the aquatic food chain, were reduced by over 99% as compared with pre-remediation levels. Using similar field and laboratory methods, GE conducted surveys at the same three locations in 2012 and obtained substantially the same results, with even further reductions in tissue PCB concentrations observed.[5] There is no reason to believe that recovery in Reaches 5A and 5C, following sediment remediation, will be any less rapid or complete, particularly considering that recovery will be enhanced by placement of a habitat layer as part of the Engineered Cap.

Fourth, in these surveys, there was no indication of colonization by invasive aquatic species documented by EPA or GE by either plant or animal species. Similarly, there is no indication from these surveys that the removal of contaminated sediment and subsequent placement of an engineered cap have caused any meaningful change in groundwater flow and/or the presence of a hyporheic zone in the riverbed.

Fifth, in the case of the banks in Reach 5A that will be remediated, extensive ecological restoration using the well-established principles of bioengineering and natural channel design are expected to lead to a recovery similar to that observed in the 1 ½-Mile Removal Reach.

With regard to the position of the Commonwealth quoted by GE, EPA notes, as GE is well aware, that these remarks were part of the Commonwealth's 2011 response to GE's Revised CMS, not to the 2014 proposed remedy or the 2015 Intended Final Decision. The current position of the Commonwealth is stated in its October 27, 2014 comment letter, as follows: "we support . . . the more specific approach to remediating the Reach 5 river banks set forth in the Proposed Cleanup Plan, which is . . . responsive to the Commonwealth's concern about ensuring that the fundamental, dynamic character of the river remains intact following the necessary remediation of eroding banks."[6]

GE Argument: Loss of banks, trees, routes, and rise of invasive species

In its October 2014 comments, GE expresses concerns at 34 para. 2 regarding the proposed remediation and subsequent stabilization of river banks in Reach 5A. The Intended Final Decision provides for removal of contaminated soil from eroding riverbanks in Reach 5A, and other contaminated soil from riverbanks in Reach 5B.[7] EPA recognizes the value of

[4] Post-Remediation Aquatic Community Assessment, 1 ½-Mile Removal Reach, December 2007, Prepared by Weston Solutions for USEPA.
[5] 2012 Aquatic Macroinvertebrate Sampling Report, 1½-Mile Reach of Housatonic River. GE. October 24, 2012
[6] Commonwealth of Massachusetts' Comments on EPA's Proposed Cleanup Plan for Rest of River (June 2014)
[7] Intended Final Decision, II.B.2.a.(1)(b)-(f); II.B.2.b.(1)(c).

undisturbed river banks and their role in providing habitat for some species of mammals, birds, and other taxonomic groups as well as in providing stability against erosional forces. However, EPA also recognizes, and has demonstrated via Housatonic River Modeling Study,[8] that many areas of river bank in Reach 5A are highly contaminated with PCBs originating from the GE facility in Pittsfield, MA and that eroding PCB-contaminated banks contribute significantly to PCB contamination that is transported downstream. Therefore, the proposed remedy requires contaminated, erodible banks in 5A and hot spots in banks in 5B be excavated and restored. The four issues that GE raises in this comment are: reduction of habitat, removal/elimination of mature trees along the banks, reduction of access routes for various animal species; and an increase in the potential for colonization by invasive species. Each of these points are addressed below.

After remediation activities are completed, restoration practices will be implemented that address the impacts of the remediation on river banks and that restore, to the extent practicable, the functions, values, characteristics, species use, and other ecological attributes existing prior to remediation. The proposed remedy requires that GE employ a design approach for the restoration of river banks, using natural channel design principles in Reach 5A, that will emphasize bioengineering methods.[9,10] The bioengineering methods (e.g. woody debris toe protection) will provide a variety of habitat.[11] Recognizing that the bank remediation/restoration will affect only a limited amount of the nearly 20 miles of river bank in Reach 5, EPA considers the short-term effects of bank remediation/restoration to be acceptable considering the long-term benefits of PCB removal and associated reduction in risk and downstream transport.

Similarly, EPA recognizes that some mature trees will need to be removed to remediate the banks. The proposed remedy stipulates ecological restoration activities that will promote and accelerate the regeneration of mature forest along the impacted banks, rather than result in a permanent change to a more open condition along the River. As noted above, the amount of bank disturbance is limited, thereby minimizing the removal of mature trees. As shown by GE's bank vegetation monitoring following remediation of the ½-Mile Removal Reach, the timely establishment of canopy trees on restored river banks can be accomplished; in 2008, which was the 7th year of monitoring, all planted areas had canopy tree numbers that exceeded the Target Performance Standard.[12] Monitoring results in 2010 further confirmed success in establishing canopy trees.[13] Based on the proven re-vegetation success that has occurred upstream, and at other large restoration projects,[14] EPA expects similar success when requiring an active restoration program for the Rest of River.

Because the extent of bank remediation will be limited to only a portion of Reach 5A, the disruption of wildlife use, including slides and burrows of mammals and access routes for reptiles, amphibians, and smaller mammals between the River and the floodplain, will also be

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[8] Final Model Documentation Report: Modeling Study of PCB Contamination in the Housatonic River. November 2006.
[9] Intended Final Decision
[10] Statement of Basis
[11] Comparative Analysis
[12] 2008 Annual Monitoring Report, Upper 1/2 Mile Reach of the Housatonic River. January 1 2009.
[13] 2010 Annual Monitoring Report, Upper 1/2 Mile Reach of the Housatonic River. January 28 2011.
[14] Comparative Analysis, Attachment 12, Attachment 13

limited. In addition, local observations from the 1½-Mile Removal Action, which involved much more extensive bank stabilization than will be necessary in the Rest of the River, show an existence of a robust beaver population a few years following bank stabilization. The beaver population rebounded so successfully in this area that additional plantings, herbivore control measures, and continued maintenance of protective tree cages[15,16] were necessary to help ensure successful re-vegetation. Based on the large extent of undisturbed banks and the monitoring observations at the upstream remediation project, EPA expects any reduction in slides and burrows and access routes for reptiles, amphibians, and smaller mammals to be temporary.

With regard to GE's final point, EPA recognizes that colonization by invasive species during and following the Proposed Remedial Action, as with any project, is a serious concern, particularly in disturbed or newly planted areas, as well as downstream impoundments and, to a lesser extent, in the backwaters. As a result, and as specified in §II.B.H.18.b of the Intended Final Decision, an Invasive Species Control Plan is a required part of the Operation and Maintenance Plan, which will be part of the Rest of River

Statement of Work and incorporated into an adaptive management approach. EPA recognizes that control of invasive species can be difficult, particularly the control of invasive forms of submerged aquatic vegetation, but "difficult" should not be interpreted to mean that properly implemented control measures will not be successful. EPA recognizes there is a risk that some invasive species already in the Housatonic River system may increase, at least temporarily, as a result of the remediation.

The probable success of a properly designed and implemented Invasive Species Control Plan in mitigating the potential threat of post-remediation colonization is demonstrated by the monitoring results for the upstream 1½-Mile Reach. As a result of the control plan implemented by GE, invasive plant species exhibited less than 5% aerial cover following remediation activities, which successfully met the established Maintenance Standards throughout the post-removal monitoring periods. This monitoring shows that the Invasive Species Control Program continues to be successful.[17]

GE Argument: Natural Channel Design Failures

At 35 para. 3 of its comments, GE cites a recently published technical paper[18] that they claim raises questions about the effectiveness of ecological restoration, and particularly of Natural Channel Design (NCD). According to GE, in the paper, the authors identify the shortcomings with the Natural Channel Design approach – notably, its failure to address chemical and biological processes – and show that river restoration is fraught with problems and has had disappointing outcomes to date. According to GE, the authors conclude that ". . . a major emphasis remains on the use of dramatic structural interventions, such as completely reshaping a channel, despite growing scientific evidence that such approaches do not enhance ecological recovery . . . ."

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[15] 2012 Annual Monitoring Report, 1 1/2 - Mile Reach of the Housatonic River. January 30 2013.
[16] 2014 Annual Monitoring Report, 1 1/2 - Mile Reach of the Housatonic River. January 29 2015.
[17] 2014 Annual Monitoring Report, 1 ½ - Mile Reach of the Housatonic River. GE. January 29, 2015.
[18] Palmer, M.A., K.L. Hondula, & B.J. Koch. 2014. Ecological Restoration of Streams and Rivers: Shifting Strategies and Shifting Goals, Annu. Rev. Ecol. Evol. Syst. 45: 247-69.

However, when taken in its entirety, this paper does not lead to the conclusion that the proposed remediation and restoration of the Rest of River cannot be successful in implementing the principles of NCD. Rather, there are numerous observations made by the authors that are germane to the remediation and restoration of the Rest of River and are fully supportive of the measures that EPA has specified in its Intended Final Decision.

First, Palmer et al. note, relative to ecological processes, that "an over-reliance on channel design may obfuscate efforts to identify the factor that most limits recovery of a stream; quite often this factor is water quality, and thus *ecological recovery will not occur until the source of pollutants is removed.*" [*emphasis added*] Palmer et al. also note that "As with restoration of any ecosystem, the most successful and sustainable approaches should *target the source of degradation* and focus on the appropriate scale." [*emphasis added*] The authors also conclude that "efforts at watershed and riparian scales that target restoration of hydrological processes and prevention of pollutants from entering the stream appear to offer the most promise." The authors observe "In any case, once stressors, such as nonnatives, uncontrolled runoff, or pollutant inputs, are removed, restoration theory suggests that a stream should recover on its own (Falk et al. 2006). This form of restoration is the ultimate type of functional restoration because the stressors exert their impact by influencing the processes, both ecological and physical, that define healthy rivers (Gilvear et al. 2013)." These points show that the paper's conclusions support the focus in the Intended Final Decision on removal of PCB contamination from the river, banks, and floodplain followed by the active restoration of remediated banks and adjacent floodplain.

The conclusions that Palmer et al. make regarding complete channel reshaping are not applicable to the specific challenges for the Housatonic River and the Intended Final Decision. First, the channel restoration projects reviewed by Palmer et al. did not specifically include contamination removal as the primary objective. Second, Palmer et al.'s comments apply less to the channel work in the Intended Final Decision because, unlike many of the projects referenced in the paper, the post-remediation restoration goal is not to *enhance* biological diversity or *improve* existing habitat, values and functions, but to replicate existing functions and values post-remediation. Therefore, the focus of the Proposed Remedial Action is fundamentally different from the goals set for the majority of stream restoration projects reviewed by Palmer et al.

Perhaps most important to reiterate in response to GE's comment, the Intended Final Decision is not an NCD project; instead, it is a contamination removal project. The cornerstone of the Proposed Remedial Action is to address contamination in river sediment and floodplain soil along the length of the degraded river corridor. The intent of the NCD and bank stabilization techniques proposed by EPA is to reduce the potential for erosion of contaminated banks and the subaqueous caps, thereby preventing additional pollutants from entering the stream system, where risks from exposure to PCBs are high. EPA fully understands that a critical aspect of the project involves applying NCD principles not in a vacuum, but as one tool to be used in concert with an active remediation and restoration program.

GE Argument: Loss of mature forested habitat

In GE's comments at 35 para. 4 regarding the loss of mature forested floodplain habitat as a result of remediation in the ROR, GE fails to recognize that the Housatonic River and its floodplain have been heavily impacted by human activity over the past 300 years, including clearing and deforestation of nearly the entire watershed, but have recovered from these impacts.[19] Considered as a whole, the floodplain forests in the ROR area consist primarily of younger trees.[20] In addition, the 45 acres of floodplain (not all of which is forested) that EPA estimates will need to be remediated[21] represents only 4.2%[22] of the entire PSA.

EPA acknowledges that the PCB remediation activities will directly affect aspects of forest ecology raised by GE such as the production of coarse woody debris and leaf litter, flood flow alteration, and soil characteristics in the short-term and on a localized scale.[23] However, the remediation and its unavoidable short-term impacts will remove PCB contamination from the floodplain soil, and remedy's Restoration requirements will result in a mature forest becoming reestablished following restoration, benefiting the river and floodplain ecosystems. The impact to the forest and its ecosystem functions will be temporary, and the ecosystem, as it has in the past, will recover as succession transforms the young vegetation that initiates the restoration process into a mature restored forest.

EPA's belief in the success of this recovery is, and will continue to be, supported by the documented success of restoration activities at numerous sites, including in the 1½-Mile Phase 4 Floodplains properties, where GE planted over 650 trees and shrubs. With proper maintenance and replanting when necessary, GE achieved a 100% survival rate. As an example, for the 79 cottonwoods planted in May 2010 in the 1 ½ Mile, the average height of the trees by the summer of 2012 (two years later) was at least 24.2 feet, with 58 of the trees having a recorded height of greater than 25 feet.[24] Similarly, post-remediation monitoring of the adjacent riverbanks in both the ½-Mile Reach and 1½-Mile Reaches of the Housatonic River indicates that the trees and shrubs planted as part of the riverbank restoration efforts have been meeting or exceeding the performance standards for survivorship and areal cover.[25,26,27] EPA expects that the future restoration of affected areas in the ROR will produce similar results.

There are restoration techniques available to mitigate the specific types of effects noted by GE in its comment. For example, during floodplain restoration coarse woody debris can be introduced through the reuse of tree trunks that were removed during remediation, and similarly, woody materials can be introduced during bank restoration. Trees that will be planted within the

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[19] Ecological Risk Assessment, Volume 3, Appendix A.1: Ecological Characterization of the Housatonic River. USEPA. November 2004. Section 2.1.
[20] Ecological Characterization of the Housatonic River
[21] Statement of Basis. As discussed in the Comparative Analysis, the exact areas (therefore habitat types) are to be determined based on habitats and occurrences of state-listed species as defined by the Core Areas.
[22] Statement of Basis and Comparative Analysis
[23] Comparative Analysis
[24] Floodplain Non-Residential Properties Adjacent to 1½ Mile Reach of Housatonic River (GECD720); Summary of August 2012 Inspection Activities for the Group 4C Floodplain Properties, GE. 11 September 2012.
[25] 2007 Summer Vegetation Monitoring Report
[26] 2012 Annual Monitoring Report 1½ - Mile Reach of the Housatonic River
[27] 2009 Annual Monitoring Report Upper ½ - Mile Reach of the Housatonic River.

remediated areas during restoration activities will begin to produce leaf litter in their first years, so the loss after clearing is a matter of degree and is temporary, as these planted trees grow and produce increasing amounts of leaf litter. Floodplain microtopography can be restored in the final grading following remediation by implementing proper survey techniques and controls as well as through the reuse of tree trunks, to restore floodplain roughness and thus water retention/flood flow.

Selecting backfill material (including manufactured soil)[28] that best mimics the characteristics of the soil currently present is a restoration technique that will also serve to offset the soil disruption that is an unavoidable effect of the remediation. GE comments that backfilled soils will not fully duplicate the characteristics of the existing floodplain soils in either their physical behavior with respect to groundwater hydrology and infiltration of surface water, nor in their ability to provide refugia and overwintering habitat for floodplain-dwelling species. EPA recognizes that it will likely not be possible for backfill to duplicate exactly all of the physical/chemical qualities of existing floodplain soils, but believes that GE's claims that backfilled soil will be environmentally unacceptable are greatly overstated. The use of soil that is reasonably similar to natural soils is implicit in the Restoration Performance Standard requiring excavated areas to be backfilled to original grade, and engineering specifications for backfill soil will be subject to EPA review and approval. Other engineering controls will also be necessary to prevent the compaction of backfill soil during and after placement. Ecological restoration in these areas will enhance the ability of backfilled areas to serve substantially the same functions as they did prior to remediation. Finally, EPA notes that less than 5% of the floodplain in the PSA is expected to be excavated; therefore, even if the backfilled soils ultimately present any of the problems that GE cites in its comment despite EPA's oversight, such problems will be limited to a number of small, non-contiguous areas of floodplain and/or subject to additional actions by GE to alleviate the concern(s). EPA believes that any short-term environmental effects are justified by the reduction of unacceptable human health and ecological risks by the excavation of contaminated floodplain soil.

Because only a small percentage of the floodplain will be disturbed and even that will be dispersed through time and space, the refugia of mature forest habitat will remain and mobile species will be able to move among mature forest patches during the remediation and restoration activities. As restored areas mature, migration and/or dispersal and re-introduction of mature forest species can be expected. The riparian corridor will remain because work in such a limited area of the floodplain will only temporarily create small openings that will have minimal impact on corridor integrity and contiguity. In addition, phasing of the remediation will prevent this small amount of clearing from occurring at the same time, further reducing its impact.

GE Argument: Vernal pool impacts

Regarding GE's comments at 36 and also at SOP Footnote 15, EPA is aware of the challenges that may be posed in the remediation of vernal pools and ecological restoration, but disagrees with the comment that this will result in irreversible changes and have a very low chance of success. EPA believes that the long-term environmental benefits of stabilizing and/or

[28] Manufactured soil can also be referred to as engineered soil or amended soil.

addressing the harmful PCB contamination in the vernal pools will outweigh short-term changes and temporal loss of functions that may happen as a result of remediation activities.

First, based on comments by GE and others on the 2014 proposed remedy, the Intended Final Decision includes modified Vernal Pool requirements to avoid excavation to the extent possible by specifying the use of an activated carbon (or similar) amendment of vernal pool soils. Activated carbon amendments act to reduce the bioavailability of organic contaminants by increasing the organic carbon content of the contaminated medium which binds the PCBs, and have shown promise in a number of applications. [29] Activated carbon (AC) and similar amendments are increasingly being used as a component of the remedy at contaminated sediment sites. [30] EPA believes there is a reasonable expectation that AC treatment will be successful in avoiding excavation in at least some of the contaminated vernal pools designated for remediation. Only if this is determined to unsuccessful does the proposed remedy require excavation and restoration of the Vernal Pools. Furthermore, should the activated carbon approach not work, no excavation is required in Core Area 1 and GE is required to minimize the impacts from excavation in Core Areas 2 and 3 on a case-by-case basis.[31]

Second, in the event that AC amendment is not successful in achieving the required reduction of bioavailability, and excavation and restoration of the Vernal Pools outside of Core Area 1 is required, EPA believes this can be successfully accomplished. EPA acknowledges that, if performed haphazardly, the cleanup and subsequent restoration efforts have the potential to cause changes in sediment types and soil composition, pool size and depth, pool hydroperiod, vegetation characteristics, shading and foliage cover, litter and coarse woody debris, and other important parameters of these ephemeral pool features. However, these and other potential impacts can be eliminated or reduced by a well-designed restoration program such as the one outlined in EPA's Intended Final Decision.

EPA has reviewed the literature and the state of the science related to the history and efficacy of vernal pool restoration and creation in the context of the Housatonic River cleanup. It is clear that vernal pool restoration in particular (as opposed to vernal pool creation) can be accomplished successfully with a careful approach and attention to detail. In the evaluation of 15 vernal pool creation projects in New England, Lichko and Calhoun (2003, as cited in Stantec Consulting 2010) note that failures of pool creation projects to replace key vernal pool functions were due primarily to lack of clear goals, poor planning, poor execution, and lack of clear criteria for measuring success. Other studies are in accord with these conclusions, and indicate that an important factor in the success of vernal pool creation is evaluating and replicating physical and biological conditions of reference pools and/or those pools to be restored, particularly in regard to hydroperiod and pool morphology.

[29] Comparative Analysis, Attachment 3.

[30] Patmont Cr, Ghosh U, Larosa P, et al. In Situ Sediment Treatment Using Activated Carbon: A Demonstrated Sediment Cleanup Technology. *Integrated Environmental Assessment and Management*. 2015; 11(2):195-207.

[31] Intended Final Decision at II.B.3.b.

For example, the vernal pool remediation efforts by GE in the 1.5-Mile Reach in 2006 at vernal pool 8-VP-1[32] provide a good indication of the potential for successful vernal pool restoration under similar circumstances. After restoration, as documented by both GE and EPA in post-remediation inspection reports, in a short time vernal pool 8-VP-1 was providing breeding habitat for vernal pool amphibian species, providing ecological functions similar to the pre-remediation pool, and was shown to be meeting the Massachusetts criteria for a certified vernal pool.[33] EPA expects similar results when existing vernal pools are remediated and restored in the Rest-of-River cleanup activities using the program outlined in the Intended Final Decision.

In selecting the preferred remediation alternative, EPA coordinated with the Commonwealth of Massachusetts and the State of Connecticut regarding cleanup approaches, and evaluated remediation alternatives against the Permit's general standards and decision factors[34]. The proposed alternative involves a requirement for avoidance and minimization of impacts to species and habitats regulated under the Massachusetts Endangered Species Act, and will employ an adaptive management approach. The phased approach to remediation construction over an estimated 13 years will also help to mitigate short term impacts on vernal pool habitats.[35]

GE Argument: Impacts on zones surrounding vernal pools

EPA acknowledges, as GE infers at 36 para. 2, that the habitat surrounding a vernal pool is as important as the pool itself in supporting populations of vernal pool species and that, to varying degrees, remediation and subsequent restoration efforts will have the potential to cause short-term changes in a number of floodplain characteristics in these buffer areas. However, EPA believes that these short-term effects will be mitigated by an active restoration program and are off-set by the reduction in exposure to harmful PCBs to the amphibian populations.

GE Argument: Spillover impacts into areas adjacent to disturbed areas

EPA acknowledges and shares the concerns noted by GE at 36 para. 3 regarding potential spillover effects (potential increases in erosion and sedimentation (even with controls), the spread of invasive plant and animal species to such areas, changes in microclimate, and the effects of noise from construction and traffic on sensitive bird and mammal species during the breeding and rearing seasons) that might occur during the construction phases of the remediation. EPA's Intended Final Decision[36] addresses these issues and provides the framework for minimizing and mitigating them. Each of the specific effects delineated in this comment is

[32] Floodplain Residential and Non-Residential Properties Adjacent to 1.5-Mile Reach of Housatonic River (GECD710 and GECD720); Summary of April/May 2009 Inspection Activities for the Group 4C Floodplain Properties. May 21, 2009.
[33] Floodplain Residential and Non-Residential Properties Adjacent to 1.5-Mile Reach of Housatonic River - Summary of April/May 2009 Inspection Activities for the Group 4C Floodplain Properties. GE, May 2009. Floodplain Residential and Non-Residential Properties Adjacent to 1½ Mile Reach of Housatonic River - Summary of April/May 2010 Inspection Activities for Group 4C Floodplain Properties, GE, June 2010. 2012 4C Floodplain Vernal Pool Monitoring Summary, May 2012; 2014 4C Floodplain Vernal Pool Survey.
[34] Statement of Basis
[35] Draft Modification to the Reissued RCRA Permit for Public Comment – June 2014.
[36] Intended Final Decision.

addressed briefly below. However, applicable to all of these issues is the fact that, as demonstrated by the body of data and other information developed at Rest of River over the last 15 years, wildlife is currently impacted by the existing PCB contamination. EPA believes that the long-term environmental benefits of removing and/or isolating the PCB contamination in the River and surrounding areas will outweigh short-term effects and temporal loss of functions that will occur as a result of the remediation and subsequent restoration activities.[37]

Erosion and Sedimentation – Erosion and sediment controls are a necessary component of any construction activity and are guided by best management practices (BMPs). The Performance Standards and Corrective Measures outlined in EPA's Intended Final Decision require that GE develop Remedial Design/Remedial Action Work Plans. EPA anticipates that these plans will: 1) provide appropriate erosion/sediment control measures (in the Final Remedial Design/Remedial Action Work Plans), 2) insure that reconstruction of river banks will minimize erosion, considering the principles of natural channel design, in areas where PCB-contaminated sediments are removed, 3) maximize the use of bioengineering methods when reconstructing riverbanks, and 4) the selection of appropriate cover/cap material for the Erosion Protection Layer of Engineered Caps.

To minimize the negative effects of construction on the community, BMPs such as phased construction, dust suppression techniques, perimeter air monitoring, and other engineering controls will be required during remedial construction[38]. There are several techniques that can control erosion by working in conjunction with the geomorphic processes and conditions of the construction site, including minimizing the time between removal of the pre-construction cover and establishment of the post-construction cover.[39]

Invasive Species – EPA acknowledges that there is the potential that areas disturbed during remediation and restoration activities could be colonized by invasive plant species. This impact will be mitigated via active control of invasive species as specified by the requirement for an Invasive Species Control Plan in the Intended Final Decision. Invasive plants will be identified and targeted for control during the post-construction monitoring and maintenance phase of remediation. The requirement for GE to develop and implement a control plan and then monitor the success of that plan during the post-construction operation and maintenance phase, will ensure that invasive species will be kept under control during and after completion of the Proposed Remedial Action. Invasive species control and documented success in the Upper ½-Mile and 1 ½ Mile Reaches was also discussed above in the subsection titled *Loss of banks, trees, routes, and rise of invasive species*.

Microclimate – Effects of remediation and restoration activities on the existing microclimate may include temporary loss of shading, increases in surface water and soil temperatures, increased wind velocities, and increased evapotranspiration, among others. As noted in the NRRB Site Information Package,[40] remediation and restoration of the river and floodplain at this scale cannot be accomplished to any meaningful level without short-term

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[37] Comparative Analysis
[38] Statement of Basis.
[39] Harbor, J. 1999. Engineering geomorphology at the cutting edge of land disturbance: erosion and sediment control on construction sites. Elsevier Science B.V., Geomorphology, 1999.
[40] National Remedy Review Board Site Information Package for the Housatonic River, Rest of River,

impacts to the present state of the river and floodplain. However, EPA believes that phasing the project and performing construction in relatively small areas of the project at any given time will reduce the scale of these impacts, and implementation of a comprehensive ecological restoration program will initiate an accelerated recovery of the ecosystem that will not only alleviate impacts caused by the remediation, but also, over the longer term, create processes that will sustain diverse river and floodplain communities.

Noise – EPA acknowledges the concern that construction-related noise during remediation activities may affect wildlife breeding and rearing of young in some species, but believes such effects will be localized and can be mitigated. Through consultation with the state and federal wildlife agencies, EPA will ensure that the remedial construction plans to be developed by GE, to the extent possible, avoid, minimize, and mitigate these effects. Time and scheduling constraints on construction activities will limit the amount of disturbance at any one time and restrict construction disturbance to seasonal schedules that allow use of the riparian corridor by native species. Furthermore, only a portion of the river system will be affected at one time, so the effects in any one area will be limited to a relatively short period of time.

GE Argument: Fragmentation of the PSA ecosystem

EPA disagrees with GE comments at 36-37 that the Primary Study Area (PSA) ecosystem will not recover following the implementation of restoration practices. The complex ecosystems that currently exist within the project area are present despite anthropogenic activities that have been influencing land cover in the area since the 1700s. These historical activities significantly affected the ecological conditions and processes around the river, including vegetation types and succession, river meandering, downstream transport of sediment via accelerated bank erosion, and deposition in the floodplain.[41] In addition to historical straightening and damming of the channel, the river and surrounding forests were impacted by the clearing of riparian areas for agriculture and development. Urban development and historical agricultural activities in the upper PSA resulted in loss of vegetation in the floodplain and riparian areas.[42] Following these past disturbances, the ecosystem was left to adjust and recover naturally, which has resulted in the current conditions in the PSA. An active restoration program will speed up the natural process of ecosystem recovery. EPA's ecological restoration strategy is to mitigate the temporary impacts related to the remediation activities, not to restore the ecosystem back to some historic, unaltered, pristine state. After remediation and restoration, it is understood that Rest of River will not mirror what is observed on-site today – an environment that has been compromised in many ways by high concentrations of PCBs – nor what was there 100 years ago before PCBs were released into the river. Instead, the goal of the ecological restoration is to restore the functions and ecosystem services that currently exist.

To maintain, to the extent practicable, undisturbed forest corridors in the PSA and minimize adverse impacts to disturbance-sensitive species, EPA will require GE to develop remediation plans that include a phased approach to construction and subsequent restoration. Phasing the work will disperse the effects of the construction activities over time (the remedial action period is estimated to be 13 years) and space (a distance of 10.5 miles),[43] and provide

[41] Comparative Analysis.
[42] Active cropland is now relatively uncommon. Ecological Characterization of the Housatonic River.
[43] Statement of Basis.

optimal coordination of restoration with remedial activities. This will limit ongoing disturbance to any one area and allow native species to continue using river corridor habitats in post-restoration areas and areas yet to be disturbed. In the Intended Final Decision,[44] GE is required to address these concerns in the restoration plans, which will be reviewed and approved by EPA (after consultation with the States). The Intended Final Decision also provides for the use of adaptive management to improve and adjust construction as well as restoration methods during later phases.

EPA has reviewed the state of the science of ecological restoration and provided examples focused on river restorations involving larger river channels and/or remediation in the Comparative Analysis.[45] These examples show that, following restoration of impacted sites throughout the world, it is possible to restore both the ecological function of areas and appearance after they are disrupted in projects on a large scale. The examples also serve to highlight the common practices that helped to establish the restoration success. Thus, EPA has concluded that implementing remediation and restoration as required in the Intended Final Decision will result in the return of the functions, values, characteristics, vegetation, habitat, species use, and other attributes, to the extent feasible and consistent with the remediation requirements.

GE Argument: Impacts on state-listed species

EPA does not agree with GE comments at 37 and in Attachment E that the proposed remedy would have "severe adverse impacts" or "substantial impacts" on state-listed species. On the contrary, the benefits of removing or significantly decreasing the exposure of such species, and others, to high levels of PCB contamination, outweighs the short-term impacts. EPA's opinion is shared by the Commonwealth of Massachusetts, whose responsibility it is to administer the Massachusetts Endangered Species Act. As discussed in the Commonwealth's comments on EPA's Proposed Cleanup Plan for Rest of River[46], the Commonwealth has been providing comments to EPA on the remediation of the Rest of River since 2008 and has been involved in discussions with EPA and the State of Connecticut since 2011. As a result of this collaboration, and after a thorough review of the components of the remedy that potentially could result in a "take" of state-listed species, the Commonwealth expressed its support for EPA's proposed remedy, noting that the plan would be protective of human health and that the plan is "directed at preserving the dynamic character of the river ecosystem and avoiding, minimizing and mitigating remedy impacts to the affected wildlife and their habitats, with a particular focus on protecting state-listed species (p. 2)[44].

Moreover, the Commonwealth specifically addressed the consistency of the proposed remedy with the MESA requirements; its support for the proposed remedy makes it is clear that GE's exaggerated claims of impacts to state-listed species are without merit.

In addition to the Commonwealth, the Massachusetts Audubon Society, one of the more prominent landowners along the Rest of River, also provided extensive comments on EPA's

[44] Intended Final Decision.
[45] Comparative Analysis, Attachment 12 - River & Floodplain Restoration
[46] Commonwealth of Massachusetts' Comments (2014).

proposed remedy.[47] Nowhere in its comments does Mass Audubon express concerns regarding the impact of the proposed remedy on the American bittern, nor on state-listed species generally. The Audubon "State of the Birds" report[48 49] cited by GE in its comment does include a species-specific review of the status of American bittern. However, one of the primary reasons listed in the Audubon report for the declining local populations of this species is habitat degradation, with "chemical contamination" cited as one of the major causes of habitat degradation. EPA agrees with this assessment. In fact, the American bittern was specifically evaluated in the Ecological Risk Assessment conducted for the GE/Housatonic River Site, and it was concluded that "American bitterns feeding and reproducing in the Housatonic River PSA are at a high risk of toxicity from exposure to PCBs in these reaches."[50] It is both technically and rationally illogical to conclude that a cleanup plan specifically targeted at the removal of the very chemical that poses a threat to American bitterns should not be conducted because it might temporarily affect the contaminated habitat occupied by those same bitterns.

Attachment C to GE Comments – Brooks, Calhoun, Hunter, ecological impacts of remedy

The topics in Attachment C were also addressed in GE's text on pages 34-37. To the extent that additional issues were raised in Appendix C, EPA's response is incorporated in the applicable sections above.

Attachment D to GE Comments – 30 articles about restoration

In its Attachment D referenced in its Statement of Position, GE claims that EPA's position that restoration would effectively and reliably re-establish the pre-remediation conditions and functions of the affected habitats is not supported, and references 30 sources it claims were not considered by EPA.

There are some general principles of ecological restoration on which GE and EPA agree:

- Ecological restoration is a fairly young discipline;

- Ecological restoration can improve the structure and function of degraded ecosystems and can, under the right circumstances, re-establish an approximation of the previous ecosystem, but takes some time to develop; and,

- Restoring the ecological integrity of degraded waterways is tough, complicated work.

Notwithstanding these basic points of agreement regarding ecological restoration, remediation with subsequent restoration is necessary within the Rest of River due to PCB contamination that poses unacceptable risks to human health and the environment, as clearly

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[47] Mass Audubon (Henry Tepper, President), Re: Proposed Remedial Action for the Housatonic River: Statement of Basis for EPA's Proposed Action for the Housatonic River "Rest of River" & General Electric Company, Pittsfield, Massachusetts Draft Modification to the Reissued RCRA Permit for Public Comment - June 2014. Letter to Dean Tagliaferro (USEPA), October 27, 2014.
[48] Mass Audubon. 2013. State of the Birds: Massachusetts Breeding Birds: A Closer Look. Mass Audubon Society.
[49] The Commonwealth of Massachusetts Natural Heritage & Endangered Species Program collaborated with Mass Audubon in the preparation of the State of the Birds report.
[50] Final Ecological Risk Assessment, at K-66.

demonstrated in EPA's Human Health Risk Assessment and Ecological Risk Assessment. Nowhere in Attachment D to GE's comments is this serious problem acknowledged (indeed, the term "PCBs" is not found anywhere in Attachment D), and in fact the authors refer only to the remediation itself as the source of the environmental degradation that requires restoration, as though the Proposed Remedial Action was being performed in a vacuum. The remediation and restoration would be unnecessary if PCBs from GE's Pittsfield facility were not currently contaminating many miles of the Housatonic River and many acres of the adjacent floodplain. Addressing the contamination in these areas will result in unavoidable temporary impacts, but will provide significant benefits for the river and its floodplain in the long term. As is shown by the title of the restoration requirements in the Intended Final Decision (Restoration of Areas Disturbed by Remediation Activities), the rationale for EPA's ecological restoration strategy is that it is being undertaken to mitigate temporary impacts related to the remediation activities, not, as claimed in Attachment D, to restore the ecosystem back to some historical state. After remediation and restoration, it is understood that the Rest of River will not mirror what is observed today, an environment compromised in many ways by high concentrations of PCBs, nor what was there 100 years ago before PCBs were released into the river. Instead, the goal of the ecological restoration is to restore, following remediation, the functions and ecosystem services that exist today but without the significant impairment from PCB contamination.

In Section II.B.1.c.of its Intended Final Decision, EPA describes the Restoration Performance Standard and associated Corrective Measures. This program was designed to include the elements that have been identified in the literature as being the major contributors to the success of restoration projects, and to avoid the causes of failure that were common for the projects that were not deemed a success (many of which GE notes in its Attachment D). The Corrective Measure lays the foundation for a successful restoration process, outlining procedures for conducting the baseline assessment; developing the restoration performance objectives and evaluation criteria; developing a restoration corrective measures coordination plan to be performed during the implementation of the corrective measures; and lastly, designing and implementing the restoration plan, and monitoring. This process will require GE to collect additional information which will form the basis of an adaptive management strategy to inform the process iteratively as the remediation proceeds downstream, and into post-construction activities.

GE's statement "… any meaningful ecological recovery of certain elements of the Rest of River ecosystem will take, at best, decades beyond the timeframe of the remediation, implies that floodplain remediation and restoration could require an extremely long and unreasonable period of time. However, EPA notes in Section II-4 of the Ecological Characterization of the Housatonic River that "Much of the upper two-thirds of the project site appear to have been cleared for agriculture at one time" and in Section II-2 that "Farm abandonment and reforestation, in the form of both natural and planted trees, began to shape the landscape of Berkshire County in the early part of the 20th century." It was also noted by the Berkshire Regional Planning Commission that "As discussed at the Rest of River Municipal Committee work session of February 27, 2014, in which EPA and DFW staff were present, it was estimated that the floodplain forests are probably in the order of 60 years old."[51] These statements indicate that much of the forested area (described by GE in Attachment D as an "ecologically vibrant reach of river") is 100 years old or less.

It is not surprising that there is a seemingly mature floodplain forest in this situation, in that a dominant forest canopy species in Rest of River floodplain – the silver maple (*Acer saccharinum* L.) is one of the fastest growing deciduous trees of the eastern and mid-western forests. It can grow 3-7 feet per year achieving a mature height of 90 feet, and is a source of fast shade, large woody debris, and litter in streams. Silver maple shares many of its sites with red maple (*Acer rubrum* L.), a medium sized tree that grows 2-5 feet per year reaching a mature height of 68 feet that is also dominant in the forested floodplain of the Rest of River. With prolific seed and such rapid growth rates, the rapid reforestation exhibited over the last century following deforestation without an active restoration program is explained. However, GE seems to be unaware of the life history characteristics of the dominant tree species in the Rest of River, stating that "one might subtract only 10 years from the 100-200 years it takes to grow a very large silver maple by planting a sapling rather than waiting for seed-based recruitment." While it may be true as a generalization that restoration of some mature forest communities can be difficult and slow to achieve, the dominance of these species in the natural communities and conditions of Rest of River is central to EPA's position that restoration of forested floodplain in these areas is feasible in a reasonable time frame.

Based on this information, it is evident that historically a substantial portion of Rest of River was in agriculture or logged, and the dominant tree forest structure removed, before the Housatonic River ecosystem established its current floral and faunal communities and ecological functions (as a "novel" ecosystem) over the past 60-100 years. This recovery process occurred naturally, not aided by active restoration activities and without careful monitoring and adaptive management. With an active restoration program in place to promote and track the restoration response after remediation, the historical ecosystem response to human intervention supports EPA's position that substantial recovery will not require centuries following remediation, but rather a much shorter period of time.

EPA's Attachment 12 (River & Floodplain Restoration) to its Comparative Analysis provides some relevant examples of successful ecological restoration projects across various settings and scales. These example projects show demonstrated successes following restoration of impacted sites throughout the world, illustrating that it is possible to restore both the ecological function of areas and appearance after they are disrupted, and highlight the common practices that helped to establish the restoration success. Examples of projects were selected where the project was of particular relevance to the Housatonic River in that they were large rivers and streams with a floodplain connection and/or with sediment/soil remediation (much of the current literature base includes much smaller river systems than the Housatonic and/or very different primary restoration goals, such as maintaining a specific stable channel form).

GE claims that "None of the case studies cited as examples of successful restoration is appropriate for comparing the potential outcomes of the proposed remediation and restoration

[51] Letter from Nathaniel W. Karns (BRPC) to Dean Tagliaferro (USEPA), October 20, 2014, Re: Comments on the Draft Modification to the Reissued RCRA Permit for Public Comment - June 2014 and the Statement of Basis for EPA's Proposed Remedial Action for the Housatonic River "Rest of River" (June 2012).

efforts in the Rest of River…." However, GE goes on to base its argument on the premise that the Rest of River area is "ecologically vibrant," and that the examples that EPA provides "were focused on rivers that were physically, chemically, and biologically degraded." As it is EPA's view that the Housatonic River and its floodplain are chemically and biologically degraded by the PCB contamination present, and the area has been physically degraded through historical alteration of the river channel and floodplain, in fact these examples serve as EPA intended.

The technical publications referenced in EPA's Attachment 12 were noted by GE as being slim and dated. GE's critique overlooks the relevance of the body of work presented in Attachment 12 and the fact that the references, which describe the history of ecosystem restoration and/or highlight successful river and floodplain restoration practices, were not intended to represent an exhaustive literature review of the subject of ecological restoration. GE's criticism of the document as though it were an attempt to do so thus constitutes a straw-man argument. Rather, the references are a selection of relevant studies that document the development of the science of restoration or provide examples of restoration with varying degrees of success, but which have common techniques proven successful that can be emulated across varying conditions.

GE's comment also emphasizes that some citations were not published in a "peer-reviewed journal," implicitly suggesting they may not have merit in the discussion of restoration science. It should be recognized that not all valid sources of information are peer-reviewed. Resources such as books or studies by academics or government agencies may be evaluated on their technical merit, though their publication process may not include the peer review process used by academic journals. For example, the Housatonic River Historical Changes in River Morphology reference[52] is not itself from a peer-reviewed journal article, but is a review of a series of peer-reviewed books and publications. For restoration projects, there is a large body of scientifically rigorous work that is not formally peer-reviewed; much of it is generated by active practitioners and has occurred relatively recently. But it is nonetheless valid and used by other scientists and managers to inform decisions. For example, only a small fraction of the tens of thousands of pages of work conducted by both EPA and GE on the GE/Housatonic River Site has been published in peer-reviewed journals, yet the research is accepted by both parties and others, as the common information upon which decisions regarding the future of the river should be based.

Much of the criticism about the references listed in EPA's Attachment 12 is aimed at a common thread – that river restoration is difficult. EPA's Attachment 12, the Statement of Basis, and other materials presented by EPA indicate EPA's agreement with this conclusion, and go on to state that it is important to obtain more site-specific investigation to set appropriate restoration targets, develop an adaptive management approach, and implement a careful plan that pays close attention to detail, is conducted by restoration experts, and reflects lessons learned from past restoration projects.

Some of the references are criticized by GE as not being relevant. For example, Leopold and Maddock, 1953 was described as being a "technical review of limited relevance to the Rest

[52] National Remedy Review Board Site Information Package, Appendix A – Historical Changes in Housatonic River Morphology

of River beyond foundation science." This criticism seems to contradict the earlier statements by the authors of Attachment D about the unknowns related to river ecology and river restoration, and implies that the knowledge of the "foundation science" is neither helpful nor necessary. Leopold and Maddock's important work sets the stage for the current understanding of river systems.

A Compilation of Research Papers Cited by GE

As with nearly any scientific discipline, there is a large body of literature available on ecological restoration and as with other disciplines, the authors of the literature often present diverging viewpoints. As GE notes in Attachment D, its search of the literature generated 9,874 references on river, stream, or floodplain restoration as of July 17, 2014. GE's Attachment D provides a selective list of 30 technical papers from this body of work; the majority of which are relatively new.

EPA's review of the papers selected by GE concludes that, while some of the papers provide information that is worth considering in the implementation of the Restoration Corrective Measures required in the Intended Final Decision, in general, none of the conclusions in these papers suggest that the restoration Performance Standards established in the Intended Final Decision will not be achievable.

In one example, Palmer et al. (2014) cited by GE make note that, in relation to ecological processes, "an over-reliance on channel design may obfuscate efforts to identify the factor that most limits recovery of a stream; quite often this factor is water quality, and thus ecological recovery will not occur until the source of pollutants is removed" (P. 251). Palmer et al. observe that "as with restoration of any ecosystem, the most successful and sustainable approaches should target the source of degradation and focus on the appropriate scale." The authors also conclude that "efforts at watershed and riparian scales that target restoration of hydrological processes and prevention of pollutants from entering the stream appear to offer the most promise." Accordingly, the paper's conclusions actually support the focus of the Intended Final Decision on stream bed, bank, and floodplain PCB removal followed by restoration. The focus of several of the research papers cited by GE appears not to be on remediating and restoring rivers that have been contaminated and present unacceptable risks to human health and the environment.[53] Rather, the focus appears more to be on the evolving nature of the river restoration science and debate on how best to restore ecosystems in general. EPA's Intended

[53] For example, GE cites the following paper, which is described as *a case study that proposes a set of technical monitoring and assessment measures in an effort to assess success and discern failures in river restoration*. Buchanan, B.P., M.T. Walter, G.N. Nagle, and R.L. Schneider. 2012. *Monitoring and assessment of a river restoration project in central New York*. River Research Applications 28:216-33. According to the authors of this paper the main impetus for this project was to protect properties along a reach of the Six Mile Creek where bank erosion had become severe. In another example, GE cites the following paper which describes reasons for failure of one stream rehabilitation project. Smith, S.M., and K.L. Prestegaard. 2005. Hydraulic performance of a morphology-based stream channel design. Water Resources Research 41(1l): W l 1413:1-17. This project was a stream rehabilitation project on a gravel bed tributary to the Patapsco River in Maryland. As the authors describe "The Deep Run reconfiguration was proposed to reduce sediment loading to a riparian wetland located immediately downstream of the project reach. The wetland project was created by gravel extraction in the Deep Run valley, which lowered the floodplain elevation."

Final Decision addresses those issues, with its multiple measures to avoid, minimize and mitigate impacts, Restoration Performance Standards, monitoring and adaptive management.

Attachment E

Cross-References to GE's Statement of Position

GE's Arguments from 1/19/2016 Statement of Position	**Location of GE's Argument**	**Location of EPA Response**
I. EPA's Out-of-State Disposal Requirement Conflict with the Consent Decree's Remedy Selection Criteria and is Unlawful	6	III(A)(2)(g)
II. EPA's Intended Remedy is Not Necessary to Protect Health and Would Cause Overall Environmental Harm and Therefore Violates the Consent Decree	11	III(A)
A. EPA's Remedy Goes Beyond What is Necessary to Protect Human Health	12	III(A)(2)
B. EPA's Remedy Would Cause Overall Harm to the Environment	14	III(A)(2)(a)
III. The Remedies for the Impoundments and Backwaters Are Inconsistent with the Consent Decree's Remedy Section [sic] Criteria and Are Arbitrary and Capricious	16	III(A)
A. EPA's Deep Dredging Remedy for Woods Pond	16	III(A)(2)(b)
B. Remedy for Reach 7 Impoundments	19	III(A)(2)(c)
C. Rising Pond Remedy	20	III(A)(2)(d)
D. Remedy for Backwaters	22	III(A)(2)(e)
IV. EPA's Engineered Cap Performance Standards and Requirements Arbitrarily Fail to Consider Cap Information Presented by GE	23	III(A)(2)(f)
V. The PCB Downstream Transport and Biota Performance Standards Exceed EPA's Authority, Are Arbitrary, and Conflict with the Consent Decree	24	III(B)(1)
VI. The Required Additional Response Actions for Third-Party Dams and Other River Projects Are Unauthorized, Contrary to the Consent Decree, and Otherwise Unlawful	27	III(B)(4)
A. Requirement to Inspect and Maintain Non-GE-Owned Dams in Massachusetts	27	III(B)(4)
B. Requirements to Conduct Response Actions for Future River Projects	28	III(B)(2)
C. Requirements to Conduct Response Actions for Future Dam Failure or Breach	30	III(B)(5)
VII. Many of the Requirements Relating to Future Activities and Uses at Floodplain Properties Conflict with the Consent Decree, Exceed EPA's Authority, and/or Are Otherwise Unjustified	30	III(B)(3)
VIII. EPA's Requirements for Habitat Restoration/Mitigation and a MESA Conservation Plan Exceed EPA's Authority and Conflict with the Consent Decree	33	III(C)
A. Habitat Restoration/Mitigation Requirements	33	III(C)(1)
B. MESA Conservation/Net Benefit Plan Requirement	34	III(C)(2)

DJ-2

TOWN OF LEE, BOARD OF HEALTH

GE-Pittsfield/Housatonic River Site
Rest of River (GECD850)
Pre-Design Investigation Work Plan for Upland Disposal Facility

SATURDAY NOVEMBER 19, 2022

EXHIBIT-5

Andrew T. Silfer
Leader, Pittsfield/Housatonic River

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Via Electronic Mail

November 24, 2021

Mr. Dean Tagliaferro
EPA Project Coordinator
U.S. Environmental Protection Agency
c/o HDR, Inc.
10 Lyman Street, Suite 2
Pittsfield, MA 01201

Re: GE-Pittsfield/Housatonic River Site
Rest of River (GECD850)
Pre-Design Investigation Work Plan for Upland Disposal Facility

Dear Mr. Tagliaferro:

In accordance with the approved Final Revised Rest of River Statement of Work, enclosed for EPA's review and approval is GE's Pre-Design Investigation Work Plan for the Upland Disposal Facility.

Please let me know if you have any questions about this Work Plan.

Very truly yours,

Andrew T. Silfer/csc

Andrew T. Silfer, P.E.
GE Project Coordinator

Enclosure

Cc: (via electronic mail)
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John Kilborn, EPA
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Dennis Lowry, AECOM
James Bieke, Sidley Austin
Michael Werth, Anchor QEA
Public Information Repository at David M. Hunt Library in Falls Village, CT
GE Internal Repository

General Electric Company

Pre-Design Investigation Work Plan for Upland Disposal Facility

November 2021

Pre-Design Investigation Work Plan for Upland Disposal Facility

November 2021

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Abbreviations

amsl	above mean sea level
APE	Area of Potential Effects
Arcadis	Arcadis US, Inc.
ASTM	ASTM International
bgs	below ground surface
CD	Consent Decree for GE-Pittsfield/Housatonic River Site
cm/s	centimeter per second
CRA	Cultural Resource Assessment
EPA	US Environmental Protection Agency
Eversource	Eversource Energy
Final Revised SOW	Final Revised Rest of River Statement of Work (September 2021)
FSP/QAPP	Field Sampling Plan/Quality Assurance Project Plan
ft	feet
GE	General Electric Company
IPaC	Information for Planning and Consultation (USFWS)
Lane	The Lane Construction Corporation
MACRIS	Massachusetts Cultural Resource Information System
MassDEP	Massachusetts Department of Environmental Protection
MHC	Massachusetts Historical Commission
mil	one thousandth (0.001) of an inch
MNHESP	Massachusetts Natural Heritage Endangered Species Program
NGVD 29	National Geodetic Vertical Datum of 1929
NRHP	National Register of Historic Places
OLIVER	MassGIS On-line Data Viewer application
PCB	polychlorinated biphenyl
PDI	pre-design investigation
PDI Work Plan	Pre-Design Investigation Work Plan

Revised Permit	Final Revised Modification of GE's Resource Conservation and Recovery Act Corrective Action Permit (December 2020)
ROR	Rest of River
SPT	standard penetration test
SRHP	State Register of Historic Places
UDF	Upland Disposal Facility
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds

1 Introduction

This Pre-Design Investigation Work Plan (PDI Work Plan) has been prepared on behalf of the General Electric Company (GE) to present the proposed pre-design investigation (PDI) activities for the Upland Disposal Facility (UDF) and UDF support area associated with the Rest of River (ROR) Remedial Action. This section provides an overview of the site background and describes the purpose, objectives, and organization of this PDI Work Plan.

The UDF will be constructed on a 75-acre property that was formerly part of an active sand and gravel quarry and that GE acquired from The Lane Construction Corporation (Lane) in April 2021. Figure 1 shows the extent of the property acquired by GE (referred to herein as the GE Parcel). That figure also shows the maximum limits of consolidated material for the UDF and the associated operational area surrounding and encompassing the limits of the consolidated material (jointly referred to herein as the UDF area). Finally, the figure shows the potential UDF support area, which is currently undefined but may include temporary facilities such as sediment dewatering and material handling areas (referred to herein as UDF support area).

1.1 Background

On December 16, 2020, pursuant to the 2000 Consent Decree (CD) for the GE-Pittsfield/Housatonic River Site, the U.S. Environmental Protection Agency (EPA) issued a final revised modification of GE's Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (Revised Permit) specifying a Remedial Action for the ROR area (EPA 2020). The ROR area consists of the portion of the Housatonic River and its backwaters and floodplain (excluding portions of certain residential properties) downstream of the confluence of the East and West Branches of the Housatonic River (the Confluence), which is located approximately two miles downstream from GE's former manufacturing facility in Pittsfield, Massachusetts. The selected ROR Remedial Action includes a provision for GE to construct and utilize a UDF at the former Lane site for the disposal of certain of the sediments and soils to be removed as part of the Remedial Action.

In accordance with the requirements of the Revised Permit, GE submitted to EPA a Rest of River Statement of Work (SOW) specifying the deliverables and activities that GE will conduct to design and implement the ROR Remedial Action. After receipt of EPA comments, GE submitted a Final Revised Rest of River SOW on September 14, 2021 (Anchor QEA et al. 2021).[1] That SOW included pre-design and design requirements for the UDF and UDF support area, including a requirement for GE to submit a PDI Work Plan for the UDF. On September 16, 2021, EPA issued an approval letter for the Final Revised SOW.

This PDI Work Plan has been prepared in accordance with the Final Revised SOW and includes descriptions for conducting desktop, field, and laboratory-based activities necessary to acquire information for design of the UDF component of the ROR Remedial Action.

[1] Although the Revised Permit is currently being appealed by other parties to the EPA Environmental Appeals Board, GE agreed in a February 10, 2020, Settlement Agreement to submit the SOW and, subject to approval by EPA, to perform the investigation and design work specified in the SOW as contractual obligations under that agreement, unless and until EPA issues a further revised permit that is not substantially similar to the current Revised Permit.

1.2 Purpose and Objectives

This PDI Work Plan describes the proposed investigations necessary to support engineering evaluations and detailed planning and design of the UDF. The results of activities and investigations conducted previously, as well as those performed as part of the PDI, will be used to develop the design for the construction, operation, monitoring, and maintenance of the UDF and associated facilities and for the final cover and closure of the UDF. If the findings or results of the UDF PDI activities indicate that additional investigations are necessary to facilitate the design for the UDF and/or UDF support area, a supplemental PDI work plan or an addendum to this PDI Work Plan will be submitted to EPA for review and approval prior to implementing such supplemental investigations. Further, given that the UDF support area requirements and related facilities are not known at this time, any additional investigations deemed necessary based on design requirements for the UDF support area components will be proposed and conducted within the UDF support area as part of the design process, as will be outlined in the Conceptual Design Plan for the UDF.

1.3 PDI Work Plan Organization

The remainder of this PDI Work Plan is organized into the following six sections:

- Section 2 presents a summary of the Performance Standards for the UDF, as described in Section II.B.5.a of the Revised Permit.
- Section 3 presents a description of the GE Parcel, including the UDF area and UDF support area, and pertinent site background and historical site data, including a summary of information currently available to support design activities.
- Section 4 presents a summary of the anticipated UDF design and site layout.
- Section 5 presents the PDI program objectives and a description of proposed desktop, field, and laboratory-based activities and investigations to address current data needs for design of the UDF and UDF support area (incorporating existing data determined to be of sufficient quality to be usable), including the following:
    - Baseline assessment of the habitat at the UDF area and UDF support area;
    - Survey of existing site features and topography;
    - Subsurface drilling for geotechnical data and sample acquisition;
    - Installation of temporary piezometers and permanent monitoring wells for baseline groundwater elevation and chemical groundwater quality monitoring; and
    - Initial Phase IA cultural resource assessment (CRA) of the UDF area and UDF support area.
- Section 6 presents a summary of data and information that will be obtained during field-based activities and the evaluations to be performed based on the acquired PDI data and information, along with a description of PDI reporting requirements.
- Section 7 presents the anticipated schedule for performing the PDI activities.

2 Performance Standards for UDF

Section II.B.5.a of the Revised Permit sets forth the Performance Standards for the UDF. In summary, those Performance Standards require that the UDF meet the following construction and design requirements:

- Be constructed at the location shown in Figure 6 of the Revised Permit (also depicted on Figure 1 herein).
- Provide a maximum design waste capacity of 1.3 million cubic yards.
- Have a consolidation area (defined as the waste-containing portion of the UDF) with a maximum footprint of 20 acres and a maximum elevation of 1,099 feet (ft) above mean sea level (amsl). If the seasonally high groundwater elevation is determined to be higher than 950 ft amsl, the maximum elevation of the consolidation area may be increased by the number of feet between the seasonally high groundwater and 950 ft amsl in order to achieve the maximum waste capacity of 1.3 million cubic yards.
- Include a double bottom liner, separated by a drainage layer, and incorporate primary and secondary leachate collection systems.
- Have the bottom liner a minimum of 15 ft above a conservative estimate of the seasonally high groundwater elevation. The seasonally high groundwater elevation will be projected using site-specific groundwater elevation data collected in the location of the UDF and modified to account for historical groundwater level fluctuations at similarly sited off-site long-term monitoring wells in Massachusetts. This estimation will be performed pursuant to a methodology reviewed and approved by EPA.
- Cover the consolidation area with a low-permeability cap to include liners, drainage layers, and vegetation.
- Ensure that the liners for both the bottom of the UDF and the cap have a permeability equal to or less than 1×10^{-7} centimeter per second (cm/s) and a minimum thickness of 30 thousands of an inch (mil) and are chemically compatible with polychlorinated biphenyls (PCBs).
- Include a stormwater management system to control surface runoff and minimize the potential for surface erosion or stormwater contribution to leachate generation.
- Include a groundwater monitoring network around the UDF to monitor for PCBs and other constituents identified in the groundwater monitoring plan as approved or modified by EPA.

Section II.B.5.a of the Revised Permit provides further that:

- GE must identify any current non-community and private water supply wells within 500 feet of the UDF consolidation area. If any such wells are identified, GE must pay the installation costs for those users to be connected to a public water supply (unless they do not consent); and if such a well owner consents at a later date or any new water users are identified within 500 feet of the UDF consolidation area, GE must pay the installation cost of a connection to a public water supply.
- GE will utilize the UDF for disposal only of sediments and soils that were generated as part of the ROR Remedial Action, and only of those sediments and soils that meet certain acceptance criteria specified in Attachment E to the Revised Permit.

- GE will be responsible for the proper functioning of the UDF during operations, for closure of the UDF (including installation of the low-permeability cap with a vegetative cover) when the UDF is full or the ROR excavation and dredging activities have been completed, and for proper operation, maintenance, and monitoring of the closed UDF thereafter.
- No material from the ROR Remedial Action may be disposed of at any other location in Berkshire County, and no material from any portion of the GE-Pittsfield/Housatonic River Site other than the ROR or from other response actions under the CD may be disposed of at the UDF.

3 Site Background and Historical Site Data Summary

This section presents background information on the UDF site, including a summary of existing site information.

3.1 Site Description

As previously noted, Figure 1 shows the extent of the GE Parcel, the anticipated limits of consolidated material for the UDF, the UDF operational area, and the UDF support area. The GE Parcel generally consists of previously disturbed and barren ground areas void of vegetation, open grassed and wooded areas, and man-made ponds which are associated with the prior quarry operations. Additionally, there is an existing Eversource Energy (Eversource) utility easement containing overhead electric lines on the western side of the GE Parcel. The bordering site features are Valley Street to the north, Woodland Road to the east, the Lee Municipal Landfill to the south, and the remaining former Lane property (now Northeast Paving, a Division of Eurovia Atlantic Coast, LLC) to the west, which is located on Golden Hill Road.

3.2 Existing Site Information

Presented in the following subsections is a summary of existing information pertaining to the GE Parcel, including the UDF area and UDF support area. This information has been used in identifying the need for additional data collection, as described in this PDI Work Plan, and in developing the preliminary conceptual UDF design described herein. That information together with the supplemental information collected during implementation of this PDI Work Plan will be used in the detailed design for the UDF and associated areas.

3.2.1 Topography

Topography of the entire former Lane property, including the GE Parcel, was surveyed by SK Design Group, Inc. and presented on a drawing dated June 4, 2010.[2] Existing topography across the GE Parcel is variable and features several localized high and low points (including pond areas) likely attributable to the site's history as a sand and gravel operation. Drainage generally pitches internally towards the localized low points. There are limited areas of the GE Parcel that drain off site to the east along Woodland Road and to the former Lane property to the west. Based on available flood insurance rate maps, the GE Parcel lays entirely outside of the mapped 500-year floodplain for the Housatonic River to the north and west (Federal Emergency Management Administration [FEMA] 1982a) and Washington Mountain Brook to the south (FEMA 1982b).

3.2.2 Habitat

Preliminary information on habitat characteristics of the GE Parcel, including natural community types, the potential presence of federally listed threatened or endangered species and state-listed rare species, potential wetlands and vernal pools, and invasive species, is available from a number of existing sources. These include on-line sources, such as the MassGIS On-line Data Viewer (OLIVER), the U.S. Fish and Wildlife Service

[2] As discussed in Section 5.2.2, the topography of the GE Parcel will be re-surveyed as part of PDI activities.

(USFWS) National Wetlands Inventory (NWI) Mapping, and the Information for Planning and Consultation (IPaC), as well as aerial photograph reviews. This existing information indicates the following:

The general habitat of the GE Parcel ranges from denuded and excavated areas lacking discernible habitat (comprising the majority of the UDF area) to open areas dominated by grass and forbs to forested areas in differing stages of succession (in the northern part of the GE Parcel).

On-line mapping tools that gauge the potential habitat of areas within Massachusetts can be found through the MassGIS OLIVER. The OLIVER interactive map, available data layers, and active data layers specific to potential and documented habitats reveal that the GE Parcel does not contain any Massachusetts Natural Heritage Endangered Species Program (MNHESP) Estimated Habitats of rare wildlife or Priority Habitats of rare species, nor does it contain any MNHESP-certified or other identified vernal pools. While several habitats were identified in the surrounding geography within five miles of the GE Parcel, the nearest Priority Habitat of rare species was located 0.15 mile to the north and the nearest MNHESP-certified vernal pool was located over one mile to the southeast.

A review of the USFWS IPaC on-line mapping tool (USFWS 2021) for the GE Parcel revealed potential habitat for northern long-eared bat (a threatened species) and monarch butterfly (a candidate for listing) in the general area. Several migratory birds were also identified within the general site area, including the bald eagle, bobolink, Canada warbler, prairie warbler, and wood thrush. Given the disturbed nature of the UDF area, the forgoing species would not be expected to inhabit that specific area.

A potential wetland area has been identified on the GE Parcel consisting of an isolated palustrine, scrub/shrub, broad-leaved deciduous, seasonally flooded area off of Woodland Road (which will not be affected by the consolidation area).[3] In addition, the parcel contains a number of man-made or modified permanently flooded areas, which are associated with the prior quarry operations.

Overall, the data gathered from reviews of readily available on-line databases, aerial photographs, and mapping indicate that the former quarry area possesses a paucity of habitat that would be considered ecologically significant to supporting plant and animal species diversity within the immediate and surrounding geography. The northern portion of the GE Parcel supports an area of natural forested cover type which will be further investigated as described in Section 5 of this PDI Work Plan.

3.2.3 Cultural Resources Assessment

Existing databases have been reviewed to determine whether any cultural resources have been previously identified within the GE Parcel.[4] Based on review of the National Register of Historic Places (NRHP), the Massachusetts State Register of Historic Places (SRHP), and the Massachusetts Cultural Resources Information System (MACRIS), no cultural resources listed in those sources are present within the GE Parcel.

[3] As discussed in Section 5.2.1, this area will be evaluated further during PDI activities to determine whether it in fact constitutes a wetland.

[4] In 2008, GE submitted to EPA a report on an *Initial Phase IA Cultural Resources Assessment (CRA) for the Housatonic Rest of River Project* (URS 2008). That Initial Phase IA CRA was conducted to assess the potential for archaeological and historical resources to exist in the portions of the Housatonic River and its floodplain that could potentially be affected by implementation of remediation activities selected by EPA – namely, Reaches 5 through 8. That Initial Phase 1 CRA did not address the Lane property that is currently the GE Parcel.

3.2.4 Utilities

There are no known underground utilities within the GE Parcel. There is an existing overhead electric utility line and associated easement that are owned and operated by Eversource on the western edge of the site. Additional underground site utility locations are unknown at this time but are not anticipated within the limits of the UDF area and UDF support area. Dig Safe was called in fall 2019 for a groundwater probe investigation conducted near the anticipated UDF location, and no utilities were identified. Another utility location survey will be conducted prior to field investigation activities to ensure that no utilities were added in the area since the earlier utility search.

3.2.5 Soils

Soils within the GE Parcel are expected to consist of some gravel and medium to fine sand. Based on publicly available web soil surveys (Natural Resources Conservation Service [NRCS] 2021), the soils originally present at the UDF site are reported to be composed of Copake fine sandy loam, Hero loam, Groton and Hinckley soils, and gravel. Despite the web soil survey indicating a larger proportion of gravel than other materials in the aforementioned composition, there is reason to believe, based on visual field operations and communication from the prior landowner (Lane), that a larger portion of finer textured material is present at the GE Parcel.

3.2.6 Groundwater Elevations

In fall 2019, a preliminary investigation was conducted at the GE Parcel to evaluate subsurface conditions. This investigation included geoprobes in the locations depicted on Figure 5 (discussed in Section 5.2.5). From this effort, groundwater was encountered between elevation 947 ft and 949 ft relative to National Geodetic Vertical Datum of 1929 (NGVD 29). The elevation of the water edge in the adjacent ponds was approximately 950 ft NGVD 29 at the time of the June 2010 aerial survey. Because of the granular nature of the site soils, the pond water surface elevations are likely coincident with groundwater. The nearest U.S. Geological Survey groundwater monitoring well location is approximately 1.2 miles to the northwest of the GE Parcel at latitude 42°21'04.76" and longitude 73°15'28.75”. Although historical data are available for this location, they are not considered representative of site conditions for the GE Parcel considering the distance from the site and significant topographic variability in this region.

A review of Massachusetts Department of Environmental Protection (MassDEP) files uncovered an Evaluation Opinion Transmittal Report (Anonymous undated), which contains a summary of groundwater elevation data collected from monitoring wells located around the nearby Schweitzer-Mauduit and Lee Municipal Landfills. The Lee Municipal Landfill is located due south of the GE Parcel on the adjacent parcel. The report indicates that groundwater elevations in two wells (MW-84-1 and MW-94-1) along the eastern edge of the Lee Municipal Landfill (also approximately in line with the eastern edge of the GE Parcel) ranged from 955.40 ft to 959.91 ft (NGVD 29), depending on the well and gauging date. The report also indicates that groundwater elevations in three wells (MW-84-2, MW-94-2, and the MW-94-7 cluster) along the western edge of that landfill (also approximately in line with the western edge of the GE Parcel) ranged from 948.85 ft to 952.59 ft, depending on well and gauging date. These data indicate an east-to-west slope in the groundwater table.

3.2.7 Groundwater Quality

There are no known data on groundwater quality within the GE Parcel. There is historical information available on bordering property; however, this information is relatively outdated.

The aforementioned Evaluation Opinion Transmittal Report includes information on groundwater quality at the Lee Municipal Landfill relative to Massachusetts groundwater standards. The report states that there is no record of oil or hazardous material being landfilled, and at the time the report was generated, the only consistent reportable concentration exceedance shown was for manganese. Because of the proximity of the Lee Municipal Landfill to the southwest of the GE Parcel, an elevated concentration of manganese in groundwater could be possible in the area between the Lee Municipal Landfill and the GE Parcel.

There are 12 U.S. Geological Survey historical groundwater wells on the southern edge of Woods Pond. There is also one groundwater well on the opposite side of Valley Street from Woods Pond and within the current mining operation property. These wells have data detailing groundwater quality; however, these data are from the early 1980s or earlier and may not be representative of current conditions.

4 Preliminary Conceptual UDF Design Summary

This section provides a summary of the conceptual UDF design developed to date.

4.1 Site Layout

As noted above, the UDF site consists of land acquired by GE from Lane that was previously part of an active sand and gravel quarry. The site will be developed to include the UDF area and UDF support area. Figure 1 depicts the boundaries of the GE Parcel, the existing features, and the conceptual design limits of the UDF area and UDF support area. It is noted that the UDF support area requirements and related facilities are not known at this time, and therefore further description of its components is not provided below. The UDF support area components and their design will be determined at a later time as part of design activities.

4.2 Anticipated UDF Design

The UDF will be an engineered disposal facility that will include features designed and operated to contain soils and sediments from the ROR Remedial Action, along with associated leachate, and to allow long-term monitoring following completion of filling and capping. The perimeter of the UDF will include a berm, likely constructed from on-site soil that is excavated from within the UDF limit of consolidated material. The perimeter berm will provide control of run-on from outside of the UDF limit of consolidated material and leachate from consolidated material placed within the UDF.

A double baseliner system will be installed within, and extending up against, the inside slope of the perimeter berm. The baseliner system will include primary and secondary low-permeability liners, each having maximum permeabilities of 1×10^{-7} cm/s and minimum thicknesses of 30 mils. A primary leachate collection system will be constructed on top of the primary liner and will drain to a sump, which will be the lowest point on the floor of the UDF. A secondary leachate collection system will be constructed between the primary and secondary liners to provide redundancy to the primary leachate collection system. The secondary leachate collection system will drain to the same sump depression as the primary system, but will be separated by the primary liner. Liquids that accumulate in the primary and secondary sumps will be removed using submersible pumps and will be stored on site in above-ground tanks prior to being taken to the GE Pittsfield Facility for treatment.

Following placement of consolidated material into the UDF, a final cover will be constructed across the limit of placement. The final cover will include a low-permeability liner with a maximum permeability of 1×10^{-7} cm/s and a minimum thickness of 30 mils, a drainage layer, and cover soils suitable for the establishment of vegetation. Stormwater runoff from the UDF will be managed by a system of diversion features, downchutes, culverts, and basins.

5 Pre-Design Investigation

Based on existing information presented in Section 3, data gaps remain in the body of knowledge needed to design, construct, and operate the UDF in accordance with the Revised Permit and current state of practice. This section describes the PDI activities that are proposed to supplement existing site information so as to support of the UDF design.

5.1 Data Collection Objectives

The data proposed for collection in this section will supplement data that have already been collected or are available and that are deemed applicable and of sufficient accuracy for use in the detailed design of the UDF. The activities discussed in this section will be implemented to address the data gaps or to confirm the current understanding of site conditions. Standard operating procedures to be used in the performance of PDI activities are summarized in Section 5.3.

5.2 Site Data Collection

The following PDI activities are proposed to address the known data gaps and are described in greater detail in the following subsections:

- Baseline habitat assessment, including a wetland survey as needed
- Topographic field survey
- Soil geotechnical investigation
- Soil environmental quality investigation
- Groundwater depth investigation
- Groundwater environmental quality investigation
- Cultural resources assessment

5.2.1 Baseline Habitat Assessment

A baseline habitat assessment will be conducted to form a detailed baseline ecological inventory and assessment of existing conditions and serve as the foundation for developing the Final Cover/Closure Plan for the UDF area and UDF support area, including potential re-use of the UDF area and restoration of the UDF support area. The baseline habitat assessment of the approximately 75-acre GE Parcel will include the following components:

- The presence, location, and species composition of terrestrial and aquatic habitats will be identified initially through on-line database reviews and aerial photograph interpretation. This process will include producing cover type mapping using the community type classification mapping that was used in the Ecological Characterization of the Housatonic River (Woodlot Alternatives 2002). This mapping currently extends from the Confluence to the south end of Woods Pond, and it will be extended from that point south through the GE Parcel. The mapping will be done with the aid of aerial photographs, and these preliminary delineations will be transferred onto the updated topographic mapping described below. Field investigations will then be conducted over the entire GE Parcel to review and verify or adjust the habitat cover type delineations.

- During the field surveys, each discrete cover type unit will be subject to a detailed inventory using the UDF/GE Parcel Habitat Inventory Form attached as Appendix A. This form will record a broad range of habitat parameters to characterize structural, physical, hydrologic, and biological conditions within each habitat cover unit. The characterization will include measurements of substrate/soil characteristics, plant species composition, a broad range of habitat features, and habitat degradation. In addition, based on the information collected, the ecological functions and values of the affected habitats will be identified and qualified.
- Aquatic resources (such as streams or potential wetlands) identified within the GE Parcel, excluding the man-made ponded areas, will be subject to field verification using current federal wetland delineation criteria. This will include completing, for those features, the U.S. Army Corps of Engineers (USACE) Wetland Determination Data Form for the Northeast Region, which is attached as Appendix B. In particular, the potential isolated scrub-shrub wetland located off Woodland Road will be evaluated using that form to determine whether it in fact constitutes a wetland.
- An evaluation will be conducted as to the presence of vernal pools at the GE Parcel through on-line aerial photography review and MNHESP database review confirmed via field verifications.
- The presence, location, and abundance of federal or state-listed threatened or endangered species or other state-listed species and their habitats will be identified through review of the USFWS on-line IPaC and review of the MNHESP records on state-listed species. In addition, GE will consult with the USFWS and MNHESP to determine whether they have any information on the existence of such species or their Priority Habitat in or near the GE Parcel. To the extent appropriate and practicable, the results of these reviews will be confirmed via field verifications. This field verification will consist of evaluating the habitat requirements of any potential state or federally listed species relative to the identified habitat characteristics on the GE Parcel.
- The presence, location, abundance, and condition of invasive species as listed by the USACE New England District or the Massachusetts Invasive Plant Advisory Group will be identified through base mapping and aerial photograph reviews in combination with field verification.

5.2.2 Topographic Field Survey

The latest topographic survey covering the GE Parcel was completed using aerial methods in 2010. Given limitations with the method used and the age of the survey, a new topographic survey will be conducted to accurately document existing conditions at the GE Parcel and support the detailed design of the UDF and UDF support area. Additionally, the GE Parcel includes several low areas that contain water (either groundwater or surface water or a combination of the two), for which no bottom data were collected in 2010. Consequently, the new survey will also include bathymetry across these water-containing depressions so that a continuous surface model can be created for the purposes of quantifying earthwork volumes that extend into the water-containing depressions.

The areas to be surveyed in the new topographic and bathymetric surveys are shown on Figure 2 and will encompass the portion of the GE Parcel to be developed for the UDF area and UDF support area, including peripheral areas planned to contain roads, drainage features, and utilities. The new topographic survey is anticipated to consist of either a traditional field survey, an aerial survey using Light Detention and Ranging

(LiDAR) technology, or a combination of these methods. In the event that traditional surveying methods are used, topographic shots will be collected at the following locations:

- Top and toe of slopes;
- Changes in slope gradient;
- Linear features such as fence lines, if any;
- Utilities;
- Edges of water;
- Edges of road;
- Tree lines;
- Other structures; and
- Intermediate ground shots.

Bathymetric shots will be collected on an approximately 50-foot grid and will be referenced to the same vertical datum as the land-based topographic survey. All surveying work will be performed by or under the supervision of a Professional Land Surveyor registered in the Commonwealth of Massachusetts.

5.2.3 Soil Geotechnical Investigation

Soil investigations are required to support the evaluations and design of the UDF. The soil investigation program for the UDF will accomplish the following objectives:

- Characterize the variability, depth, and engineering properties of site soils.
- Collect soil data through field and laboratory testing to support and identify geotechnical design considerations, such as settlement and stability, which will be addressed in the engineering design of the UDF.
- Characterize site soils for use in construction of the UDF and operational area facilities and identification of the intended use of soils excavated for construction of the UDF and operational area facilities.

The following sections provide further details regarding the proposed boring locations and depths, soil sampling, and field and laboratory testing. This investigation program has been developed assuming that site soils are granular and are composed of sands and silty sands, which is consistent with the findings of the 2019 geoprobe investigation at the site and available subsurface information from the nearby Lee Municipal Landfill. As indicated above, requirements and facilities pertaining to the UDF support area are not known at this time, Accordingly, soil investigations for the UDF support area are not included as part of this PDI Work Plan. If deemed necessary based on design requirements for the UDF support area components, soil investigations will be proposed and conducted within the UDF support area at a later time, as outlined in the Conceptual Design Plan for the UDF.

5.2.3.1 Soil Boring Program

The proposed locations of the geotechnical borings are shown on Figure 3 and summarized in Table 1. A total of 18 borings are planned, and the borings are positioned within and outside of the anticipated UDF limits. Table 1 identifies the anticipated usage of the proposed borings. As indicated in that table, all 18 borings will be utilized for geotechnical testing purposes. Additionally, 11 of the 18 borings will also be utilized for soil quality testing purposes. Eight of the 18 borings will be utilized for the installation of temporary piezometers within and outside of the UDF footprint, as discussed in Section 5.2.5.1. Six of the 18 borings will be utilized for the installation of monitoring wells outside of the UDF footprint, as discussed in Section 5.2.5.2. The locations are based on the anticipated limits of the UDF, likely groundwater flow direction, and spatial distribution of data points across the site.

For geotechnical purposes, the borings will be advanced to a target elevation of 935 ft or lower. Where the borings will also serve as monitoring wells and temporary piezometers, the depth to groundwater also requires a minimum target depth. The deeper of the two criteria will be used when determining the minimum boring depth. Table 1 identifies the minimum depth below ground surface (bgs) for each proposed boring.

Data collected from the proposed borings will support the settlement evaluation of the UDF, the review of the liquefaction potential of the UDF foundation soils, the completion of a liquefaction analysis if required, and the stability evaluations for the final UDF buildout and any other critical interim construction phases.

Ten geotechnical borings are planned along the perimeter of the UDF. These borings will support stability evaluations of temporary excavation conditions during construction of the UDF and of the proposed UDF grading design. The perimeter borings will be spaced approximately 500 ft apart and will be located based on groundwater quality monitoring and depth-to-groundwater data needs.

It is assumed that the geotechnical borings will be completed using a drill rig mounted on an all-terrain vehicle and equipped with a 4.25-inch inner diameter hollow-stem auger. Continuous soil sampling will be performed through the first 30 ft of each boring followed by a five-foot sample interval to the boring depth. All sampling will be completed using a two-inch-diameter split-spoon sampler, with standard penetration tests (SPTs) following ASTM International (ASTM) D1586, which will be conducted for each sample collected. Soil recovered from each sample interval will be visually characterized for color, texture, and moisture content and field screened with a photoionization detector. The presence of visible staining, sheen, product, and obvious odors encountered in the soil, if any, will be noted.

Between six and eight split spoon samples from each boring will be submitted for laboratory analysis of grain size, moisture content, Atterberg limits, and specific gravity. The SPT data, field descriptions, and laboratory data will be used in the geotechnical evaluations for design of the UDF.

Arcadis U.S. Inc. (Arcadis) will supervise drilling and direct the drillers to perform SPT sampling, record blow counts on the split-spoon sampler, log the borehole, record groundwater elevations, and document details related to the advancement and sampling of each boring.

Soil cuttings will be staged on site in an appropriate waste container (e.g., roll-off, drum, lined area). Soil cuttings will be field screened for the presence of volatile organic vapors using a photoionization detector. Soil cuttings (and other investigation-derived waste) will be managed and disposed of in an appropriate manner (either on site or off site) based on the field screening results and in accordance with applicable rules and regulations.

5.2.3.2 Soil Testing for Engineering Properties

The following types of soil testing will be performed through both field and laboratory means to determine the engineering properties of the site soils.

- Standard Penetration Testing: As discussed above, SPT sampling will be conducted during the advancement of each geotechnical boring. SPT sampling will be performed using a standard two-inch-outside-diameter split-spoon sampler, 24 inches long, and driven by a 140-pound automatic hammer with a 30-inch drop per ASTM D1586. The SPT blow count (or "N-value" term) for each sample will be recorded and will represent the number of blows required for one-foot penetration into the soil after the initial six-inch seating drive depth. The N-values will be used during the design of the UDF to estimate the engineering properties of the site soils.
- Soil Classification: Each sample collected from the geotechnical borings will be classified in the field through visual-manual procedures that conform to ASTM D2488 and the Arcadis Field Guide for USCS Soil Classification (Appendix C). In addition, selected samples from each boring will be submitted for laboratory classification using the Unified Soil Classification System, which is based on the soil index property tests described below and for quality control of the field classifications. The samples chosen for laboratory testing will generally focus on depths and locations within each soil layer to confirm the observed stratigraphy noted in the boring logs, within zones of loose or soft soils, and at depths below the groundwater table. Soil descriptions in the boring logs will be updated where needed to conform to the laboratory-determined soil classifications.
- Soil Index Properties: Soil index properties will be developed from the testing of grain size (ASTM D6913), moisture content (ASTM D2216), Atterberg limits (ASTM D4318), and specific gravity (ASTM D854). Sufficient soil from the split spoons (or from a combination of split spoons) will be provided to the selected geotechnical laboratory for completing the index property testing in accordance with the corresponding ASTM standard. The results will be used for quality control of the field soil classifications, determination of site stratigraphy, and development of engineering parameters, such as shear strength and soil elastic modulus, to support the stability and settlement evaluations. These data will also be beneficial for determining re-use criteria of excavated materials during construction of the UDF and for estimation of the permeability of the site soils.

5.2.4 Soil Quality Testing

Soil testing for environmental quality will be performed at each soil boring associated with a permanent monitoring well (six total) plus one soil boring associated with a temporary piezometer internal to the UDF footprint. The proposed soil borings are described in Section 5.2.3.1. Figure 4 identifies the 11 specific soil borings proposed for environmental testing. The choice of borings for environmental testing was based on the use of the monitoring wells to document long-term environmental quality before, during, and after construction of the UDF. Sampling of soil from two temporary piezometers within the UDF footprint is proposed to further document environmental quality. The environmental testing of the soils from the borings will be used to determine the presence (if any) and concentration of chemical constituents in the existing soil to establish baseline chemical conditions for comparative evaluations during UDF operations and post-closure monitoring.

At each boring location, samples will be collected at the following approximate depth intervals:

- Ground surface to a depth of 1 ft bgs, with this first depth interval obtained by manually digging at the boring location prior to commencing boring operations with the drill rig;
- 13 to 15 ft bgs;
- 28 to 30 ft bgs;

- 43 to 45 ft bgs;
- 58 to 60 ft bgs; and
- At groundwater table interface.

The actual sample depth interval and the need for additional testing at each location will be determined based on photoionization detector readings and visual observations at the time of the in-field soil investigation.

All samples will be submitted for analysis of PCBs and the full list of analytes presented in Table 2 of GE's 2013 Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP; Arcadis 2013). Although the full analyte list is recommended for establishing baseline chemical conditions, the analyte list to be used during UDF operations or long-term monitoring may be modified based on initial sampling results or the nature of the materials being disposed of.

5.2.5 Piezometer and Groundwater Well Installation

A system of temporary piezometers and permanent monitoring wells will be installed in the soil borings to be advanced on the GE Parcel. The proposed soil borings are described in Section 5.3.3.1, and the specific borings to be used for piezometers (identified with a prefix of "PZ") and monitoring wells (identified with a prefix of "MW") are presented on Figure 5. Collectively, both types of features will provide groundwater data that will be used in the design of the UDF. The permanent monitoring wells may also be used for long-term monitoring of site groundwater during construction, operation, and post-closure of the UDF. As indicated above, requirements and facilities pertaining to the UDF support area are not known at this time, Accordingly, groundwater investigations for the UDF support area are not included as part of the PDI Work Plan. If deemed necessary based on design requirements for the UDF support area components, groundwater investigations will be proposed and conducted within the UDF support area at a later time, as outlined in the Conceptual Design Plan for the UDF.

5.2.5.1 Temporary Piezometer Well Installation

Eight temporary piezometers will be located within the limits of consolidated material and around the perimeter of the UDF for the purpose of gauging groundwater elevations over a limited period of time prior to the commencement of UDF construction. The temporary piezometers will supplement the permanent monitoring wells (described below) to provide a more complete and spatially disperse understanding of groundwater elevations that will be used in the design of the UDF. The proposed piezometer locations are depicted on Figure 5 and preliminary construction details are presented in Table 2. It should be noted that the preliminary information in that table is subject to change based on field conditions as observed and documented by the hydrogeologist overseeing the soil borings and piezometer/monitoring well installation. Because of their anticipated use for groundwater elevation gauging only, the piezometers will consist of one-inch-diameter casing, rather than the two-inch-diameter casing used for monitoring well construction. Following installation, the location, ground surface elevation, and top of casing elevation will be surveyed by a Professional Land Surveyor registered in the Commonwealth of Massachusetts.

5.2.5.2 Permanent Monitoring Well Installation at UDF Perimeter

Six permanent monitoring wells will be installed in selected soil borings at the perimeter of the GE Parcel, as shown on Figure 5. Preliminary construction details are presented in Table 3. It should be noted that the preliminary information in that table is subject to change based on field conditions as observed and documented by the hydrogeologist overseeing the soil borings and piezometer/monitoring well installation. As discussed in Section 3.5, historical gauging of monitoring wells associated with the Lee Municipal Landfill to the south of the UDF indicates a generally east-to-west groundwater flow gradient. The monitoring wells are therefore positioned such that three wells (MW 2022-3, MW 2022-4, and MW 2022-5) are located along the western edge and downgradient of the UDF, one well (MW 2022-1) is located to the east and upgradient of the UDF, and two wells (MW 2022-2 and MW 2022-6) are located to the northwest and southwest and sidegradient of the UDF. The latter two wells also provide some contingency in the event groundwater flow direction has a northerly or southerly component. Finally, MW 2022-6 is positioned between the Lee Municipal Landfill and the UDF and can serve to indicate changes in groundwater quality at that location relative to the upgradient MW 2022-1 well.

The borehole depths for five of the monitoring wells are based on intercepting the estimated groundwater table at an elevation of approximately 950 ft. However, the borehole for MW 2022-4 will be advanced to a depth that is below the estimated bed elevation of the Housatonic River. Based on available on-line data, the river water surface elevation is approximately 935 ft. Because the depth of the River is unknown and possibly variable, the bottom of the borehole will be advanced to an elevation of 910 ft or lower to be conservative.

Following installation, the location, ground surface elevation, and top of casing elevation will be surveyed by a Professional Land Surveyor registered in the Commonwealth of Massachusetts.

5.2.6 Groundwater Depth Monitoring

Once installed, both the temporary piezometers and monitoring wells will be gauged on a quarterly basis for a minimum of one year (a total of four events minimum) to provide a seasonal range of groundwater elevations. Prior to UDF construction, the temporary piezometers will be abandoned in place. However, the monitoring wells will remain in service for continued gauging and sampling, as discussed in Section 5.2.7.

5.2.7 Groundwater Testing for Environmental Quality

Groundwater testing for environmental quality will be performed at the six permanent groundwater monitoring wells described in Section 5.2.5.2 to determine existing (baseline) groundwater chemical quality conditions for comparative evaluations during UDF operations and post-closure monitoring. Figure 6 identifies the location of the monitoring wells to be used for chemical quality testing. It should be noted that, because of their temporary nature and smaller casing diameter, none of the piezometers will be used for chemical quality testing.

Samples will be collected semi-annually for a period of two years. Samples will be submitted for analysis of the full list of analytes presented in Table 2 of the 2013 FSP/QAPP. Although the full analyte list is recommended for establishing baseline chemical conditions, the analyte list to be used during UDF operations or long-term monitoring may be modified based on initial sampling results or the nature of the materials being disposed of. Each monitoring well will also be gauged immediately prior to sampling for each event.

5.2.8 Phase 1A Cultural Resources Assessment

As noted in Sections 4.2.1.7 and 4.2.2 of the Final Revised SOW, an initial Phase IA CRA of the UDF are and UDF support area will be conducted separately from the CRA for the remediation areas and their associated support areas. The initial Phase 1A CRA for the UDF area and UDF support area will include the following activities:

- An archaeological Area of Potential Effects (APE) and an historic architectural APE will be defined based on the location and extent of the UDF area and UDF support area.
- Desktop and on-line evaluations will be conducted of the Massachusetts Historical Commission's (MHC's) report files and databases, including the MACRIS, Massachusetts State Historic Preservation Plan, and MHC State Reconnaissance Survey Reports, to determine whether the UDF area or UDF support area contains or could affect cultural resources included in those databases.
- Desktop and on-line evaluations will also be conducted of the local Historic District Commission literature and databases for the same purpose.
- GE will consult with the MHC and Native American Tribal Preservation Officers regarding the locations of cultural resources and traditional cultural properties in the vicinity of the GE Parcel.
- An evaluation will be conducted of the GE Parcel, including the UDF area and UDF support area, for the potential to contain unidentified potentially significant cultural resources (i.e., whether they have no, low, or high potential to contain such resources).[5] This evaluation will be conducted using the approach previously developed for the 2008 Initial Phase IA CRA (URS 2008), mentioned above, which incorporated data layers for soil types, slope, land use, and the location of known archaeological sites within a GIS database. As described in that 2008 report, this approach uses the following key variables to identify the potential for an area to contain pre-contact archaeological resources:
  - **High Potential**
    - water source within 150 meters (m)
    - well drained sandy soils
    - level to fairly level topography (0 – 3%)
    - none to minimal disturbance
    - known sites in the immediate area
  - **Moderate Potential**
    - water source within 150 to 300 m
    - well drained to fairly well drained, sandy to cobbly soils
    - moderate slopes (3 – 8%)
    - minimal to moderate disturbance
    - known sites in the vicinity
  - **Low Potential**
    - water source greater than 300 m
    - poorly drained soils

[5] For purposes of these CRA evaluations, potentially significant cultural resources mean archaeological and/or historical architectural resources that are listed or could potentially meet the criteria for listing on the NRHP, resources that are listed on the Massachusetts SRHP and included on the State Inventory of Historic and Archaeological Assets, and potentially significant scientific, prehistorical, historical, or archaeological data subject to the Archaeological and Historic Preservation Act. Such resources will include properties of traditional religious and cultural importance that fall into any of the foregoing categories.

- steep slopes (> 8%)
- moderate to extensive disturbance
- no known sites in the vicinity

In addition, for historic-period archaeological sites, areas within 100 m of major historic transportation networks will be added to the high potential zone.

- Evaluation of known or suspected historic structures within the historic architectural APE will be accomplished by starting with existing historic structure inventories compiled by the MHC and local historic organizations. The locations of these structures will be plotted in the project GIS system for systematic comparison with the location of the GE Parcel. Following compilation of the existing inventory data, a reconnaissance-level windshield survey will be conducted by a qualified architectural historian to field verify the current status of each previously recorded resource, and to identify other potential historic structures within the APE.
- To the extent that the foregoing activities identify any known and potentially significant cultural resources within the archaeological APE or any known or suspected historic structures within the historic architectural APE, or indicate that the UDF area or UDF support area has a high potential to contain potentially significant cultural resources (particularly in areas not disturbed by prior operations), GE will develop and submit to EPA a supplemental plan to further evaluate whether such resources are present, including through survey activities as necessary.

5.3 Sampling and Analysis Procedures

The procedures to be followed in conducting the sampling and analysis and related activities described in Section 5.2 will consist of those provided in the 2013 FSP/QAPP, as applicable. Applicable standard operating procedures for field-based activities are found in Volume II of that FSP/QAPP and are listed below:

- Appendix A Soil Sampling Procedures for Analysis of Volatile Organic Chemicals (VOCs)
- Appendix C Soil Boring Installation and Soil Sampling Procedures
- Appendix D Groundwater Purging and Sampling Procedures for Monitoring Wells
- Appendix L Handling, Packing, and Shipping Procedures
- Appendix M Standard Operating Procedures for Shipment of Department of Transportation Hazardous Materials
- Appendix N Photoionization Detector Field Screening Procedures
- Appendix Q Water Level/Oil Thickness Measurement Procedures
- Appendix S Monitoring Well Installation and Development Procedures
- Appendix W Equipment Cleaning Procedures
- Appendix Y Selection of Drilling Method
- Appendix Z Monitoring Well Inventory Procedures
- Appendix GG Monitoring Well Decommissioning Procedures

In the event that the new FSP/QAPP for the ROR is has been submitted to and approved by EPA prior to initiation or during implementation of the PDI field activities for the UDF area and UDF support area, then the remaining PDI activities will be performed in accordance with that ROR FSP/QAPP.

5.4 Health and Safety

The PDI field activities for the UDF area and UDF support area will be performed in accordance with the Health and Safety Plan (HASP) for the ROR (GE 2017). If an updated HASP for the ROR has been submitted to EPA prior to initiation or during implementation of the PDI field activities for the UDF area and UDF support area, the remaining PDI activities will be performed in accordance with that updated HASP.

6 Data Evaluation and PDI Reporting

This section describes the evaluation and reporting of data to be collected as part of the PDI.

6.1 Data Evaluation

Following completion of the PDI field work, laboratory analyses, and receipt of data, an evaluation will be performed of the new data along with existing data. The evaluations to be performed are dependent upon the nature of the data collected. The results of the baseline habitat assessment will be used to determine and quantify ecological conditions and functions within the UDF area and UDF support area, as well as to identify appropriate avoidance and minimization efforts that could be implemented to preserve significant or critical habitat (if any).

The topographic field survey will be combined with bathymetric survey of the water-filled depressions to yield a continuous top-of-existing-ground-surface model. The ground-surface model resulting from the PDI survey will exist digitally and will be used with earthwork modeling software for the design of the UDF area and UDF support area. It will also be used to depict existing conditions on the GE Parcel in UDF design drawings and other report figures.

The geotechnical soil investigation data will be used to derive engineering properties for site soils. These properties will be used in the UDF design to evaluate slope stability, settlement, and other geotechnical performance aspects. The soil classifications will also be used in the design of stormwater infiltration basin(s), although additional field testing may be necessary once the footprint and depth of the basin(s) are established as part of the detailed design phase. Chemical quality data for site soils and groundwater will be used to document the condition of site media prior to construction and operation of the UDF.

Groundwater elevation data will be evaluated following collection of a minimum of four quarterly rounds of monitoring well and piezometer gauging. The seasonally high groundwater elevation will be developed using the groundwater elevation in each well, modified, as appropriate, by a technical method that has been reviewed and approved by EPA using variations reported over time at other existing monitoring wells in Massachusetts. The conservative estimate of the seasonally high groundwater elevation will be used to establish the bottom elevation of the UDF (a minimum of 15 feet above the seasonally high groundwater elevation) and to evaluate slope stability. Each set of quarterly groundwater gauging data, as well as the groundwater elevation data, will also be plotted to create a series of groundwater contour maps to confirm the anticipated east-to-west groundwater gradient.

The results of the initial Phase 1A CRA will be used to assess the next steps in the process. The results of the initial Phase 1A will either result in a determination that the UDF area and UDF support area will not affect any potentially significant cultural resources (thereby satisfying the applicable or relevant and appropriate requirements relating to cultural resources), or else will be used to identify additional information needs that require further investigations, including potentially a Phase 1B archaeological or architectural field survey.

6.2 Reporting

As discussed in the Final Revised SOW, a UDF PDI Summary Report will be prepared following completion of the PDI. That Summary Report will:

- Summarize the activities and investigations conducted previously as well as those performed as part of the PDI;
- Summarize the data obtained from the PDI;
- Summarize the results of the baseline habitat assessment of the UDF area and UDF support area, including an identification of the affected habitats and their functions;
- Summarize the results of the initial Phase 1A CRA of the UDF area and UDF support area, including an identification of the presence or likely presence of any potentially significant cultural resources in those areas and the need for further investigations to evaluate such resources;
- Include the other data evaluations described in Section 6.1;
- Present pertinent documentation prepared during the PDI, such as boring logs, photographs, water level measurements; and
- Present a schedule for submitting a Conceptual Design Plan for the UDF.

7 Schedule

The PDI data collection will be initiated following EPA's approval of this PDI Work Plan. It is noted, however, that the majority of the field work is weather-dependent and thus cannot commence until the onset of warmer weather and melting of snow and ice that may otherwise prevent site entry, obscure the ground surface, and prevent direct observation of growing season conditions.

The PDI data collection (except for the two-year groundwater quality sampling program) is anticipated to take approximately 15 months from approval of this PDI Work Plan, including the water elevation gauging of the eight temporary piezometers and the six monitoring wells for four quarters. Within 60 days after the last of these gauging events, GE will submit the UDF PDI Summary Report described in Section 6.2.

At that time, however, the second year of the two-year semi-annual groundwater quality monitoring program will not have been completed. Accordingly, those final two events will subsequently be completed; and GE will, within 60 days after receipt of the results from the last such event, submit an addendum to the UDF PDI Summary Report to document the results from the second year of groundwater testing.

8 References

Anchor QEA, LLC, AECOM, and Arcadis. 2021. Final Revised Rest of River Statement of Work. Prepared for General Electric Company, Pittsfield, Massachusetts. September. Available online at https://semspub.epa.gov/work/01/659938.pdf

Anonymous. Undated. LSP Evaluation Opinion Lee Landfill. Obtained May 2008 from MassDEP file review.

Arcadis. 2013. Field Sampling Plan/Quality Assurance Project Plan, Revision 5, Volumes I, II, and III. Prepared for General Electric Company, Pittsfield, Massachusetts. July 2. Available online at: https://semspub.epa.gov/work/01/540450.pdf, https://semspub.epa.gov/work/01/540451.pdf, and https://semspub.epa.gov/work/01/540452.pdf.

EPA. 2020. Revised Final Permit Modification to the 2016 Reissued RCRA Permit and Selection of CERCLA Remedial Action and Operation & Maintenance for Rest of River. December 16. Available online at: https://semspub.epa.gov/work/01/650440.pdf.

FEMA. 1982a. Flood Insurance Rate Map, Town of Lee, Massachusetts, Berkshire County Community Panel Number 250028 0003 B. June 1.

FEMA. 1982b. Flood Insurance Rate Map, Town of Lee, Massachusetts, Berkshire County Community Panel Number 250028 0007 B. June 1.

GE. 2017. Health and Safety Plan, GE-Pittsfield/Housatonic River Site – Rest of River. September 8. for General Electric Company, Pittsfield, Massachusetts. Available online at: https://semspub.epa.gov/work/01/622332.pdf.

Natural Resources Conservation Service. 2021. *Web Soil Survey*. Retrieved October 2021 from https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

URS. 2008. Initial Phase IA Cultural Resources Assessment for the Housatonic River – Rest of River Project. Prepared for General Electric Company, Pittsfield, Massachusetts. March 20; Public Release Version submitted on April 3, 2008.

U.S. Fish and Wildlife Service. 2021. *Information for Planning and Consultation*. Retrieved October 2021 from https://ecos.fws.gov/ipac/.

Woodlot Alternatives, Inc. 2002. *Ecological Characterization of the Housatonic River.* Prepared for EPA Region 1, September.

Tables

Table 1
Proposed Soil Boring Details
Pre-Design Investigation Work Plan
Upland Disposal Facility
General Electric Company - Pittsfield, Massachusetts

ARCADIS

Boring ID	Anticipated Use				Coordinates (NAD 83 State Plane, US ft)		Ex. Ground El. (ft, NGVD 29)	Min. Btm. Boring Depth (ft Below Ground Surface)
	Soil Geotechnical Data	Soil Environmental Data	Monitoring Well	Temporary Piezometer	Northing	Easting		
MW 2022-1	X	X	X		2,954,259.2	187,006.6	1,037.1	93.1
MW 2022-2	X	X	X		2,955,026.6	186,248.6	989.9	45.9
MW 2022-3	X	X	X		2,954,723.7	185,960.9	955.0	11.0
MW 2022-4	X	X	X		2,954,209.5	186,347.0	1,028.4	84.4
MW 2022-5	X	X	X		2,953,739.3	186,064.6	1,005.0	61.0
MW 2022-6	X	X	X		2,953,267.3	186,393.2	1,029.8	85.8
PZ 2022-1	X	X		X	2,954,941.5	186,656.6	995.0	51.0
PZ 2022-2	X	X		X	2,954,588.0	186,497.2	998.7	54.7
PZ 2022-3	X	X		X	2,954,622.3	186,844.2	1,035.2	91.2
PZ 2022-4	X	X		X	2,954,209.5	186,347.0	1,022.5	78.5
PZ 2022-5	X			X	2,954,154.1	186,703.0	1,035.0	91.0
PZ 2022-6	X			X	2,953,770.5	186,503.8	990.0	46.0
PZ 2022-7	X			X	2,953,872.7	186,980.9	1,033.9	89.8
PZ 2022-8	X	X		X	2,953,539.2	186,870.2	1,036.6	92.6
B 2022-1	X				2,954,035.2	186,569.6	1,029.0	94.0
B 2022-2	X				2,954,354.1	186,496.2	1,034.2	99.2
B 2022-3	X				2,954,487.0	186,219.7	997.2	62.2
B 2022-4	X				2,954,867.3	186,397.4	989.7	54.7

Notes:
1. Existing ground elevation at each boring location is based on June 2010 survey by SK Design Group, Inc..
2. Following installation, each boring location will be field surveyed to document installed coordinates, ground elevation adjacent to the well casing, and elevation of top of well casing.
3. In general, minimum bottom of boring is based on advancing to at least 1 foot below the bottom of the anticipated screen inverval for borings to be used for temporary piezometers or monitoring wells. Minimum bottom of boring for MW 2022-4 is based on reaching a target elevation of 910 ft or lower, which is anticipated to be below the bed of the downgradient Housatonic River. Minimum bottom of boring for soil geotechnical data purposes only is based on advancing to el. 935 ft or lower.

Table 2
Proposed Temporary Piezometer Construction Details
Pre-Design Investigation Work Plan
Upland Disposal Facility
General Electric Company - Pittsfield, Massachusetts

Piezometer ID	Coordinates (NAD 83 State Plane, US ft)		Elevations (ft, NGVD 29)			Depths (ft Below Ground Surface)	
	Northing	Easting	Ex. Ground	Estimated GW El.	Well Screen Interval	Depth to GW	Min. Btm. Boring
PZ 2022-1	2,954,941.5	186,656.6	995.0	950	945 - 955	45.0	51.0
PZ 2022-2	2,954,588.0	186,497.2	998.7	950	945 - 955	48.7	54.7
PZ 2022-3	2,954,622.3	186,844.2	1,035.2	950	945 - 955	85.2	91.2
PZ 2022-4	2,954,209.5	186,347.0	1,022.5	950	945 - 955	72.5	78.5
PZ 2022-5	2,954,154.1	186,703.0	1,035.0	950	945 - 955	85.0	91.0
PZ 2022-6	2,953,770.5	186,503.8	990.0	950	945 - 955	40.0	46.0
PZ 2022-7	2,953,872.7	186,980.9	1,033.9	950	945 - 955	83.8	89.8
PZ 2022-8	2,953,539.2	186,870.2	1,036.6	950	945 - 955	86.6	92.6

Notes:

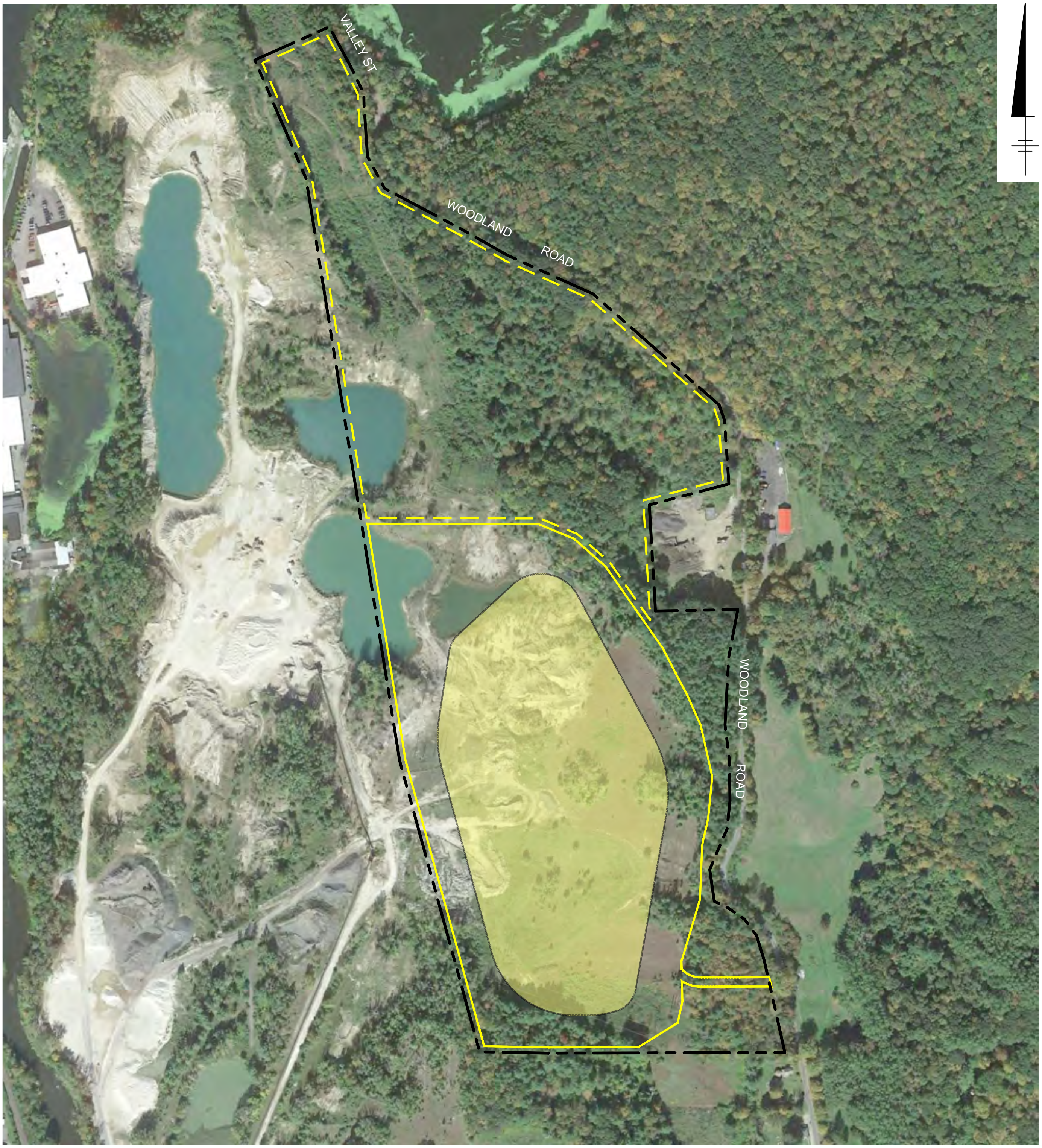
1. Existing ground elevation at each piezometer is based on June 2010 survey by SK Design Group, Inc..
2. Following installation, each piezometer will be field surveyed to document installed coordinates, ground elevation adjacent to the piezometer casing, and elevation of top of piezometer casing.
3. Groundwater elevation listed is estimated based on available information. Indicated screen interval is intended to bracket the groundwater elevation and may be modified based on groundwater elevation at time of piezometer installlation.
4. Minimum bottom of boring is based on advancing to at least 1 foot below the bottom of the indicated screen inverval.

Table 3
Proposed Monitoring Well Construction Details
Pre-Design Investigation Work Plan
Upland Disposal Facility
General Electric Company - Pittsfield, Massachusetts

Monitoring Well ID	Anticipated Use in Monitoring Program	Coordinates (NAD 83 State Plane, US ft)		Elevations (ft, NGVD 29)			Depths (ft Below Ground Surface)	
		Northing	Easting	Ex. Ground	Estimated GW El.	Well Screen Interval	Depth to GW	Min. Btm. Boring
MW 2022-1	Upgradient (Background)	2,954,259.2	187,006.6	1,037.1	950	945 - 955	87.1	93.1
MW 2022-2	Sidegradient	2,955,026.6	186,248.6	989.9	950	945 - 955	39.9	45.9
MW 2022-3	Downgradient	2,954,723.7	185,960.9	955.0	950	945 - 955	5.0	11.0
MW 2022-4	Downgradient	2,954,335.2	185,913.9	1,028.4	950	945 - 955	78.4	84.4
MW 2022-5	Downgradient	2,953,739.3	186,064.6	1,005.0	950	945 - 955	55.0	61.0
MW 2022-6	Sidegradient	2,953,267.3	186,393.2	1,029.8	950	945 - 955	79.8	85.8

Notes:
1. Existing ground elevation at each well is based on June 2010 survey by SK Design Group, Inc..
2. Following installation, each well will be field surveyed to document installed coordinates, ground elevation adjacent to the well casing, and elevation of top of well casing.
3. Groundwater elevation listed is estimated based on available information. Indicated screen interval is intended to bracket the groundwater elevation and may be modified based on groundwater elevation at time of well instatllation.
4. Minimum bottom of boring is based on advancing to at least 1 foot below the bottom of the indicated screen inverval.

Figures



LEGEND:

- GE PARCEL BOUNDARY
- UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL
- UPLAND DISPOSAL FACILITY OPERATIONAL AREA
- POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA

0 500' 1000'

GRAPHIC SCALE

NOTES:

1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

SITE PLAN

ARCADIS

FIGURE
1

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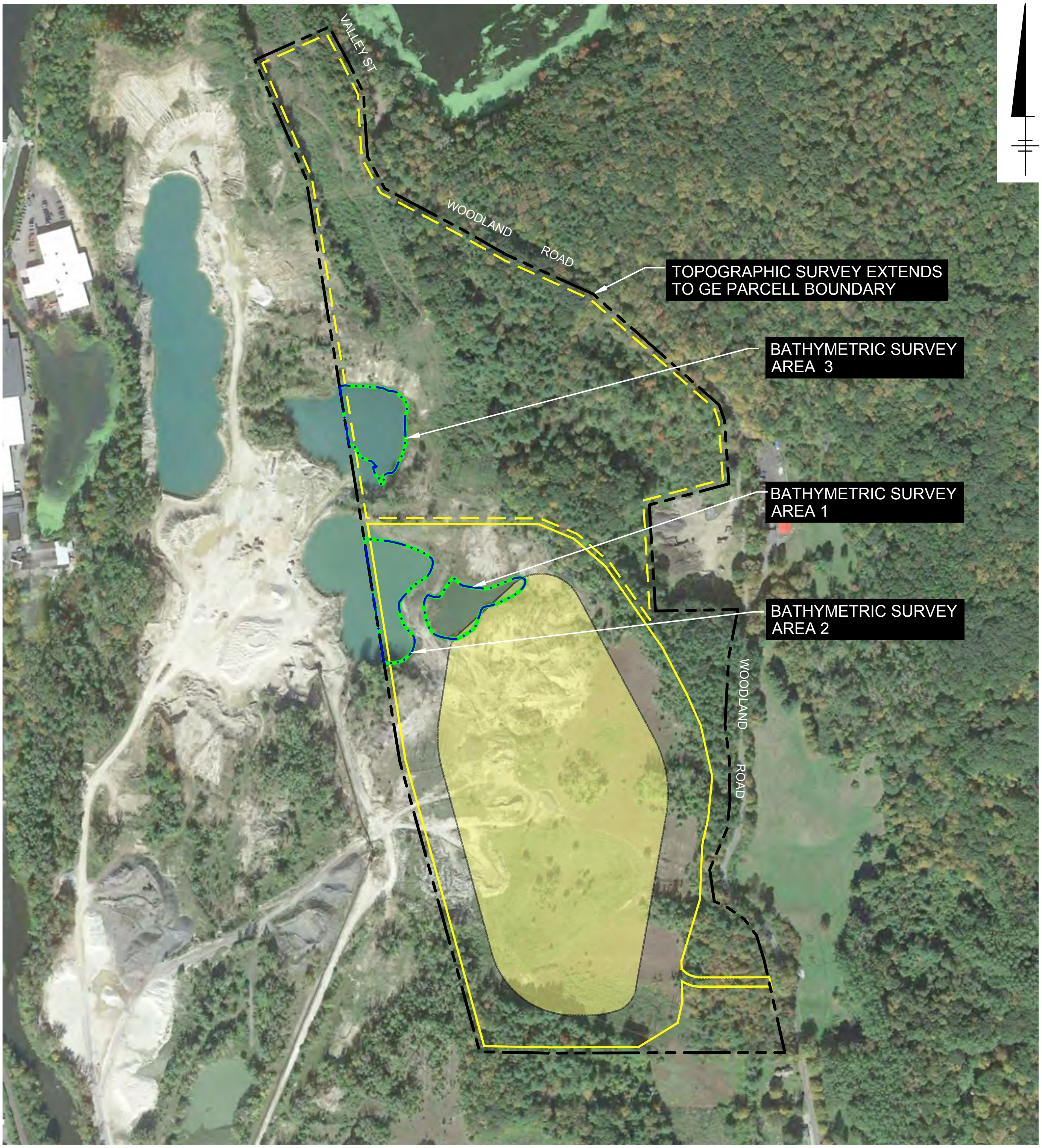

LEGEND:

- GE PARCEL BOUNDARY
- UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL
- UPLAND DISPOSAL FACILITY OPERATIONAL AREA
- POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA

NOTES:

1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. EXTENTS OF BATHYMETRIC SURVEY AREAS ARE APPROXIMATE AND ARE DEPENDENT ON WATER LEVEL AT TIME OF SURVEY.
4. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

PROPOSED FIELD SURVEY ACTIVITIES

ARCADIS

FIGURE
2

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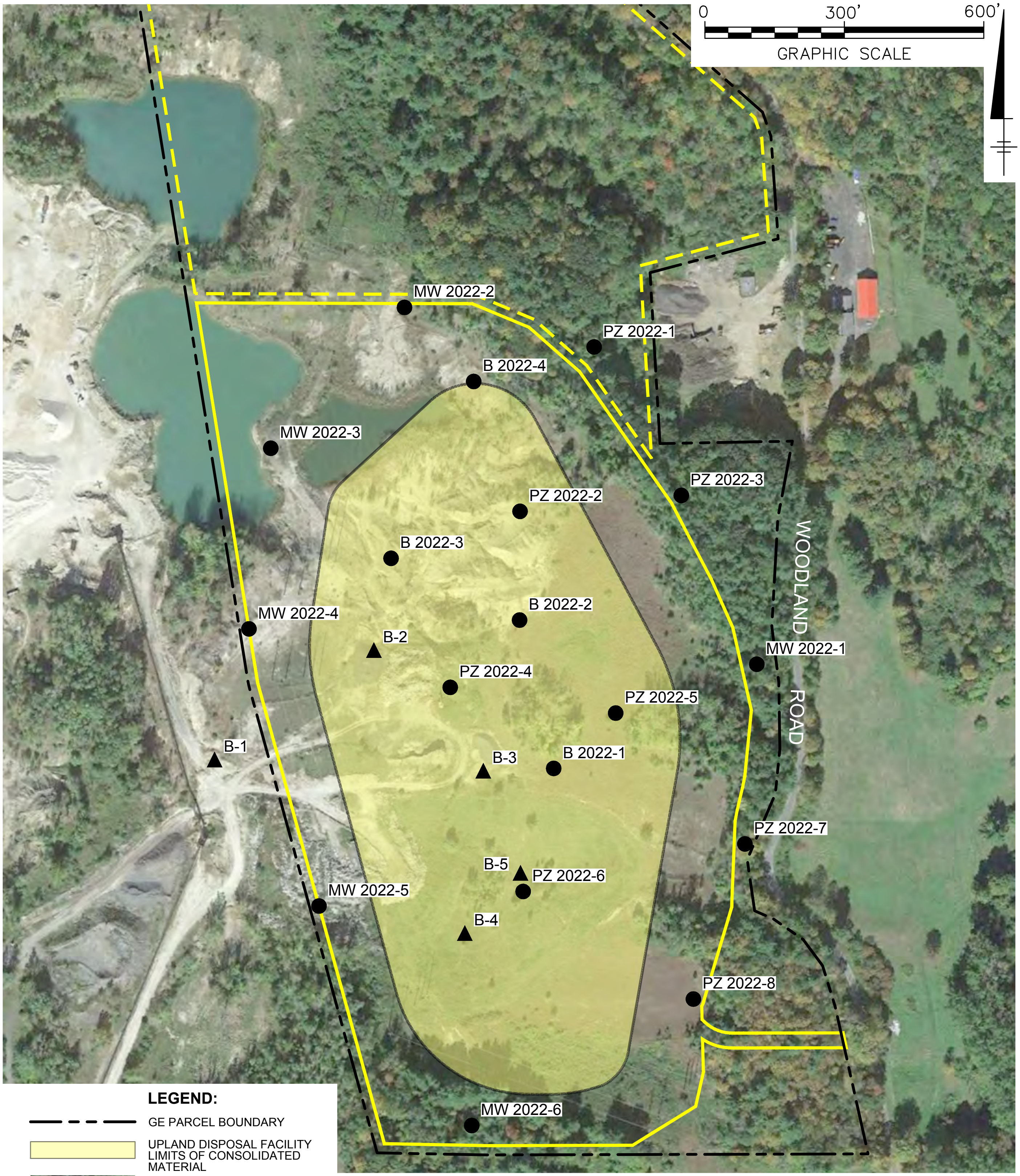

LEGEND:

- GE PARCEL BOUNDARY
- UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL
- UPLAND DISPOSAL FACILITY OPERATIONAL AREA
- POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA
- ▲ HISTORICAL GEOPROBE LOCATIONS
- ● PROPOSED SOIL BORINGS WITH GEOTECHNICAL SAMPLING

NOTES:

1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

PROPOSED SOIL GEOTECHNICAL INVESTIGATION

ARCADIS

FIGURE
3

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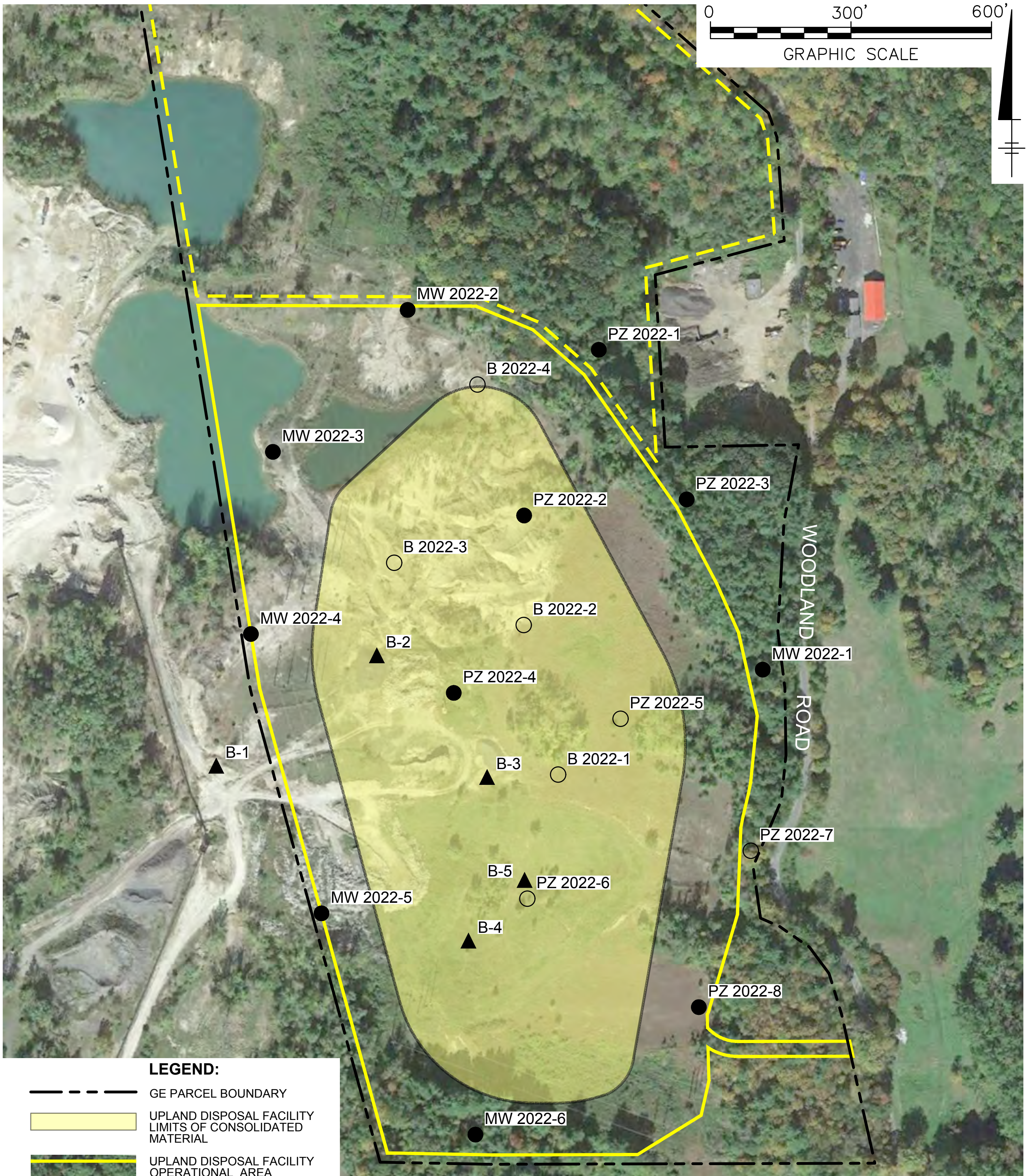


LEGEND:

GE PARCEL BOUNDARY

UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL

UPLAND DISPOSAL FACILITY OPERATIONAL AREA

POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA

▲ HISTORICAL GEOPROBE LOCATIONS

● PROPOSED SOIL BORINGS WITH SOIL QUALITY SAMPLING

○ PROPOSED SOIL BORINGS (NO SOIL QUALITY SAMPLING)

NOTES:

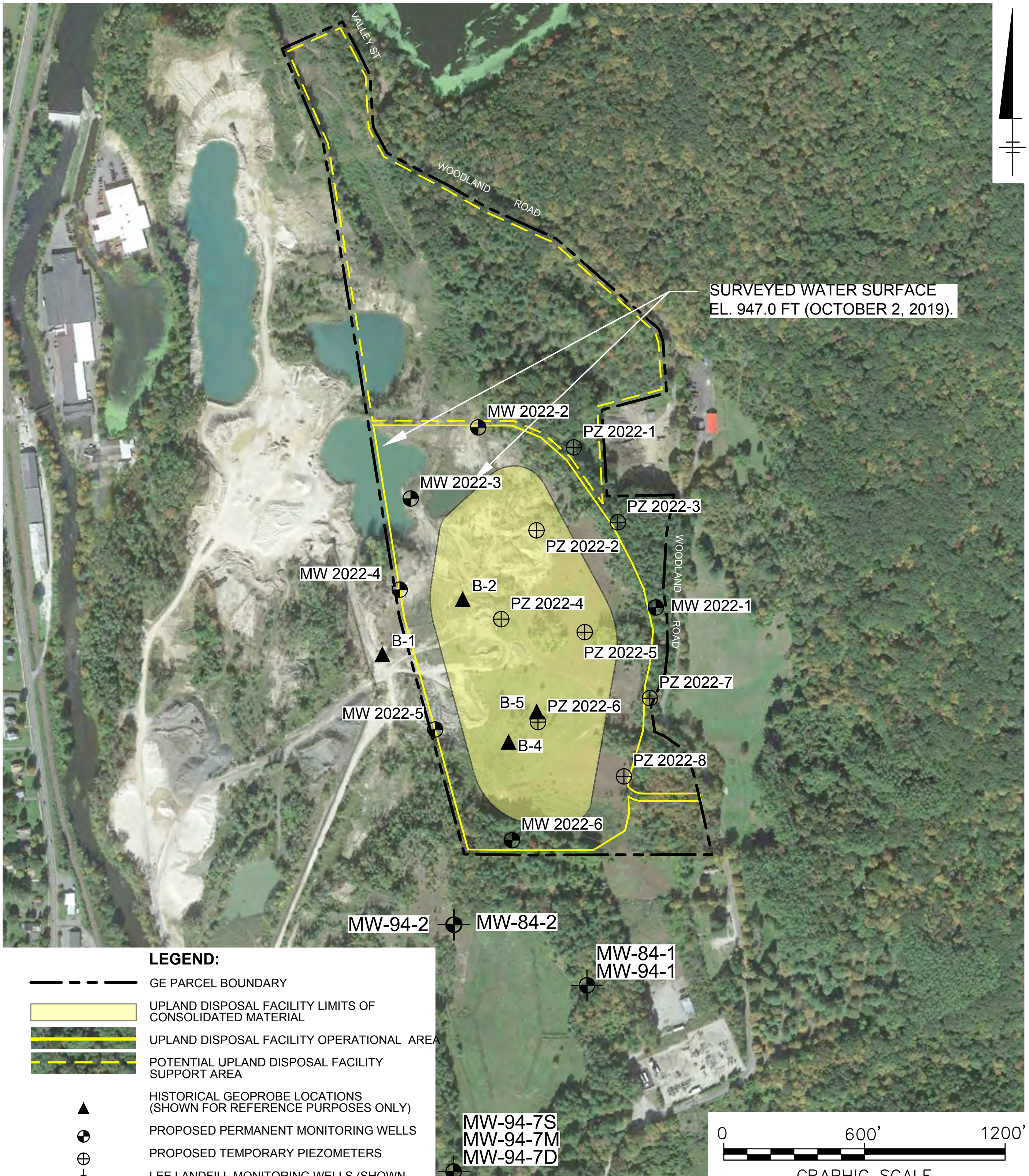
1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

PROPOSED SOIL QUALITY INVESTIGATION

ARCADIS

FIGURE
4



LEGEND:

- GE PARCEL BOUNDARY
- UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL
- UPLAND DISPOSAL FACILITY OPERATIONAL AREA
- POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA
- HISTORICAL GEOPROBE LOCATIONS (SHOWN FOR REFERENCE PURPOSES ONLY)
- PROPOSED PERMANENT MONITORING WELLS
- PROPOSED TEMPORARY PIEZOMETERS
- LEE LANDFILL MONITORING WELLS (SHOWN FOR REFERENCE PURPOSES ONLY, SEE NOTE 3)

NOTES:

1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. MONITORING WELLS AROUND LEE MUNICIPAL LANDFILL ARE APPROXIMATE AND ARE BASED ON LOCATIONS SHOWN ON FIGURE 4A "WATER TABLE AQUIFER GROUNDWATER CONTOUR MAP (19 JUNE 1995)" FROM SUPPLEMENTAL COMPREHENSIVE SITE ASSESSMENT - WILLOW HILL ROAD SANITARY LANDFILL, LEE MASSACHUSETTS (ERM-NEW ENGLAND, INC., JANUARY 19, 1996) AND FIGURE TITLED "BEDROCK AND OVERBURDEN GROUNDWATER CONTOURS JANUARY 30, 1995" FROM LICENSED SITE PROFESSIONAL (LSP) EVALUATION OPINION TRANSMITTAL - LEE LANDFILL, LEE, MASSACHUSETTS (AUGUST 23, 1995).
4. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

PROPOSED GROUNDWATER DEPTH INVESTIGATION

ARCADIS

FIGURE
5

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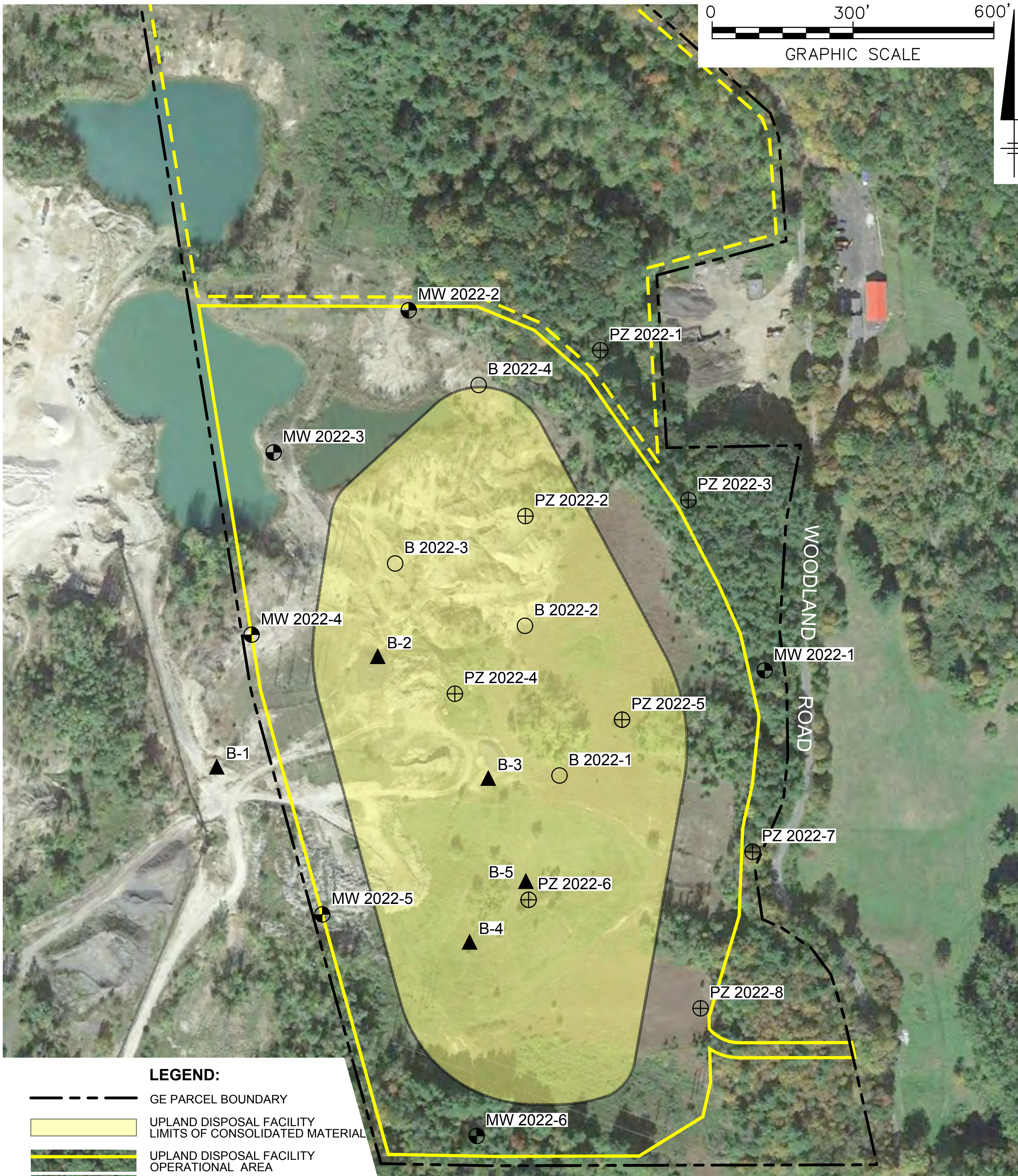

LEGEND:

- GE PARCEL BOUNDARY
- UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL
- UPLAND DISPOSAL FACILITY OPERATIONAL AREA
- POTENTIAL UPLAND DISPOSAL FACILITY SUPPORT AREA
- HISTORICAL GEOPROBE LOCATIONS
- PROPOPSED PERMANENT MONITORING WELLS WITH GROUNDWATER QUALITY SAMPLING
- PROPOSED TEMPORARY PIEZOMETER (NO GROUNDWATER QUALITY SAMPLING)

NOTES:

1. SITE FEATURES OBTAINED FROM DRAWING ENTITLED "PLAN OF LAND SURVEYED FOR THE LANE CONSTRUCTION CORPORATION" PREPARED BY SK DESIGN GROUP, INC., DATED JUNE 4, 2010.
2. AERIAL IMAGERY WAS OBTAINED VIA GOOGLE EARTH DATED 10/04/2018, ACCESSED 09/22/2021.
3. UPLAND DISPOSAL FACILITY LIMITS OF CONSOLIDATED MATERIAL, OPERATIONAL AREA, AND SUPPORT AREAS SHOWN ARE CONCEPTUAL ONLY.

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
HOUSATONIC RIVER

PROPOSED GROUNDWATER QUALITY INVESTIGATION

ARCADIS

FIGURE
6

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Appendix A

UDF/GE Parcel Habitat Inventory Form

General Electric Housatonic Rest of River
Upland Disposal Facility and GE Parcel Habitat Inventory Form

I. General Information

Site Name

Location/Physical Description

Date(s) of Site Visit(s) and Data Collection

Weather Conditions During Site Visit

Field Staff Performing Evaluation

Date this form was completed

II. Site Description

A. Hydrology/Water Regime

- ☐ Permanently flooded
- ☐ Intermittently exposed
- ☐ Semi-permanently flooded
- ☐ Seasonally flooded
- ☐ Upland
- ☐ Saturated
- ☐ Temporarily flooded
- ☐ Intermittently flooded
- ☐ Artificially flooded

B. Community Cover Type(s)

Wetland

- ☐ Transitional floodplain forest
- ☐ High terrace floodplain forest
- ☐ Red maple swamp
- ☐ Vernal pool
- ☐ Black ash-red maple-tamarack calcareous seepage swamp
- ☐ Deep emergent marsh
- ☐ Shallow emergent marsh
- ☐ Shrub swamp
- ☐ Wet meadow

Upland

- ☐ Northern Hardwoods-Hemlock-White Pine Forest
- ☐ Rich mesic forest
- ☐ Red Oak-Sugar Maple Transition Forest
- ☐ Agricultural fields
- ☐ Cultural grassland
- ☐ Successional northern hardwoods
- ☐ Spruce-fir-northern hardwood forest
- ☐ Developed/disturbed cover types
- ☐

Bordering Riverine/Aquatic Habitat

- ☐ High-gradient stream
- ☐ Medium-gradient stream
- ☐ Low-gradient stream
- ☐ Moderately alkaline lake/pond

☐ Backwater ☐

C. Inventory (Plant community)

% Cover: ______ Trees (> 20’) ______ Shrubs (< 20’) ______ Woody vines ______ Mosses ______ Herbaceous

Plant Lists (species that comprise 10% or more of the vegetative cover in each strata; “*” designates a dominant plant species for the strata):

Strata	Plant Species	Strata	Plant Species

D. Inventory (Soils)

______ Soil Survey Unit ______ Drainage Class

______ Texture (upper part) ______ Depth

Representative Soil Pit Log

Soil Horizon	Depth (inches)	Color	Soil Texture	Mottling
Notes:				

III. Important Habitat Features

Wildlife Food

Important Wetland/Aquatic Food Plants (smartweeds, pondweeds, wild rice, bulrush, wild celery)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Important Upland/Wetland Food Plants (hard mast and fruit/berry producers)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Shrub thickets or streambeds with abundant earthworms (American woodcock)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Cover/Perches/Basking/Denning/Nesting Habitat

Shrub and/or herbaceous vegetation suitable for veery nesting

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Trees (live or dead) > 30" DBH

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Standing Dead Trees (potential for cavities and perches):

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Tree Cavities in trunks or limbs:

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Small mammal burrows:

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Dense herbaceous cover (voles, small mammals, amphibians & reptiles)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Large woody debris on the ground (small mammals, mink, amphibians & reptiles)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Rocks, crevices, logs, tree roots or hummocks under water's surface (turtles, snakes, frogs)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Rocks, crevices, fallen logs, overhanging branches or hummocks at, or within 1m above the water's surface (turtles, snakes, frogs, wading birds, wood duck, mink, raccoon)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Rock piles, crevices, or hollow logs suitable for:

☐ otter ☐ mink ☐ porcupine ☐ bear ☐ bobcat ☐ turkey vulture

Live or dead standing vegetation overhanging water or offering good visibility of open water (e.g., osprey, kingfisher, flycatchers, cedar waxwings)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Depressions that may serve as seasonal (vernal/autumnal) pools

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Standing water present at least part of the growing season, suitable for use by

☐ Breeding amphibians ☐ Non-breeding amphibians (foraging, re-hydration)

☐ Turtles ☐ Foraging waterfowl

Sphagnum hummucks or mats, moss-covered logs or saturated logs, overhanging or directly adjacent to pools of standing water in spring (four-toed salamander)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Important habitat characteristics

Medium to large (> 6”), flat rocks within a stream (cover for stream salamanders and nesting habitat for spring & two-lined salamanders)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Flat rocks and logs on banks or within exposed portions of streambeds (cover for stream salamanders and nesting habitat for dusky salamanders)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Underwater banks of fine silt and/or clay (beaver, muskrat, otter)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Undercut or overhanging banks (small mammals, mink, weasels)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Vertical sandy banks (bank swallow, kingfisher)

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Areas of ice-free open water in winter

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Mud flats

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Exposed areas of well-drained, sandy soil suitable for turtle nesting

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Wildlife dens/nests (if observed)

Turtle nesting sites

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Bank swallow colony

☐ Abundant ☐ Present ☐ Absent ☐ Not Applicable

Nest(s) present of ☐ Bald Eagle ☐ Osprey ☐ Great Blue Heron

Den(s) present of ☐ Otter ☐ Mink ☐ Beaver

Emergent Wetlands (if Applicaple)

Emergent wetland vegetation at least seasonally flooded during the growing season (wood duck, green heron, black-crowned night heron, king rail, Virginia rail, coot, etc.)

Flooded > 5 cm	☐ Present	☐ Absent
Flooded > 25 cm (pied-billed grebe)	☐ Present	☐ Absent

Persistent emergent wetland vegetation at least seasonally flooded during the growing season (mallard, American bittern, sora, common snipe, red-winged blackbird, swamp sparrow, marsh wren)

Flooded > 5 cm	☐ Present	☐ Absent
Flooded > 25 cm (least bittern, common moorhen)	☐ Present	☐ Absent

Cattail emergent wetland vegetation at least seasonally flooded during the growing season

Flooded > 5 cm (marsh wren)	☐ Present	☐ Absent
Flooded > 25 cm (least bittern, common moorhen)	☐ Present	☐ Absent

Fine-leafed emergent vegetation (grasses and sedges) at least seasonally flooded during the growing season (common snipe, spotted sandpiper, sedge wren)

Flooded > 5 cm	☐ Present	☐ Absent
Flooded > 25 cm (least bittern, common moorhen)	☐ Present	☐ Absent

IV. Habitat Degradation

☐ Evidence of significant levels of dumping

☐ Evidence of significant erosion or sedimentation problems

☐ Significant invasion of exotic plants (e.g., purple loosestrife, *Phragmites*, glossy buckthorn)

☐ Disturbance from roads or highways ☐ Evidence of fire

☐ Evidence of other human disturbance

Appendix B

USACE Wetland Determination Data Form for the Northeast Region

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: ______________________ City/County: ______________ Sampling Date: ________

Applicant/Owner: ______________________________ State: _____ Sampling Point: ______

Investigator(s): ______________________ Section, Township, Range: ____________________

Landform (hillslope, terrace, etc.): ____________ Local relief (concave, convex, none): __________ Slope (%): ____

Subregion (LRR or MLRA): ________ Lat: ____________ Long: ____________ Datum: ______

Soil Map Unit Name: ______________________________ NWI classification: ___________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ______	No ______	**Is the Sampled Area within a Wetland?** **Yes ______ No ______**
Hydric Soil Present?	Yes ______	No ______	
Wetland Hydrology Present?	Yes ______	No ______	If yes, optional Wetland Site ID: ______________

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Water-Stained Leaves (B9)
___ High Water Table (A2)	___ Aquatic Fauna (B13)
___ Saturation (A3)	___ Marl Deposits (B15)
___ Water Marks (B1)	___ Hydrogen Sulfide Odor (C1)
___ Sediment Deposits (B2)	___ Oxidized Rhizospheres on Living Roots (C3)
___ Drift Deposits (B3)	___ Presence of Reduced Iron (C4)
___ Algal Mat or Crust (B4)	___ Recent Iron Reduction in Tilled Soils (C6)
___ Iron Deposits (B5)	___ Thin Muck Surface (C7)
___ Inundation Visible on Aerial Imagery (B7)	___ Other (Explain in Remarks)
___ Sparsely Vegetated Concave Surface (B8)	

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No _____	Depth (inches): ________
Water Table Present?	Yes _____	No _____	Depth (inches): ________
Saturation Present? (includes capillary fringe)	Yes _____	No _____	Depth (inches): ________

Wetland Hydrology Present? Yes ______ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION – Use scientific names of plants. Sampling Point: ___________

Tree Stratum (Plot size: _______________)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	________ = Total Cover		
Sapling/Shrub Stratum (Plot size: _______________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	________ = Total Cover		
Herb Stratum (Plot size: _______________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	________ = Total Cover		
Woody Vine Stratum (Plot size: _______________)			
1.			
2.			
3.			
4.			
	________ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____________ (A)

Total Number of Dominant Species Across All Strata: ____________ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____________ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___________	x 1 = ___________
FACW species	___________	x 2 = ___________
FAC species	___________	x 3 = ___________
FACU species	___________	x 4 = ___________
UPL species	___________	x 5 = ___________
Column Totals:	___________ (A)	___________ (B)

Prevalence Index = B/A = ______________

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ______ **No** ______

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL Sampling Point: ___________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7) (**LRR R, MLRA 149B**)
___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
___ Loamy Mucky Mineral (F1) (**LRR K, L**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
___ Coast Prairie Redox (A16) (**LRR K, L, R**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
___ Dark Surface (S7) (**LRR K, L**)
___ Polyvalue Below Surface (S8) (**LRR K, L**)
___ Thin Dark Surface (S9) (**LRR K, L**)
___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
___ Red Parent Material (F21)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________________________

Depth (inches): ______________________

Hydric Soil Present? Yes ______ No ______

Remarks:

Appendix C

Arcadis Field Guide for USCS Soil Classification

FIELD GUIDE FOR USCS SOIL CLASSIFICATION
SEPTEMBER 1, 2020; REV 0

ARCADIS

Color Examples:

- Medium Bluish Gray (5B 5/1)
- Brownish Gray (5YR 4/1)
- Light Olive Brown (5Y 5/6)
- Light Olive (10Y 5/4)
- Grayish Olive (10Y 4/2)
- Grayish Brown (5YR 3/2)
- Pale Red (5R 6/2)
- Dark Reddish-Brown (10R 3/4)
- Light Brown (5YR 6/4)
- Moderate Red (5R 4/6)
- Moderate Reddish-Brown (10R 4/6)
- Pale Yellowish Orange (10YR 8/6)
- Moderate Yellowish Brown (10YR 5/4)
- Moderate Reddish Orange (10R 6/6)
- Grayish Yellow (5Y 8/4)

Colors may vary slightly due to reproduction

Description Format:

1. USCS Group Name (USCS Group Symbol);	5. minor constituents,
2. density/consistency,	6. moisture,
3. color,	7. additional details,
4. major constituents,	8. [geologic origin] (eg fill, alluvium, etc)

* Major/minor constituent descriptions should include particle size range and angularity for granular soils and plasticity for fine-grained soils.

Example Descriptions:

- Lean Clay with Sand (CL); Very stiff, dark gray, medium plasticity fines, coarse, angular sand, trace gravel, moist [levee fill]
- Well-Graded Sand with Silt (SW-SM); Medium dense, brown, subangular sand, low plasticity fines, moist, slightly organic [holocene terrace deposits]

Coarse-Grained Soil Flow Chart

				Group Symbol		Group Name
% gravel > % sand	≤5% fines	Well-graded		GW	<15% sand	well-graded gravel
					≥15% sand	well-graded gravel with sand
		Poorly graded		GP	<15% sand	poorly-graded gravel
					≥15% sand	poorly-graded gravel with sand
	5%-15% fines	Well-graded	silt fines	GW-GM	<15% sand	well-graded gravel with silt
					≥15% sand	well-graded gravel with silt and sand
			clay fines	GW-GC	<15% sand	well-graded gravel with clay
					≥15% sand	well-graded gravel with clay and sand
		Poorly graded	silt fines	GP-GM	<15% sand	poorly-graded gravel with silt
					≥15% sand	poorly-graded gravel with silt and sand
			clay fines	GP-GC	<15% sand	poorly-graded gravel with clay
					≥15% sand	poorly-graded gravel with clay and sand
	≥15% fines	silt fines		GM	<15% sand	silty gravel
					≥15% sand	silty gravel with sand
		clay fines		GC	<15% sand	clayey gravel
					≥15% sand	clayey gravel with sand
% sand > % gravel	≤5% fines	Well-graded		SW	<15% gravel	well-graded sand
					≥15% gravel	well-graded sand with gravel
		Poorly graded		SP	<15% gravel	poorly-graded sand
					≥15% gravel	poorly-graded sand with gravel
	5%-15% fines	Well-graded	silt fines	SW-SM	<15% gravel	well-graded sand with silt
					≥15% gravel	well-graded sand with silt and gravel
			clay fines	SW-SC	<15% gravel	well-graded sand with clay
					≥15% gravel	well-graded sand with clay and gravel
		Poorly graded	silt fines	SP-SM	<15% gravel	poorly-graded sand with silt
					≥15% gravel	poorly-graded sand with silt and gravel
			clay fines	SP-SC	<15% gravel	poorly-graded sand with clay
					≥15% gravel	poorly-graded sand with clay and gravel
	≥15% fines	silt fines		SM	<15% gravel	silty sand
					≥15% gravel	silty sand with gravel
		clay fines		SC	<15% gravel	clayey sand
					≥15% gravel	clayey sand with gravel

Density of Granular Soils

Density	N-value
Very Loose	< 5
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Minor Constituent Descriptors

Term	Percent Present
Trace	< 5 %
Few	5 to 10 %
Little	15 to 25 %
Some	30 to 45 %
Mostly	50 to 100 %

Note: This field guide is intended as a quick-reference guide for basic soil logging information. More detailed information is provided in ASTM D2488.

FIELD GUIDE FOR USCS SOIL CLASSIFICATION
SEPTEMBER 1, 2020; REV 0

ARCADIS

Fine Grained Soil Flow Chart

			Group Symbol				Group Name
LL<50	slightly to moderately sticky when wet	- medium plasticity - none to slow dilatancy - medium to high dry strength	CL	<30% sand & gravel	<15% sand & gravel		lean clay
					15-29% sand & gravel	sand≥gravel	lean clay with sand
						sand<gravel	lean clay with gravel
				≥30% sand & gravel	sand≥gravel	<15% gravel	sandy lean clay
						≥15% gravel	sandy lean clay with gravel
					sand<gravel	<15% sand	gravelly lean clay
						≥15% sand	gravelly lean clay with sand
		- nonplastic to low plasticity - slow to rapid dilatancy - none to low dry strength	ML	<30% sand & gravel	<15% sand & gravel		silt
					15-29% sand & gravel	sand≥gravel	silt with clay
						sand<gravel	silt with gravel
				≥30% sand & gravel	sand≥gravel	<15% gravel	sandy silt
						≥15% gravel	sandy silt with gravel
					sand<gravel	<15% sand	gravelly silt
						≥15% sand	gravelly silt with sand
LL>50	very sticky when wet	- high plasticity - no dilatancy - high to very high dry strength	CH	<30% sand & gravel	<15% sand & gravel		fat clay
					15-29% sand & gravel	sand≥gravel	fat clay with sand
						sand<gravel	fat clay with gravel
				≥30% sand & gravel	sand≥gravel	<15% gravel	sandy fat clay
						≥15% gravel	sandy fat clay with gravel
					sand<gravel	<15% sand	gravelly fat clay
						≥15% sand	gravelly fat clay with sand
		- low to medium plasticity - none to slow dilatancy - low to medium dry strength	MH	Elastic silt soil is uncommon. If encountered, follow group name convention for other fine grained soils. (i.e. elastic silt, elastic silt with sand, elastic silt with gravel, sandy elastic silt, etc.)			

* Record as organic soil (OL/OH) if there is enough organic particles to influence soil properties. Follow group name convention for other fine grained soils.

Plasticity of Cohesive Soils

Nonplastic	A 1⁄8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limi

Consistency of Cohesive Soils

Consistency	SPT N-value	Pocket pen (tsf)	Hand Manipulation
Very Soft	<2	<0.25	Easily penetrated >1 in. by thumb
Soft	2 – 4	0.25 - 0.5	Easily penetrated ~1 in. by thumb
Med. Stiff	5 – 8	0.5 - 1.0	Penetrated by thumb with moderate effort
Stiff	9 – 15	1.0 - 2.0	Readily indented by thumb but not penetrated
Very Stiff	16 - 30	2.0 - 4.0	Readily indented but thumbnails, but thumb will not indent
Hard	>30	>4.0	Thumbnail will not indent soil

Note:
Order of priority in determining consistency of cohesive soils:
1. Field Vane Shear Test
2. Torvane
3. Pocket Pen
4. N-value

Particle Size Distribution

Material	Fraction	Sieve Size	Grain Size (mm)	Approximate Scale Size
Boulders		12 in. +	300 +	Basketball
Cobbles		3 - 12 in.	300 - 75	Baseball to basket ball
Gravel	Coarse	3/4 - 3 in.	75 - 19	Thumb to baseball
	Fine	No 4 - 3/4 in.	19 - 4.75	pea to thumb
Sand	Coarse	No 10 - No 4	4.75 - 2	rock salt to pea
	Medium	No 40 - No 10	2 - 0.425	sugar to rock salt
	Fine	No 200 - No 40	0.425 - 0.075	flour to sugar
Fines		Passing No 200	< 0.075	smaller than flour

Moisture Condition of Soils

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

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Syracuse
New York 13202
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DJ-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
EPA NEW ENGLAND

PERMIT UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) AS AMENDED (42 U.S.C. SECTION 6901 ET SEQ.)

General Electric Company
1 Plastics Avenue
Pittsfield, Massachusetts 01201
EPA I.D. No. MAD002084093

The Permittee is required to conduct certain activities at areas affected by releases of hazardous waste and/or hazardous constituents from the General Electric Facility located in Pittsfield, Massachusetts, in accordance with Sections 3004(u), 3004(v), and 3005(c) of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), as specified in the conditions set forth herein.

This Revised Final Permit Modification to the 2016 Reissued RCRA Permit (or "Permit") has been prepared for RCRA Corrective Action activities to be performed by General Electric pursuant to a final Consent Decree, United States, et al. v. General Electric Company (D. Mass.) ("Consent Decree"). The Consent Decree memorializes an agreement to address releases of waste materials, including hazardous substances, hazardous waste, and/or hazardous constituents from the General Electric Company's Facility in Pittsfield, Massachusetts, including, but not limited to, the releases of hazardous waste and/or hazardous constituents addressed in this Permit. This Permit, upon the Effective Date, shall replace the HSWA Permit previously issued to the Permittee, initially issued on February 8, 1991, modified effective January 3, 1994, reissued in October 2000 and reissued again, effective December 5, 2007. Upon the Effective Date of this Permit, the previously issued 2007 Permit hereby is revoked, and, pursuant to the Consent Decree, the Remedial Action set forth in this Permit shall be implemented pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Consent Decree.

Dated: 12/16/2020

Signed: ______________________
Dennis Deziel, Regional Administrator
U.S. Environmental Protection Agency, EPA New England
5 Post Office Square – Suite 100
Boston, Massachusetts 02109-3912

GENERAL ELECTRIC CO. – PITTSFIELD, MA
RCRA CORRECTIVE ACTION PERMIT

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DEFINITIONS

Unless otherwise expressly provided herein, terms used in this Permit (including all tables, figures and attachments), which are defined in the Consent Decree, or in CERCLA, RCRA, or in regulations promulgated under CERCLA or RCRA, shall have the meaning assigned to them in the Consent Decree, CERCLA, RCRA, or in such regulations.

1. "2016 Permit" means the Final Permit Modification to the Reissued RCRA Permit issued by EPA on October 20, 2016 for the Rest of River portion of the GE-Pittsfield/Housatonic River Site.

2. "2020 Settlement Agreement" means the Settlement Agreement entered into in February 2020 by the following parties: EPA, State of Connecticut, City of Pittsfield, the Rest of River Municipal Committee (representing the Towns of Lee, Lenox, Stockbridge, Great Barrington, and Sheffield), Massachusetts Audubon Society, Berkshire Environmental Action Team, C. Jeffrey Cook, and General Electric Company.

3. "Act" or "RCRA" means the Solid Waste Disposal Act, as amended (also known as the Resource Conservation and Recovery Act), 42 United States Code (U.S.C.) §§ 6901 et seq.

4. "Backwaters" means the areas that are typically inundated or open water adjacent to the main channel of the river in Reaches 5, 6, and 7, a preliminary identification of which is generally depicted on Figure 3-17 of GE's October 2010 Revised Corrective Measures Study.

5. "CERCLA" means the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. §§ 9601 et seq.

6. "Consent Decree", "Decree", or "CD" means the Consent Decree among the General Electric Company, the United States, Massachusetts and Connecticut state governmental agencies, the City of Pittsfield, Massachusetts, and the Pittsfield Economic Development Authority, which was entered by the United States District Court for the District of Massachusetts on October 27, 2000, in the case of United States et al. v. General Electric Company, Civil Action No. 99-30225-MAP and consolidated cases.

7. "Core Habitat Areas", "Core Area 1", "Core Area 2", and "Core Area 3" mean the areas above Woods Pond in the Rest of River that Massachusetts Division of Fisheries and Wildlife (DFW) mapped to assist the governments in determining areas for habitat protection and the locations of habitats and state-listed species that might be particularly sensitive to impacts from remediation activities. These Core Habitat Areas are described in a letter transmitted from DFW to EPA on July 31, 2012 and shown in accompanying maps, which are included in Attachment B.

8. "Corrective Measure" means corrective measure under RCRA until the Permit, or any severable portion thereof, is finalized pursuant to Paragraph 22 of the Consent Decree, whereupon the finalized corrective measure converts to and means response action under CERCLA.

9. “Effective Date” shall mean the date upon which any relevant Performance Standard(s), Corrective Measure(s) and/or other requirements in this Permit become(s) finalized pursuant to the process set forth in the Consent Decree, Paragraph 22, including, but not limited to, the regulations at 40 C.F.R. Part 124.

10. “EPA” means the United States Environmental Protection Agency, EPA New England, and any successor department or agency.

11. “Exposure Point Concentration” or “EPC” means the concentration of a contaminant that is used in the calculation of risk to humans or ecological receptors.

12. “Floodplain” means the area located within the floodplain of the Housatonic River to which hazardous waste and/or hazardous constituents originating at the GE Facility are migrating, have migrated, or may have migrated.

13. “Frequently Used Subareas” or “Heavily Used Subareas” means the areas subject to frequent use by humans, including, but not limited to, trails, access points, and known recreational areas that pose a direct contact risk, which generally include the areas shown in Figure 5.

14. “GE Facility” means, for the purposes of this Permit, the General Electric facility in Pittsfield, Massachusetts, as generally depicted on the map attached hereto as Attachment A.

15. “Hazardous Constituents” include those constituents listed in Appendix VIII to 40 C.F.R. Part 261 and Appendix IX to 40 C.F.R. Part 264.

16. “Hazardous Waste” means a solid waste or combination of solid wastes defined as a hazardous waste under 40 C.F.R. Part 261.

17. “HSWA” means the Hazardous and Solid Waste Amendments of 1984.

18. “Impoundment” means any area of sediment, soil, or water subject to the influence of a dam or dam component, including, but not limited to, sediment or soil present in spillways, sluiceways, channels, by-passes, conduits, ponds, settling basins, intake structures, or other structures used for collection, withdrawal, or use of water and any water withdrawn and used as process water, non-contact cooling water, etc.

19. “Legally Permissible Future Project or Work” shall mean when the property owner, the owner’s successors and assigns, or any other party with an interest in the property such as a lessee or easement holder: (1) has submitted a plan to the appropriate governmental authority(ies) to authorize any project or work (if such plan or authorization is necessary) and such plan (if required) has been approved by the governmental authority(ies), or, provides documentation that a proposed project or work is legal without additional government approvals (for example, authorized by an easement or existing permit) and (2) provides to EPA and to Permittee (directly or through EPA) other documented evidence of a commitment to such project or work (for example, such evidence may include evidence of financing or other financial assurance for the project or work, other plans for implementing the project or work (such as architectural plans, contracts for performance of the project or work, or other similar plans), or

an affidavit that the owner intends to go forward with the project or work or if the necessary response actions are taken). Legally Permissible Future Projects or Work includes, but is not limited to, construction and repair of structures; utility work; flood management activities; road and infrastructure projects; dam removal, maintenance, repair, upgrades, and enhancement activities; and activities such as the installation of canoe/boat launches and docks.

20. “Legally Permissible Future Use” shall mean A) when the property owner, the owner’s successors and assigns, or any other party with an interest in the property such as a lessee or easement holder: (1) has submitted a plan to the appropriate governmental authority(ies) to authorize any use (if such plan or authorization is necessary) and such plan (if required) has been approved by the governmental authority(ies), or, provides documentation that a proposed use is legal without additional government approvals (for example, authorized by an easement or existing permit) and (2) provides to EPA and to Permittee (directly or through EPA) other documented evidence of a commitment to such use (for example, such evidence may include evidence of financing or other financial assurance for the project, other plans for implementing the project (such as architectural plans, contracts for performance of the project, or other similar plans), or an affidavit that the owner intends to go forward with the project or other change in use if the necessary response actions are taken); or B) the use of a property changes from the exposure scenario upon which the initial or subsequent remediation(s) was determined, to a different exposure scenario, including those scenarios identified in Tables 2, 3 and 4.

21. “Monitored Natural Recovery” means a remedy for contaminated sediment that typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment, and requires monitoring the natural processes and/or concentrations of contaminants in surface water, sediment, or biota to see if recovery is occurring at the expected rate, and the maintenance of institutional controls until the necessary reductions in risk have occurred.

22. “PCBs” means total polychlorinated biphenyls.

23. “Performance Standards” mean cleanup standards, design standards, and other measures and requirements necessary to protect human health and the environment. Such Performance Standards that must be achieved and maintained are identified in the Consent Decree, this Permit, and/or will subsequently be identified in the Rest of River Statement of Work (“Rest of River SOW” or “SOW”), and/or amendments thereto.

24. “Permittee” means the General Electric Company.

25. “Reach” means the designation established by EPA in its 2000 Supplemental Investigation Work Plan for different segments of the East Branch and main stem of the Housatonic River shown in Figures 1 and 2.

26. “Release” includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, disposing, or migrating into the environment.

27. “Rest of River or Rest of River area” shall mean, for the purposes of this Permit, all sediments, surface waters, and Floodplain soils of the Housatonic River which are downstream

of the confluence of the East and West branches of the River, including Backwaters in the Floodplain, and to which releases of hazardous wastes and/or hazardous constituents are migrating or have migrated from the GE Facility, but excluding any Actual/Potential Lawns within the Housatonic River Floodplain – Current Residential Properties Downstream of Confluence, within the definition of the Removal Actions Outside the River in the Consent Decree.

28. “Restoration of Areas Disturbed by Remediation” means, for all areas disturbed by remediation activities under this Permit, the implementation of measures to return such areas to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements.

29. “Revised Final Permit Modification to the 2016 Reissued RCRA Permit” or “Permit” or “Revised Final Permit” means this Revised Final Permit Modification to the 2016 Reissued RCRA Permit issued by EPA for the “Rest of River” portion of the GE-Pittsfield/Housatonic River Site.

30. “Solid Waste” means a solid waste as defined in 40 C.F.R. § 261.2.

31. “States”, for purposes of this Permit, means the Commonwealth of Massachusetts and the State of Connecticut.

32. “Surface Water” means water occurring immediately adjacent to land as overland flow, open channel flow, closed conduit flow, and waters in lakes, ponds, and reservoirs.

33. “Upland Disposal Facility” means the facility described in Section II.B.5. of this Permit and generally depicted in Figure 6.

34. “Vernal Pools” mean ephemeral fresh-water wetlands that meet the criteria specified in the Commonwealth of Massachusetts Natural Heritage & Endangered Species Program’s Guidelines for Certification of Vernal Pool Habitat (March 2009 publication, Sections I, II, and III).

I. GENERAL PERMIT CONDITIONS

A. Background

1. Overview of Permit and Consent Decree

On October 27, 2000, the U.S. District Court for the District of Massachusetts, Western Division, entered a Consent Decree in United States, State of Connecticut, and Commonwealth of Massachusetts v. General Electric Company, Civil Action No. 99-30225, 99-30226, 99-30227 – MAP (consolidated cases) (the “Consent Decree,” or “Decree”).

The following explanation summarizes and describes certain provisions of the Consent Decree regarding the process for finalizing the modified

Permit and implementing the work selected in the final Permit as a CERCLA remedial action pursuant to the Consent Decree. Nothing in this summary shall modify or otherwise change the meaning of the Consent Decree.

The Consent Decree, at Paragraph 22.p through 22.dd, provides explicit direction on Permittee's opportunities for challenge of the final permit modification, the ability of EPA or Permittee to perform work pursuant to the final permit modification prior to conclusion of all challenges to the final permit modification, the obligations in the event of the final permit modification, or a revised final permit modification is vacated or remanded, and the obligation of Permittee to perform the work, or severable work, in the permit modification decision as a CERCLA remedial action and any required Operation and Maintenance (O&M) at the conclusion of all opportunities for a challenge to the final permit modification, or severable portion(s) of the permit modification. (The process for severing portions of the Permit and work is described in Paragraph 3 below).

2. Final Permit Modification Pursuant to Process Set Forth in Consent Decree

Following issuance of the 2016 Permit, certain provisions of the 2016 Permit were not challenged by any party. Permittee has submitted several design documents for the uncontested portions of the 2016 Permit.

Permittee has agreed, pursuant to the 2020 Settlement Agreement, in order to expedite response actions, to commence and perform investigation and design work as contractual obligations effective February 10, 2020. Specifically, Permittee shall submit a schedule for the Rest of River Scope of Work (SOW), develop the Rest of River SOW, and, subject to approval by EPA, implement the investigation and design components of the Rest of River SOW and subsequent Work Plans to accelerate the commencement of the Rest of River cleanup. Such Rest of River SOW shall include provisions and schedules for the subsequent development by the Permittee of Remedial Design Work Plan(s), Remedial Action Work Plan(s), Quality Assurance Project Plan/Field Sampling Plan, and/or other appropriate associated plans to achieve and maintain the Performance Standards and other requirements set forth in this modification of the Reissued RCRA Permit. Paragraph 22.x. of the Consent Decree explains the process for developing a Rest of River SOW. Following EPA approval, disapproval, or modification of the Rest of River SOW, the Permittee shall develop and submit the necessary Remedial Design and Remedial Action Work Plans and other documents to EPA for review and approval in accordance with the Rest of River SOW and Section XV of the Consent Decree and subject to Paragraph 39 of the Consent Decree.

The obligation to perform this investigation and design work shall continue unless and until EPA issues a revised permit that does not contain terms substantially similar to those in the terms of the 2016 Permit, revised as specified by terms in Sections II and III of the 2020 Settlement Agreement.

Otherwise, this Permit, or severable portion(s) thereof, after the opportunity for challenges to the EPA Environmental Appeals Board as specified in the Decree and described below in this Revised Final Permit, shall be performed by the Permittee as a CERCLA remedial action pursuant to the Consent Decree.

As provided in Paragraph 22.z of the Consent Decree, the Permittee shall design and implement the Rest of River Remedial Action, and any required O&M, as a CERCLA remedial action pursuant to the Consent Decree, in accordance with EPA's final RCRA permit modification decision, or severable portion(s) thereof, the final outcome of any dispute resolution proceedings, the Rest of River SOW, and any approved Work Plans thereunder. For purposes of the Rest of River Remedial Action and O&M, EPA's modification of the Reissued RCRA Permit, or severable portion(s) thereof, to select such Remedial Action and O&M that is effective at the time of initiation of the Rest of River Remedial Design/Remedial Action shall be considered to be the selected remedial action pursuant to Section 121 of CERCLA and Section 300.430 of the National Oil and Hazardous Substances Contingency Plan (NCP). If such modification is changed by appeals and/or remands, the subsequent modification of the Reissued RCRA Permit shall be considered the selected remedial action pursuant to Section 121 of CERCLA and Section 300.430 of the NCP, and any and all performance or actions required of the Permittee under this Reissued RCRA Permit shall be incorporated into, and conducted pursuant to, the Consent Decree.

3. Performance of Severable Work during Remedy Challenges

   a. Initial Challenge to Final Permit Modification

      In addition to the expedited work commitment by Permittee described above, and the performance of uncontested obligations described above, the Decree provides opportunities for the Rest of River Remedial Action to take place during challenges to this Permit.

   b. Second Appeal

      Pursuant to the 2020 Settlement Agreement, Permittee has agreed not to challenge the Revised Final Permit unless the Revised Final Permit is inconsistent with the terms of the 2020 Settlement

Agreement. EPA's position is that this Revised Final Permit is not inconsistent with the terms of the 2020 Settlement Agreement, and accordingly the Permittee's obligation to not challenge the Revised Final Permit remains in force.

Paragraph 22.u of the Decree provides that upon EPA's issuance of a revised permit modification decision, Permittee shall perform the selected Rest of the River Remedial Action and O&M set forth in EPA's revised permit modification decision unless Permittee timely files a petition for review with the EPA Environmental Appeals Board ("EAB"). Further, pursuant to Paragraph 22.u.(iii), in that event, Permittee shall perform all severable work which is not subject to the dispute. Permittee shall perform such severable work in accordance with EPA's revised permit modification decision and a Rest of River SOW developed in accordance with that decision and Paragraph 22.x of the Decree.

Paragraph 22.u.(ii), 22.u.(iv), and 22.u.(v) provide for a stay of the disputed portions of the revised permit modification decision in certain circumstances, but pursuant to Paragraphs 22.u.(iv) and 22.u.(v), Permittee is also required to proceed with severable work on the selected Rest of River Remedial Action and O&M in certain circumstances.

c. Subsequent Appeals

Pursuant to the 2020 Settlement Agreement, Permittee has agreed not to challenge the Revised Final Permit unless the Revised Final Permit is inconsistent with the terms of the 2020 Settlement Agreement. Pursuant to Paragraph 22.v of the Decree, if the EAB or the United States Court of Appeals for the First Circuit ("First Circuit Court of Appeals") vacates or remands all or part of EPA's revised permit modification decision, EPA may again revise its permit modification decision. Permittee shall perform such Rest of the River Remedial Action and O&M in accordance with such further revised permit modification unless Permittee timely files a petition for review. Further, Paragraph 22.v provides for a stay of the disputed portions of the revised permit modification decision in certain circumstances, and for Permittee to proceed with severable work on the selected Rest of River Remedial Action and O&M in certain circumstances.

If there are no challenges to the permit modification decision, or no challenges to a severable portion of the permit modification decision, or at the conclusion of all challenges to the permit modification decision, or at the conclusion of all challenges to any severable portion of the permit modification decision, Permittee shall perform the final selected Rest of River Remedial Action and O&M, as stated in the final permit modification, or final portion thereof, as a CERCLA remedial action pursuant to the Consent Decree.

B. General Obligations and Commitments

1. Duty to Mitigate

In addition to the requirements of the Consent Decree, in the event of any noncompliance with the corrective action requirements of the Permit that results in a new release of hazardous waste and/or hazardous constituents to the environment, the Permittee shall take all reasonable steps to minimize releases of hazardous waste and/or hazardous constituents to the environment, and shall carry out such measures as are reasonable to prevent its noncompliance from having significant adverse impacts on human health and/or the environment.

2. Property Rights

a. The issuance of this Permit does not convey any property rights of any sort, or any exclusive privilege to the Permittee.

b. The issuance of this Permit does not authorize any injury to persons or property or invasion of other private rights.

3. Duty to Provide Information

a. Within a reasonable time, the Permittee shall furnish to EPA any relevant non-privileged information which EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Permit, or to determine compliance with this Permit. Upon request, the Permittee shall also furnish to EPA copies of records required to be kept or prepared by this Permit and copies of other documents and information within the Permittee's possession or control relating to the implementation of this Permit, in accordance with and subject to Section XXX of the Consent Decree.

b. All information which the Permittee furnishes to EPA, either in the form of a request or a report pursuant to this Permit, shall contain or reference the sources from which the information was obtained.

4. Inspection and Entry

The Permittee shall provide EPA or an authorized representative, upon presentation of credentials and other documents as may be required by law, with access at reasonable times to the GE Facility or other property owned by the Permittee where any activity under this Permit is located or conducted, for the purpose of conducting, inspecting, or monitoring any activity pursuant to this Permit; inspecting or copying records required to be kept under this Permit; conducting sampling or other investigations related to implementation of this Permit; assessing the Permittee's compliance with this Permit; or conducting other activities described in Paragraph 53 (access obligations) of the Consent Decree insofar as they relate to activities under this Permit. The Permittee's provision of such access to EPA or an authorized representative shall be in accordance with and subject to Paragraph 53 of the Consent Decree.

5. Monitoring and Records

a. Samples and measurements taken for the purpose of waste analysis shall be representative of the waste to be analyzed. The method used to obtain a representative sample of the waste to be analyzed must be the appropriate method from Appendix I of 40 C.F.R. Part 261 or as provided in the approved and most recent edition of the Project Operations Plan (including the Field Sampling Plan and Quality Assurance Project Plan) and any amendments approved thereto.

b. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

c. The Permittee shall retain the records described in Paragraph 206.a of the Consent Decree, insofar as they relate to implementation of this Permit, for the time period specified in the second sentence of Paragraph 206.b of the Consent Decree.

d. Records of data obtained through monitoring shall include:

(1) The date, exact place, and time of sampling or measurements;

(2) The individual(s) who performed the sampling or measurements;

(3) The raw data (e.g., chromatograms) collected and data reduction;

(4) The date(s) analyses were performed;

(5) The individuals(s) who performed the analyses;

(6) The analytical techniques or methods used;

(7) The result of analyses; and

(8) The quality assurance/quality control data.

6. Signatory Requirements

All proposals, reports, and other documents submitted by the Permittee under this Permit shall be signed by an authorized representative of the Permittee, which may include the Permittee's Project Coordinator, designated pursuant to Section II.J.

7. Notice of Anticipated Noncompliance

The Permittee shall give advance notice to EPA and the States of any planned changes in any corrective action activity under this Permit which may result in noncompliance with the requirements of this Permit.

8. Transfer of Permit

This Permit shall not be transferred to a new owner or operator except after notice to and approval of the planned transfer by EPA, which may require that the Permit be modified or revoked and reissued.

9. Twenty-Four-Hour Reporting and Follow-Up

The Permittee shall comply with the reporting requirements set forth in Paragraph 69 of Section XIV of the Consent Decree; provided, however, that the Permittee shall not be subject to multiple enforcement actions or liable for multiple penalties under the Consent Decree, CERCLA, the Emergency Planning and Right-to-Know Act, RCRA, and/or this Permit for the same instance of noncompliance with such requirements.

10. Other Notification and Reporting Requirements

a. The Permittee shall report to EPA all instances of noncompliance with the terms of this Permit in the monthly progress reports to be provided pursuant to Paragraph 67 of the Consent Decree. Copies of such reports shall also be sent to Massachusetts and Connecticut Project Coordinators. For each instance of noncompliance, such report shall contain the following information:

(1) A description of the noncompliance;

(2) The name and quantity of materials released, if any, as a result of such noncompliance;

(3) The extent of injuries, if any, resulting from such noncompliance;

(4) An assessment of actual or potential hazards to human health and/or the environment, where applicable, resulting from such noncompliance;

(5) Any steps taken to mitigate the impact of such noncompliance or otherwise to correct such noncompliance; and

(6) A description of the impact of such noncompliance on the performance and timing of other activities required under this Permit.

b. When the Permittee becomes aware that it failed to submit any relevant facts in a required report, or submitted incorrect information in a required report to EPA, it shall promptly submit the correct facts or information.

11. Computation of Time

a. For the purpose of compliance with this Permit, computation of time periods shall be made by the methodology specified in 40 C.F.R. 124.20.

b. Where this Permit requires the submission of written reports or notification to EPA, the report or notification shall be deemed submitted on the post-marked date.

12. Severability

The provisions of this Permit are severable, and if any provision of this Permit or the application of any provision of this Permit to any circumstances is held invalid, the application of such provision to other circumstances and the remainder of this Permit shall not be affected thereby.

13. Confidentiality of Information

In accordance with 40 C.F.R. Part 2, any information submitted to EPA pursuant to this Permit may be claimed as confidential by the submitter. Any such claim must be asserted at the time of submission in the manner prescribed on the application form or instructions or, in the case of other submissions, by stamping the words Confidential Business Information on each page containing such information. If no claim is made at the time of submission, EPA may make the information available to the public without further notice. If a claim is asserted, the information will be treated in accordance with the procedures in 40 C.F.R. Part 2.

14. Interpretation of Migration from GE Facility

For purposes of this Permit, the Permittee agrees that, for hazardous waste and/or hazardous constituents in the Rest of River area which are also present both at the GE Facility and at the Former Oxbow Areas (as defined in the Consent Decree) and which could have migrated to the Rest of River area from either the GE Facility or the Former Oxbow Areas, the Permittee will not contend that such waste and/or constituents did not migrate from the GE Facility.

II. SPECIAL CONDITIONS

A. Introduction

The special conditions in this Permit for Rest of River describe the Rest of River Remedial Action and required O&M, including the Performance Standards, Corrective Measures, and other related requirements necessary to achieve and maintain such Performance Standards that the Permittee shall perform pursuant to the CD and this Permit, as finalized, or finalized portions thereof.

As described in the CD and this Permit, all Permittee activities shall be conducted pursuant to this Permit and the CD under the oversight and approval of EPA. All EPA approvals, disapprovals, or modifications of plans and other submittals under this Permit will be pursuant to Section XV of the CD, including the reasonable opportunity for review and comment by the Commonwealth of Massachusetts (MA) and Connecticut Department of Energy and Environmental Protection (CT DEEP). "Approval" by EPA, as used in this Permit, represents this process.

Additionally, as described in Section VI of the 2020 Settlement Agreement, EPA has made specific commitments to coordinate and consult with stakeholders throughout the design and implementation of the actions described in this Permit.

Any modification by EPA of a Performance Standard (e.g., work in a riverbank that modifies Performance Standards set forth in Section II.B.2.a.(1)) would have to be based on EPA's determination under Paragraphs 162-163 of the CD or based on agreement under Paragraph 217 of the CD.

B. Description of Performance Standards and Corrective Measures.

Section II.J. of the 2007 Permit provides that this modification of the Permit will include Performance Standards, and the appropriate Corrective Measures necessary to meet the Performance Standards. In Section II.B. of this Permit, provided below are such Performance Standards and Corrective Measures.

1. General

a. Downstream Transport

(1) Performance Standard

The Downstream Transport Performance Standard shall be the PCB flux over Woods Pond Dam and Rising Pond Dam as described in the table below.

An exceedance of the Performance Standard occurs when the average PCB flux is greater than the standard (at either Woods Pond or Rising Pond) in any three or more years within any 5-year period following completion of construction-related activities outlined herein.

Woods Pond		**Rising Pond**	
Average Daily Flow at Woods Pond Dam Gage (cubic feet per second (cfs))	**Average PCB Flux (kg/yr)**	**Average Daily Flow at Great Barrington USGS Gage (cfs)**	**Average PCB Flux (kg/yr)**
≤ 325	2.2	≤ 485	1.9
> 325 ≤ 395	2.8	> 485 ≤ 600	2.4
> 395 ≤ 1,450	3.3	> 600 ≤ 2,670	4.0
> 1,450	NA	> 2,670	NA

Note: The average PCB flux values that correspond to the associated flow ranges were determined as follows: The PCB fate and transport model (EFDC) results were used to generate average annual PCB fluxes at both Woods Pond and Rising Pond for the years following construction, which include a range of average annual flows. The model was run based on the sediment/bank remediation requirements, excluding the use of activated carbon in Reach 5B and the Backwaters, as set forth in this Permit. The average annual fluxes were segregated into the flow ranges shown in the table above and the maximum flux for each flow range was determined. To account for uncertainty, the value at the upper flow range for each flow-bin was selected from a 95% prediction interval of the regression of average annual flux versus flow.

In the event that this Downstream Transport Performance Standard is exceeded, the Permittee shall evaluate and identify the potential cause(s) of the exceedance and propose, to EPA for review and approval, additional actions necessary to achieve and maintain the Performance Standard. EPA, upon reasonable opportunity for review and comment by the States, will determine any additional actions necessary to achieve and maintain the Performance Standard in accordance with the CD.

(2) Corrective Measures

To achieve and maintain this Performance Standard, Permittee shall conduct all of the Corrective Measures set forth in this Section II.B. In addition, Permittee shall measure compliance with the Performance Standard in accordance with Sections II.B.1.a.(2)(a) through II.B.1.a.(2)(g) below and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Install, operate and maintain a flow gauge at the outlet of Woods Pond that is similar to the USGS gage downstream of Rising Pond Dam (gage number 01197500).

(b) Conduct sampling at regularly scheduled intervals (each year), regardless of stream flow. On days when the average daily flow exceeds 1,450 cfs at Woods Pond or 2,670 cfs at Rising Pond, sampling does not need to occur.

(c) Calculate the average daily flow for each sampling event using the data from the gage to be installed at Woods Pond outlet for Woods Pond and data from the USGS gage near Great Barrington (gage number 01197500) for Rising Pond.

(d) For each year of sampling, calculate the arithmetic average of the average daily flows on days when samples were collected. This average daily flow determines the flow bin for a given year.

(e) Calculate the PCB flux by multiplying the sample concentration times the daily average flow for the date sampled. The average PCB flux for a given year is the arithmetic average of the flux calculations for each day of sampling.

(f) Compare the average PCB flux to the standard in the table for the corresponding flow bin for Woods Pond and for Rising Pond.

(g) Permittee shall propose further details for EPA approval in a Work Plan submitted pursuant to Section II.H.5.

b. Biota

(1) Performance Standards

(a) The Short-Term Biota Performance Standard shall be an average total PCB concentration of 1.5 milligrams per kilogram (mg/kg) wet weight, skin off, in fish fillet[1] in each entire reach of the river and Backwaters to be achieved within 15 years of completion of construction-related activities for that reach (or if the reach is subject to Monitored Natural Recovery (MNR), upon completion of the

[1] Based on the probabilistic risk assessment central tendency exposure (CTE) adult exposure Hazard Index (HI) = 1.

closest upstream reach subject to active remediation) under this Permit.

In the event that the Short-Term Biota Performance Standard is exceeded in any two consecutive monitoring periods after the 15-year period specified above, the Permittee shall evaluate and identify the potential cause(s) of the exceedance and propose, to EPA for review and approval, additional actions necessary to achieve and maintain the Performance Standard. EPA, upon reasonable opportunity for review and comment by the States, will determine any additional actions necessary to achieve and maintain the Performance Standard in accordance with the CD.

(b) The Long-Term Biota Monitoring Performance Standard shall be the requirement that the Permittee continue to monitor, even after the Short-Term Biota Standard has been attained, the reduction in risk posed by the biota and the progress towards achieving an average total PCB concentration of 0.064 mg/kg, wet weight, skin off, in fish fillet[2] in each entire reach of the river and Backwaters in Massachusetts, 0.00018 mg/kg, wet weight, skin off, in fish fillet[3] in each entire reach of the river in Connecticut, and 0.075 mg/kg in duck breast tissue[4] in all areas along the river.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall conduct all of the Corrective Measures set forth in this Section II.B. Permittee shall propose, pursuant to Section II.H., a methodology to evaluate compliance with the Short-Term Biota Performance Standard and a plan to continue to monitor biota after the Short-Term Biota Performance Standard has been achieved.

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[2] Based on the probabilistic risk assessment Reasonable Maximum Exposure (RME) 1 x 10^{-5} cancer risk.

[3] Based on CT DEEP consumption calculation assuming 365 fish meals per year and a 1 x 10^{-6} cancer risk.

[4] Based on the probabilistic risk assessment RME 1 x 10^{-5} cancer risk.

c. Restoration of Areas Disturbed by Remediation Activities

(1) Performance Standards

For all areas disturbed by remediation activities under this Permit, the Permittee shall:

(a) Implement a comprehensive program of restoration measures that addresses the impacts of the Corrective Measures on all affected ecological resources, species and habitats, including but not limited to, riverbanks, riverbed, floodplain, wetland habitat, and the occurrence of threatened, endangered or state listed species and their habitats, and

(b) Return such areas to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements[5].

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall complete the activities in Sections II.B.1.c.(2)(a) through II.B.1.c.(2)(d) below as components of a program that addresses the impacts of the Corrective Measures on all affected ecological resources, species and habitats, including but not limited to: riverbanks, riverbed, floodplain, wetland habitat; the occurrence of threatened, endangered or state-listed species and their habitats; the restoration of all such areas to pre-remediation conditions (to the extent feasible and consistent with the remediation requirements); and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Prepare a Work Plan detailing steps to conduct a Baseline Restoration Assessment (BRA). Perform a baseline assessment of pre-remediation conditions, functions, and values of river bottom, bank, Backwater, Floodplain, Impoundment, and Vernal Pool habitat, and the occurrence of threatened,

[5] The requirements of Section II.B.1.c. do not alter or modify the Permittee's obligation to comply with ARARs including, but not limited to, any activities to satisfy the separate net benefit mitigation standard in the Massachusetts Endangered Species Act (MESA). See Section II.E.

endangered or state-listed species in the areas affected by Corrective Measures. This BRA shall include, but not be limited to:

i. Identification of the presence and location of specific habitat types, including delineation of existing wetlands;

ii. Identification of the presence, location, abundance, and condition of threatened, endangered or state-listed species and their habitats and other representative species;

iii. Identification of the presence, location, abundance, and condition of invasive species;

iv. Evaluation of Vernal Pool locations, hydrology, and species use; and

v. Characterization of physical/biological attributes (e.g., substrate characteristics, water depth, velocity, temperature, elevation/bathymetry, species composition, density, percent cover, structural components).

(b) Develop Restoration Performance Objectives and Evaluation Criteria (RPOEC) to guide the design, remediation, restoration, construction, implementation of Corrective Measures, and evaluation of restoration success. The RPOEC shall include, but not be limited to:

i. Definition of restoration objectives, including without limitation:

A. While achieving the Performance Standards described in this Permit, minimization of the impacts on all ecological resources and habitats, including the riverbanks and Floodplain, resulting from the implementation of the Corrective Measures;

B. Restoration of all ecological resources and habitats, including the riverbanks and Floodplain, impacted as a result of implementing the Corrective Measures;

ii. Identification of measurable evaluation criteria and applicable methods or specifications, including, without limitation, criteria and methods or specifications for evaluating the success in achieving the restoration objectives developed pursuant to Section II.B.1.c.(2)(b)i;

iii. Identification of stakeholder concerns;

iv. Preliminary Monitoring Program;

v. Preliminary Maintenance Program; and

vi. Specification of corrective actions and circumstances.

(c) Develop a Restoration Corrective Measures Coordination Plan (RCMCP) to be performed during the implementation of the Corrective Measures. This RCMCP shall include, but not be limited to:

i. Integration of restoration activities with remediation activities (e.g., locations of access roads/staging areas, harvesting of material for subsequent use in restoration construction, habitat layer characteristics, bank stabilization methods, construction of bed/bank interface);

ii. Timing/phasing of remediation activities;

iii. Identification of restoration specialists, roles, and responsibilities;

iv. Specification of pre-construction preparation requirements (e.g., installation of silt fence or other protective/exclusion measures, propagation of materials, monitoring/relocation/propagation of species, field delineation of species occurrences/Vernal Pool boundaries); and

v. Specification of protocols to be implemented prior to and during construction to minimize impacts to threatened, endangered or state-listed species and their habitats, including elements discussed above as well as other measures such as seed-banking, transplanting, wildlife exclusion barriers, and turtle tracking.

(d) Design a Restoration Plan (RP) to return all areas disturbed by the remediation activities to pre-remediation conditions (e.g., the functions, values, characteristics, vegetation, habitat, species use, and other attributes), to the extent feasible and consistent with the remediation requirements. This RP shall include, but not be limited to:

i. Identification of materials, sources, and specifications;

ii. Development of restoration construction plans;

iii. Identification of restoration specialists, roles, and responsibilities;

iv. Revised Monitoring Program; and

v. Revised Maintenance Program.

2. River Sediment and Banks

a. Reach 5A

(1) Performance Standards

(a) Throughout Reach 5A, river bed sediment shall be removed and an Engineered Cap (references in this Permit to “Engineered Cap” shall mean an Engineered Cap as described below in Section II.B.2.i.) shall be placed over the entire riverbed.

(b) Contaminated soil from eroding riverbanks in Reach 5A shall be removed.

(c) A bank shall be considered contaminated if it contains ≥ 5 mg/kg total PCBs.

(d) A bank shall be considered to be erodible if the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) rating is classified in the BANCS model as "Moderate-High" or greater at the same transect location as the PCB samples.

(e) Excavated riverbanks shall be reconstructed to minimize erosion considering the principles of Natural Channel Design[6] and result in a channel that is in dynamic equilibrium, balances flow and sediment loads, and reduces erosive forces. This will allow the maximum use of bioengineering methods in restoring riverbanks. Riverbank reconstruction shall follow a hierarchy of approaches as follows, with i. being the most preferred.

i. Reconstruct disturbed banks with solely bioengineering restoration techniques;

ii. Reconstruct disturbed banks with an Engineered Cap extending into the riverbank placed under a bioengineering layer; or

iii. Place rip-rap cap or hard armoring on residual surface of banks (e.g., where needed for protection of adjacent infrastructure).

(f) Implementation of remediation activities shall result in no net loss of flood storage capacity (FSC) and no increase in water surface elevation in this Reach.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall remove sediment, install an Engineered Cap in the entire riverbed, remove riverbank soils, reconstruct the riverbanks, and perform all other related activities. Permittee shall perform the foregoing pursuant to the

[6] Natural Channel Design methods are described in Chapter 11, Rosgen Geomorphic Channel Design, of the Stream Restoration Handbook (Part 654) and in the Natural Channel Design Review Checklist Manual.

Performance Standards and the requirements in Sections II.B.2.a.(2)(a) through II.B.2.a.(2)(d) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Sediment and riverbank removal and subsequent capping shall result in a final grade generally consistent with the original grade or with modifications, as approved by EPA, considering the principles of Natural Channel Design. Performance of removal and capping shall generally use engineering methods employed from within the river channel or other methods approved by EPA.

(b) The location of contaminated eroding riverbanks shall be determined using a BANCS model[7] calibrated for the Housatonic River and the collection of additional riverbank soil PCB data. A bank shall be considered contaminated if it contains ≥ 5 mg/kg total PCBs measured in the surficial 0 to 12 inches as the average of three 12-inch cores taken at the toe, midpoint, and top of the bank at a maximum spacing of every 25 feet of linear bank. The Permittee shall complete bank excavation for the Thiessen polygon[8] representing the sample transect that is contaminated and eroding.[9]

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[7] A description of the BANCS or "Bank Assessment for Non-point source Consequences of Sediment" model can be found at http://water.epa.gov/scitech/datait/tools/warsss/pla_box08.cfm and in the River Stability Field Guide, David Rosgen, copyright 2008 by Wildland Hydrology.

[8] Thiessen polygon method is described in Technical Attachment E of Appendix E to the Consent Decree.

[9] EPA's May 2012 status report entitled "Potential Remediation Approaches to the GE-Pittsfield/Housatonic River Site 'Rest of River' PCB Contamination" (the Status Report) highlighted the objectives of addressing the unacceptable risks posed by PCBs and of minimizing the amount of bank excavation to preserve the dynamic character and related biodiversity and habitats of the river. To that end, the Status Report proposed a remedial approach that, based on data collected prior to the issuance of the Permit, would result in an amount of bank excavation in Reach 5A of 3.5 miles, and an amount of bank excavation in Reach 5B of 0.2 miles. The actual remediation amounts will be determined during remedial design pursuant to the process described herein. If the new data to be collected identifies the need for greater bank excavation, then the foregoing amounts of bank excavation will change based on new data. Consistent with the remedial approach identified in the Status Report, the Corrective Measures for the riverbanks will be designed and implemented to achieve the Performance Standards while minimizing impacts on river dynamics and other ecological processes, and on the abundance of state-listed and other wildlife species and the diversity of their habitats that are supported by the existing river ecosystem.

(c) For Reach 5A banks that do not otherwise require remediation pursuant to Sections II.B.2.a.(2)(a) through II.B.2.a.(2)(b) above, the Permittee shall also evaluate the PCB data, erosion potential, adjacent floodplain removal (if any), constructability issues, and likelihood of future downstream transport at such concentrations should such banks erode, and based on these factors, shall consider supplemental riverbank removal, and shall propose any further action consistent with the evaluation above.

(d) The location of soil excavated shall be determined based on the collection, pursuant to this Permit, of bank soil PCB data and bank erosion/shear stress data, and a further evaluation of bank soils pursuant to subsection (c) of this Section.

b. Reach 5B

(1) Performance Standards

(a) The river bed sediment associated with each discrete sample with ≥ 50 mg/kg total PCBs shall be removed and backfilled. The backfill shall consist of material with characteristics similar to existing sediment and placed to original grade.

(b) Subsequent to excavation and backfill, Enhanced Monitored Natural Recovery (Enhanced MNR or EMNR) shall be implemented throughout Reach 5B. Permittee shall place an amendment such as activated carbon and/or other comparable amendments proposed by Permittee and approved by EPA throughout Reach 5B to reduce the bioavailability of the remaining PCBs in the sediment bed.

(c) The riverbank soil with ≥ 50 mg/kg total PCBs shall be removed, and disturbed banks shall be reconstructed using bioengineering methods to minimize erosion and reduce downstream transport of the residual PCBs in bank soil (see footnote 9).

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall remove sediment, install backfill in the riverbed, implement EMNR, including placement of an amendment such as activated carbon and/or other comparable amendments, remove riverbank soils, reconstruct the riverbanks, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.2.b.(2)(a) through II.B.2.b.(2)(d) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Four cores (thalweg, center, left, right) shall be collected from the surficial 0 to 12 inches of the river bed along transects at a spacing of every 25 linear feet of river channel. Sediment shall be removed from the Thiessen polygon associated with each discrete sample with ≥ 50 mg/kg total PCBs.

(b) Riverbank soil shall be removed from Thiessen polygon represented by a concentration ≥ 50 mg/kg total PCBs in any of three samples (bottom, midpoint, or top of the riverbank) collected from the surficial foot of the riverbank at an interval of 25 feet of linear bank.

(c) For Reach 5B banks that do not otherwise require remediation pursuant to Sections II.B.2.b.(2)(a) and II.B.2.b.(2)(b) above, the Permittee shall also evaluate the PCB data, erosion potential, adjacent floodplain removal (if any), constructability issues, and likelihood of future downstream transport at such concentrations should such banks erode, and, based on these factors, shall consider any supplemental riverbank removal, and shall propose further action consistent with the evaluation above.

(d) The location of soil and sediment excavated per this subsection shall be determined based on the collection of the bank soil and sediment PCB data collected pursuant to this Permit and a further evaluation of bank soils pursuant to subsection (c) of this Section.

c. Reach 5C

(1) Performance Standards

(a) Throughout Reach 5C, sediments shall be removed, including any areas with ≥ 50 mg/kg total PCBs, to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment (0- to 12-inch depth) and subsurface sediment in each averaging area and depth interval.

(b) Permittee shall backfill as necessary to ensure channel stability; however, the placement of backfill shall not be considered in the spatially-weighted averaging calculations. The backfill shall be a minimum of 6 inches and consist of material with characteristics similar to existing sediment to provide functions and values equivalent to the pre-existing surficial sediment substrate.

(c) Sediment shall be removed with either dredging or wet excavation techniques to be approved by EPA and, if feasible, conveyed hydraulically to the Upland Disposal Facility location for processing.

(d) Implementation of remediation activities shall result in no net loss of FSC and no increase in water surface elevation in this Reach.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall remove sediment and backfill the riverbed and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.2.c.(2)(a) and II.B.2.c.(2)(b) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall propose in Work Plans separate averaging areas within Reach 5C, additional sampling for PCBs, and a method for averaging surface and subsurface PCB concentrations, including proposed depth intervals.

(b) River bed sediment shall be removed, generally using engineering methods employed from within the river channel with dredging or wet excavation techniques to be approved by EPA. Regardless of sediment removal technique, the sediment shall, if feasible, be conveyed hydraulically to the Upland Disposal Facility location for processing. Sediment removal and subsequent backfill shall result in a final grade generally consistent with the original grade or with modifications, as approved by EPA, considering the principles of Natural Channel Design.

d. Backwaters adjacent to Reaches 5, 6, and 7

(1) Performance Standards

(a) For contaminated sediment in the portions of Backwaters located outside of Core Area 1 Priority Habitat (as generally shown in Attachment B):

i. For surface sediment (0- to 12-inch depth): remove sufficient sediment, including any areas ≥ 50 mg/kg total PCBs, and replace with a contiguous Engineered Cap to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in each averaging area. When calculating post-remediation surficial spatially-weighted average concentrations, a PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in capped areas.

ii. For subsurface sediment: in areas outside the footprint of the Engineered Cap necessary to meet the requirements in Section II.B.2.d.(1)(a)i. above, remove sufficient sediment and replace with a contiguous Engineered Cap(s) to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in subsurface sediment in each averaging area and depth interval. For areas beneath an Engineered Cap, a total PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in spatial-weighting calculations.

iii. In lieu of the provisions in Sections II.B.2.d.(1)(a)i. and II.B.2.d.(1)(a)ii. above, Permittee may propose to excavate sediments, including any areas ≥50 mg/kg total PCBs, to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment (0- to 12-inch depth) and subsurface sediment in each averaging area and depth interval. The placement of backfill shall not be factored in the spatially-weighted averaging calculations.

iv. All backfilling or capping shall result in a final grade generally consistent with the original grade.

(b) In the portions of Backwater areas located within Core Area 1 habitat with discrete total PCB concentrations ≥ 50 mg/kg in surficial (0- to 12-inch) sediment, the sediment for each sample ≥ 50 mg/kg shall be removed followed by placement of an Engineered Cap to original grade.

(c) The Permittee shall place an amendment such as activated carbon and/or other comparable amendments proposed by Permittee and approved by EPA to reduce the bioavailability of the remaining PCBs in areas defined as Core Area 1 habitat where total PCB concentrations are between 1 mg/kg and 50 mg/kg in the surficial (0 to 12 inches) of sediment.

(d) Sediment shall be removed with either dredging or wet excavation techniques to be approved by EPA and, if feasible, conveyed hydraulically to the Upland Disposal Facility location for processing.

(e) Remediation activities shall result in no net loss of FSC and no increase of water surface elevation in this Reach.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall remove sediment, install an Engineered Cap or backfill in the Backwaters, and place an amendment such as activated carbon and/or other comparable amendments in the Backwaters, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.2.d.(2)(a) through II.B.2.d.(2)(c) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall propose in a Pre-Design Work Plan (see Section II.H.3. below) additional sampling for PCBs in sediment, and a method for averaging surface and subsurface PCB concentrations using a 50-foot grid, including proposed averaging areas and depth intervals.

(b) The location of sediment excavated or dredged and/or capped per this subsection shall be determined based on the collection of additional PCB data on a 50-foot sample grid. For Section II.B.2.d.(1)(b), sediment shall be removed from the Thiessen polygon associated with each discrete sample with ≥50 mg/kg total PCBs.

(c) Sediment shall be removed with either dredging or wet excavation techniques to be approved by EPA and, if feasible, conveyed hydraulically to the Upland Disposal Facility location for processing.

e. Woods Pond (Reach 6)

(1) Performance Standards

(a) Sediment shall be removed throughout the pond and an Engineered Cap shall be placed over residual PCBs to result in a post-capping minimum water depth of 6 feet measured from the crest of the dam, except in near-shore areas where the slope from the shore to the 6-foot water depth shall be as steep as possible, while also being stable and not subject to erosion or sloughing. In areas deeper than 6 feet prior to remediation, sufficient sediment shall be removed to allow for the placement of an Engineered Cap so that the final grade is equal to or deeper than the original grade.

(b) Permittee shall conduct updated bathymetric surveys before sediment removal, and before and after capping. The post-capping bathymetry survey shall be the baseline used in determining the amount of future sediment deposition on the Engineered Cap.

(c) If during monitoring following construction, EPA determines that significant concentrations and depths of PCB-contaminated sediment have accumulated above the Engineered Cap in Woods Pond, the Permittee shall remove such accumulated sediment while ensuring the integrity of the Engineered Cap.

(d) Remediation activities shall result in no net loss of FSC and no increase of water surface elevation in this Reach.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall conduct sediment removal, capping, bathymetric surveys, and perform all other related activities. Sediment shall be removed with dredging or wet excavation techniques to be approved by EPA and, if feasible, conveyed hydraulically to the Upland Disposal Facility location for processing. Permittee shall perform the foregoing pursuant to the Performance Standards and in accordance with plans submitted pursuant to Section II.H. below.

f. Columbia Mill Impoundment (Reach 7B), Eagle Mill Impoundment (Reach 7C), Willow Mill Impoundment (Reach 7E), and Glendale Impoundment (Reach 7G).

(1) Performance Standards

(a) For surface sediment (0- to 12-inch depth): remove sufficient sediment, including any areas with $\geq$ 50 mg/kg total PCBs, and replace with a contiguous Engineered Cap to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment in each averaging area. When calculating post-remediation surficial spatially-weighted average concentrations, a total PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in capped areas.

(b) For subsurface sediment: for areas outside the footprint of the Engineered Cap necessary to meet the requirements in Section II.B.2.f.(1)(a) above, remove sufficient sediment and replace with contiguous Engineered Cap(s) to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in subsurface sediment in each averaging area and depth interval. For areas beneath an Engineered Cap, a total PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in spatial-weighting calculations.

(c) Engineered Capping shall result in a final grade generally consistent with original grade. Engineered Capping pursuant to Sections II.B.2.f.(1)(a) and II.B.2.f.(1)(b) above shall not exceed 3 acres within Reach 7E and 6.5 acres within Reach 7G.

(d) For Reaches 7B and 7C, in lieu of the provisions in Sections II.B.2.f.(1)(a) through II.B.2.f.(1)(c) above, Permittee shall remove sediment and remove the dams in these impoundments (which include the coves/ponds adjacent to Columbia Street in Lee). Materials requiring removal under this paragraph shall include sufficient sediment, including any areas with ≥ 50 mg/kg total PCBs, to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs, in surface sediment (0- to 12-inch depth) and subsurface sediment in each averaging area and depth interval. Permittee shall backfill with a minimum of 6 inches of backfill of suitable material and additional material as necessary to ensure channel stability; however, the placement of backfill shall not be considered in the spatially-weighted averaging calculations.

(e) In Reaches 7E and 7G, in lieu of the provisions in Sections II.B.2.f.(1)(a) through II.B.2.f.(1)(c) above, Permittee may propose to excavate sediments, including any areas with ≥ 50 mg/kg total PCBs, to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment (0- to 12-inch depth) and subsurface sediment in each averaging area and depth interval. Permittee shall backfill with a minimum of 6 inches of backfill of suitable material as necessary to ensure channel stability; however, the placement of backfill shall not be considered in the spatially-weighted averaging calculations. Permittee shall use this approach to ensure that no more than 3 acres within Reach 7E and 6.5 acres within Reach 7G require capping.

(f) For Reaches 7E and/or 7G, in lieu of the provisions in Sections II.B.2.f.(1)(a) through II.B.2.f.(1)(c), Permittee may propose to EPA for review and approval that Permittee coordinate with any entity planning to remove any Reach 7 dam. Such proposal shall include a schedule for reaching an agreement with an entity(s) on the scope and extent of the work to be performed, the entity(s) conducting the work, the allocation of costs, and, if applicable, the prompt payment by Permittee of costs in advance of implementation of the necessary work on the dam removal once necessary approvals have been received. Materials requiring removal under this paragraph shall include soil or sediment that could be mobilized downstream as part of dam removal and sediments greater than 1 mg/kg total PCBs in the river bed. For any Floodplain area created as a result of dam removal (former impounded areas exposed due to removal of a dam), Permittee shall follow the process outlined in Section II.B.7.b.(2)(b)ii.[10] If Permittee cannot secure and implement an agreement pursuant to this Section in a timely manner, the Permittee shall implement the requirements in Sections II.B.2.f.(1)(a) through II.B.2.f.(1)(c) above and/or implement actions in Section II.B.2.f.(1)(e) above.

[10] In addition to the requirements outlined above, at the time that the dam removal work is anticipated, EPA expects that there will be an agreement in place that, among other things, will ensure that the planned dam removal and material removal are conducted in accordance with applicable legal requirements, and that will ensure EPA review and approval of work plans and oversight of the sediment removal work.

(g) Remediation activities shall result in no net loss of FSC and no increase of water surface elevation in each of Reaches 7B, 7C, 7E and 7G.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall remove sediment, install an Engineered Cap or backfill in the Impoundments, remove dams in Reaches 7B and 7C, and/or secure and implement an agreement with entity(s) to remove dam(s) in Reaches 7E and/or 7G, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards, the requirements in this Section, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

Permittee shall propose in Work Plans separate averaging areas within each Impoundment, additional sampling for PCBs, and a method for averaging surface and subsurface PCB concentrations using a 50-foot grid, including proposed depth intervals. This plan shall include characterization for the three approaches in Sections II.B.2.f.(1)(a) through II.B.2.f.(1)(f) above.

g. Rising Pond (Reach 8)

(1) Performance Standards

(a) For surface sediment (0- to 12-inch depth): remove sufficient sediment, including any areas with ≥ 50 mg/kg total PCBs, and replace with a contiguous Engineered Cap to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment in each averaging area. When calculating post-remediation surficial spatially-weighted average concentrations, a total PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in capped areas.

(b) For subsurface sediment: for areas outside the footprint of the Engineered Cap necessary to meet the requirements in Section II.B.2.g.(1)(a) above, remove sufficient sediment and replace with contiguous Engineered Cap(s) to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in subsurface sediment in each averaging area and depth interval. For areas beneath an Engineered Cap, a total PCB concentration equal to 1% of the existing average surficial concentration shall be used as the PCB concentration in spatial-weighting calculations.

(c) Engineered Capping shall result in a final grade generally consistent with original grade. Engineered Capping pursuant to Sections II.B.2.g.(1)(a) and II.B.2.g.(1)(b) above shall not exceed 31 acres.

(d) In lieu of the provisions in Sections II.B.2.g.(1)(a) through II.B.2.g.(1)(c) above, the Permittee may propose to excavate sediments, including any areas with ≥ 50 mg/kg PCBs, to achieve a spatially-weighted average concentration of 1 mg/kg total PCBs in surface sediment (0- to 12-inch depth) and subsurface sediment in each averaging area and depth interval. Permittee shall backfill with a minimum of 6 inches of backfill of suitable material as necessary to ensure channel stability; however, the placement of backfill shall not be considered in the spatially-weighted averaging calculations. Permittee shall use this approach to ensure that no more than 31 acres within Reach 8 require capping.

(e) Permittee shall conduct updated bathymetric surveys before sediment removal and before and after capping. The post-capping bathymetry survey shall be the baseline used in determining the amount of future sediment deposition.

(f) If during monitoring following construction, EPA determines that significant concentrations and depths of PCB-contaminated sediment have accumulated, the Permittee shall remove such accumulated sediment while ensuring the integrity of the Engineered Cap, where present.

(g) Remediation activities shall result in no net loss of FSC and no increase of water surface elevation in this Reach.

(2) Corrective Measures

To achieve and maintain Performance Standards, Permittee shall remove sediment, install an Engineered Cap or backfill, conduct bathymetric surveys and monitoring activities, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in this Section, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

Permittee shall propose in a Pre-Design Work Plan (see Section II.H.3. below) separate averaging areas within the pond, additional sampling for PCBs on a 50-foot grid, and a method for averaging surface and subsurface PCB concentrations, including proposed depth intervals. For Section II.B.2.g.(1)(d), sediment shall be removed from the Thiessen polygon associated from each discrete sample with ≥ 50 mg/kg total PCBs.

h. Flowing Subreaches in Reach 7 and Throughout Reaches 9 Through 16, Including Impoundments

(1) Performance Standard

Monitored Natural Recovery (MNR) shall be implemented in these reaches.

(2) Corrective Measure

To achieve and maintain this Performance Standard, Permittee shall conduct monitoring of PCB concentrations in affected media (including surface water, sediment, and biota) in these reaches to see if recovery is occurring at the expected rate, maintain institutional controls, and perform all other related activities. Permittee shall perform the foregoing pursuant the Performance Standard and in accordance with Sections II.B.4., II.B.7., and II.H. of this Permit.

i. Engineered Caps

(1) Performance Standards

(a) All Engineered Caps constructed shall include the following layers or functions:

i. A Mixing Layer to prevent contamination of the chemical isolation layer due to mixing with underlying contaminated sediment during cap placement, taking into account geotechnical considerations, placement techniques, and other factors as appropriate.

ii. Chemical Isolation Layer sufficient to minimize (reduce by 99%) the flux of PCB concentrations through the isolation layer.

iii. Erosion Protection Layer to prevent erosion in accordance with federal and state requirements and consistent with pertinent EPA or U.S. Army Corps of Engineers (USACE) guidance.

iv. Geotechnical Filter Layer, as needed based on the design evaluation, to prevent mixing between other layers.

v. Bioturbation Layer to prevent bioturbation from impacting underlying layers.

vi. Habitat Layer to provide functions and values equivalent to the pre-existing surficial sediment substrate.

(b) Installation of the cap shall not result in a loss of FSC, and there shall be no increase in water surface elevations in any of the reaches where Engineered Caps are installed.

(c) Engineered Caps shall be inspected, monitored, and maintained to ensure long-term protectiveness and to ensure that they continue to function as designed.

(2) Corrective Measures

To achieve and maintain these Performance Standards, the Permittee shall design, construct, inspect, monitor, and maintain Engineered Caps and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Section II.B.2.i.(2), including, but not limited to, Sections II.B.2.i.(2)(a) through II.B.2.i.(2)(g) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

The Permittee shall design and construct all Engineered Caps to physically isolate contaminated sediments from potential ecological and human receptors, and minimize the transport of PCBs from the sediment beneath the caps to the bioavailable surface layer and the water column, consistent with the principles presented in pertinent EPA or

USACE guidance such as EPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005) and Guidance for In-Situ Subaqueous Capping of Contaminated Sediments (Palermo et al., 1998) and in accordance with federal and state requirements.

Engineered Cap designs generally specify mixing, chemical isolation, erosion protection, filter, bioturbation, and habitat layer(s). They also may specify the inclusion of an amendment such as activated carbon where necessary to minimize the flux of PCBs. Under some circumstances, a single layer of material may serve more than one purpose in achieving the Performance Standards above. Engineered Cap design must also take into account constructability concerns (e.g., placement tolerances, method of construction). The design process shall address the following items:

(a) Mixing Layer

Evaluate the composition and thickness necessary to meet the Performance Standard.

(b) Chemical Isolation Layer

i. Modeling of the isolation layer shall be performed in general accordance with EPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005) and Guidance for In-Situ Subaqueous Capping of Contaminated Sediments (Palermo et al., 1998).

ii. Modeling shall be conducted using site-specific data collected during the design process, as appropriate.

iii. Modeling shall consider the processes of advection, diffusion, sorption, bioturbation, and exchange with the surface water, and sediment deposition consistent with current state-of-the practice for cap design.

iv. Modeling shall be used to determine the thickness and composition (i.e., the amount of activated carbon/total organic carbon (TOC) or equivalent sorptive amendment) of the chemical isolation layer sufficient to meet Performance Standards.

(c) Erosion Protection Layer

i. The stable particle sizes necessary to resist the erosive forces in the different reaches of the Housatonic River shall be computed in accordance with federal and state requirements and consistent with pertinent EPA and USACE guidance such as EPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005) and Guidance for In-Situ Subaqueous Capping of Contaminated Sediments (Palermo et al., 1998).

ii. The design flow event for the erosion protection layer is a flow event up to and including the applicable return interval event (for example, 100 year or 500 year flow event), which shall be calculated using up-to-date flow data. However, consideration shall also be given during the cap design to the potential impact of climate change on cap performance, and to including appropriate measures to mitigate the potential impacts.

iii. Site-specific data and modeling will be used to determine the design velocities and associated bed shear stresses associated with various flow events.

iv. In addition, other potential erosional forces, including, but not limited to, bioturbation, wind-generated waves, debris, motor boat wakes, and ice impacts will be considered.

(d) Geotechnical Filter Layer

The use of a geotechnical filter layer between the chemical isolation layer material and erosion protection layer material shall be evaluated and may be necessary for those areas requiring cobble or larger sized material in the erosion protection layer.

(e) Bioturbation Layer

The assemblage of species, bioturbation depth profile, and abundances of dominant organisms shall be evaluated to determine the need for and thickness of a bioturbation layer to be included.

(f) Habitat Layer

Engineered Caps shall include a habitat layer that provides functions and values equivalent to the pre-existing surficial sediment substrate.

(g) Other Design Considerations

i. The geotechnical stability of the caps (e.g., bearing capacity, slope stability, ebullition) shall be evaluated.

ii. The need for over-placement allowances with additional excavation for each layer shall be considered.

iii. The requirement for periodic removal of contaminated sediment that accumulates on top of the Engineered Caps at Woods Pond and Rising Pond shall be considered in the design of such Engineered Caps.

j. Additional Response Actions and/or Inspection, Monitoring and Maintenance for Dams and Impoundments in Reaches 5 through 9

(1) Performance Standards

(a) The Permittee shall minimize PCB releases related to dams and Impoundments by ensuring inspection, monitoring, and maintenance of such dams and Impoundments, and operating the Woods Pond and Rising Pond Dams.

(b) If there is a catastrophic failure and/or a material breach of any dam or component of the dam that results in a release of PCBs that is materially greater than the PCB transport from that dam under the normal range of flow conditions, the Permittee shall propose and implement a response to maintain the Performance Standards or to maintain the effectiveness of the Rest of River Remedial Action.

(c) The Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work including, but not limited to, dam removal (either before or after completion of any response action conducted pursuant to Sections II.B.2.e. through II.B.2.g. above). Permittee shall conduct such response actions (including material handling and off-site disposal and engineering controls) to allow such Legally Permissible Future Project or Work to be conducted in a manner that maintains Performance Standards and/or maintains the effectiveness of the Rest of River Remedial Action.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall perform the following: ensure the inspection, monitoring, and maintenance of the dams, and/or Impoundments; operate Woods Pond and Rising Pond Dams to minimize releases; conduct response actions to be protective of any Legally Permissible Future Project or Work including, but not limited to dam removal; if there is a catastrophic failure and/or material breach of any dam or dam component, propose and respond to such release to maintain the Performance Standards or to maintain the effectiveness of the Rest of River Remedial Action; and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards, the requirements in Sections II.B.2.j.(2)(a) through II.B.2.j.(2)(e) below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall operate, inspect, monitor, and maintain Woods Pond and Rising Pond Dams, even if the Permittee transfers ownership interest in the dams. Such activities shall include, (i) maintaining the integrity of the dam to contain contaminated sediments and (ii) conducting materials handling and off-site disposal and engineering controls related to dam maintenance, repair, upgrades, and enhancement activities (including, but not limited to, addressing sedimentation in sluiceways, conveyances, and other channels that transport water over, through or around the dam); and (iii) and all other related activities. Upon conveyance of either dam, Permittee may seek EPA approval for another party to implement some or all of Permittee's operation, inspection, monitoring and maintenance obligations.

(b) For all other dams, except Eagle Mill Dam remnants, and Impoundments in Massachusetts Permittee shall ensure inspection, monitoring and maintenance for such dams. Such activities shall include, (i) maintaining the integrity of the dam to contain contaminated sediments, and (ii) conducting materials handling and off-site disposal, and engineering controls related to dam maintenance, repair, upgrades, and enhancement activities (including, but not limited to, addressing sedimentation in sluiceways, conveyances, and other channels that transport water over, through or around the dam) and (iii) and all other related activities. Permittee shall make best efforts to obtain an access agreement with each owner of a dam to allow Permittee to perform such inspection, monitoring and maintenance activities. Permittee may seek EPA approval for another party to implement some or all of the Permittee's inspection, monitoring and maintenance activities. If Permittee uses best efforts but cannot fulfill these obligations, Permittee may submit to EPA for review and approval a plan that includes, without limitation, the reasons why Permittee cannot fulfill these obligations, any proposed actions Permittee will take to remediate the PCB contamination behind the dams, any further actions to be taken to obtain agreement from the dam owner, and whether the Engineered Caps will maintain effectiveness without Permittee having fulfilled its obligations regarding dam inspection, monitoring and maintenance.

(c) If there is a catastrophic failure and/or a material breach of any dam or dam component that results in a release of PCBs from the dam that is materially greater than the PCB transport from that dam and/or Impoundment under the normal range of flow conditions, Permittee shall, within thirty (30) days of notification by EPA of such failure or breach, submit a Report for EPA approval that (i) proposes repairs to, or removal of, such dam, and (ii) proposes a plan to characterize and respond to the

PCBs released by such failure and/or breach (if necessary to maintain the Performance Standards or to maintain the effectiveness of the Rest of River Remedial Action). The Report shall include a proposed schedule to implement the required response actions. Following receipt of EPA's approval of the Report and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule.

(d) Permittee shall every five years determine whether there has been a change in ownership of any dam. In addition, within 30 days of conducting response actions behind a dam, and at any time there is a change in ownership of such dam, and every five years after any of the foregoing events, Permittee shall provide notice to such dam owner (for the initial notice, notice shall also be sent to any holders of easements), with copies to EPA, MA DEP, CT DEEP, and applicable regulatory agencies, of:

i. A commitment that the Permittee will conduct the requirements set forth in Sections II.B.2.j.(1)(b) and II.B.2.j.(1)(c) above, and will conduct response actions including inspections, monitoring and maintenance (such as dam maintenance, repair, upgrades, and enhancement activities), including, without limitation, engineering controls, restoration of any aspect of the Rest of River Remedial Action disturbed by such work, and materials handling and off-site disposal. For any activities that would involve the removal, disposal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such excavation activities, in accordance with applicable laws and regulations.

ii. Notice of contact persons for Permittee, EPA, MA DEP, and CT DEEP and a request that the property owner notify the contact persons prior to conducting work at the dam, and

iii. A description of the PCB contamination behind the dam, including the presence of an Engineered Cap, if applicable.

(e) If Permittee or another entity implements a Legally Permissible Future Project or Work including, but not limited to, the removal of any dam (either before or after completion of any response actions conducted pursuant to Sections II.B.2.e. through II.B.2.g. above), Permittee shall conduct sufficient response actions (including materials handling and off-site disposal and engineering controls) to allow such Legally Permissible Future Project or Work to be conducted in a manner that maintains the Performance Standards and/or maintains the effectiveness of the Rest of River Remedial Action. Permittee may seek EPA approval for another party to implement some or all of these obligations. Further response actions under this Section II.B.2.j. will be (i) in accordance with and pursuant to the Consent Decree; and (ii) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

k. Additional Response Actions for Sediment, Riverbanks, Backwaters, Impoundments in Reaches 5 through 9

(1) Performance Standard

The Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work. Permittee shall conduct such response actions (including material handling and off-site disposal and engineering controls) to allow such Legally Permissible Future Project or Work to be conducted in a manner that maintains Performance Standards and/or maintains the effectiveness of the Rest of River Remedial Action.

(2) Corrective Measures

To achieve and maintain this Performance Standard, Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work. Such response actions may include, without limitation, material handling and off-site disposal and engineering controls, repairing any aspect of the Rest of River Remedial Action disturbed by such Legally Permissible Future Project or Work, and all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards, the requirements in Sections II.B.2.k.(2)(a) and II.B.2.k.(2)(b) below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work. Within 30 days of Permittee receiving notification from EPA that EPA has determined that an entity has met the criteria for a Legally Permissible Future Project or Work, Permittee shall submit to EPA for approval, a work plan and schedule to respond to such Legally Permissible Future Project or Work. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such excavation activities, in accordance with applicable laws and regulations. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations. Further response actions under this Section II.B.2.k. will be (i) in accordance with and pursuant to the Consent Decree; and (ii) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

(b) Permittee shall annually provide letters to the Conservation Commissions and Departments of Public Works ("DPWs") for the municipalities located along the River, and the Massachusetts Department of Transportation District 1 ("MA DOT") (with copies to EPA, MA DEP, and CT DEEP), that provide notice of the potential for contamination and request that such entities notify Permittee, EPA, MA DEP, CT DEEP prior to approving any application for and prior to implementing any Legally Permissible Future Project or Work in the Reaches 5 through 9 of the River and/or Floodplains.

l. Additional Response Actions for Dams and Impoundments and Sediment, Riverbanks, and Backwaters in Reaches 10 through 16

(1) Performance Standards

(a) The Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work, where documentation is provided that such Legally Permissible Future Project or Work requires the handling or disturbance of sediment or riverbank soils with total PCBs greater than 1 mg/kg. Permittee shall conduct such response actions (including material handling and off-site disposal and engineering controls) to allow such Legally Permissible Future Project or Work to be conducted in a manner that maintains Performance Standards and/or maintains the effectiveness of the Rest of River Remedial Action.

(b) If there is a catastrophic failure and/or a material breach of any dam or dam components that results in a release of PCBs that is materially greater than the PCB transport from that dam under the normal range of flow conditions, the Permittee shall propose and implement a response to maintain the Performance Standards and/or to maintain the effectiveness of the Rest of River Remedial Action.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work including, without limitation, engineering controls, and materials handling and off-site disposal, and if there is a catastrophic failure and/or material breach of any dam or dam component, propose and respond to such release, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards, the requirements in Sections II.B.2.l.(2)(a) through II.B.2.l.(2)(d) below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall conduct further response actions to be protective of any Legally Permissible Future Project or Work. Within 30 days of Permittee receiving notification from EPA that that EPA has determined a) that an entity has met the criteria for a Legally Permissible Project or Work, and b) that such Legally Permissible Project or Work requires the handling or disturbance of sediment or riverbank soils with total PCBs greater than 1 mg/kg, Permittee shall submit to EPA for approval, a work plan and schedule to respond to such Project or Work, including, without limitation, sampling and analysis, engineering controls, and materials handling and off-site disposal. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such excavation activities, in accordance with applicable laws and regulations. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations.

(b) Permittee shall every five years, determine whether there has been a change in ownership of each dam. In addition, any time there is a change in ownership of such property, and every five years thereafter, Permittee shall provide notice to the dam owner (for the initial notice, notice shall also be sent to any holders of easements), with copies to EPA, CT DEEP and applicable regulatory agencies, of:

i. A commitment that the Permittee will conduct the requirements set forth in Section II.B.2.l.(2)(a) above, and will conduct response actions to be protective of any Legally Permissible Future Project or Work in locations where documentation is provided that such Project or Work requires the handling or disturbance of sediment or riverbank soils with total PCBs greater than 1 mg/kg. Such response actions include, without limitation, sampling and analysis, engineering controls, and materials handling and off-site disposal. For any activities that would involve materials handling or the removal of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper handling, management, and off-site disposal of such materials and the protection of workers and other individuals during such excavation activities, in accordance with applicable laws and regulations.

ii. Notice of contact persons for Permittee, EPA and CT DEEP, and

iii. A description of the PCB contamination behind the dam.

(c) If there is a catastrophic failure and/or a material breach of any dam or dam component that results in a release of PCBs from the dam that is materially greater than the PCB transport from that that dam under the normal range of flow conditions, Permittee, shall within thirty (30) days of notification by EPA of such failure of breach, submit a Report for EPA approval that (i) proposes repairs to such dam and (ii) proposes a plan to characterize and respond to the PCBs released by such failure and/or breach (if necessary to maintain the Performance Standards or to maintain the effectiveness of the Rest of River Remedial Action). The report shall include a proposed schedule to implement the required response actions. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with

EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations.

(d) Further response actions under this Section II.B.2.l. will be (i) in accordance with and pursuant to the Consent Decree; and (ii) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

3. Floodplain and Vernal Pools

a. Floodplain Soil Adjacent to Reaches 5 through 8

(1) Performance Standards

(a) Primary Floodplain Performance Standards and Secondary Floodplain Performance Standards are outlined in Table 1.

(b) For each Exposure Area (see Figures 3, 3A, and 4), excavate and replace the top 12 inches of soil to achieve either the Primary Floodplain Performance Standards or Secondary Floodplain Performance Standards based upon the approach set forth in Section II.B.3.a.(2) below. The excavated areas shall be backfilled to original grade.

(c) In addition, for each Frequently Used Subarea (shown in Figure 5), excavate and replace the top 3 feet of soil to achieve the Performance Standards presented in Table 2. The excavated areas shall be backfilled to original grade.

(d) For Residential Floodplain Parcels adjacent to Reach 5A, as identified in Table 5, Permittee shall excavate and replace soil to achieve the Residential Performance Standards set forth in Table 3. For the residential floodplain properties in Reach 5C that are identified in Table 5, Permittee shall, if the Town of Lenox determines that any of the property owners consent to such removal, excavate and replace soil at such consented-to property(ies) to achieve the Residential Performance Standards set forth in Table 3.

(e) Permittee shall avoid excavation in Core Area 1 habitat (other than Frequently Used Subareas) except in limited areas where necessary to meet Secondary Floodplain Performance Standards in Table 1.

(f) Permittee shall minimize the impacts from remediation on a case-by-case basis[11] for Core Areas 2 and 3 (as shown in Attachment B); however, at a minimum, Secondary Floodplain Performance Standards in Table 1 shall be attained.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall excavate and backfill Floodplain soil and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.3.a.(2)(a) through II.B.3.a.(2)(g) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) The Permittee shall conduct additional sampling of Floodplain soil (as needed) to determine the total PCB exposure point concentration (EPC)[12] for each Exposure Area using a Thiessen polygon approach.

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[11] Minimization of impacts from remediation of Floodplain and Vernal Pool soil in Core Area 2 and 3 habitat means the implementation of a range of best construction practices that includes, but is not limited to, minimizing impacts when determining the location and scale of staging areas and access roads, phasing the work, use of time of year restrictions, tracking and/or exclusion of animals from work areas, plant transplantation. Minimization of impacts may also include the avoidance of remediation in certain areas where, e.g., the impact to state-listed species or their habitats of constructing an access road or a staging area to remediate such areas outweighs the benefits of remediation. Permittee may propose areas to avoid excavating based on this concept; however, final approval of any avoidance in Core Area 2 and 3 habitats will be made by EPA, after consultation with the States.

[12] EPCs for properties being cleaned to residential standards shall be calculated using the spatial averaging procedures outlined in Attachment E to Appendix E of the Consent Decree and used to evaluate the actual and potential lawns of floodplain residential properties under the CD. For the remaining exposure areas, the EPCs shall be calculated using the methods described in Appendix D to the GE's Corrective Measures Proposal and subsequent revisions described in Section 4.4 in GE's October 2010 Revised Corrective Measures Study, including the use of an approved 95th Upper Confidence Limit method to estimate the mean concentration of total PCBs, the use of spatially interpolated representation of Floodplain soil PCB data, and factoring in habitat community mapping where applicable.

(b) Where applicable per Section II.B.3.a.(1)(d), the Permittee shall submit to EPA for approval a proposed remediation plan based on meeting the Residential Performance Standards in Table 3.

(c) The Permittee shall submit to EPA for approval a proposed remediation plan based on meeting Primary Floodplain Performance Standards in Table 1 for each Exposure Area and the Performance Standards in Table 2 in each Frequently Used Subarea using the following approach:

i. Remediation in Frequently Used Subareas to attain Floodplain Performance Standards in Table 2;

ii. Remediation in all Exposure Areas to attain Primary Floodplain Performance Standards in Table 1;

iii. A proposal for avoidance of Core Area 1 habitat (other than Frequently Used Subareas) except in limited areas where necessary to meet Secondary Floodplain Performance Standards in Table 1; and

iv. A proposal for minimization on a case-by-case basis for Core Areas 2 and 3 (as shown in Attachment B); however, at a minimum, Secondary Floodplain Performance Standards in Table 1 shall be attained.

(d) Based on the proposal submitted pursuant to Section II.B.3.a.(2)(c) above, EPA shall identify any modification to areas proposed to be avoided, and the Permittee shall recalculate the EPC, to ensure that the resultant excavation plan meets, at a minimum, Secondary Floodplain Performance Standards in Table 1 in each Exposure Area as a whole and the Performance Standards in Table 2 for Frequently Used Subareas.

(e) To the extent that Secondary Floodplain Performance Standards are not met in each Exposure Area as a whole, the Permittee shall propose additional areas to be excavated in order to meet, at a minimum, Secondary Performance Standards in the Exposure Area as a whole, repeating the steps in Sections II.B.3.a.(2)(c) and II.B.3.a.(2)(d) as needed.

(f) In conjunction with the steps in Sections II.B.3.a.(2)(c) through II.B.3.a.(2)(e), the Permittee shall also evaluate the presence of any areas of remaining PCB concentrations in Floodplain soil for erosion potential and the likelihood of future downstream transport at concentrations that could result in the exceedance of the General Performance Standards specified in Sections II.B.1.a. and II.B.1.b. Based on the erosion potential and likelihood of future downstream transport at such concentrations, the Permittee shall reevaluate, as needed, any area of proposed Floodplain soil remediation, considering the steps in Sections II.B.3.a.(2)(c) through II.B.3.a.(2)(e) above, and shall propose further action as necessary.

(g) The Permittee shall submit the revised evaluation to EPA. Upon approval by EPA, the Permittee shall implement the required actions.

b. Vernal Pools Adjacent to Reaches 5 Through 8

(1) Performance Standards

(a) In addition to any remediation conducted in Vernal Pools in order to meet the Floodplain Performance Standards in Section II.B.3.a.(1) above, the Permittee shall remediate Vernal Pools that exceed a spatially-weighted average concentration of 3.3 mg/kg total PCBs (based upon risk to amphibians).

(b) The Permittee shall evaluate the best approach to remediation of Vernal Pools by first conducting a pilot study on not more than ten (10) vernal pools ("Pilot Vernal Pools"), evaluating the following approaches:

i. On a select number of Pilot Vernal Pools, place an amendment such as activated carbon and/or other comparable amendments in Vernal Pools that exceed a spatially-weighted average concentration of

3.3 mg/kg total PCBs to reduce the bioavailability of PCBs to a level less than or equivalent to the bioavailability of PCBs associated with 3.3 mg/kg total PCBs in sediment.

ii. On a select number of Pilot Vernal Pools, excavate soil and backfill Vernal Pools to pre-excavation elevations to achieve a spatially-weighted average concentration of 3.3 mg/kg total PCBs in each Vernal Pool except for Vernal Pools in Core Area 1, where no excavation shall occur. Permittee shall minimize the impacts from excavation in Vernal Pools in Core Areas 2 and 3 (as shown in Attachment B) on a case by case basis in the manner described in footnote 11.

iii. Based on EPA's evaluation of the initial pilot round of Vernal Pool remediation and restoration and taking into the consideration the Core Area habitat, EPA will determine the preferred method/approach to remediation and restoration of each subsequent Vernal Pool and the Permittee shall implement this approach.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall place an amendment such as activated carbon and/or other comparable amendments, and/or conduct excavation and backfill, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.3.b.(2)(a) through II.B.3.b.(2)(h) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(a) The Permittee shall submit a plan to EPA and, upon approval, conduct one or more site visits to identify potential Vernal Pools. EPA will make the determination as to what constitutes a Vernal Pool. Areas determined not to be Vernal Pools shall be considered Backwaters or Floodplain soil under Sections II.B.2.d or II.B.3.a, respectively, depending on whether or not the area is typically inundated.

(b) The Permittee shall conduct additional sampling and characterization of Vernal Pools, to generate baseline data on the concentrations of total PCBs, the presence and abundance of animal species and a range of taxa, including, but not limited to, threatened, endangered or state-listed species, and water and soil chemistry. The Permittee shall also conduct additional field reconnaissance as needed to evaluate the potential ecological effects of remediation of the Vernal Pools. The Permittee shall conduct the above actions in accordance with a work plan approved by EPA.

(c) The Permittee shall identify Vernal Pools that exceed a spatially-weighted average concentration 3.3 mg/kg total PCBs.

(d) The Permittee shall submit a plan for EPA approval proposing the number of Vernal Pools to be piloted for remediation by both the use of activated carbon or other comparable sediment amendment and for remediation by traditional excavation and restoration methods. For both methods, Permittee shall submit plans describing the methods to be used and the criteria for success for both reduction of bioavailability/concentration of PCBs and impact to ecological receptors and as outlined below.

(e) Permittee shall, in the plan referenced immediately above, describe the type of activated carbon or other comparable sediment amendment, how it would be applied, and a method to measure the effectiveness of activated carbon or sediment amendment to meet the Performance Standard for reduction in PCB bioavailability in Sections II.B.3.b.(1)(a) and II.B.3.b.(1)(b) above. Such methods may include, but are not limited to, measuring the reduction in PCB concentrations in porewater, surface water, benthic invertebrates and/or other biota. The plan shall also identify the criteria for success and how to measure the ecological effects of the placement of activated carbon or sediment amendment in comparison to the pre-remediation conditions documented in Section II.B.3.b.(2)(b) above.

(f) Permittee shall, upon EPA approval of the plan submitted pursuant to Section II.B.3.b.(2)(d) above, implement the placement of activated carbon and/or other comparable sediment amendment in an initial set of Vernal Pools and submit a report describing the following: the effectiveness of placement activities in achieving the Performance Standards in Sections II.B.3.b.(1)(a) and II.B.3.b.(1)(b) and Section II.B.1.c. above; the ecological effects of the activated carbon and/or other comparable sediment amendment on Vernal Pools compared to the criteria for success; any suggested modifications to the procedures; and a proposal for how to address the remaining Vernal Pools such that the Performance Standard in Sections II.B.3.b.(1)(a) or II.B.3.b.(1)(b) will be met.

(g) The Permittee shall submit a plan for remediation by excavation and backfill of an initial number of pools, to achieve a spatially-weighted average concentration of 3.3 mg/kg total PCBs in each Vernal Pool. Permittee shall, upon EPA approval of the plan, implement this method and submit a report describing the following: the effectiveness of excavation and backfill activities in achieving the Performance Standards in Sections II.B.3.b.(1)(a) and II.B.3.b.(1)(b) and Section II.B.1.c. above; the ecological effects of the excavation and backfill on Vernal Pools compared to the criteria for success; and any suggested modifications to the procedures. Permittee shall conduct subsequent remediation activities using excavation and backfill pursuant to EPA approval of this report.

(h) Upon EPA review and approval of the reports submitted pursuant to Sections II.B.3.b.(2)(e) through II.B.3.b.(2)(g) above, after providing an informal opportunity for public input, Permittee shall proceed with remediation of the remaining Vernal Pools with the placement of activated carbon and/or other comparable amendment, or implementation of excavation and backfill (excluding Vernal Pools in Core Area 1), or a combination of the two methods. The excavation and backfill shall be conducted such that the hydrology necessary for a Vernal Pool is not adversely affected.

4. Inspection, Monitoring and Maintenance for All Response Actions Except for Those Related to the Upland Disposal Facility.

a. Performance Standard

Permittee shall implement a baseline and construction monitoring program and an inspection, monitoring and maintenance program.

b. Corrective Measure

To achieve and maintain this Performance Standard, Permittee shall implement baseline and construction monitoring, and inspection, monitoring and maintenance activities, and perform all other related activities. Permittee shall perform the foregoing pursuant to this Performance Standard and the requirements in Sections II.B.4.b.(1) and II.B.4.b.(2) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(1) Baseline and Construction Monitoring Program

A baseline and construction monitoring program shall be implemented, including but not limited to, the following:

(a) Prior to the commencement of construction activities, PCB data in surface water, sediment, and biota (and other data) shall be collected to serve as a baseline for the evaluation of the potential impacts of the Corrective Measures and project operations as well as to inform model parameterization in the model re-evaluation plan.

(b) The Permittee shall propose a program to minimize adverse impacts of construction activities on the environment (e.g., resuspension) including:

i. Measures to assess these impacts (e.g., establishing notification and action levels for PCBs measured in surface water);

ii. A monitoring plan to collect these data; and

iii. Establishing response actions (e.g., slowdown and evaluation of operations, stop work and modification of operations, etc.).

This program shall be designed to be consistent with an adaptive management approach, as outlined in Section II.F. below.

(2) An inspection, monitoring, and maintenance program shall be conducted in phases and be implemented upon completion of each phase of the Rest of River Remedial Action, except for areas subject to MNR. For areas where MNR is the Performance Standard, monitoring shall begin with baseline monitoring and shall continue throughout the Remedial Action and O&M.

The inspection, monitoring, and maintenance program shall be implemented throughout the Remedial Action to evaluate the effectiveness of the Corrective Measures in achieving Performance Standards, to evaluate MNR, to monitor the sediment accumulation above the Engineered Caps at Woods Pond and Rising Pond, and to conduct maintenance, repair, or other response actions necessary to achieve and maintain compliance with Performance Standards. This program shall be designed to be consistent with an adaptive management approach as outlined in Section II.F. below.

5. Upland Disposal Facility

a. Performance Standards

(1) The Permittee shall construct an Upland Disposal Facility to contain certain sediment, floodplain soils and other waste material (as defined in the Consent Decree) generated as part of the Rest of River Remedial Action that meet the Acceptance Criteria in Attachment E to this Permit at the location shown in Figure 6.

(2) The Upland Disposal Facility shall meet the following design Performance Standards:

(a) The Upland Disposal Facility shall have a maximum design capacity of 1.3 million cubic yards.

(b) The landfill consolidation area shall have a maximum footprint of 20 acres and a maximum elevation of 1,099 feet above mean sea level. If the seasonally high groundwater elevation is determined to be higher than 950 feet above mean sea level, the maximum elevation of the landfill consolidation area may be increased by the number of feet that is the difference between the seasonally high groundwater elevation and 950 feet above mean sea level in order for the Upland Disposal Facility to have a maximum capacity of 1.3 million cubic yards.

(c) The Upland Disposal Facility shall consist of a double bottom liner, separated by a drainage layer, and shall incorporate primary and secondary leachate collection systems.

(d) The bottom liner of the landfill will be installed a minimum of 15 feet above a conservative estimate of the seasonally high groundwater elevation. The seasonally high groundwater elevation will be projected using site-specific groundwater elevation data collected in the location of the Upland Disposal Facility, modified by an appropriate technical method that takes into account historic groundwater level fluctuations at similarly-sited off-site long-term monitoring wells in Massachusetts. The estimation of a seasonally high groundwater elevation will be performed pursuant to a methodology reviewed and approved by EPA. The estimate of seasonally high groundwater elevation shall then be used to support the design of the landfill relative to achieving the required minimum separation distance from the bottom of the liner system to the seasonally high groundwater elevation.

(e) The landfill will be capped with a low-permeability cap to include liner(s) drainage layer(s) and vegetation.

(f) Liners (bottom liners and cap liners) shall have a permeability equal or less than 1×10^{-7} cm/sec, a minimum thickness of 30 mils and be chemically compatible with PCBs.

(g) Landfill design will include a stormwater management system to control surface runoff, to minimize the potential for surface erosion or stormwater contribution to leachate generation.

(h) A groundwater monitoring network shall be designed and installed around the Upland Disposal Facility to monitor for PCBs and other constituents identified in the groundwater monitoring plan as approved or modified by EPA. Groundwater monitoring shall include a sufficient number of monitoring wells to allow detection of groundwater impacts.

(3) Permittee shall identify all non-community and private water supply wells currently within 500 feet of the Upland Disposal Facility consolidation area. Unless the well owner does not consent, Permittee shall pay the installation cost of a connection to public water. In the event that a well owner consents at a later date or any new water users (e.g., new construction) move within 500 feet of the Upland Disposal Facility consolidation area during construction or O&M, Permittee shall pay the installation cost of a connection to public water.

(4) Permittee shall be responsible for the proper functioning of the Upland Disposal Facility landfill during landfill operations and shall remain responsible for the proper O&M of the landfill thereafter. Permittee shall be responsible for the closure of the landfill including the installation of the low-permeability cap and vegetative cover promptly upon EPA's determination that either of the following conditions has occurred: (1) the landfill is full (e.g., when the maximum footprint, elevation and/or design capacity are reached), or (2) excavation and dredging activities conducted as part of the Rest of River Remedial Action are complete. Permittee shall be responsible for post-closure activities and monitoring thereafter.

(5) No material from the Rest of River Remedial Action will be disposed of at any other location in Berkshire County.

(6) No one shall take any materials to the Upland Disposal Facility for disposal except those meeting Acceptance Criteria and generated pursuant to this Permit. No materials from previously remediated sites in the Upper 2-Mile Reach of the Housatonic River cleanup nor any other materials associated with the other response actions conducted pursuant to the Site Consent Decree may be disposed of at the Upland Disposal Facility.

b. Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall construct, operate and maintain an Upland Disposal Facility. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(1) Landfill operations, inspections, maintenance, and air and groundwater sampling activities will be conducted in accordance with approved plans.

(2) Permittee shall include in its landfill design submissions one or more proposals (based on Permittee's consultations with officials from the Town of Lee) describing how Permittee will prepare the Upland Disposal Facility for potential re-use once the landfill is capped if the Town of Lee desires. Any such proposals shall be described in the final Remedial Design/Remedial Action Work Plans.

(3) During the implementation of the Corrective Measures, the Permittee may propose to EPA for approval the use of innovative treatment technologies as part of an adaptive management approach as outlined in Section II.F. below.

6. Off-Site Disposal of Contaminated Sediment and Soil

a. Performance Standards

(1) The Permittee shall dispose of contaminated sediment and soil, as well as other waste material, that do not meet the Acceptance Criteria for the Upland Disposal Facility outlined in Attachment E, and any other waste material that is otherwise not placed in the Upland Disposal Facility, off-site at existing licensed facilities that are approved to receive such waste material and are in compliance with EPA's off-site rule (40 C.F.R. 300.440).

(2) At a minimum, 100,000 cubic yards of PCB-contaminated soil and/or sediment will be disposed of off-site.

b. Corrective Measures

To achieve and maintain this Performance Standard, Permittee shall dispose of certain contaminated sediment and soil, as well as other waste material, at an approved and licensed existing off-site disposal facility and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standard and the requirements in Sections II.B.6.b.(1) and II.B.6.b.(2) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(1) The Permittee shall propose the methods and locations for off-site disposal to EPA for review and approval. Permittee's proposal shall include measures to maximize the transport of such waste material to off-site facilities via rail, to the extent practicable.

(2) During the implementation of the Corrective Measures, the Permittee may propose to EPA for approval the use of innovative treatment technologies as part of an adaptive management approach as outlined in Section II.F. below.

7. Institutional Controls and Related Requirements

a. Biota Consumption Advisories

(1) Performance Standard

The Permittee shall cooperate with and support EPA and the States regarding all biota consumption advisories issued by EPA and/or the States for the Rest of River area until such time that the advisories are discontinued.

(2) Corrective Measures

To achieve and maintain this Performance Standard, the Permittee shall cooperate with and support EPA and the States to improve public awareness of the advisories by conducting the following: preparing, distributing, inspecting, monitoring and maintaining educational and outreach activities, including the producing and posting of signs; providing to hunting and fishing license distributors appropriate written notices regarding such advisories to be included with licenses; and performing all other related activities. Signs and outreach material shall be produced in languages appropriate for communities that hunt or fish in the Rest of River area. Permittee shall perform the foregoing pursuant to the Performance Standard, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

b. Floodplain soils (inclusive of Vernal Pools and Backwaters) in Exposure Areas in Reaches 5 through 8.

(1) Performance Standards

(a) On all property without a registered or recorded Environmental Restriction and Easement (ERE) or Notice ERE (including Conditional Solution properties as discussed below), and for all non-subordinated property interests on properties with an ERE or a Notice ERE, Permittee shall conduct such response actions (including material handling and off-site disposal, engineering controls, repairing any aspect of the Rest of River Remedial Action) to allow such Legally Permissible Future Project or Work to be conducted in a manner that maintains Performance Standards and/or maintains the effectiveness of the Rest of River Remedial Action.

(b) For all Exposure Areas (see Figures 3 and 4) that do not meet the Performance Standard for Residential Use set forth in Table 3, Permittee shall, for the portion of the property within the Exposure Area, record (hereinafter "record" shall mean record or register as appropriate) an ERE or a notice ERE for the purposes of implementing, ensuring non-interference with and/or ensuring the integrity and protectiveness of the response actions performed; or after a response has been implemented pursuant to Section II.B.3. above, implement a Conditional Solution to achieve and maintain the applicable Performance Standard set forth in Tables 3 and/or 4 for any Legally Permissible Future Use and for the purposes of ensuring the integrity and protectiveness of the response actions performed.

(2) Corrective Measures

To achieve and maintain these Performance Standards, Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work, and shall, for all Exposure Areas (see Figures 3 and 4) that do not meet the Performance Standard for Residential Use set forth in Table 3, for the portion of the property within the Exposure Area, record an ERE, a Notice ERE or after a response has been implemented pursuant to Section II.B.3. above implement a Conditional Solution to achieve and maintain the applicable Performance Standard in Tables 3 or 4 for any Legally Permissible Future Use, and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards, the requirements in Sections II.B.7.b.(2)(a) through II.B.7.b.(2)(c) below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Environmental Restriction and Easements:

For all Exposure Areas (see Figures 3 and 4) that do not meet the Performance Standard for Residential Use set forth in Table 3, Permittee shall, for the portion of the property within the Exposure Area:

i. Prepare and record EREs for properties owned by Permittee in accordance with Section XIII of the CD.

ii. Prepare and record Notices of Environmental Restriction and Easements (Notice EREs) for properties owned by the Commonwealth. These activities shall be conducted in accordance with Section XIII and the Twelfth Modification of the Consent Decree.

iii. For properties not owned by Permittee or the Commonwealth, make best efforts to obtain and record an ERE with an offer of appropriate compensation in accordance with Section XIII of the CD. Permittee shall make such best efforts in coordination with requesting access from the property owners to implement the response actions to be conducted pursuant to Section II.B.3. above or on a schedule approved by EPA.

iv. Permittee shall, on an annual basis after the recordation or registration of an ERE or Notice ERE, conduct an inspection of any property with an ERE or a Notice ERE that is not owned by Permittee as generally described in Appendix Q to the Consent Decree. For properties not owned by Permittee or the Commonwealth, Permittee shall also on an annual basis determine if there has been an ownership change in the property. Whenever there is an ownership change, and at a minimum of every two years, Permittee shall send a letter to the property owner notifying them of the presence of the ERE.

(b) Conditional Solutions:

If the owner declines the ERE offer in Section II.B.7.b.(2)(a)iii. above, or an easement holder or an entity with a property interest declines to subordinate its property interest to the ERE, Permittee shall, after a response has been implemented pursuant to Section II.B.3. above, implement a Conditional Solution to be protective of a Legally Permissible Future Project or Work and/or to achieve and maintain the applicable Performance Standards set forth in Table 3 or 4 to be protective of any Legally Permissible Future Use in accordance with the following requirements:

i. Response actions to be protective of a Legally Permissible Future Project or Work:

For any response action to be protective of any Legally Permissible Future Project or Work that would involve handling, excavation, or the removal of sediment or soil, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such sediment or soil, the protection of workers and other individuals during such activities, and restoration of any aspect of the Remedial Action, in accordance with applicable laws and regulations. Further response actions under this Section II.B.7.b. will be (A) in accordance with and pursuant to the Consent Decree; and (B) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

ii. Response Action to achieve and maintain the applicable Performance Standards set forth in Table 3 or 4 to be protective of any Legally Permissible Future Use:

For any change in the exposure scenario basis from Table 1 (or from the exposure scenario basis for subsequent response actions), Permittee shall conduct additional response actions, if necessary, to achieve and maintain the applicable Performance Standards in Tables 3 and/or 4. Permittee shall:

A. Determine the appropriate exposure scenario from Tables 3 and 4.
B. Determine the EPC for the exposure area.
C. Evaluate whether or not the EPC meets the Primary Performance Standard for Table 3 and/or the Performance Standard for Table 4. For non-agricultural future uses, if the EPC exceeds the Primary Performance Standard, follow the procedures outlined in Section II.B.3 of this Permit to determine if additional response actions are required.
D. The Permittee shall submit this evaluation to EPA. Upon approval, by EPA, the Permittee shall implement the required actions.
E. Further response actions under this Section II.B.7.b. will be (I) in accordance with and pursuant to the Consent Decree; and (II) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

iii. Timing Requirements for implementing Sections II.B.7.b.(2)(b)i. and II.B.7.b.(2)(b)ii. above. Permittee shall:

Within 30 days of the date that EPA notifies Permittee in writing that EPA has determined that the criteria for a Legally Permissible Future Use or a Legally Permissible Future Project or Work has been met, Permittee shall submit to EPA for approval, a work plan and schedule for the additional response actions described in Sections II.B.7.b.(2)(b)i. and II.B.7.b.(2)(b)ii above. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations. Further response actions under this Section II.B.7.b. will be (A) in accordance with and pursuant to the Consent Decree; and (B) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

iv. Notifications

Within 30 days of completion of response actions conducted pursuant to Section II.B.3 or Sections II.B.7.b.(2)(b)i. and II.B.7.b.(2)(b)ii above, at any time there is a change in ownership of such property, and no later than every two years after the most recent notification, Permittee shall provide notice to the owner (for the initial notice, notice shall also be sent to any holders of easements), with copies to EPA, MA DEP and applicable regulatory agencies, of:

A. A commitment that the Permittee will conduct the requirements set forth in Sections II.B.7.b.(2)(b)i. through II.B.7.b.(2)(b)iii. above, including the requirements for conducting response actions to be protective of any Legally Permissible Future Project or Work, or any

Legally Permissible Future Use including without limitation, materials handling and off-site disposal, engineering controls, and restoration of any aspect of the Rest of River Remedial Action disturbed by such work. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such activities, in accordance with applicable laws and regulations.

B. A recommendation that the property owner notify EPA or MA DEP prior to conducting soil excavation or disturbance or a change in use. In addition, provide contact persons for Permittee, EPA and MA DEP, and

C. A description of the residual PCB contamination on the property where the Conditional Solution has been implemented.

v. Annual inspections and determinations of property ownership

Following the implementation of any Conditional Solution pursuant to Section II.B.7.b.(2)(b) above, Permittee shall on an annual basis: determine if there is new ownership and conduct an inspection of such property to determine: whether there has been any change in uses that are inconsistent with the exposure scenario basis upon which the Conditional Solution was implemented; identify any activities resulting in the disturbance of 10 or more cubic yards of soil; and identify other items based on additional criteria developed in accordance with the Institutional Controls and Related Requirements Plan submitted pursuant to Section II.H.20. of this Permit. Within 30 days of such inspection, Permittee shall submit a report to EPA and MA DEP based on an evaluation of the criteria set forth above and in the Institutional Controls and Related Requirements Plan submitted pursuant to Section II.H.20. of this Permit.

(c) Additional Conditional-Solution related requirements:

With respect to the following three scenarios, Permittee shall within 30 days of Permittee receiving notification from EPA that EPA has determined that an entity has met the criteria for a Legally Permissible Future Project or Work, Permittee shall submit to EPA for approval, a work plan and schedule to respond to such use, project, or work, including, without limitation, sampling and analysis, materials handling and off-site disposal, engineering controls, restoration of any aspect of the Rest of River Remedial Action disturbed by such work. Such scenarios are as follows: prior to the recording of ERE or Notice ERE; after recording of an ERE or a Notice ERE for property interests that do not subordinate their property rights, including property interests other than the owner for properties with a recorded Notice ERE; and, prior to implementing the initial response action set forth in Section II.B.3. for a Conditional Solution. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such activities, in accordance with applicable laws and regulations. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to assume some or all of these obligations. Further response actions under this Section II.B.7.b. will be (i) in accordance with and pursuant to the Consent Decree; and (ii) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

Permittee shall also, in accordance with a schedule set forth pursuant to Section II.H., provide notice to the owner (for the initial notice, notice shall also be sent to any holders of easements), with copies to EPA, MA DEP and applicable regulatory agencies, that meets the requirements of Section II.B.7.b.(2)(a)iv. above.

c. Floodplain Soils outside Exposure Areas in Reaches 5-16

(1) Performance Standards

(a) Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work where there is sampling data documenting that total PCBs are greater than 1 mg/kg on the Floodplain portion of the property subject to the Legally Permissible Future Project or Work.

(b) Permittee shall conduct response actions to achieve and maintain the applicable Performance Standards in Tables 3 and 4 for the Floodplain portion of properties where there is sampling data documenting that total PCBs are greater than 1 mg/kg on the Floodplain portion of the property to be protective of any Legally Permissible Future Project or Work or any change in use of the property after the Effective Date of the Permit that constitutes a Legally Permissible Future Use.

(2) Corrective Measure

To achieve and maintain these Performance Standards, Permittee shall: conduct response actions to be protective of any Legally Permissible Future Project or Work where there is sampling data documenting that there are greater than 1 mg/kg total PCBs on the Floodplain portion of the property; conduct response actions to achieve and maintain the applicable Performance Standards in Tables 3 and 4 for the Floodplain portion of properties where there is sampling data documenting that total PCBs are greater 1 mg/kg on the Floodplain portion of the property to be protective of any Legally Permissible Future Project or Work or any change in use of the property after the Effective Date of the Permit that constitutes a Legally Permissible Future Use; and perform all other related activities. Permittee shall perform the foregoing pursuant to these Performance Standards, the requirements in Sections II.B.7.c.(2)(a) through II.B.7.c.(2)(c) below, and in accordance with the plans submitted and approved pursuant to Section II.H. of this Permit.

(a) Permittee shall conduct response actions to be protective of any Legally Permissible Future Project or Work, including, but not limited to, flood management activities, road and infrastructure projects, and activities such as the installation of canoe and boat launches. Within 30 days of the date that EPA notifies Permittee in writing that EPA has determined: a) that the criteria for a Legally Permissible Project or Work has been met, and b) that there is sampling data documenting that there are greater than 1 mg/kg total PCBs on the Floodplain portion of the property, Permittee shall submit to EPA for approval, a work plan and schedule to respond to such Legally Permissible Future Project, or Work, including, without limitation, sampling and analysis, engineering controls, repairing any aspect of the Rest of River Remedial Action disturbed by such work, and materials handling and off-site disposal. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such activities, in accordance with applicable laws and regulations. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations.

(b) For any property subject to Section II.B.7.c.(2)(a) above, and for any property with a change in use of the property after the Effective Date of the Permit that constitutes a Legally Permissible Future Use where there is sampling data documenting that there are greater than 1 mg/kg total PCBs on the Floodplain portion of the property, Permittee shall implement additional response actions, (including characterization and evaluation activities) to achieve the applicable Performance Standards in Tables 3 and 4. Permittee shall:

i. Determine the appropriate exposure scenario from Tables 3 and 4.

ii. Determine the EPC for the exposure area.

iii. Evaluate whether or not the EPC meets the Primary Performance Standard for Table 3 and/or the Performance Standard for Table 4. For non-agricultural future uses, if the EPC exceeds the Primary Performance Standard, follow the procedures outlined in Section II.B.3. of this Permit to determine if additional response actions are required, substituting Table 3 for Table 1. For agricultural future uses, if the EPC exceeds the Performance Standard in Table 4, evaluate soil removal necessary to meet the Performance Standard in Table 4.

iv. The Permittee shall submit this evaluation to EPA. Upon approval by EPA, the Permittee shall implement the required actions.

(c) Within 30 days of the date that EPA notifies Permittee that the criteria in this subsection have been met, Permittee shall submit to EPA for approval a work plan and schedule for the additional response actions. Permittee shall submit to EPA for approval such work plan and schedule, including, without limitation, sampling and analysis, engineering controls, repairing any aspect of the Rest of River Remedial Action disturbed by such work, materials handling and off-site disposal. For any activities that would involve the removal, handling or excavation of sediments and/or soils, Permittee shall be required to take response actions to ensure the proper excavation, management, and off-site disposal of such materials and the protection of workers and other individuals during such activities, in accordance with applicable laws and regulations. Following receipt of EPA's approval of the work plan and schedule, Permittee shall implement the additional response actions in accordance with EPA's approval, including the approved schedule. Permittee may seek EPA approval for another party to implement some or all of these obligations.

Further response actions under this Section II.B.7.c. will be (i) in accordance with and pursuant to the Consent Decree; and (ii) consistent with the scope of the response actions selected in this Permit. Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

d. Upland Disposal Facility

(1) Performance Standard

Permittee shall record an ERE to restrict future uses of land and groundwater that are inconsistent with the use of the Upland Disposal Facility.

(2) Corrective Measure

To achieve and maintain this Performance Standard, Permittee shall prepare and record an ERE in accordance with Paragraph 54 of the CD to prohibit excavation of the landfill, prohibit extraction, consumption, or utilization of the groundwater located underneath the Upland Disposal Facility, including a 500-foot zone around the consolidation area, and restrict the future use of and access to the Upland Disposal Facility. Permittee shall perform the foregoing pursuant to the Performance Standard above, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

8. Water Withdrawals and Uses

a. Performance Standard

The Permittee shall minimize/mitigate impacts during implementation of Corrective Measures to withdrawals and/or uses of water from the Rest of River by any entity.

b. Corrective Measures

To achieve and maintain this Performance Standard, Permittee shall minimize/mitigate impacts during implementation of Corrective Measures to withdrawals and/or uses of water from the Rest of River by any entity and perform all other related activities. Permittee shall perform the foregoing pursuant to the Performance Standards and the requirements in Sections II.B.8.b.(1) through II.B.8.b.(3) below, and in accordance with plans submitted and approved pursuant to Section II.H. of this Permit.

(1) Identify all industrial, commercial, private, or other withdrawals and/or uses of water from the Rest of River;

(2) Identify requirements associated with these uses (including water quality and quantity) that may be affected by implementation of Corrective Measures; and

(3) Propose methods to minimize/mitigate impacts during implementation of response actions.

C. Operation and Maintenance

Permittee shall implement an O&M program upon completion of the Remedial Action for the Rest of River. The O&M program shall be implemented to maintain the effectiveness of the Corrective Measures, to evaluate MNR, and to conduct inspection, maintenance, repair, or other response actions necessary to achieve and maintain compliance with Performance Standards. This program shall be designed to be consistent with an adaptive management approach, as outlined in Section II.F. below.

The O&M Plan will be a component of the Final Remedial Action Completion Report. Permittee shall submit a draft O&M Plan to EPA for review as a component of the Draft Remedial Action Completion Report. Upon approval or modification of the Final Remedial Action Completion Report, the O&M Plan will take effect. Components of the O&M Plan shall include, but not be limited to:

1. Monitoring of PCBs in groundwater, surface water, air, sediment, and biota.

2. Inspection and maintenance of Engineered Caps.

3. Inspection and maintenance of the Upland Disposal Facility, including collection and management of leachate.

4. Maintenance/implementation of Institutional Controls and Related Requirements in Section II.B.7. and the requirements in Sections II.B.2.j. through II.B.2.l.

5. Inspection and maintenance of restoration activities, including invasive species control.

6. Inspection and maintenance of other Corrective Measures to ensure that Performance Standards are maintained.

D. Review of Response Actions

In accordance with Paragraph 43 of the CD, the Permittee shall conduct studies and investigations as requested by EPA to permit EPA to conduct periodic reviews, consistent with Section 121(c) of CERCLA and any applicable regulations, of whether the Rest of River Remedial Action is protective of human health and the environment. The Permittee shall also comply with any additional requirements pursuant to Section X of the Consent Decree with respect to periodic reviews.

E. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

The federal and state laws and regulations that constitute applicable or relevant and appropriate requirements (ARARs) for the response actions for Rest of River and To Be Considered (TBC) requirements are identified in Attachment C.

The ARAR tables include a description of the listed ARARs and a determination by EPA as to whether the listed ARARs will be met, any ARARs waived and any modified performance requirements based on EPA's waiver determination, and all TBC requirements. EPA may also, in accordance with CERCLA and the National Contingency Plan, 40 C.F.R. 300, waive an ARAR during the implementation of the remedy.

In addition, the technical Remedial Design/Remedial Action (RD/RA) submittals for response actions for the Rest of River shall, consistent with CERCLA, specify additional ARARs (not listed in Attachment C), if any, for such response actions. Additionally, such RD/RA submittals shall contain a proposal as to how the response action will comply with any such additional ARARs, and to the extent that EPA determines a waiver is appropriate, any modified performance requirement. The Permittee shall comply with and attain any such additional ARARs that EPA determines should be met by such response action.

F. Adaptive Management

An adaptive management approach shall be implemented by the Permittee in the conduct of any of the Corrective Measures, whether specifically referenced in the requirements for those Corrective Measures or not, to adapt and optimize project activities to account for "lessons learned," new information, changing conditions, evaluations of the use of innovative technologies, results from pilot studies, if any, and additional opportunities that may present themselves over the duration of the project, including during periodic reviews. The Permittee shall modify the implementation of the Corrective Measures, with EPA approval, after a reasonable opportunity for review and comment by the States, through this process to minimize any adverse impacts of the response action, expedite the response, improve the Corrective Measures, and/or to ensure compliance with, or continued progress towards, achieving Performance Standards. To implement an adaptive management approach effectively, Permittee shall submit deliverables identified in Section II.H. (Rest of River SOW) in phases, where appropriate, and identify how any lessons learned and any new information will be incorporated into subsequent deliverables and/or other methods to optimize project activities.

The Permittee shall perform the Corrective Measures in accordance with any modifications that are so identified by the Permittee (with EPA's approval), or that are identified and required by EPA, including, but not limited to, applying an adaptive management approach to the Rest of River SOW, or any other plans, specifications, schedules, or other documents. Any requirements identified by EPA pursuant to this provision cannot be inconsistent with the Consent Decree (including, but not limited to, Paragraphs 39, 162 and 163).

G. Coordination of Corrective Measures

Corrective Measures associated with the Rest of River will require a significant level of project scheduling, coordination, and sequencing, which shall be addressed by the Permittee in the Rest of River SOW. As the corrective measures are expected to be implemented in a phased approach, it is expected that the work to be implemented in each phase will have its own set of deliverables, including several of the deliverables identified in Section II.H.

H. Requirements for the Rest of River SOW

As required in Paragraph 22.x of the CD, the Permittee shall submit a Rest of River SOW for the implementation of the Corrective Measures, including pre-design activities and the subsequent performance of Corrective Measures. The SOW shall incorporate the Performance Standards and Corrective Measures from this Permit, or portion thereof, and shall include a description of, and a submittal schedule for, at a minimum, the documents outlined below. In addition, the contents of the documents required in the SOW are subject to modification or adjustment based on specific activities for a given Corrective Measure and any site- or activity-specific considerations, including, but not limited to, resulting from an adaptive management approach. If deviations to such documents are proposed, such proposals shall be presented for EPA approval in the technical deliverables specific to that Corrective Measure.

1. Expedited Deliverables

a. In order to expedite response actions, Permittee shall commence and perform investigation and design work as contractual obligations effective February 10, 2020. Specifically, Permittee shall submit a schedule for the Rest of River SOW, develop the SOW, and, subject to approval by EPA, implement the investigation and design components of the SOW and subsequent Work Plans to accelerate the commencement of the Rest of River cleanup. The obligation to perform this investigation and design work shall continue unless and until EPA issues a revised permit that does not contain terms substantially similar to those in the 2016 Permit, revised as specified by the 2020 Settlement Agreement.

b. Permittee agreed in the 2020 Settlement Agreement to coordinate as soon as practicable with municipal officials and affected landowners regarding work activities, schedules and traffic routes. Permittee's coordination with officials and landowners shall be described in the relevant work plans submitted to EPA.

c. Permittee has already submitted pursuant to the 2016 Permit the following documents:

- Rest of River Initial Statement of Work, including a section meeting the Requirements for the Overall Strategy and Schedule for Implementation of Corrective Measures submittal relating to GE's project organizational structure: roles, responsibilities, and lines of communication among GE, EPA, and state and local entities
- Baseline Monitoring Plan
- Floodplain Pre-Design Investigation Work Plan, Reach 5A (and related documents)
- Health and Safety Plan, a component of the Updated Project Operations Plan
- Components of the Institutional Controls and Related Requirements Plan limited to Biota Consumption Advisory Outreach Plan – Connecticut; Biota Consumption Advisory Outreach Plan – Massachusetts; and Plan for Obtaining Environmental Restrictions and Easements
- Dam Operation, Inspection, Monitoring and Maintenance Plans and related documents for Woods Pond Dam and Rising Pond Dam

2. Overall Strategy and Schedule for Implementation of the Corrective Measures

The Permittee shall present its overall strategy for implementing the Corrective Measures that have been selected by EPA in this Permit, including the preparation of work plans, designs, and reports, completion of pre-design investigations, construction and implementation of the remediation, and inspection, maintenance, and monitoring. In addition, the Permittee shall describe the Permittee's project organizational structure, roles, and responsibilities, and lines of communication among the Permittee, EPA, and state and local entities, as appropriate, and will include the project organization and a project implementation schedule. The overall strategy shall include:

a. Coordination of Floodplain and sediment and bank remediation;

b. Sequence of remediation;

c. Project management structure.

3. Pre-Design Investigation Work Plans, including for the Upland Disposal Facility

4. Pre-Design Investigation Summary Reports

5. Plan for Measuring Compliance with Performance Standards

6. Conceptual Remedial Design/Remedial Action Work Plans, including for the Upland Disposal Facility

7. Final Remedial Design/Remedial Action Work Plans, including for the Upland Disposal Facility

8. Supplemental Implementation Plans (e.g., contractor health and safety plans (HASPs), operations plan)

9. Updated Project Operations Plan and Field Sampling Plan/Quality Assurance Project Plan for Rest of River-specific changes, including a Construction Monitoring Plan

10. On-Site and Off-Site Transportation Plan

11. Quality of Life Compliance Plan:

    a. Noise, air, odor, light standards;

    b. Continued recreational activities during and after the remediation, including that Permittee shall work cooperatively with the City of Pittsfield, the Towns of Great Barrington, Lee, Lenox, and Stockbridge, and the State of Massachusetts to facilitate their enhancement of recreational activities, such as canoeing and other water activities, hiking, and bike trails in the Rest of River corridor, on properties where remediation will occur and/or where temporary access roads are constructed;

    c. Road use, including restrictions on transport of waste material through residential areas and methods to minimize and/or mitigate transportation related impacts to neighborhoods, infrastructure and the general public; consideration of methods to reduce residential impacts where practical, including remediation techniques that further restrict transport of waste material through residential areas. Examples of roads that would warrant such further restrictions include: Brunswick, Kenilworth, Warwick, and Chester Streets; Noblehurst Avenue; Revilla Terrace; Shetland, Clydesdale, Pinto, and Palomino Drives; and Anita, Lucia, Quirico, Joseph, and Eric Drives;

d. Coordination with local governments, affected residents and landowners at or near areas impacted by remediation to take reasonable steps to minimize the adverse impact of work activities by, among others, coordinating work activities, scheduling, and traffic routes; and

e. Community Health and Safety

(1) The Permittee shall maintain a website (similar to http://www.hudsondredging.com/) to provide community access to information such as data, technical reports, work plans, and project fact sheets, as well as updates on current and future project activities; and

(2) The Permittee shall establish and maintain a system to identify and address community complaints and concerns during construction activities.

12. Baseline Restoration Assessment (BRA) Work Plan, Baseline Restoration Assessment, Restoration Performance Objectives and Evaluation Criteria (RPOEC), Restoration Corrective Measures Coordination Plan (RCMCP), and Restoration Plan (RP)

13. Adaptive Management Plan

14. Sustainability and Climate Adaptation Plan, including measures to ensure that Corrective Measures are designed and constructed to be resilient to potential changes due to climate change and incorporate, where practical and appropriate, methods to minimize greenhouse gas emissions.

15. Work Plan for Phase 1B Cultural Resource Survey and Overall Cultural Resource Plan

16. Model Reevaluation Plan

17. Dam Removal-Related Activities Plan(s)

18. Inspection, Monitoring and Maintenance Plan

a. Inspection, Monitoring and Maintenance Plan(s) (including an Invasive Species Control Plan, a plan for the accumulation of contaminated sediment on top of the Woods Pond and Rising Pond Engineered Caps, a plan for Engineered Caps, and a plan to measure the effectiveness of MNR.)

19. Upland Disposal Facility Operation, Maintenance, and Monitoring Plan

20. Institutional Controls and Related Requirements Plan

21. Dam Operation, Inspection, Monitoring and Maintenance Plan

22. Water Withdrawal and Uses Plan

23. Plan for Further Response Actions, and any implementation of further response actions, in accordance with Section X of the Consent Decree (Review of Response Actions).

24. Remedial Action Completion Report, including an O&M Plan.

I. Schedule

As required under Paragraph 22.x of the CD, whenever the Permittee is required to design and implement the Rest of River Remedial Action or a portion thereof as the Permit or portions of the Permit become finalized, the Permittee shall develop and submit within 7 days to EPA for review and approval, a schedule for the subsequent submission of the SOW or relevant portions thereof. The schedule for the submittal for the SOW or relevant portions thereof shall be no sooner than 90 days and no later than 120 days from the Effective Date of this Permit, or relevant portions thereof. The SOW shall contain schedules for the subsequent development of Remedial Action activities.

Implementation of the Corrective Measures shall begin concurrently, if feasible. Permittee shall begin such concurrent implementation in Reach 5A (sediment and Floodplain) and Woods Pond, unless Permittee proposes, and EPA approves an alternate approach.

Unless the Permittee proposes and EPA approves a modified schedule, Corrective Measures shall proceed downstream from Reach 5A and Woods Pond on a parallel track. The final sediment caps in the Impoundments shall not be placed, however, until all remediation in the upstream reaches has been completed. Following the placement of the cap in Reach 7G, sediment removal and subsequent capping shall take place in Rising Pond (Reach 8). This approach shall be subject to review under an adaptive management approach to evaluate the effectiveness of sequencing.

The Corrective Measures in the Floodplain shall be performed by the Permittee while the adjacent sediment cleanup activities are taking place and shall share construction infrastructure to the maximum extent practicable to minimize the Corrective Measures footprint.

J. Project Coordinators

1. Pursuant to the Consent Decree, EPA and the Permittee have each designated a Project Coordinator and an Alternate Project Coordinator.

2. EPA and the Permittee shall provide at least five (5) working days' written notice prior to changing Project Coordinators or Alternate Project Coordinators, unless impracticable but in no event later than the actual day the change is made.

3. The absence of EPA's Project Coordinator shall not be cause for stoppage of work by the Permittee.

4. Unless otherwise specified, reports, notices, or other submissions required under the Permit shall be in writing and shall be sent to:

EPA's Project Coordinator
Dean Tagliaferro
U.S. Environmental Protection Agency
EPA New England
5 Post Office Square Suite 100
Boston, MA 02109-3912

EPA's Alternate Project Coordinator
Alternate Housatonic Rest of River Project Coordinator
U.S. Environmental Protection Agency
EPA New England
5 Post Office Square Suite 100
Boston, MA 02109-3912

Permittee's Project Coordinator
Andrew T. Silfer
General Electric Company
Corporate Environmental Programs
319 Great Oaks Boulevard
Albany, NY 12203

Permittee's Alternate Project Coordinator
Alternate Housatonic Rest of River Project Coordinator
General Electric Company
Corporate Environmental Programs
1 Plastics Avenue
Pittsfield, MA 01201

Massachusetts Project Coordinators
Michael Gorski
Massachusetts Department of Environmental Protection
436 Dwight Street - Fifth Floor
Springfield, MA 01103

Mark Tisa
Massachusetts Department of Fish and Game
Division of Fisheries and Wildlife
Field Headquarters, One Rabbit Hill Road
Westborough, MA 01581

Connecticut Coordinator

Connecticut Housatonic Rest of River Coordinator
Planning and Standards Division
Bureau of Water Protection and Land Reuse
Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford, CT 06103

K. Sampling Requirements

The Permittee shall provide the results of all sampling and/or tests or other data generated by the Permittee or on the Permittee's behalf with respect to the implementation of the Permit to EPA and shall submit these results to EPA, at a minimum, in monthly progress reports. Data and supporting information shall be provided in electronic format and shall include locational information for all samples collected.

At the request of EPA, the Permittee shall allow split or duplicate samples to be taken by EPA and/or its authorized representative, of any samples collected by the Permittee or on the Permittee's behalf pursuant to the implementation of this Permit. The Permittee shall notify EPA not less than seven (7) days in advance of any sample collection activity.

EPA will notify the Permittee not less than seven (7) days in advance of any sample collection activity by EPA in connection with the implementation of this Permit. At the request of the Permittee, EPA shall provide to the Permittee, or allow the Permittee to take split or duplicate samples of any samples collected by EPA or on EPA's behalf in conducting work in the Rest of River area.

L. Reservation of Rights

EPA and the Permittee reserve all rights and defenses that they may have, subject to the provisions of the Consent Decree.

M. Access to or Use of Property

1. To the extent that the work required of the Permittee under this Permit requires access to or use of property currently owned or under the control of persons other than the Permittee, the Permittee shall use its best efforts to obtain access in accordance with the provisions of Paragraph 59.a of the Consent Decree relating to access.

2. Except as otherwise provided in the Consent Decree or this Permit, nothing in this Permit shall be construed to limit EPA's authority to exercise its rights pursuant to Section 3007 of RCRA, 42 U.S.C. 6927, or to affect any rights of entry possessed by EPA pursuant to any applicable laws, regulations, or permits.

N. Dispute Resolution

Resolution of disputes arising from implementation of this Permit shall be resolved consistent with the provisions in the Consent Decree.

TABLES

Table 1 Performance Standards for PCBs for Floodplain Soil by Exposure Area – Current Use

Exposure Areas	Performance Standard (in mg/kg)		Exposure Scenario Basis	
	Primary (RME 10^{-5}/ Hazard Index (HI)=1)	Secondary (RME 10^{-4}/ HI=1)	Exposure Scenario/Receptor	Assumed Frequency of Use (days per year)
10a, 10b, 70, 87	4.6	4.6	General Recreation, young child (high use)	90d/yr
10	4.6	6.9	General Recreation, young child (high use)	90d/yr
2b, 25, 78, 85b	27	27	General Recreation, older child (high use)	90d/yr
3, 11, 13-17, 19, 20, 24, 32, 33, 38, 44-46, 48, 54, 58, 67-69, 73-77, 79, 89	14	38	General Recreation, adult (high use)	90d/yr
2, 4, 5, 7, 12, 21, 22, 26a, 26F, 27, 28, 30, 31, 31a, 35, 35a, 37, 37b, 40, 40b, 55, 57, 59, 60, 90	14	27	General Recreation, adult/older child (high use)	90d/yr
1, 56	21	40	General Recreation, adult/older child (medium use)	60d/yr
23, 88	40	40	General Recreation, older child (medium use)	60d/yr
18, 34, 41, 42, 43	21	58	General Recreation, adult (medium use)	60d/yr
6, 49, 50, 51, 80a, 81, 82, 84	43	115	General Recreation, adult (low use)	30d/yr
2a, 9	80	80	General Recreation, older child (low use)	30d/yr
29	43	80	General Recreation, adult/older child (low use)	30d/yr
37a, 38a, 40a, 41a, 42a, 43a, 59a, 70a, 71,72, 87a	26	42	Bank Fishing adult/older child	30d/yr
22a, 27a, 28a	14	14	Dirt Biking/ATVing (older Child)	90 d/yr
8,47, 47F, 52, 53, 60a, 85a	12	28	Recreational Canoeist	Adult 60 d/yr Older child 30 d/yr

Table 1 Performance Standards for PCBs for Floodplain Soil by Exposure Area – Current Use (Continued)

Exposure Areas	Performance Standard (in mg/kg)		Exposure Scenario Basis	
	Primary (RME 10^{-5}/ Hazard Index (HI)=1)	Secondary (RME 10^{-4}/ HI=1)	Exposure Scenario/Receptor	Assumed Frequency of Use (days per year)
39	7.8	13	Marathon Canoeist	150d/yr
26b, 36b, 80b	12	43	Agricultural Use (farmer)	40d/yr
36a	89	126	Low-use Commercial (groundskeeper)	30d/yr
83, 86	18	25	High-use Commercial (groundskeeper)	150 d/yr
61-66	169	242	Utility Worker	5 d/yr
50a, 51a, 55a, 56a	90	140	Waterfowl Hunting	14 d/yr

Table 2 Performance Standards for PCBs for Floodplain Soil Frequently Used Subareas – Current Use

Exposure Area	Performance Standard (in mg/kg)	Exposure Scenario Basis	
		Exposure Scenario/Receptor	Assumed Frequency of Use (days per year)
4, 12, 26a, 37b, 40, 58, 59	14	General Recreation, adult/older child (high use)	90 d/yr
39	7.8	Marathon Canoeist	150 d/yr
47, 52, 53, 60a	12	Recreational Canoeist	Adult 60 d/yr Older child 30 d/yr

Table 3 Performance Standards for PCBs for Floodplain Soil – Future Use

Type of Area/Exposure Scenario	Receptor	Assumed Frequency of Use	Performance Standards (in mg/kg)	
			Primary (RME 10^{-5}/ HI=1)	Secondary (RME 10^{-4}/ HI=1)
Residential	All	All	2*	2*
General Recreation	Young child	90 d/yr	4.6	4.6
		15 d/yr	27	27
	Older child	90 d/yr	27	27
		60 d/yr	40	40
		30 d/yr	80	80
	Adult	90 d/yr	14	38
		60 d/yr	21	58
		30 d/yr	43	115
Bank fishing	Older child	30 d/yr	42	42
	Adult	30 d/yr	26	56
Dirt biking/ATVing	Older child	90 d/yr	14	14
Marathon canoeist	Adult	150 d/yr	7.8	13
Recreational canoeist	Older child	30 d/yr	42	42
	Adult	60 d/yr	12	28
Waterfowl hunting	Older child	14 d/yr	140	140
	Adult	14 d/yr	90	196
Agricultural use (farmer) (See note)	Adult	40 d/yr	12	43
Commercial (groundskeeper)	Adult	150 d/yr	18	25
		30 d/yr	89	126
Utility worker	Adult	5 d/yr	169	242

*The Performance Standard for residential use is 2 mg/kg at 0-1 foot depth increment, 2 mg/kg at the 1-X depth increment where X equals the depth at which PCBs are detected at 2 mg/kg or greater (up to a maximum depth of 15 feet), and a not-to exceed of 10 mg/kg in the top foot.

Note: Values in this table for agricultural use represent human exposure to soil. For Performance Standards representing future agricultural use (protective of exposure through consumption of dietary items grown in the Floodplain), see Table 4.

Table 4 Performance Standards for PCBs for Agricultural Uses in Floodplain Soil

Because cleanup standards for future agricultural uses were derived as diet, a formula back-calculating from the dietary concentrations to concentration of PCBs in Floodplain soil was necessary. The equation below incorporates a soil concentration (Cea) calculated using the deterministic reasonable maximum exposure (RME) risk equations for each agricultural scenario from the baseline Human Health Risk Assessment. Each Cea is the more stringent of the two soil concentrations corresponding to an excess lifetime cancer risk of 1×10^{-5} and a Hazard Index of 1. The equation below also takes into account the fraction of the use conducted in the Floodplain.

$$C_t = \frac{Cea}{Ft},$$

where:

C_t = Performance Standard in Floodplain soil where agricultural activities will take place (in mg/kg)

C_{ea} = Soil concentration in mg/kg for a given agricultural use assuming 100% of the use is in the Floodplain. See table below for the C_{ea} for specific agricultural uses

F_t = Fraction of agricultural use in the Floodplain

Note: If this formula results in a C_t less than 2 mg/kg total PCBs, the Performance Standard will be 2 mg/kg total PCBs.

Agricultural Scenario	**C_{ea} (in mg/kg)**
Commercial Farm Family: Dairy Consumption	2.4
Backyard Farm Family: Dairy Consumption	0.059
Commercial Farm Family: Beef Consumption	0.17
Backyard Farm Family: Beef Consumption	0.16
Commercial Farm Family: Poultry Meat Consumption	0.15
Backyard Farm Family: Poultry Meat Consumption	0.27
Commercial Farm Family: Poultry Egg Consumption	0.062
Backyard Farm Family: Poultry Egg Consumption	0.091
Commercial Farm Family: Produce Consumption	4.1
Backyard Farm Family: Produce Consumption	6.5

See July 20, 2012 letter from The Science Collaborative to Weston Solutions, titled *Calculate Performance Standards for Agricultural Production Consumption* for the basis of the Performance Standard.

Table 5 Floodplain Properties Subject to Residential Performance Standards

Reach 5A Floodplain Properties Subject to Residential Performance Standards (Listed by Tax Parcel ID)			
I6-1-42	J4-3-10	J3-1-12	J3-2-5
I6-3-13	J4-3-11	J3-1-13	J3-2-6
J6-2-3	J3-1-8	J3-1-14	K3-1-2
J4-3-7	J3-1-9	J3-2-2	K2-1-10
J4-3-8	J3-1-10	J3-2-3	
J4-3-9	J3-1-11	J3-2-4	

Reach 5C Floodplain Properties Subject to Residential Performance Standards (Listed by Tax Parcel ID) (if the Town of Lenox determines that any of the property owners consent to such soil removal, and with the costs to be shared equally by the Permittee and the Town of Lenox)		
24-1	24-3	24-5
24-2	24-4	24-6

FIGURES

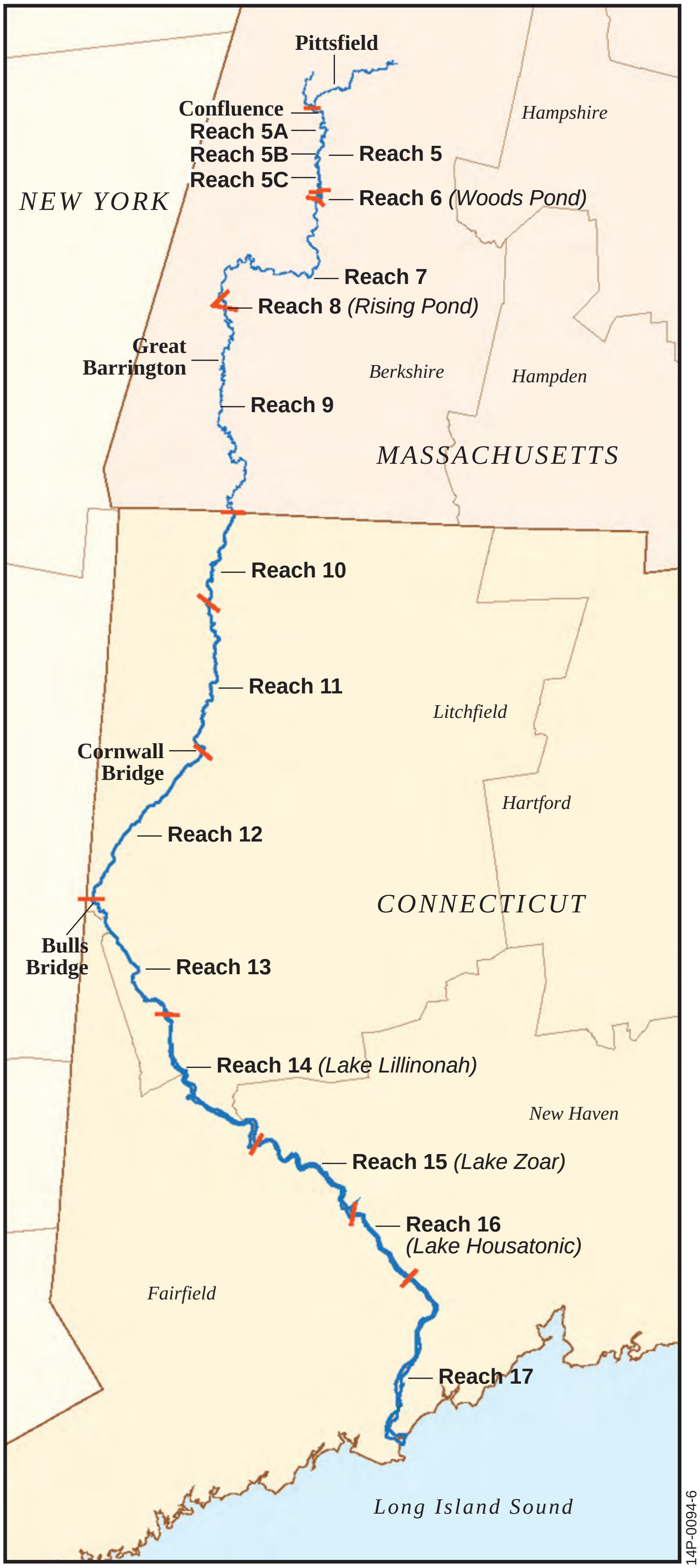
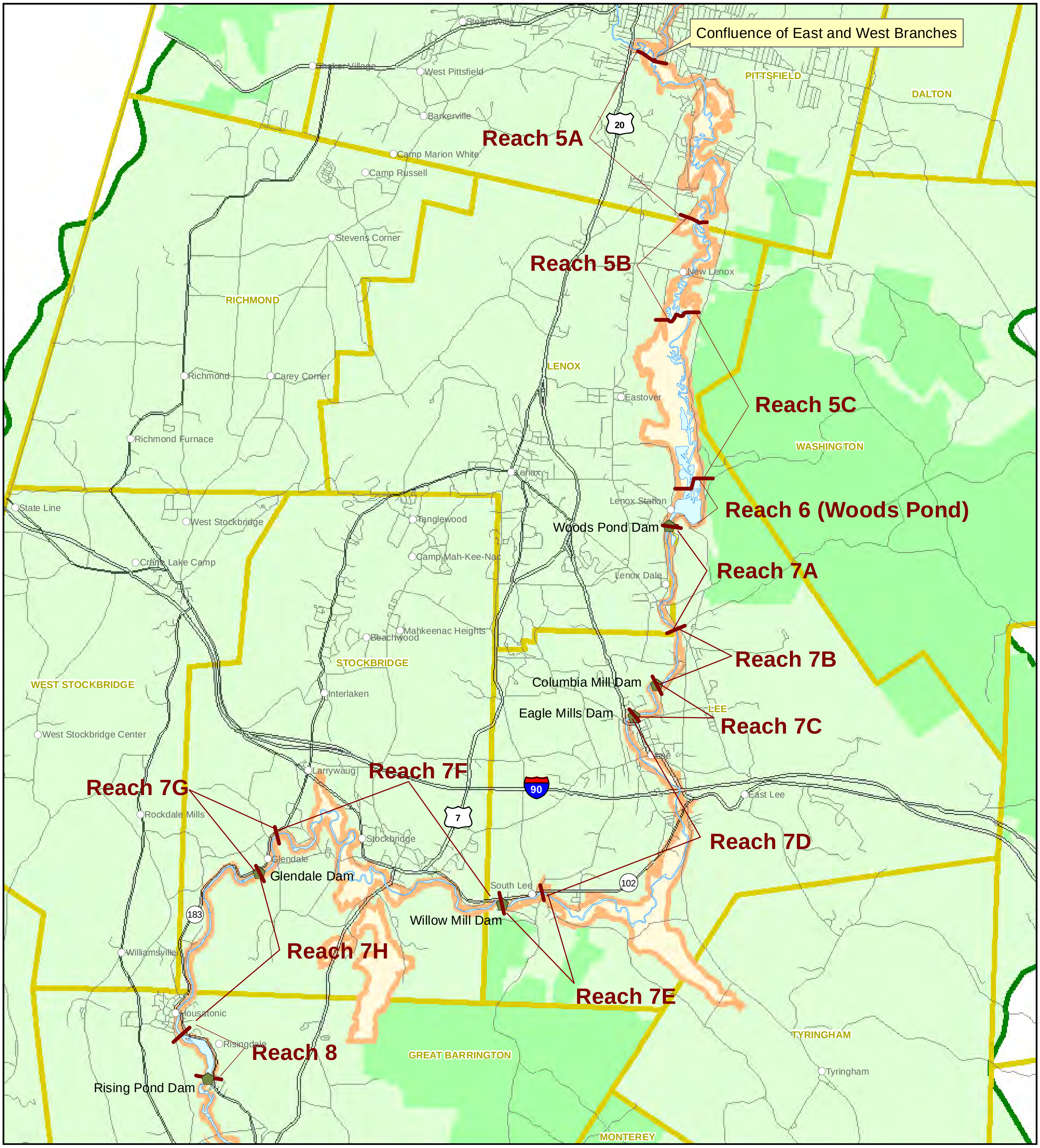


FIGURE 1 HOUSATONIC RIVER, REACHES 5 THROUGH 17



LEGEND:

- Town/City
- Roads
- Reach Division Line
- Housatonic River
- State Park
- Municipal Boundary
- 10-Year Floodplain

N
W E
S

1 0.5 0 1 Miles

0.85 0.425 0 0.85 Kilometers

GE- Pittsfield/Housatonic River Site
Rest of River

FIGURE 2
HOUSATONIC RIVER,
PRIMARY STUDY AREA
(REACHES 5 AND 6) AND
REACHES 7 AND 8

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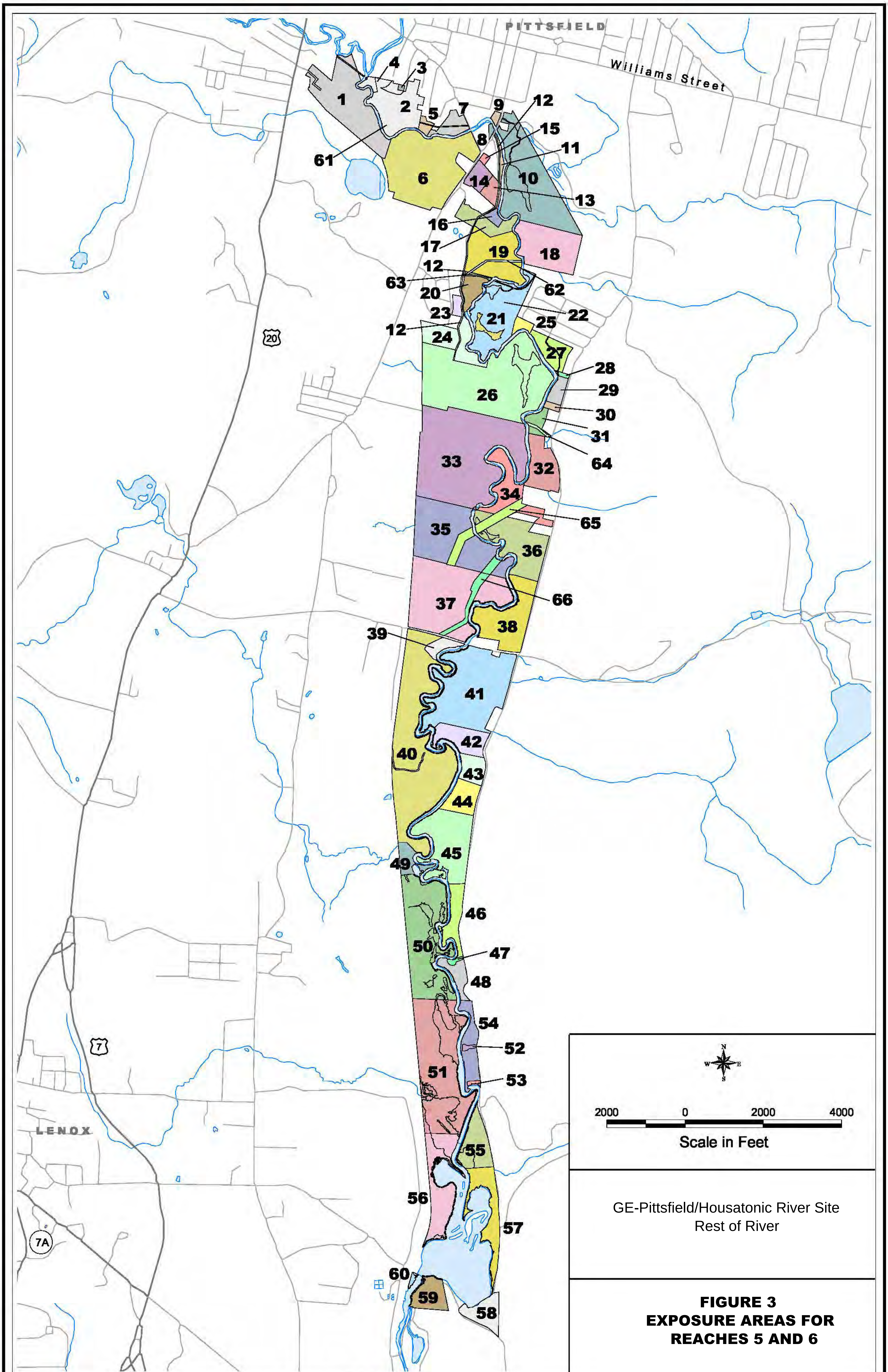

GE-Pittsfield/Housatonic River Site
Rest of River

FIGURE 3
EXPOSURE AREAS FOR REACHES 5 AND 6

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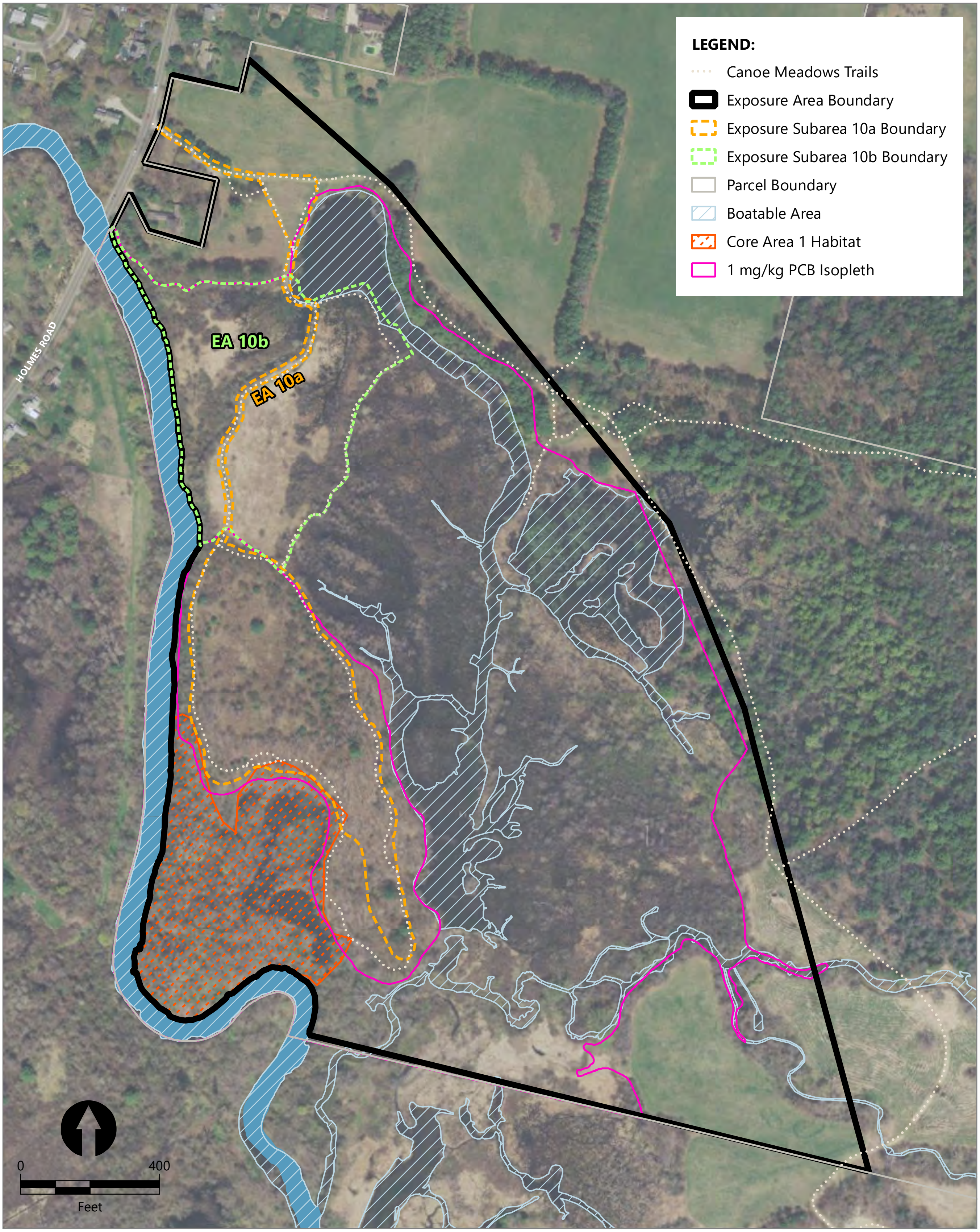
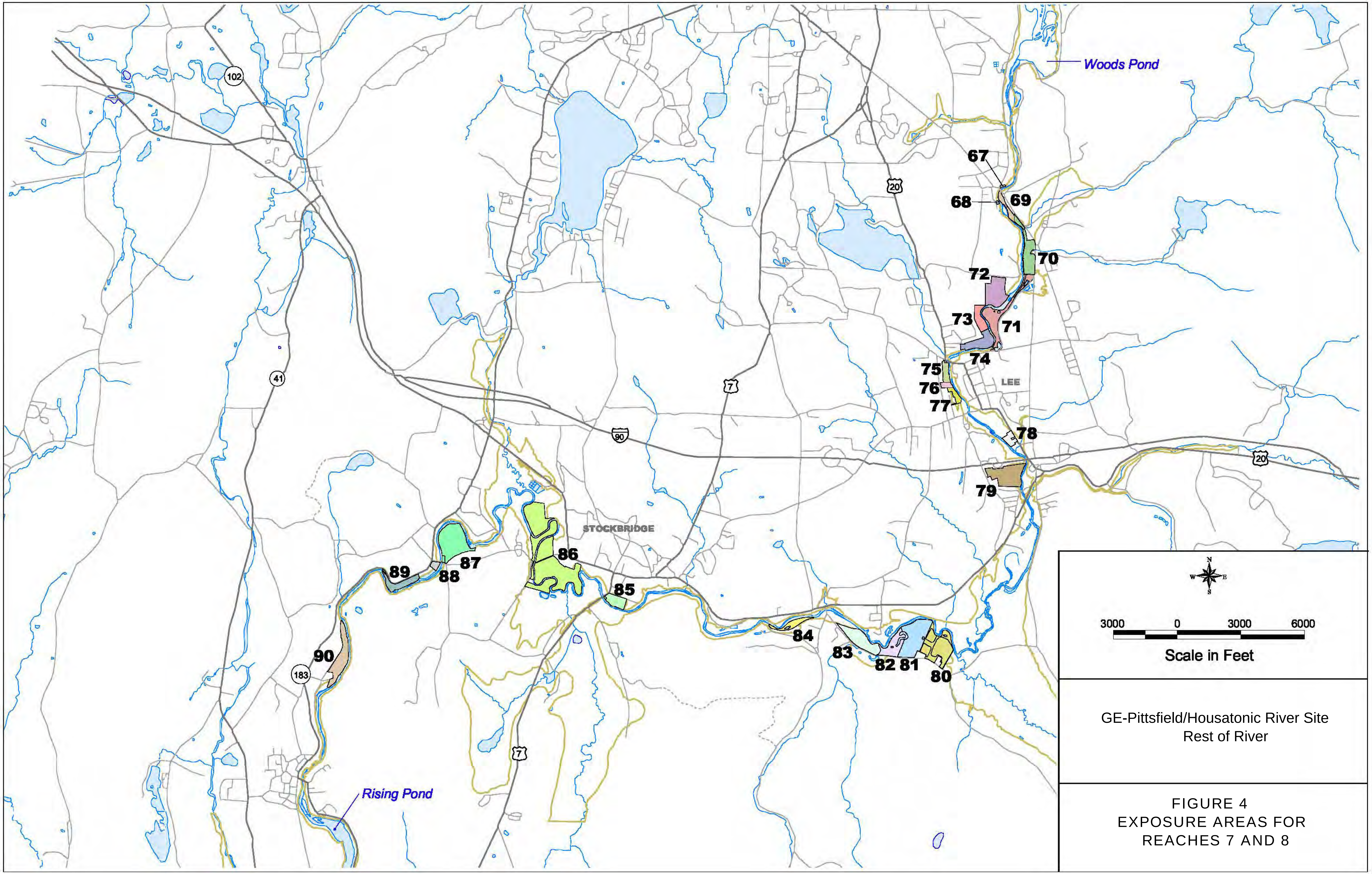


Figure 3A
Exposure Area 10
GE-Pittsfield/Housatonic River
Rest of River



GE-Pittsfield/Housatonic River Site
Rest of River

FIGURE 4
EXPOSURE AREAS FOR
REACHES 7 AND 8

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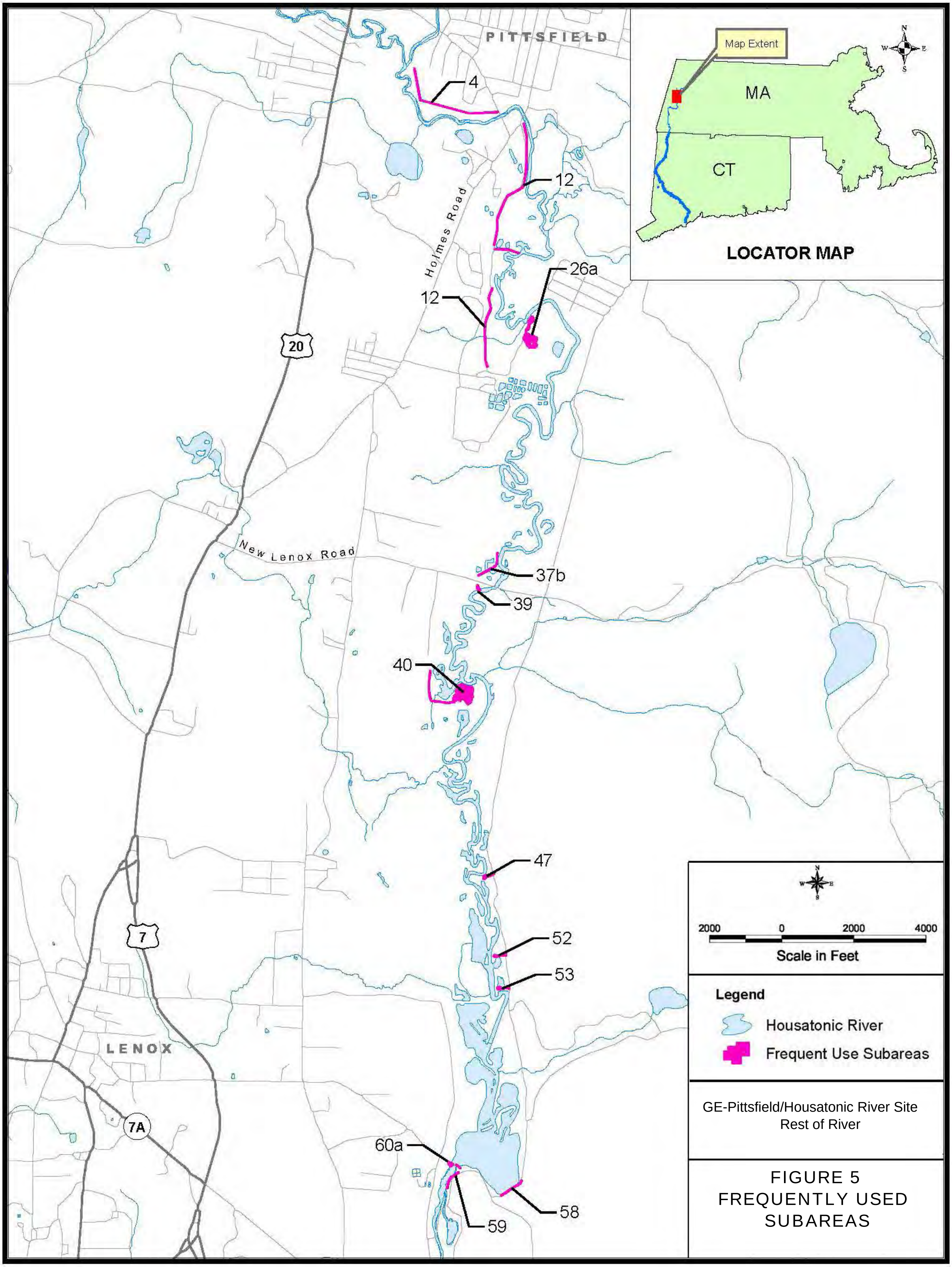

PITTSFIELD
Map Extent
MA
CT
LOCATOR MAP
4
12
Holmes Road
26a
12
20
New Lenox Road
37b
39
40
47
7
52
53
LENOX
7A
60a
59
58
2000 0 2000 4000
Scale in Feet
Legend
Housatonic River
Frequent Use Subareas
GE-Pittsfield/Housatonic River Site
Rest of River
FIGURE 5
FREQUENTLY USED
SUBAREAS

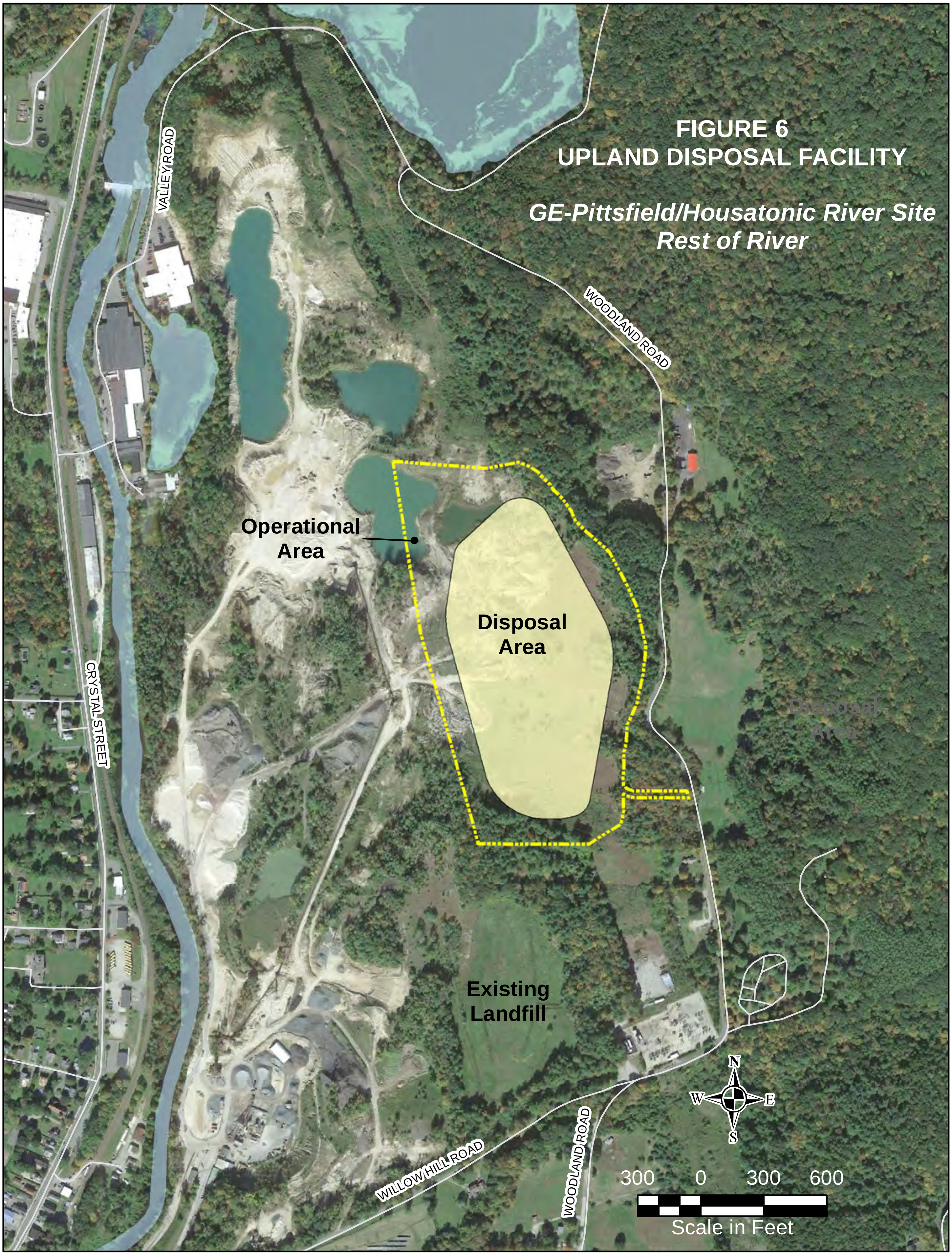


FIGURE 6
UPLAND DISPOSAL FACILITY

GE-Pittsfield/Housatonic River Site
Rest of River

ATTACHMENT A
GE FACILITY MAP

LEGEND

GE FACILITY

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY; AND BLASLAND AND BOUCK ENGINEERS, P.C. P.C. CONSTRUCTION PLANS.
2. NOT ALL PHYSICAL FEATURES SHOWN.
3. SITE BOUNDARIES/LIMITS ARE APPROXIMATE.

0 500' 1000'
APPROXIMATE SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS

GE FACILITY

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

ATTACHMENT A

L: ON=*, OFF=REF, OXBOWS, GEFACILITY2
P: STD-PCP/DL
8/10/99 SYR-54-GMS CBM
20140002/20140SM1.DWG

ATTACHMENT B
MASSACHUSETTS DIVISION OF FISHERIES AND WILDLIFE CORE HABITAT AREA FIGURES, HOUSATONIC RIVER PRIMARY STUDY AREA (PSA), AND JULY 31, 2012 LETTER FROM MASSACHUSETTS DIVISION OF FISHERIES AND WILDLIFE

July 31, 2012

Robert G. Cianciarulo, Chief
Massachusetts Superfund Section
Office of Site Remediation and Restoration
EPA New England (OSRR-07-01)
5 Post Office Square
Boston, MA 02109-3912

Re: Housatonic River, Core Habitat Areas in the Primary Study Area

Dear Mr. Cianciarulo:

As you are aware, the states of Massachusetts and Connecticut have been working cooperatively for the last several months to discuss potential approaches to clean up the Rest of River portion of the GE Housatonic site. These discussions have focused, in part, on the need to address the risks from polychlorinated biphenyls (PCBs) to humans, fish, and wildlife while avoiding, mitigating or minimizing the impacts of the cleanup on the unique ecological character of the Housatonic River. Minimizing impacts to habitat and, in particular, species listed pursuant to the Massachusetts Endangered Species Act, M.G.L. c. 131A ("MESA"), and 321 CMR 10.00 (the "MESA Regulations") presents unique challenges as almost the entire Primary Study Area (PSA) is mapped as Priority Habitat for state-listed species (for a description of Priority Habitat and its regulatory function please see: http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/priority_habitat/priority_habitat_home.htm. Therefore, in order to help identify the most important areas for habitat protection, as well as habitats and species that might be particularly sensitive to impacts from PCB remediation activities, the Massachusetts Division of Fisheries and Wildlife ("DFW") developed maps of "Core Habitat Areas." The purpose of this letter is to provide an overview of the approach we used to identify the Core Areas.

As part of our Priority Habitat mapping process, taxonomic experts from DFW's Natural Heritage & Endangered Species Program ("NHESP") routinely delineate habitat for each state-listed species, based on actual field-documented records, or "occurrences." There are four types of Housatonic Core Areas. Core Areas 1, 2, and 3 represent subsets of the delineated state-listed species habitat found in the PSA. Core Area 4 represents a subset of the documented and potential vernal pool habitat in the PSA. Please refer to the enclosed maps dated May 21, 2012 which depict the locations of these Core Areas, entitled "Core Habitat Areas, Housatonic River Primary Study Area (PSA)", "Core Habitat Areas (Core Area 2), Housatonic River Primary Study Area (PSA)", and "Part of the Housatonic River Showing Primary Study Area, High Species Richness, and Vernal Pools".

Core Area 1 includes the highest quality habitat for species that are most likely to be adversely impacted by PCB remediation activities (Table 1). As can be seen in Table 1, most of these species are plants that are not mobile, and are very sensitive to the expected effects of soil remediation activities. Core Area 1 also includes habitat for one state-listed moth species that inhabits mature floodplain forest, one habitat area for the Jefferson's Salamander, and Triangle Floater mussel beds. Some of the plant species found in Core Area 1 are located in floodplain forest, which is not readily restorable and would take decades to return to its current state, if ever. Finally, Core 1 includes areas that are excellent examples of two rare natural communities—High Terrace Floodplain Forest and Black Ash Bur Oak Hemlock Swamp.

Core Area 2 includes the highest quality habitat for more mobile species that may be less vulnerable to remediation impacts, species where the habitat is likely to be somewhat more easily restored, and listed species that may be of a somewhat lower conservation concern, given their state-wide distribution (e.g. American Bittern; see Table 2). For example, the Mustard White is a Threatened butterfly species of significant conservation concern that uses a mix of natural areas along the river and old field habitat. It may be possible to remediate its habitat in phases, restoring and replacing host plants as the work is completed.

Core Area 3 includes those areas with dense concentrations of state-listed species. Specifically, Core Area 3 includes areas where Division biologists have delineated overlapping habitat for eight (8) or more state-listed species.

Core Area 4 includes all certified vernal pools in the PSA as well as additional potential vernal pool habitat areas which, based on information provided by GE and EPA, are likely to meet the Massachusetts criteria for vernal pool certification based on the presence of "obligate" vernal pool breeding amphibians see:
http://www.mass.gov/dfwele/dfw/nhesp/vernal_pools/vernal_pool_cert.htm.

These Core Areas played an important role during recent discussions between the EPA and the states of Massachusetts and Connecticut regarding potential remediation approaches to Rest of River. Consistent with the requirements of MESA and the MESA Regulations, the Core Areas are helping to guide efforts to avoid, minimize and mitigate impacts to state-listed species. Although a final MESA evaluation will not be completed until the remedy design phase, by focusing on the Core Areas, EPA and the Commonwealth believe that a framework has been established to achieve MESA permitting standards of assessing alternatives to both temporary and permanent impacts to state-listed species, and of limiting the impact to an insignificant portion of the local populations of affected species. See 321 CMR 10.23. For example, the parties focused on avoidance of some of the most important and sensitive rare species habitats in Core Area 1. Similarly, in Core Areas 2 and 3, avoidance of impacts when practical, careful consideration of PCB remediation methods and the sequence and timing of remediation activities, as well as after-the-fact habitat mitigation are all approaches that will assist in achieving the substantive requirements of MESA. Although the Core Areas play an important role in guiding avoidance and minimization of impacts to state-listed species, in some cases the "take" of state-listed species is likely to be unavoidable. In those cases, consistent with MESA's status as a location-specific applicable or relevant and appropriate requirement ("ARAR"), the Commonwealth will work with GE and the EPA to minimize impacts and to ensure that an adequate long-term net-benefit mitigation plan for the affected state-listed species is designed and implemented, as required by 321 CMR 10.23(2)(c).

If you have any questions about this letter, please don't hesitate to contact me.

Sincerely,

Jon Regosin, Ph.D.
Chief of Conservation Science
Natural Heritage & Endangered Species Program

Encl.: Table 1. Species and Natural Communities Included in Core Area 1 Delineation
Table 2. Species and Natural Communities Included in Core Area 2 Delineation

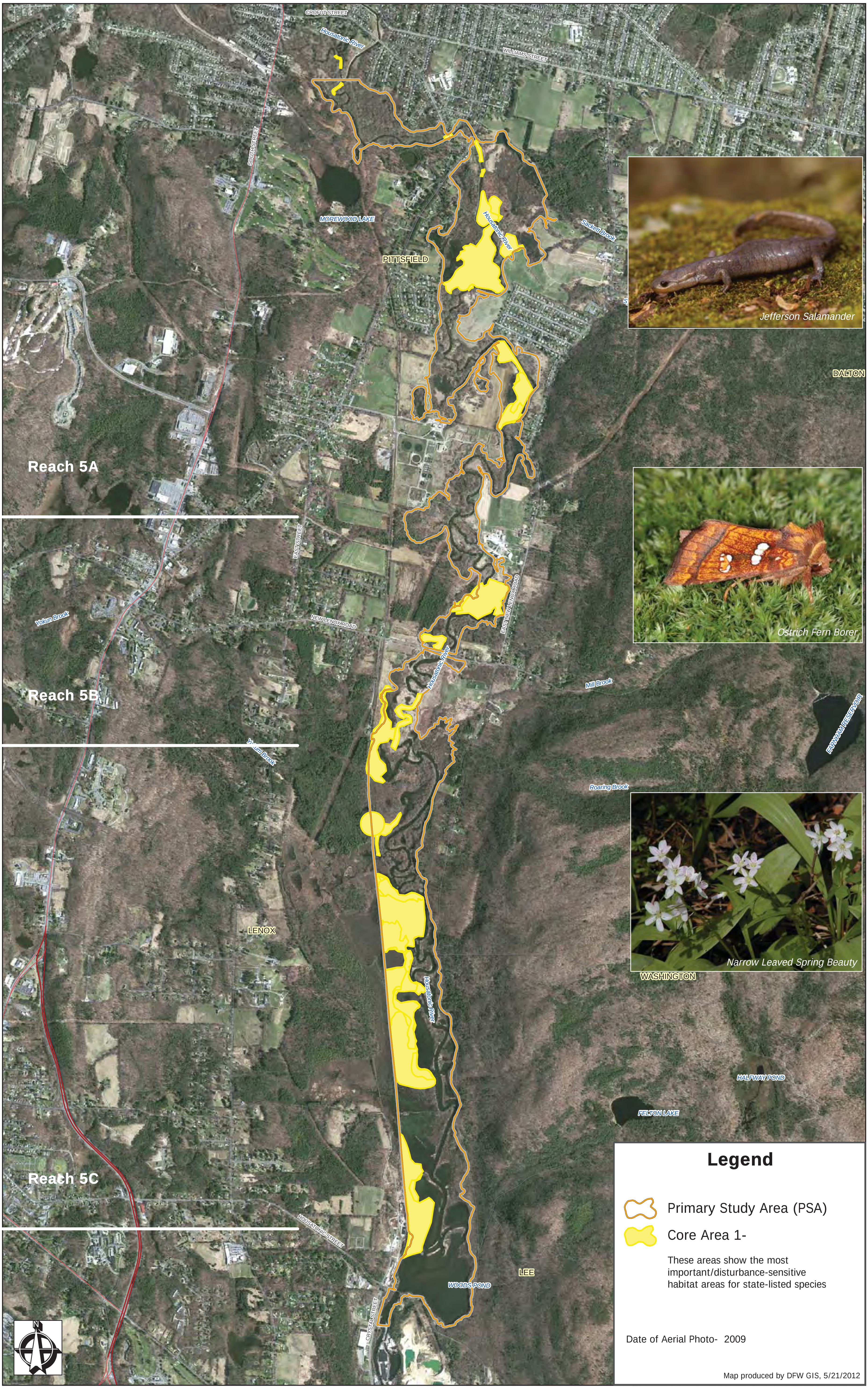
cc: Mark Tisa, MA Division of Fisheries & Wildlife
Richard Lehan, MA Department of Fish & Game
Mike Gorski, MA Dept. of Environmental Protection
Eva Tor, MA Dept. of Environmental Protection
Traci Iott, CT Dept. of Energy & Environmental Protection

TABLE 1. Species and Natural Communities Included in Core Area 1 Delineation

Common Name	Scientific Name	Taxonomic Group	MESA Status
Triangle Floater	*Alasmidonta undulata*	Mussel	No Longer Listed
Crooked-Stem Aster	*Symphyotrichum prenanthoides*	Plant	Special Concern
Wapato	*Sagittaria cuneata*	Plant	Threatened
Bristly Buttercup	*Ranunculus pensylvanicus*	Plant	Special Concern
Bur Oak	*Quercus macrocarpa*	Plant	Special Concern
Ostrich Fern Borer	*Papaipema sp. 2 nr. pterisii*	Butterflies & Moths	Special Concern
High-terrace floodplain forest		Natural Community	
Red Maple - Black Ash - Hemlock - Bur Oak Swamp		Natural Community	
Hairy Wild Rye	*Elymus villosus*	Plant	Endangered
Intermediate Spike Sedge	*Eleocharis intermedia*	Plant	Threatened
Narrow Leaved Spring Beauty	*Claytonia virginica*	Plant	Endangered
Tuckerman's Sedge	*Carex tuckermanii*	Plant	Endangered
Gray's Sedge	*Carex grayi*	Plant	Threatened
Jefferson Salamander	*Ambystoma jeffersonianum*	Amphibian	Special Concern

TABLE 2. Species and Natural Communities Included in Core Area 2 Delineation

Common Name	Scientific Name	Taxonomic Group	MESA Status
American Bittern	*Botaurus lentiginosus*	Bird	Endangered
Mustard White	*Pieris oleracea*	Butterfiles & Moths	Threatened
Wood Turtle	*Glyptemys insculpta*	Turtle	Special Concern
Common Moorhen	*Gallinula chloropus*	Bird	Special Concern

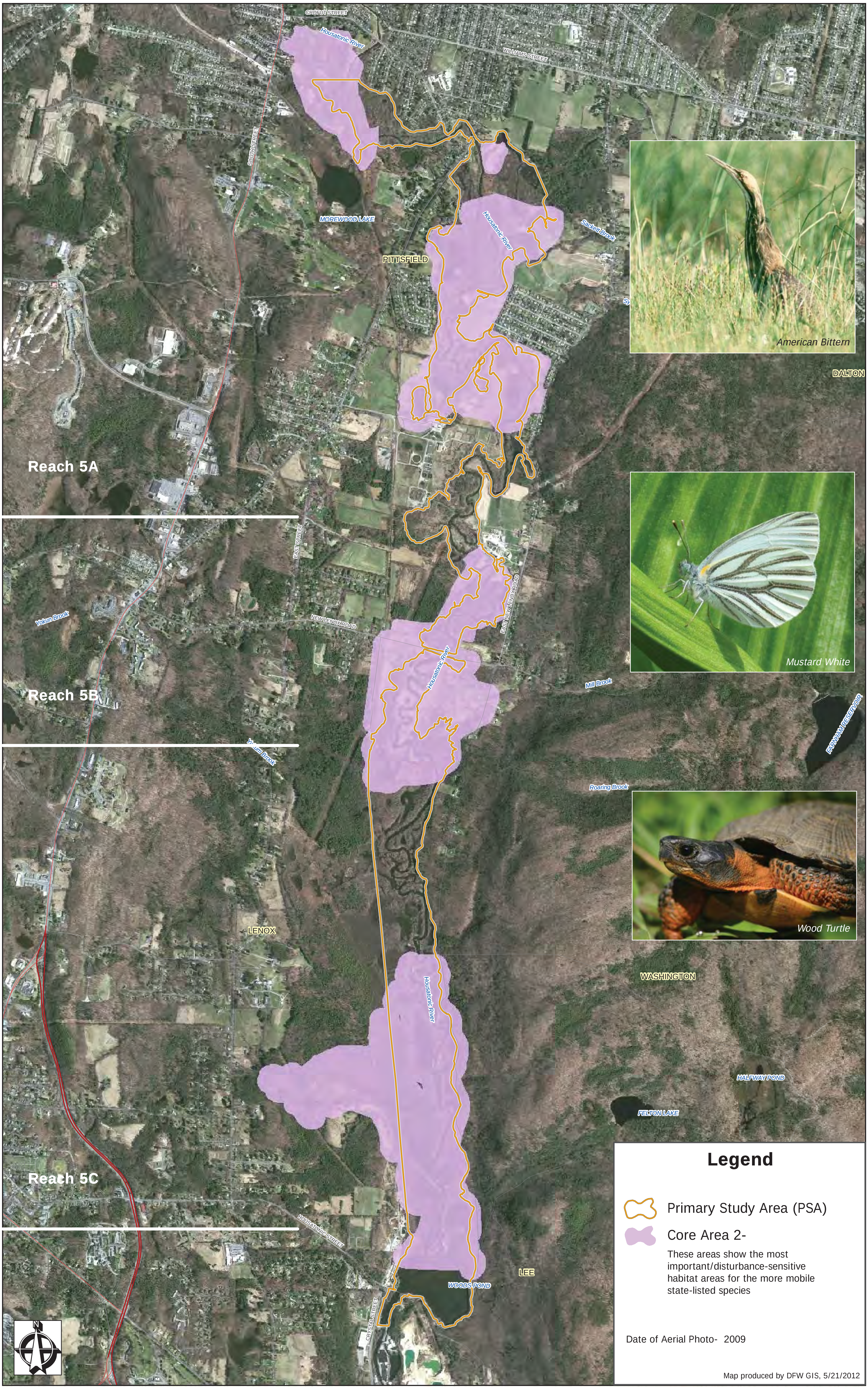


Core Habitat Areas
Housatonic River Primary Study Area (PSA)

1 0.5 0 1 Miles

Part of the Housatonic River
Showing Primary Study Area, High Species Richness, and Vernal Pools

1 0.5 0 1 Miles



Core Habitat Areas (Core Area 2)
Housatonic River Primary Study Area (PSA)

1 0.5 0 1 Miles

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
CHEMICAL-SPECIFIC ARARs				
Federal ARARs				
None				
State ARARs				
Connecticut Remediation Standards Regulations, Direct Exposure Criteria for Soil	Conn. Gen. Stat. 22a-133k-1 through k-3 Appendix A	Establishes soil cleanup standards, including those for residential use.	Potentially applicable	The Rest of River includes Reaches 10-16 in Connecticut. This Permit provides that under certain circumstances, response actions may be required to address risks posed by PCB-contaminated soil in Connecticut. The remedy[c] includes Performance Standards for residential use in Connecticut that are based upon the Residential Direct Exposure Criteria, including the Alternative Soil Criteria. Based on a site-specific risk evaluation consistent with the CT Remediation Standards Regulations, EPA has established a standard of 2 ppm as the Performance Standard for residential properties in Rest of River, including Connecticut.
To Be Considered				
Cancer Slope Factors (CSFs)	EPA Integrated Risk Information System	Guidance values used to evaluate the potential carcinogenic hazard caused by exposure to PCBs.	To be considered	CSFs have been used to compute the individual cancer risk resulting from exposure to carcinogens in site media.
Reference Doses (RfDs)	EPA Integrated Risk Information System	Guidance values used to evaluate the non-cancer hazards associated with exposure to PCBs.	To be considered	RfDs have been used to characterize human health risks due to non-carcinogens in site media.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
PCBs: Cancer Dose Response Assessment and Application in Environmental Mixtures (EPA, 1996).	EPA/600/P-96/001F (National Center for Environmental Assessment, Office of Research and Development, September 1996)	Guidance describing EPA's reassessment regarding the carcinogenicity of PCBs.	To be considered	The guidance has been used in characterization of site risks.
Guidelines for Carcinogenic Risk Assessment (EPA, 2005)	EPA/630/P-03/001F (EPA Risk Assessment Forum, March 2005)	Framework and guidelines for assessing potential cancer risks from exposure to pollutants and other environmental agents.	To be considered	Guidelines have been used in assessing risks.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (EPA Risk Assessment Forum, March 2005)	Guidance on issues related to assessing cancer risks associated with early-life exposures, including an adjustment for carcinogens acting through a mutagenic mode of action.	To be considered	Guidance has been used in assessing risks.
Massachusetts Fish Consumption Advisory	Massachusetts Department of Public Health, Freshwater Fish Consumption Advisory List (2007)	Advises that the public should not consume any fish from the Housatonic River from Dalton to Sheffield due to PCBs; also includes frogs and turtles.	To be considered	This advisory will be considered in reference to biota consumption and actions to reduce fish consumption risks, including institutional controls.
Massachusetts Waterfowl Consumption Advisory	Massachusetts Department of Public Health, Provisional Waterfowl Consumption Advisory (1999)	Advises that the public should avoid eating all mallards and wood ducks from the Housatonic River and its impoundments from Pittsfield to Rising Pond.	To be considered	This advisory will be considered in reference to waterfowl consumption and actions to reduce waterfowl consumption risks, including institutional controls.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Connecticut Fish Consumption Advisory	Connecticut Department of Public Health (CDPH), 2010 Advisory for Eating Fish from Connecticut Water bodies	Establishes advisories on consuming fish from the Housatonic River in Connecticut (above Derby Dam), including Lakes Lillinonah, Zoar and Housatonic, due to PCBs in fish. Advisories vary by species, location and group of consumers, ranging from "do not eat" to "one meal per week."	To be considered	This advisory will be considered in reference to fish consumption and actions to reduce fish consumption risks, including institutional controls.
LOCATION-SPECIFIC ARARs				
Federal ARARs				
Clean Water Act – Section 404 and implementing regulations	33 USC 1344 33 CFR Parts 320-323, 325, 332 (ACOE) 40 CFR Part 230 (EPA)	Under these requirements, no activity that adversely affects a wetland, including vernal pools, shall be permitted if a practicable alternative with less adverse effect on the aquatic ecosystem is available; a discharge cannot cause or contribute, after consideration of disposal site dilution and dispersion, to violation of any applicable water quality standard, violate an applicable toxic effluent standard, jeopardize existence of endangered or threatened species; contribute to significant degradation of waters of the U.S. Discharger must take appropriate and practicable steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem. Mitigation/restoration required for unavoidable impacts to resources.	Applicable	The remedy is designed to reduce human health and environmental risks posed by PCBs, and includes actions to excavate riverbed sediments, bank soils and Floodplain soils, with backfilling and capping. The remedy will include excavation technology and multiple engineering controls to minimize resuspension of any PCB-contaminated water, including any from wetlands. The remedy will proceed generally from upstream to downstream, with capping to follow in parts of the River. Any remedy activities that will alter wetlands, including excavation of contaminated wetland soils and sediments, backfilling and capping, will be conducted in accordance with these standards. (For purposes of this Attachment C, compliance with ARARs or standards refers to compliance with the substantive requirements, criteria, or limitations of each provision). There is no practicable alternative with lesser effects on the aquatic ecosystem. The remedy will not cause or contribute to violation of any applicable water quality standard, violate an applicable toxic effluent standard, jeopardize existence of endangered or threatened species; or contribute to significant degradation of waters of the U.S.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
				Implementation of the remedy will include appropriate and practicable steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem. Mitigation/restoration will be conducted consistent with these regulations.
Floodplain Management and Protection of Wetlands	44 CFR Part 9	Regulation sets forth policy, procedure and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Relevant and appropriate	The remedy includes actions, including excavation and capping activities, to reduce human health and environmental risks in wetlands and the floodplain. Executive Orders will be implemented and enforced consistent with the policy, procedure and responsibilities stated in these regulations.
Rivers and Harbors Act of 1899, Section 10	33 USC 403	U.S. Army Corps of Engineers approval is generally required to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of the channel of any navigable water in the U.S.	Applicable	The remedy includes excavation and filling of the Housatonic River, and so may alter or modify navigable waters as provided under the Act. Any remedy activities subject to this Act will comply with any substantive requirements of this provision. Remedy will be coordinated with the U.S. Army Corps of Engineers.
Fish and Wildlife Coordination Act	16 U.S.C. 662 et seq.	Sets forth requirements related to federal actions that may modify a water body.	Applicable	This remedy may modify a water body as provided under the Act. Any remedy activities subject to this Act will comply with any substantive requirements.
Resource Conservation and Recovery Act (RCRA) requirements for hazardous waste facilities in floodplains	40 CFR 264.1(j)(7) 40 CFR 264.18(b)	Remediation waste management sites must be designed, constructed, operated and maintained to prevent washout of any hazardous waste by a 100-year flood, unless procedures are in effect to have waste removed safely before flood waters reach the facility or no adverse effects on human health or the environment will result if washout occurs.	Potentially relevant and appropriate	The remedy does not include disposal pursuant to these regulations, but to the extent that these materials are removed from the Area of Contamination and temporary movement of waste (stockpiling) during remediation occurs, measures will be taken to prevent washout.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
National Historic Preservation Act and regulations	54 USC 300101 et seq. 36 CFR Part 800	A federal agency must take into account the project's effect on properties included or eligible for inclusion in the National Register of Historic Places.	Applicable	If this remedy affects historic properties/structures subject to these requirements, activities will be coordinated with the state, tribal and federal authorities and conducted in accordance with the substantive requirements of these regulations.
Archaeological and Historic Preservation Act	54 U.S.C. 312501 et seq.	When a Federal agency finds, or is notified, that its activities in connection with a Federal construction project may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data, such agency shall notify state, tribal or federal authorities. Such agency may request state, tribal or federal authorities to undertake the preservation of such data or it may undertake such activities. If the state, tribal or federal authorities determine that such data is significant and is being or may be irrevocably lost or destroyed, it is to conduct a survey and other investigation of the areas which are or may be affected and recover and preserve such data which are not being, but should be, recovered and preserved in the public interest.	Applicable	If during remedial design or remedial action, it is determined that this remedy may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archaeological data, EPA will notify state, tribal or federal authorities and comply with the substantive requirements in this statute.
Executive Order 11988 (Floodplain Management)	Executive Order	Federal agencies are required to avoid impacts associated with the occupancy and modification of a floodplain and avoid support of a floodplain development whenever there is a practicable alternative.	To be considered	In the remedy, activities will be performed in the floodplain. All activities will be conducted to ensure that they do not result in occupancy and modification of the floodplain. There is no practicable alternative to remedial activities in the floodplain; the remedy is designed to minimize harm to or within the floodplain.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Executive Order 11990 (Protection of Wetlands)	Executive Order	Federal agencies are required to avoid adversely impacting wetlands unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use.	To be considered	Activities subject to this Executive Order will be conducted in accordance with the substantive requirements of these standards. There is no practicable alternative to remediation activities in the wetlands; the remedy is designed to minimize harm to wetlands.
Endangered Species Act and Regulations	16 USC 1536(a)-(d) 50 CFR Part 402, Subparts A&B 50 CFR 17.	Must identify whether threatened or endangered (T&E) species or critical habitat is affected by proposed action, or take mitigation measures so that action does not affect species/habitat.	Applicable	These provisions will be complied with in regard to federally-listed threatened or endangered species and their critical habitat.
State ARARs				
Massachusetts Waterways Law and Regulations	MGL Ch. 91 310 CMR 9.00, including 9.40.	Regulates construction, placement, excavation, alteration, removal or use of fill or structures in waterways. Among the requirements is 310 CMR 9.40, Standards for Dredging and Dredged Material Disposal, which includes restrictions on improvement dredging.	Applicable	This remedy includes construction, placement, excavation, alteration, removal and use activities in the Housatonic River. Except as otherwise provided herein, measures undertaken will meet the substantive environmental standards and limit impacts. Portions of the remedy in the River will take place within the ACEC. If the dredging in the ACEC is governed by 310 CMR 9.40, the dredging is permitted as an Ecological Restoration Project. If it is deemed to not be an Ecological Restoration Project, EPA reiterates the waiver in the 2016 Permit in which EPA, in consultation with the Commonwealth, waived pursuant to CERCLA 121(d)(4)(C), the requirements of 310 CMR 9.40 that prohibit dredging in an ACEC.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Massachusetts Clean Water Act – Water Quality Certification Regulations	314 CMR 9.00 et seq., including 9.06-9.07	For discharge of dredged or fill material, criteria at 9.06 include, without limitation, the following: (a) no discharge is permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences; (b) no discharge is permitted unless appropriate and practicable steps have been taken which will avoid and minimize potential adverse impacts to bordering or isolated vegetated wetlands or land under water; (c) no discharge is permitted to Outstanding Resource Waters, except as specified in 9.06(3); (d) discharge to certified Vernal Pools requires a demonstration per 9.08; (e) no discharge is permitted for the impoundment or detention of stormwater for purposes of controlling sedimentation or other pollutant attenuation; (f) stormwater is to be controlled with best management practices; and (g) no discharge shall be permitted in rare circumstances where the activity will result in substantial adverse impacts to the physical, chemical, or biological integrity of surface waters.	Applicable	The remedy includes placement of clean fill in the River, riverbank and floodplain, following excavation/dredging, as well as the application of a sediment amendment, such as activated carbon, to Vernal Pools, or in the alternative, excavation of Vernal Pools. All activities will be conducted in accordance with these regulations, in particular, without limitation: There is no practicable alternative to the remedy which would have less adverse impact on the aquatic ecosystem; The remedy includes activities to avoid and minimize potential adverse impacts to bordering or isolated vegetated wetlands or land under water; Any discharge to Outstanding Resource Waters (certified Vernal Pool) would satisfy the substantive requirements of 9.08 because all reasonable measures will be taken to avoid, minimize and mitigate adverse effect on the environment and the remedy is justified by an overriding public interest. Remedial work that may affect specified habitat sites of Rare Species will be carried out in accordance with the MESA ARAR requirement for a Conservation and Management Plan. Therefore, the remedy will not necessitate a waiver from the prohibition of 9.06(2). There will not be any discharge of dredged or fill material for impoundment or detention of stormwater for purposes of controlling sedimentation or other pollutant attenuation within Waters of the United States or the Commonwealth. The remedy will use best management practices to control stormwater. The remedy will not include activities that result in substantial adverse impacts to the physical, chemical or biological integrity of surface waters.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
		For dredging and dredged material management, criteria at 9.07 include, without limitation, the following: (a) no dredging is allowed if there is a practicable alternative that would have less impact on the aquatic ecosystem, no dredging is permitted unless appropriate and practicable steps have been taken to avoid, minimize or mitigate adverse effects on land under water, and no dredging is allowed which will have adverse effect on specified habitat sites of rare species except under certain conditions; (b) dredging and dredged material management must be conducted to ensure protection of human health, public safety, public welfare and the environment,; (c) dredged material shall not be disposed if a feasible alternative exists that involves the reuse, recycling, or contaminant destruction and/or detoxification; (d) all dredged material management activities must comply with 314 CMR 9.00 and other statutes and regulations; (e) dredged material placed on or in the land at upland locations are subject to release notification requirements and thresholds; (f) dredging not permitted for impoundment or detention of stormwater for purposes of controlling sedimentation or other pollutant attenuation, or in Outstanding		The remedy includes excavation/dredging of river sediments, and excavation of bank and floodplain soils. The remedy also includes the application of a sediment amendment, such as activated carbon, to Vernal Pools, or in the alternative, excavation of Vernal Pools. All activities will be conducted in accordance with these regulations, in particular, without limitation: There is no practicable alternative to the remedy which would have less adverse impact on the aquatic ecosystem. The remedy includes appropriate and practicable steps to avoid, minimize or mitigate adverse effects on land under water. Remedial work that may affect specified habitat sites of Rare Species will be carried out in accordance with the MESA ARAR requirement for a Conservation and Management Plan. Therefore, the remedy will not necessitate a waiver from the prohibition of 9.07(1)(a). Dredging in the remedy will be conducted in a manner that ensures protection of human health, public safety, public welfare and the environment. There is no feasible alternative to the disposal of dredged material involving reuse, recycling, or contaminant destruction and/or detoxification. All dredged material management activities will comply with 314 CMR 9.00 and other pertinent statutes and regulations. Dredged material placed on the land at upland locations will comply with pertinent thresholds and requirements. Implementation of the remedy will meet the requirements for an Intermediate Facility in 314 CMR 9.07(4) because the

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
		Resource Waters; dredging may be permitted to manage stormwater for flood control purposes if there is no practicable alternative and best management practices are implemented; (g) no dredging is permitted in rare circumstances where the activity will result in substantial adverse impacts to the physical, chemical, or biological integrity of waters; (h) no dredging is permitted in Outstanding Resource Waters.		remedy will be designed and implemented so there are no permanent adverse impacts on the ACEC. Any dredging for stormwater detention or management purposes would be conducted per the requirements. Any dredging in Outstanding Resource Waters (certified Vernal Pool) would satisfy the substantive requirements of 9.08 because all reasonable measures will be taken to avoid, minimize and mitigate adverse effect on the environment and the remedy is justified by an overriding public interest. The remedy does not include dredging where the activity will result in substantial adverse impacts to the physical, chemical, or biological integrity of waters.
Massachusetts Wetlands Protection Act and Regulations	MGL c. 131, section 40 310 CMR 10.00, including 10.53	These requirements govern removal, dredging, filling or altering of banks, riverfront areas, inland wetlands, land subject to flooding and other areas, including provisions on limited projects. Provisions include 10.53(3), which authorizes certain projects as "limited projects", including, in 10.53(3)(q), responses to a release or threat of release of oil and/or hazardous materials in accordance with the Massachusetts Contingency Plan (MCP), where there is no practicable alternative consistent with the MCP and that would be less damaging to resource areas, and which avoids or minimizes impacts to resources, including meeting specific standards to the maximum extent practicable.	Applicable	Any remedy activities that remove, dredge, fill, or alter such areas will be conducted in accordance with these standards. The remedy, to be implemented as a CERCLA response action, is in accordance with the MCP, has no practicable alternative consistent with the MCP that would be less damaging to resource areas, and avoids or minimizes impacts to resource areas, including meeting specific standards to the maximum extent practicable, and thus meets the standards for a "limited project" under 10.53(3)(q). Remedial work that may affect specified habitat sites of Rare Species will be carried out in accordance with the MESA ARAR requirement for a Conservation and Management Plan. Therefore, the remedy will not necessitate a waiver from the prohibition in 10.53(3).

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Massachusetts Dam Safety Standards	302 CMR 10.00	Regulations govern design and construction of new and existing dams, and removal of existing dams, and inspection of dams.	Applicable	The remedy includes provisions for inspection, operation and maintenance of dams, removal of dams, and management of materials generated during work on, or removal of, a dam. Additionally, the remedy will comply with these regulations for Massachusetts dams in the area of remedy activity.
Massachusetts Site Suitability Criteria	310 CMR 16.40(3),(4)	Site suitability criteria for solid waste facilities, including facility-specific and general site suitability criteria.	Potentially applicable to the temporary management of excavated materials; potentially applicable or relevant and appropriate for Upland Disposal Facility.	The remedy includes, among other components, the excavation of PCB-contaminated soil and sediment and the off-site disposal of at least 100,000 cubic yards of the PCB-contaminated material, including all PCB material that averages greater than or equal to 50 ppm (as determined by Attachment E to the Permit) at existing licensed facilities approved to receive such material, and the on-site disposal at the Upland Disposal Facility of material averaging less than 50 ppm PCBs. Portions of the remedy will be implemented in the ACEC, or in a Resource Area or Riverfront Area. As provided in Attachment D to the Permit, PCB-contaminated sediments and soils in the Rest of River are regulated for cleanup and disposal as PCB-remediation waste under 40 C.F.R. Part 761. For the portion of the remedy involving sediments and soils with PCB concentrations that average less than 50 ppm (see Attachment E to the Permit), siting standards in 310 CMR 16 are potentially relevant and appropriate. EPA believes that the remedy can comply with all substantive provisions of 310 CMR 16 except for the provisions of 310 CMR 16.40(4)(d). For any provision of 310 CMR 16, to the extent that they are deemed to be an ARAR but cannot be met at the Upland Disposal Facility, EPA determines that compliance would pose a greater risk to human health and the environment and accordingly, EPA waives the provisions pursuant to CERCLA 121(d)(4)(B) (in this Attachment C, references to CERCLA 121(d)(4) include 40 C.F.R. 300.430(f)(1)(ii)(C)).

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
				For each area in which solid waste may be disposed of on-site during remedy implementation, including those within the ACEC or Resource Area or Riverfront Area, the remedy includes provisions for restoration of the disposal facility. To the extent: 1. The materials disposed of on-site during implementation of the remedy constitute solid waste under this regulation; and 2. The locations for disposal of the materials are within the ACEC (or, the locations are outside but adjacent to the ACEC and such locations fail to protect the outstanding resources of the ACEC) or in a Resource Area or Riverfront Area; the requirements are not appropriate for the Upland Disposal Facility because compliance will create greater risk to human health and the environment than implementation of the remedy set forth in this Permit given the already damaged and altered area surrounding the Upland Disposal Facility location, the existing contamination from current industrial uses at or near the Upland Disposal Facility location, the multiple protectiveness safeguards built in to the design of the Upland Disposal Facility, the risks inherent to the disposal alternatives besides the Upland Disposal Facility, and the benefits of the proposed remedy. However, if the provisions of 310 CMR 16.40(4)(d) are deemed to be ARARs, EPA considers as waived, pursuant to CERCLA 121(d)(4)(B), the requirements of 16.40 that prohibit or restrict such disposal locations during implementation of the remedy. For the provisions at 16.40(4)(d), the remedy portions in the ACEC (or, at locations outside but adjacent to the ACEC) or at a Resource Area or Riverfront Area may necessarily include temporary management of material excavated during implementation prior to disposal. Such temporary

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				management includes, without limitation, temporary stockpiling or storage of materials, and the potential inclusion of locations related to railroad transport of materials excavated during implementation of the remedy. To the extent: 1. the provisions of 16.40 apply to the temporary management of materials during implementation of the remedy after excavation and prior to disposal; 2. the materials temporarily managed on-site during implementation of the remedy constitute solid waste under this regulation; and 3. the locations for management of the materials are within the ACEC (or, the locations are outside but adjacent to the ACEC and such locations fail to protect the outstanding resources of the ACEC) or in a Resource Area or Riverfront Area: EPA, in consultation with the Commonwealth, considers as waived, pursuant to CERCLA 121(d)(4)(C), the requirements of 16.40 that prohibit or restrict such temporary solid waste management locations during implementation of the remedy.
Massachusetts Facility Location Standards	310 CMR 30	Location standards for hazardous waste management facilities, including, but not limited to, Land Subject to Flooding and Areas of Critical Environmental Concern (ACEC). Criteria for proposed projects that name specific sites, including restrictions on projects in an ACEC or in wetlands.	Potentially applicable for the temporary management of excavated materials; not an ARAR for the Upland Disposal Facility.	The remedy does not include disposal of hazardous waste on-site so this provision does not apply to disposal of materials at the Upland Disposal Facility. The remedy includes, among other components, the excavation of PCB-contaminated soil and sediment and the off-site disposal of at least 100,000 cubic yards of the PCB-contaminated material, including all PCB material that averages greater than or equal to 50 ppm (as determined by Attachment E to the Permit) at existing licensed facilities approved to receive such material, and the on-site disposal of material averaging less than 50 ppm PCBs at the Upland Disposal Facility. Both the on-site and off-site disposal of PCBs are addressed pursuant to 40 C.F.R. 761.61(c) and EPA's revised risk-based determination in Attachment D of this Permit.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
				For disposal of material on-site, to the extent any material averaging less than 50 ppm is deemed to be Massachusetts hazardous waste solely because of the presence of PCBs, EPA has determined that the requirements are not appropriate. However, if any provision of 310 CMR 30 is deemed to be an ARAR, EPA waives it pursuant to CERCLA 121(d)(4)(B) because compliance with the prohibition of disposal at the Upland Disposal Facility would pose a greater risk to human health and the environment than the proposed remedy, given the already damaged and altered area surrounding the Upland Disposal Facility location, the existing contamination from current industrial uses at or near the Upland Disposal Facility location, the multiple protectiveness safeguards built in to the design of the Upland Disposal Facility, the risks inherent to the disposal alternatives besides the Upland Disposal Facility, and the benefits of the proposed remedy. The remedy portions in the ACEC may necessarily include temporary management of material excavated during implementation prior to disposal. Such temporary management includes, without limitation, temporary stockpiling or accumulation of materials, and the potential inclusion of locations related to railroad transport of materials excavated during implementation of the remedy. For each area in which hazardous waste is temporarily managed during remedy implementation, including those within the ACEC, the remedy includes provisions for restoration of what is disturbed by the temporary management of materials, and for final disposition of materials through disposal.

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Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
				To the extent: 1. The provisions of 310 CMR 30 apply to the temporary management of materials during implementation of the remedy after excavation and prior to disposal; 2. The materials temporarily managed on-site during implementation of the remedy constitute hazardous waste under this regulation, and are not subject to any regulatory exemption such as 310 CMR 30.104(3)(f) exempting dredged materials; and 3. The locations for temporary management of the materials are within the ACEC (or, the locations are outside but adjacent to or in close proximity to the ACEC and such locations are not protective of the outstanding resources of the ACEC); EPA, in consultation with the Commonwealth, considers as waived, pursuant to CERCLA 121(d)(4)(C), the requirements of 310 CMR 30 that prohibit such temporary hazardous waste management locations during implementation of the remedy.
Massachusetts Historical Commission Act and Regulations	MGL c. 9, section 27C 950 CMR 71.07	If a project has an area of potential impact that could cause a change in the historical, architectural, archaeological, or cultural qualities of a property on the State Register of Historic Places, these provisions establish a process for notification, determination of adverse impact, and evaluation of alternatives to avoid, minimize or mitigate such impacts.	Relevant and appropriate	If such properties are present in the area of remedy activities, the remedy will comply with these requirements.

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Massachusetts Endangered Species Act (MESA) and Regulations	MGL c. 131A 321 CMR 10.00, Parts I, II, and V. 321 CMR 10.00, Part IV	A proposed activity in mapped Priority Habitat for a state-listed rare, threatened, endangered species or species of special concern, or other area where such a species has occurred may not result in a "take" of such species, unless it has been authorized for conservation and management purposes that provide a long-term net benefit to the conservation of the affected state-listed species. A conservation and management permit may be issued provided an adequate assessment of alternatives to both temporary and permanent impacts to State-listed species has taken place, an insignificant portion of the local population would be impacted by the project or activity, and an approved conservation and management plan is carried out that provides a long-term Net Benefit to the conservation of the State-listed species. Projects that will alter a designated Significant Habitat must be reviewed to ensure that they will not reduce the viability of the habitat to sustain an endangered or threatened species.	Applicable	The remedy will take place in priority habitat for one or more state-listed species. In implementing the remedy, impacts to state-listed species and their habitats will be avoided or minimized wherever possible. The processes outlined as part of the remedy for work in Core Habitat areas were developed in consultation with the Commonwealth and will satisfy these requirements. To the extent that unavoidable impacts result in a take of state-listed species, EPA would follow the regulatory requirements with respect to implementing a conservation and management plan providing for a long-term net benefit to the affected state-listed species. In a July 31, 2012 letter to EPA, the MA National Heritage and Endangered Species Program identified those state-listed species potentially affected in the project area. Note that since that date, Massachusetts has delisted particular species; in design and implementation of the remedy, EPA, in consultation with MA, will use the then-current listing of State-listed species. There are no designated Significant Habitats in the remedy area. To the extent that a Significant Habitat is designated in the remedy area, this provision will be complied with.

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Massachusetts Area of Critical Environmental Concern (ACEC)	301 CMR 12.11(1)(c)	Provides for establishment of Areas of Critical Environmental Concern in the State. ACEC designation affects other state laws and regulations.	Relevant and appropriate	The ACEC regulations pertain to State agency actions, and are not applicable to the federal EPA action. However, the remedy complies with the substantive requirements of 301 CMR 12.11(1)(c), which may be relevant and appropriate, by advancing the values of 301 CMR 12.11(1)(c), while avoiding adverse effects on identified values in section 12.11(1)(c).
Connecticut Dam Safety Regulations	CGS 22a-401 to 22a-411 Conn. Agencies Regs. Section 22a-409-2.	Regulations govern design and construction of new and existing dams, and removal of existing dams, and inspection of dams.	Potentially applicable	The remedy includes provisions for management of materials generated during work on, or removal of, a dam. To the extent that these regulations are applicable to a Connecticut dam in the area of remedy activity, the remedy will comply with these regulations.
Connecticut Inland Wetlands and Watercourses Act and regulations	CGS 22a-36 et seq. Conn. Agencies Regs. Sec. 22a-39-4	Permit required for activities that remove material from inland wetlands or watercourses; Connecticut Department of Energy and Environmental Protection (CT DEEP) is allowed to issue general permit for minor activities with minimal environmental impacts, defined to include monitoring and sampling.	Potentially applicable	To the extent that the remedy includes activity in Connecticut that removes material from inland wetlands or watercourses, the remedy will comply with this provision.

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Connecticut Endangered Species Act	Conn. Gen. Stat. 26-303 through 26-316	Requires state agency to: (a) ensure that any action authorized or performed by it does not threaten the continued existence of a listed endangered or threatened species or result in destruction or adverse modification of habitat essential to such species, unless an exemption is granted; and (b) take all reasonable measures to mitigate any adverse impacts of the proposed action on such species or habitat. Prohibits "taking" of endangered or threatened species, except where State determines that a proposed action would not appreciably reduce likelihood of survival or recovery of the species.	Potentially applicable	To the extent that any remedy activity takes place that is subject to this statute, EPA will ensure that the remedy will comply with these regulations.
To Be Considered				
MassDEP Guidance	Dam Removal and the Wetland Regulations, 2007	Provides guidance on permitting issues and review considerations associated with dam removal projects, especially as it relates to the Massachusetts Wetlands Protection Act.	To be considered	The remedy now includes dam removal requirements. To the extent that this guidance is pertinent to a Massachusetts dam that is in the area of remedy activity, the remedy will consider this guidance.
Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) Guidance	Dam Removal in Massachusetts: A Basic Guide for Project Proponents, 2007	Provides guidance through the initial conceptualization of a project, the feasibility studies, and the permitting process.	To be considered	The remedy now includes dam removal requirements. To the extent that this guidance is pertinent to a Massachusetts dam that is in the area of remedy activity, the remedy will consider this guidance.

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Massachusetts Department of Fish and Game Guidance	Impounded Sediment and Dam Removal in Massachusetts: 2003	Provides guidance on a decision-making framework regarding dam removal and in-stream management options for impounded sediment.	To be considered	The remedy now includes dam removal requirements. To the extent that this guidance is pertinent to a Massachusetts dam in the area of remedy activity, the remedy will consider this guidance.
ACTION-SPECIFIC ARARs				
Federal ARARs				
Toxic Substances Control Act (TSCA) Regulations on Cleanup of PCB Remediation Waste	40 CFR 761.61(c)	Risk-based approval through a TSCA determination issued by EPA is pursuant to 40 CFR 761.61(c) and requires demonstration that cleanup method will not pose an unreasonable risk of injury to health or the environment.	Applicable	This Permit includes a revised TSCA risk-based determination issued by EPA as Attachment D ("TSCA Determination"). Both the on-site and off-site disposal of PCBs are addressed pursuant to the TSCA Determination. The TSCA Determination finds that the remedy will not pose an unreasonable risk of injury to health or the environment as long as the remedy complies with all of the conditions set out in the TSCA Determination.
TSCA Regulations on Storage of PCB Remediation Waste	40 CFR 761.50 40 CFR 761.65 40 CFR 761.61(c)	General and specific requirements for storage of PCB Remediation Waste. Regulations include specific provisions for storage of PCB Remediation Waste in piles at the cleanup site or site of generation for up to 180 days (761.65(c)(9)). Also allows for risk-based approval by EPA of alternate storage method (761.61(c)), based on demonstration that it will not pose an unreasonable risk of injury to health or the environment.	Applicable	The remedy will comply with these provisions.

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SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
TSCA Regulations on Discharge of PCB-containing Water	40 CFR 761.50(a)(3)	Prohibits discharge of water containing PCBs to navigable waters unless PCB concentration is <3 mg/L or discharge is in accordance with NPDES discharge limits.	Applicable	Any discharge to navigable waters will comply with this provision.
TSCA Regulations on Decontamination	40 CFR 761.79	Establishes decontamination standards and procedures for removing PCBs from water, organic liquids, and various types of surfaces.	Applicable	To the extent the remedy involves decontamination activities, this provision will be complied with.
Clean Water Act and National Pollutant Discharge Elimination System (NPDES) Regulations	33 USC 1342 40 CFR 122 including, but not limited to 122.3(d) and 122.44(a) & (e) 40 CFR 125.1-125.3	These standards include that point source discharge must meet technology-based effluent limitations (including those based on best available technology for toxic and non-conventional pollutants and those based on best conventional technology for conventional pollutants) and effluent limitations and conditions necessary to meet state water quality standards.	Applicable	The remedy will include dewatering of sediments excavated from the River and wetland soils. However, at this stage, it has not been determined if water from the remedy, such as from dewatering or other processing of sediment and wetland soils will be then discharged into the River, or if the water will be transported to Permittee's water treatment plant in Pittsfield for treatment, or if another technique will be used. Additionally, under 40 CFR 122.3(d), EPA, consistent with its remediation in the 1.5 Mile Reach of the River, can establish discharge standards. If the remedy includes discharge into the River, the remedy will comply with these standards.
Clean Water Act – NPDES Regulations (stormwater discharges)	40 CFR 122.26(c)(1)(ii)(C) 40 CFR 122.44(k)	Best management practices (BMPs) must be employed to control pollutants in stormwater discharges during construction activities.	Applicable	These standards will be complied with during construction activities.
RCRA regulations on identification of Hazardous Waste	40 CFR 261	Establishes standards for identifying and listing hazardous waste under RCRA.	Potentially applicable	Under the remedy, testing of wastes subject to removal will take place consistent with these requirements during design/implementation of the remedy.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
RCRA regulations for Generators of Hazardous Waste	40 CFR 262.30-33	Pre-transportation requirements for generators of hazardous waste.	Potentially applicable	If RCRA hazardous wastes are identified, and these materials are removed from the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with these requirements.
RCRA regulations on less-than-90-day Accumulation of Hazardous Waste	40 CFR 262.34	Provides for on-site accumulation of hazardous waste in certain circumstances, provided compliance with other specified requirements.	Potentially applicable	If RCRA hazardous wastes are identified, and these materials are removed from the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with these requirements.
RCRA Hazardous Waste Management Facilities –General requirements.	40 CFR 264.1(j)	General requirements for hazardous waste management facilities (waste analysis, security, precautions regarding ignition or reaction of wastes, preventing washout of units).	Potentially applicable	If RCRA hazardous wastes are identified, and these materials are removed from the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with these requirements.
State ARARs				
Massachusetts Clean Waters Act – Water Quality Certification Regulations	314 CMR 9.01 -9.08	See Synopsis of Requirements in the Location-specific entry for this ARAR	Applicable	See Action(s) to be Taken to Achieve ARARs in the Location-specific entry for this ARAR.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Massachusetts Clean Water Act and Wetlands Protection Act – stormwater management standards	310 CMR 10.05(6)(k) 314 CMR 9.06(6)(a)	Projects subject to regulation under the Wetlands Protection Act or that involve discharge of dredged or fill material must incorporate stormwater BMPs to attenuate pollutants in stormwater discharges, as well as to provide a setback from receiving waters and wetlands, in accordance with 10 specified stormwater management standards.	Applicable	The remedy will comply with stormwater requirements.
Numeric Massachusetts Water Quality Criteria for PCBs – Massachusetts Surface Water Quality Standards	314 CMR 4.05(5)(e)	Freshwater chronic aquatic life criterion (based on protection of mink): 0.014 µg/L. Human Health criterion based on human consumption of water and organisms: 0.000064 µg/L.	Relevant and appropriate	The remedy activities to be conducted are designed to reduce human health and environmental risks posed by PCBs including not contributing to any exceedances of the Water Quality Criteria. The remedy includes, among other components, excavation and capping of PCB contamination from the riverbed, riverbanks, Floodplains and Backwaters. The remedy will include excavation technology and multiple engineering controls to minimize resuspension of any PCB-contaminated water. The freshwater chronic aquatic life criterion of 0.014 µg/L will be met by the remedy. Regarding the human health criterion based on human consumption of water and organisms of 0.000064 µg/L: in the 2016 Permit, EPA, in consultation with the Commonwealth, waived this criterion on the grounds that achievement of this ARAR is technically impracticable, given that based on current data, it is not predicted to be met by this or any sediment alternative in Massachusetts. To be protective of human health and the environment, as specified in this Permit, EPA is establishing alternative criteria (that are not ARARs) for this waived criterion.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Massachusetts Hazardous Waste Regulations on Identification and Listing of Hazardous Waste	310 CMR 30.100	Establishes criteria and lists for determining whether a waste is a hazardous waste under state law.	Applicable	Wastes subject to removal will be tested consistent with these requirements during design/implementation of the remedy.
Massachusetts hazardous waste regulations for generators	310 CMR 30.321-324	Pre-transport requirements for generators of hazardous waste	Potentially applicable	To the extent that non-PCB hazardous wastes are identified, and these materials are removed from the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with these pre-transport requirements.
Massachusetts hazardous waste management – general requirements	310 CMR 30.513, 514, 524, 560	General requirements for hazardous waste management facilities	Potentially applicable	To the extent that non-PCB hazardous wastes are identified, and these materials are removed from the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with these general requirements.
Massachusetts Hazardous Waste regulations - technical requirements for storage	310 CMR 602, 640, 580, 660.	Requirements related to storage of hazardous waste.	Potentially applicable	To the extent that non-PCB hazardous wastes are identified, and are moved out of the Area of Contamination during remedy implementation but remain on-site during remedy implementation, the remedy will comply with the substantive requirements of these regulations.
Massachusetts Air Pollution Control Regulations	310 CMR 7.00	These provisions regulate air emissions, dust, odor, and noise, among other things.	Applicable	Remedy will comply with these provisions.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
Connecticut Water Quality Standards for PCBs	Connecticut Water Quality Standards, Section 22a-426-1 to 22a-426-9	Freshwater chronic aquatic life criterion (based on protection of mink): 0.014 µg/L. Human health criterion based on human consumption of water and organisms: 0.000064 µg/L.	Relevant and appropriate	To the extent that remedy activities take place in a Connecticut waterway, such remedy activities will be conducted so as to not contribute to an exceedance of Water Quality Criteria. Remedy activities will contribute to the achievement of the State Water Quality Standards. Regarding the human health criterion based on human consumption of water and organisms of 0.000064 µg/L: In Connecticut, the remedy is intended to meet the standard. Current modeling shows the remedy will achieve attainment in at least 3 of the 4 impoundments. However, the results from the Connecticut model are very uncertain due to the empirical, semi-quantitative nature of the analyses. As such it is not possible to predict with certainty attainment or lack of attainment of the human health criterion based on human consumption of water and organisms of 0.000064 µg/L in Connecticut (Reaches 10-16). Thus, EPA, in consultation with Connecticut, does not believe that there is a basis to establish alternative standards at this time. In addition, this concentration (0.000064 µg/L) cannot be reliably measured using available analytical techniques. Monitoring, using appropriate analytical techniques and reporting levels, will be conducted to measure progress toward this standard over time throughout the Housatonic River in Connecticut.

ATTACHMENT C
SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Statute/Regulation	Citation[a]	Synopsis of Requirements	Status	Action(s) to be Taken to Achieve ARARs[b]
To Be Considered				
TSCA PCB Spill Cleanup Policy	40 CFR Part 761, Subpart G	Policy used to determine adequacy of cleanup of spills resulting from the release of materials containing PCBs at concentration of 50 mg/kg or greater.	To be considered	To the extent that such a spill occurs in the remedy, this policy will be considered in the response.
EPA Contaminated Sediment Remediation Guidance	EPA-540-R-05-012 OSWER 9355.0-85 December 2005	Provides guidance on remediation of contaminated sediment sites.	To be considered	The guidance has been considered in remedy selection and will be considered in remedy implementation and operation and maintenance.
Clean Water Act, National Recommended Water Quality Criteria for PCBs	National Recommended Water Quality Criteria: 2002, EPA-822-R-02-047, USEPA, Office of Water, Office of Science and Technology (Nov. 2002).	Freshwater chronic aquatic life criterion (based on protection of mink): 0.014 µg/L. Human health criterion based on human consumption of water and organisms: 0.000064 µg/L.	To be Considered	To be considered with respect to Action(s) to be Taken to Achieve ARARs in connection with Massachusetts and Connecticut Water Quality Standards.

a. The substantive requirements, including environmental performance standards, contained in the statutes, regulations, and other documents referenced in the column captioned "Citation" shall control to determine the requirements that must be met and the actions to achieve such requirements. Other references in the table that summarize the requirements of or action necessary to achieve ARARs are summary in nature, may not be all-inclusive, and are not controlling.

b. For purposes of this Attachment C, compliance with ARARs or standards refers to compliance with the substantive requirements, criteria, or limitations of each provision.

c. For purposes of this Attachment C, "remedy" includes the corrective measures, remedial design and remedial action activities, and operation and maintenance activities undertaken pursuant to this Permit.

ATTACHMENT D
TSCA 40 C.F.R. SECTION 761.61(C) DETERMINATION

ATTACHMENT D

TSCA 40 C.F.R. SECTION 761.61(C) DETERMINATION

PCB-contaminated sediments and soils in the Rest of River likely meet the definition of PCB remediation waste as defined under 40 C.F.R. Section 761.3 and thus are regulated for cleanup and disposal under 40 C.F.R. Part 761.

EPA's Rest of River administrative record available for public review includes extensive information on the nature of the contamination, location and extent of the contamination, the procedures used relative to sampling, and Human Health and Ecological Risk Assessments. The Rest of River cleanup plan is specified in the Permit. In accordance with the requirements under the Toxic Substances Control Act (TSCA) and 40 C.F.R. Section 761.61(c), and as supported by the Administrative Record for this matter, EPA has made a finding that the manner of sampling, storage, cleanup, and disposal of PCB-contaminated sediment and soil as set out in this Permit, including attainment of the Performance Standards and associated Corrective Measures to meet the Performance Standards, including Tables 1-4, will not result in an unreasonable risk of injury to human health or the environment as long as the following conditions are met:

- A combination of off-site disposal and disposal in an on-site Upland Disposal Facility will be used to manage contaminated sediment and floodplain soil removed as part of the cleanup.

- At least 100,000 cubic yards of contaminated sediment and Floodplain soil that is removed will be disposed of off-site at an existing TSCA-approved disposal facility or RCRA hazardous waste landfill or a landfill permitted by the receiving state to accept PCB remediation wastes, depending on the contaminant levels and waste classifications.

- The average concentrations of PCBs to be placed in the Upland Disposal Facility are estimated to be 20 to 25 milligrams per kilogram (or parts-per-million (ppm)). Segregation of the material will be based on sampling protocols that are also outlined in the Permit, including Attachment E.

- The Upland Disposal Facility design criteria outlined in the Permit include a double bottom liner (at least 15 feet above the seasonal high groundwater elevation), leachate collection and management, a groundwater monitoring network, and a multi-layer low permeability engineered cap/cover. The bottom liners and the cap material shall have a permeability equal or less than 1 x 10^{-7} cm/sec, a minimum thickness of 30 mils and be chemically compatible with PCBs. The Upland Disposal Facility will only accept materials that are part of the Rest of River cleanup.

- Several components of the Permit require construction of an Engineered Cap following sediment removal. Such Engineered Caps will be constructed in accordance with the Engineered Cap Performance Standards and design protocols identified in the Permit.

- Protocols, developed in accordance with TSCA, will be developed and maintained for the decontamination of all equipment used when handling TSCA-regulated material to ensure proper decontamination of equipment and to avoid mixing of TSCA-regulated material with non-TSCA material.

- The use of activated carbon or another amendment as part of Rest of River remediation will be implemented in accordance with the Permit to reduce the bioavailability of PCBs following remediation.

- Institutional Controls, O&M, and Periodic Reviews will be carried out as a component of the cleanup, both in the areas of sediment and Floodplain removal, in areas subject to Monitored Natural Recovery, and at the Upland Disposal Facility.

- Air monitoring and dust suppression measures for PCBs will be maintained until excavation and transport of PCB-contaminated soil and sediment, and capping and disposal of PCB-contaminated soil and sediment is complete.

- Temporarily stockpiled TSCA-regulated material will be bermed and properly covered to capture runoff in accordance with the requirements of §761.65. Runoff shall be collected and disposed of, as appropriate, in accordance with § 761.60 or § 761.79(b)(1), or as otherwise approved by EPA pursuant to the process outlined in this Permit.

- A financial assurance provision is incorporated into the remedy via the Consent Decree.

ATTACHMENT E
CRITERIA/METHODS APPLICABLE TO DISPOSAL OF MATERIAL EXCAVATED IN REST OF RIVER REMEDIAL ACTION

ATTACHMENT E

Criteria/Methods Applicable to Disposal of Material Excavated in Rest of River Remedial Action

1. For floodplains in each of the 90 Exposure Areas shown in Figure 4, to the extent that remediation is required in any given Exposure Area, GE will segregate and dispose of off-site (out-of-state) soils containing high concentrations so that the remaining floodplain soil to be disposed of in the Upland Disposal Facility averages less than 50 mg/kg PCBs. The process is further described as follows:

   - After additional data collection required by the 2016 Permit, the horizontal footprint and vertical removal depth (the volume) of soil that needs to be removed in each Exposure Area will be determined.

   - The volume-weighted average PCB concentration of all soil to be removed from each Exposure Area will be calculated (using the same PCB data set used to delineate the soil to be removed).

   - If the volume-weighted average PCB concentration in the soil to be removed equals or exceeds 50 mg/kg in an Exposure Area, the soil with the highest PCB concentrations (e.g., "hot spots") in the Exposure Area will be segregated, or separated out, for out-of-state disposal until the average concentration of the remainder of the soil to be removed in the Exposure Area decreases to less than 50 mg/kg for disposal at the Upland Disposal Facility.

2. For Reach 5A banks, GE will segregate and dispose of off-site (out-of-state) soils containing high concentrations so that the remaining Reach 5A bank soil to be disposed of in the Upland Disposal Facility has a volume-weighted average of less than 50 mg/kg PCBs. In calculating the volume-weighted average concentration of PCBs in Reach 5A riverbank soils for disposal purposes, the only soils that will be considered are soils to be removed from Reach 5A riverbanks.

3. GE will dispose of all riverbank and sediment from Reach 5B off-site (out-of-state), except in the following circumstances: If, pursuant to Section II.C. of the agreement, GE removes additional riverbank soil with PCB concentrations less than 50 mg/kg, this material may be disposed of in the Upland Disposal Facility.

4. For all sediment except for Reach 5B, GE will segregate and dispose of off-site (out-of-state) sediments containing high concentrations so that the remaining sediment to be disposed of in the Upland Disposal Facility averages 25 mg/kg PCBs or less on a reach or subreach basis as described below.

   - The 25 mg/kg average applies individually to: Reach 5A, Reach 5C, Woods Pond, Backwaters, Reach 7 Subreaches (Subreach 7B [Columbia Mill Impoundment], Subreach 7C [Eagle Mill Impoundment], Subreach 7E [Willow Mill Impoundment], Subreach 7G [Glendale Impoundment]), and Rising Pond. These reaches/subreaches are depicted in Figures 3 and 4. The segregation of sediment for Reach 5B is described in item 3 above, which provides that all sediment removed from Reach 5B shall disposed of off-site (out-of-state).

- As described in the 2016 Permit, each subreach, and in some cases each reach, has its own Performance Standards to be achieved through sediment removal and capping or backfill. Following additional data collection, the area and amount of sediment to be removed to meet the Performance Standard will be determined. After the horizontal footprint and vertical removal depth are determined, the volume-weighted average PCB concentration of the sediment within that footprint will be calculated.

- If the volume-weighted average PCB concentration within a reach or subreach removal footprint exceeds 25 mg/kg, sediment with the highest PCB concentrations (e.g., "hot spots") will be segregated for out-of-state disposal until the average concentration of the remaining sediment to be removed from the reach or subreach decreases to 25 mg/kg or less for disposal at the Upland Disposal Facility.

- Relevant data from the RCRA Facility Investigation (RFI) and data collected pursuant to the 2016 Permit or Revised Final Permit will be used in determining average concentrations for comparison to the 25-mg/kg criterion for placement in the Upland Disposal Facility.

- EPA agrees to work with GE to design an appropriate transition and hybrid disposal averaging area in the Woods Pond Headwaters area between Reach 5C and Woods Pond.

5. In addition, for all sediment in reaches and subreaches, including backwaters, except for Reach 5B, GE will segregate and dispose of off-site (out-of-state) sediment that is represented by a 3-dimensional polygon associated with a single vertical core that has an average concentration greater than or equal to 100 mg/kg PCBs, as further described below:

- GE will compare the 100 mg/kg criterion to the average concentration in each individual vertical core.

- Vertical core polygons will be generated by a Thiessen polygon method. Thiessen polygon mapping involves the use of computer software to draw perpendicular bisector lines between adjacent sample locations to create two-dimensional polygon areas. The two-dimensional Thiessen polygon will be extended vertically to the depth of sediment removal to create a three-dimensional polygon.

- The data used in this evaluation will be limited to, and representative of, the depth intervals that correspond to depth of removal associated with the location where the core was collected.

- If sampling data, at a given vertical core location, consist of data from different depth intervals, the vertical PCB average concentration will be calculated as a depth-weighted average at that location.

- Vertical sediment cores will be of sufficient depth to characterize sediment PCB concentrations throughout the full vertical interval required to comply with the Performance Standards for each reach, subreach and backwater under the 2016 Permit or Revised Final Permit.

- If the vertical depth-weighted PCB average in a polygon is equal to or greater than 100 mg/kg, then all sediment associated with the vertical core polygon will be segregated and disposed of off-site (out-of-state).

- For all reaches except Subreaches 5A and 5C, relevant data from the RFI and additional data collected by GE pursuant to the 2016 Permit or Revised Final Permit, as applicable, will be used in determining these vertical depth-weighted core averages.

- Additional vertical core samples will be collected by GE pursuant to the 2016 Permit or Revised Final Permit, as applicable, in Reach 6 (Woods Pond) to supplement existing data and to fill in data gaps.

- For Reaches 5A and 5C, only data collected pursuant to the 2016 Permit or Revised Final Permit shall be used in this evaluation. Vertical core samples will be collected in 6-inch increments. The sampling will consist of three vertical cores per transect (left, center and right of the channel) with transects performed at a linear spacing of 250 linear feet of the river channel.

- Additional vertical sediment cores may be collected to further refine the areas where average sediment concentrations exceed 100 mg/kg and/or to assist in achieving the relevant Performance Standards in all reaches or subreaches.

- GE will submit sediment sampling plans to EPA for review and approval. These plans shall detail, at a minimum, the approach for collection of vertical sediment cores and the data analysis approach to determine compliance with the 100 mg/kg criterion.

6. GE will not dispose of material classified as federal RCRA hazardous waste, or free liquids, free product, or any intact drums, capacitors or containers, into the Upland Disposal Facility. GE can use relevant data from the RFI and apply the 20 times rule (i.e., dividing the concentration in the sample by 20 and comparing the result to certain threshold values described in 40 C.F.R. 261) to determine if there are compounds that could potentially exceed the Toxicity Characteristic Leaching Procedure (TCLP) testing requirements. GE can also use relevant data from EPA's 1.5-Mile Reach Removal Action (e.g., TCLP data and other RCRA Characteristic requirements, including ignitability, corrosivity and reactivity). If existing data are not sufficient to demonstrate that material will not contain RCRA hazardous waste, then GE will propose additional sampling in the appropriate Work Plans. In any subreach where RCRA hazardous waste may be present, GE will collect a reasonable number of composite samples for analysis (for example, TCLP sampling for metals). If any composite sample demonstrates the

material is RCRA hazardous waste, then: a) the material can be treated until testing demonstrates that the material is non-hazardous, or b) the material can be disposed of at an off-site facility in compliance with EPA's off-site rule (40 C.F.R. § 300.440).

7. Any other materials to be disposed of not otherwise addressed above will be sampled prior to disposal and disposed of in the Upland Disposal Facility if they have less than 50 mg/kg PCBs. (This could apply to haul road materials, etc. that GE may need to dispose of as part of the overall remedy construction.)

8. GE will dispose of the segregated high concentration sediment, soil and waste materials, and any free liquids, free product, or intact drums, capacitors or containers, in any facility that is licensed/permitted to accept such waste and will accept it, including RCRA Subtitle C Landfills, so long as said facility is in compliance with EPA's off-site rule (40 C.F.R. § 300.440).

DJ-4

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT, and WESTPORT COMMUNITY SCHOOLS, Plaintiffs, v. MONSANTO COMPANY, SOLUTIA INC., and PHARMACIA CORPORATION Defendants.	))))))))	C.A. No. 14-CV-12041

DEFENDANTS' STATEMENT OF UNDISPUTED MATERIAL FACTS
IN SUPPORT OF THEIR MOTION FOR SUMMARY JUDGMENT

Defendants Monsanto Company, Solutia Inc., and Pharmacia Corporation (collectively "Pharmacia") submits the following Statement of Material Facts in support of its Motion for Summary Judgment:

I. PCB HISTORICAL MANUFACTURE AND USES

1. Polychlorinated biphenyls (PCBs) are a class of 209 nonpolar chlorinated hydrocarbons with a biphenyl nucleus on which one to ten of the hydrogens have been replaced by chlorine. Commercial PCBs were manufactured and sold as complex mixtures containing multiple isomers (congeners) at different degrees of chlorination. Deposition of Robert G. Kaley, II, Ph.D. (hereinafter "Kaley (04/05/16) Dep.") at 55:20-56:4, April 5, 2016, excerpts attached as Exhibit 1; Expert Report of Maureen Reitman, Sc.D. (hereinafter "Reitman Report") at 14, June 30, 2016, attached as Exhibit 2; Expert Report of Jack V. Matson, Ph.D., PE (hereinafter "Matson Report") at 2-3, May 27, 2016, attached as Exhibit 3.

2. PCBs were produced in many countries, including: USA (1930-1977);West Germany (1930-1983); Russian Federation (1939-1993); France (1930-1984); United Kingdom (1954-1977); Japan (1954-1972); Italy (1958-1983); Democratic Republic of Korea (1960s-2012); Spain (1955-1984); Former Czechoslovakia (1959-1984); China (1965-1980); Poland (1966-1977). International Agency for Research on Cancer (hereinafter "IARC (2016)"), "Polychlorinated and Polybrominated Biphenyls", Vol. 107 at 72, Table 1.14 (2016), excerpt attached as Exhibit 4; INTERDEPARTMENTAL TASK FORCE ON PCBS, POLYCHLORINATED BIPHYENLS AND THE ENVIRONMENT, COM-72-10419, at 84 (May 1972), excerpts attached as Exhibit 5. PCBs were also manufactured in Poland, East Germany and Austria in unknown amounts. Breivik et al., "Towards a global historical emission inventory for selected PCB congeners–a mass balance approach", 290 THE SCIENCE OF THE TOTAL ENVIRONMENT 181, 183 (2002), attached as Exhibit 6.

3. Monsanto Company began the manufacture and sale of PCB mixtures in 1935 when it purchased the Swann Chemical Company. Reitman Report at 12; Matson Report at 3. The Monsanto PCB mixtures were sold under the registered trademark of Aroclor. Kaley (04/05/16) Dep. at 50. The Monsanto PCB-containing Aroclor numbers included 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Reitman Report at 12-15; Matson Report at 4-5. With the exception of 1016, the last two digits of the Aroclor series number correspond to the percent of chlorine. Reitman Report at 15, n. 8; Matson Report at 4. For example, Aroclor 1254 contains 54% chlorine by weight. Reitman Report at 15, n. 8; Matson Report at 4.

4. The lower-chlorinated commercial mixtures are clear, viscous liquids. The more highly chlorinated mixtures are more viscous. Matson Report at 4. For example, Aroclor 1242

is a "mobile liquid" and Aroclor 1260 is a "sticky resin." *See* ITF Report at 10. Although the physical and chemical properties vary widely across the class, PCBs have low water solubility and low vapor pressures. Reitman Report at 15 & 16. They are soluble in most organic solvents, oils, and fats. PCBs are stable compounds and do not degrade easily. Id.

5. Aside from Monsanto, PCBs were also manufactured in the United States by several other entities, including Geneva Industries. Geneva Industries manufactured PCBs in the United States from 1971 - 1973. Geneva Industries is estimated to have produced 454 tons of PCBs in the United States. Breivik at 183. PCBs have also been and continue to be inadvertently manufactured through a number of chemical processes, including those associated with the manufacture products as diverse as surfactants, fungicides, fuel additives, PVC, solvents, lubricants, adhesives, coatings, paint pigments, flame retardants used in plastics, paints, adhesives, sealants and caulks, and numerous consumer products from toothpaste to antifreeze. *See generally* City of Spokane Wastewater Management Department, "PCBs in Municipal Products, Revised", July 21, 2015, attached as Exhibit 7; Hu, D., Hornbuckle, K.C., *Inadvertent polychlorinated biphenyls in commercial paint pigments*, 44 ENVIRON. SCI. TECHNOL. 2822, 2825 (2010), attached as Exhibit 8.

6. PCB production in the United States began in response to the electrical industry's need for improved dielectric insulating fluids which would also provide increased fire resistance when used in transformers and capacitors. *See* Reitman Report at 12 & 15; Deposition of Robert G. Kaley, II, Ph.D. Volume II (hereinafter "Kaley (04/06/16) Dep.") at 568, April 6, 2016, excerpts attached as Exhibit 9. As the unique functional characteristics of these materials became more fully understood additional uses were

found. *See* Reitman Report at 12. Their non-flammability made them an excellent choice in high pressure hydraulic applications associated with high risk of fire such as die casting and steel production. *See* Matson Report at 5. Their thermal stability and non-flammability were valuable in heat transfer systems. *See* Kaley (04/06/16) Dep. at 567-68. Their non-flammability, thermal stability and viscosity characteristics made their use desirable in hot melt adhesives and other plasticizer applications. Erickson, "Applications of polychlorinated biphenyls", 18 ENVIRON SCI POLLUT RES. 135, 147 (2011), attached as Exhibit 10; *see* Kaley (04/06/16) Dep. at 571-72. PCBs therefore evolved as unique class of chemicals which met important needs for both industry and society. *See* Matson Report at 5; Kaley (04/06/16) Dep. at 567-69, 571-72. In many instances fire and building codes required PCBs for the protection of life and property. Kaley (04/06/16) Dep. at 569; Deposition of Jack Vincent Matson (hereinafter "Matson Dep.") at 148-49, September 9, 2016, excerpts attached as Exhibit 11.

7. In 1970, in response to growing information regarding PCB's environmental presence, Monsanto began to voluntarily phase out the sale of PCBs for various applications. Letter from Monsanto Company to Customer (February 27, 1970), attached as Exhibit 12. Sales of PCBs for use as plasticizers were phased out as of August 1970. Letter from Monsanto Company to Customer (June 1, 1970), attached as Exhibit 13. By 1972, Monsanto had ceased the manufacture and sale of PCBs for all uses other than as a dielectric fluid for use in enclosed electrical equipment. *See* Kaley (04/06/16) Dep. at 644-45. Monsanto's voluntary restrictions on sales resulted in a 64 percent reduction in sales from 1970 to 1972. *See* ITF Report at 5-10.

8. Monsanto voluntarily ended the manufacture and sale of PCBs for all uses in 1977 when members of the electrical industry identified alternative dielectric fluids. Kaley (04/06/16) Dep. at 644-45. Before that time, the termination of sales for dielectric uses would have resulted in severe economic and social dislocation. Kaley (04/06/16) Dep. at 640-41. In 1971, an Interdepartmental Task Force made up of eight federal agencies and sub-agencies was convened to study the needs for PCBs. ITF Report at 1. In a report issued the following year, the Interdepartmental Task Force concluded that the continued use of PCBs for transformers and capacitors was considered "necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from ban on PCB use." ITF Report at 4.

9. At no time in its corporate history did Monsanto manufacture, formulate, sell, or market caulks or paints. Kaley (04/06/16) Dep. at 575. Rather, it sold a number of chemical additives, called plasticizers, for these products. Reitman Report at 15; Matson Report at 7. A plasticizer is a raw material used as part of various industrial mixtures. Reitman Report at 15 & 23; Matson Report at 6-7. Monsanto manufactured dozens of different plasticizers for use by industry. Reitman Report at 12-13; Matson Report at 7.

10. Caulk compositions were determined by formulators, and typically included multiple interacting components, including the base resin, one or more fillers, one or more plasticizers, and other additives. Kaley (04/06/16) Dep. at 575-76; Reitman Report at 21-23; Matson Dep. at 335-37. The specific composition, including the chemical types and relative amounts of the components, affects physical and chemical properties of the caulk, including durability and lifetime of the caulk. Reitman Report at 20, 24-25.

11. Product formulators like Product Research & Chemical Corporation ("PRC") selected PCB plasticizers for use in caulks because of a unique and desirable combination of properties, including low volatility. Matson Dep. at 308-09; Reitman Report at 18-19; Kaley (04/06/16) Dep. at 576. PCBs rendered caulk formulations longer lasting, more flexible and durable. Reitman Report at 15 & 18; Kaley (04/06/16) Dep. at 571-72. PCBs also provided chemical, UV, and biological resistance to caulk formulations. Reitman Report at 15.

12. In 1970, when Monsanto withdrew PCB plasticizers from the market, there was no one-to-one replacement, such that products made with PCBs had to be discontinued or reformulated to have different properties and characteristics. Reitman Report at 8, 16, 40; Kaley (04/06/16) Dep. at 523-24.

II. THE PCB CUSTOMERS ("FORMULATORS") AND THE SUPPLY CHAIN

13. Pharmacia shipped its raw PCBs in 55 gallon drums (or railroad cars or tank trucks) to distributors and product manufacturers (or "formulators"), like PRC. Kaley (04/05/16) Dep. at 72. Formulators were often sophisticated companies with dedicated research staffs and chemists. Kaley (04/06/16) Dep. 573-74; *see* Kaley (04/05/16) Dep. at 196-97; Reitman Report at 17; Matson Dep. at 156.

14. Caulk formulations were proprietary to their manufacture. Matson Dep. at 58-60; Reitman Report at 23; Kaley (04/05/16) Dep. at 53-54. Formulators included the PCBs as one component within a proprietary formula for products such as caulk and sealants. Matson Dep. at 58-60. Formulators, not Pharmacia, made decisions as to which

chemicals – including plasticizers – it would include in their formulae. Matson Dep. at 156; Kaley (04/06/16) Dep. at 575-76; *see* Reitman Report at 22-23.

15. At all times relevant to this matter, including the time when PRC selected PCBs for use as a plasticizer in its caulk formulations, formulators knew that all plasticizers including PCBs could volatilize from the consumer product. Matson Dep. at 308-09, 318; Videotaped Deposition of Franklin L. Dorman, Ph.D. (hereinafter "Dorman Dep.") at 98-100, Sept. 8, 2016, excerpts attached as Exhibit 14; *see also* Matson Report at 15-16.

16. The rate at which PCBs volatilize from a formulation like caulk depends on a large number of factors, including the selection and quantities of other chemicals in the formula and the end use conditions where it was used. (e.g., the thickness with which the caulk is applied, the surface area of its application, and the temperature, air circulation, and humidity where applied). Matson Dep. at 188, 326-28; Matson Report at 11; Reitman Report at 18-23, 39; Kaley (04/06/16) Dep. at 583-84; Dorman Dep. at 89-92.

17. Neither the formulation nor the end use conditions could be defined or controlled by Pharmacia. *See* Matson Dep. at 326-28; Reitman Report at 18-23. Therefore, even if Pharmacia knew the specifics of the caulk application including the temperature, humidity, and other conditions of the space in which it is applied, Pharmacia could not predict the rate of volatilization of PCBs from caulk. Reitman Report at 7, 14, 20, 23 & 39; *see* Matson Report at 11; Kaley (04/05/16) Dep. at 106-07.

18. The formulators' customers then resold the PCB-containing products to other manufacturers who incorporated them into another product, or to distributors, who might sell the products to general contractors, who sold the caulk to contractors, builders, and

architects, and who then resold the caulk to subcontractors who ultimately included the product into a building. Kaley (04/05/16) Dep. at 54, 60-61, 196-99; Products Research & Chemical Corporation, Annual Report (1968), attached as Exhibit 15.

19. Caulk manufacturers, such as PRC, employed large staffs of scientists who determined the specific formulas used in their products. *See* Matson Dep. at 28, 154, 156, 318-19; Products Research & Chemical Corporation, Annual Report (1968).

20. Plaintiff in this case designated two expert witnesses to testify regarding the adequacy of warnings issued by Monsanto to its customers: Sugarman and Matson. Plaintiff withdrew Sugarman as an expert following his deposition. *See* Pl.'s Resp. Defs.' Mot. Exclude the Expert Testimony of Robert C. Sugarman (Doc. 192). Plaintiff has disavowed the use of Matson to testify or opine that caulk manufacturers "would not have chosen to use PCBs as plasticizers if they had [] additional information [regarding volatility]." Pl.'s Mem. Opp. to Defs.' Mot. Exclude the Expert Testimony of Jack V. Matson, Ph.D., PE (Doc. 185) at 15.

21. Dr. Jack Matson, Westport's designated expert on Pharmacia's knowledge and conduct from the 1930s through the 1970s,[1] testified:

> Q. Doctor, it has been common knowledge in science and industry for most of the 20th century, correct, that plasticizers used in plastics will volatilize? Correct?
>
> A. To some degree they all do, yes.
>
> Q. And certainly the PRCs and Thiokols of the world were aware of that. Correct? …
>
> THE WITNESS: I assume that they were.

Matson Dep. at 318:19-319:4.

[1] Pl.'s Mem. Opp. to Defs.' Mot. Exclude the Expert Testimony of Jack V. Matson, Ph.D., PE (Doc. 185) at 1.

Q. Sir, are you aware of any manufacturer in the 1950s who would have not used Aroclor 1254 as a plasticizer had they been made aware of SRI's extrapolation as opposed to the data presented in Monsanto's technical bulletins [on PCB vapor pressure]? …

THE WITNESS: I think that's an unanswerable question….

* * *

Q. You just don't know though, do you? …

THE WITNESS: Well, we can't reconstruct what was in the minds of plasticizer purchasers back in 1950s.

Matson Dep. at 310:13-311:14.

III. MONSANTO'S WARNINGS

22. Beginning in the 1930s, Monsanto commissioned hundreds of toxicological tests of PCBs from leading institutions such as the Harvard School of Public Health and the Kettering Institute of the University of Cincinnati. Expert Witness Statement for James C. Lamb IV, Ph.D., DABT, ATS (hereinafter "Lamb Report") at 7-10, attached as Exhibit 16. Those tests disclosed that PCBs, like all industrial chemicals, were capable of causing systemic toxicity at high does, but could be safely manufactured, and, if recommended precautions are followed, can be used safely. *See* Video deposition of James R. Olson, PhD. (hereinafter "Olson Dep.") at 137, 155, 182-83, 225, 228-29, August 24, 2016, excerpts attached as Exhibit 17.

23. At all times relevant to this case, Pharmacia supplied Aroclor product bulletins and warning labels to each of its customers. Kaley (04/05/16) Dep. at 85-87, 90-91. These bulletins contained then-known toxicological information regarding exposures to PCBs and information on their safe handling. *See e.g.* October 11, 1937 Warning, MONS

046543, attached as Exhibit 18. These bulletins also provided physical and chemical characteristics for the Aroclors. Kaley (04/05/16) Dep. at 85-87. Pharmacia also issued warnings on its labeling for barrels and tank cars. Kaley (04/05/16) Dep. at 88-89, 102.

24. In 1937, Pharmacia warned its customers: "Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects." October 11, 1937 Warning. This warning was repeated in a 1943 application data bulletin, in which Pharmacia warned: "Experimental work on animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects." Monsanto Chemical Company, "The Aroclors: Physical Properties and Suggested Applications", No. P-115, April, 1943, attached as Exhibit 19. In a 1955 technical bulletin, Pharmacia provided the following warning: "The vapors emitted by Aroclor 1248 heated to elevated temperatures are injurious to the liver on prolonged exposure and should not be breathed." Monsanto Chemicals Plastics, "An Indirect Aroclor Heater for Unit Chemical Operators", Monsanto Technical Bulletin No. O-130, at 4, October, 1955, attached as Exhibit 20. In a 1966 technical bulletin, Pharmacia warned: "If these precautions are neglected acne may develop and excessive exposure may cause liver damage." Monsanto, "Aroclor for Capacitors" at 23, 1966, attached as Exhibit 21.

25. Dr. Robert Sugarman, Westport's withdrawn warnings expert, agreed that Pharmacia warned its customers about breathing volatilized PCBs:

Q. Would you agree that Monsanto warned its customers about the dangers of breathing PCBs that had volatilized in the technical bulletins that it provided to its customers as set forth on page 7 of your report? …

THE WITNESS: That is correct. This is taken from a technical bulletin, and it does talk about the exposure varying with volatility and the hazard of that toxic exposure.

Video deposition of Robert Sugarman, PhD, PE at 142:10-20, August 25, 2016, excerpts attached as Exhibit 22.

26. In early 1970, Pharmacia issued warning letters to all of its known customers and distributors alerting them to the developing information regarding the environmental presence of PCBs. Letter from Monsanto Company to Customer (February 27, 1970). Monsanto encouraged its customers to provide similar information to the customers of their customers. Id.

27. In March of 1970, Pharmacia reissued its Aroclor technical bulletins, including Technical Bulletin o/PL-306A entitled, Aroclor Plasticizers. Attached as Exhibit 23. In that Bulletin, Monsanto included the following Environmental Hazard warning:

Environmental Hazards

Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, Aroclor 1268, Aroclor 4465, and Montar 1 all contain polychlorinated biphenyls (PCB) of various types and in varying amounts. PCB residues in small amounts have been found in the environment and some studies have indicated that they may be harmful to certain forms of animal life. Extreme care should therefore be taken by all users of PCB-containing products to prevent any entry into the environment through spills, leakage, use, disposal, vaporization or otherwise. Further, the products in which PCB materials are used, or which are formulated using PCB materials as a component, should be given careful study to eliminate the possibility that PCB might reach the environment as a result of use in a given application.

Some specific applications where the use of PCB should definitely be avoided are in paints and sealants for swimming pools, paints and waterproofing agents in silos and other buildings where food products for humans or animals are stored, and as a component of any container or wrapping used in the packaging of food products.

28. There are no scientific studies, either during the period of Pharmacia's manufacture of PCBs or today, that purport to demonstrate that PCBs in indoor air and surfaces from PCB-containing building products cause adverse health effects. Olson Dep. at 54-55, 104-05, 245; Deposition of Robert F. Herrick (hereinafter "Herrick Dep.") at 151 & 152, August 18, 2016, excerpts attached as Exhibit 24; Matson Dep. at 122, 201, 332.

29. There are no scientific studies, either during the period of Pharmacia's manufacture of PCBs or today, that purport to demonstrate that the levels of PCBs found at Westport Middle School cause human disease. Herrick Dep. at 151 & 152; Olson Dep. at 54-55, 104-05, 245; Matson Dep. at 122, 201, 332.

30. Dr. Jack Matson, Westport's designated state of the art expert,[2] testified:

> Q. Can you name a scientific article that documented injury to human beings due to exposure to environmental levels of PCBs prior to 1970? Yes or no?
>
> A. No, because the science wasn't there yet.

Matson Dep. at 122:16-21.

> Q. Are you aware of any scientific studies that purport to demonstrate that PCBs volatilizing from building products cause adverse health effects?
>
> * * *
>
> A. I'm not aware one way or the other.

Matson Dep. at 201:25-202:8.

31. Robert F. Herrick, Westport's designated industrial hygiene expert,[3] testified:

[2] Pl.'s Mem. Opp. to Defs.' Mot. Exclude the Expert Testimony of Jack V. Matson, Ph.D., PE (Doc. 185) at 1.
[3] Plaintiffs' Mem. Opp. to Defs.' Mot. Exclude the Expert Opinions of Robert Herrick (Doc. 186) at 1.

Q. Did you cite any papers that purport to demonstrate that PCBs found in buildings causes health problems?

A. I didn't cite any. That's partly because there really haven't – those studies haven't been done.

Herrick Dep. at 151:24-152:5.

Q. Are you aware of any studies that would verify a hypothesis that the PCB levels found in the Westport Middle School caused health problems? …

A. To my knowledge, those studies have never been done.

Herrick Dep. at 152:6-13.

32. Dr. James R. Olson, Westport's designated toxicologist,[4] testified:

Q. Do you -- were you made aware of the congener-specific analyses done in the air in the Westport building?

A. No. I don't have that information.

* * *

Q. And without that information, you can't make any scientific statements as to whether anyone at the Westport school was at an increased risk because of exposure to those congeners that you discuss in your report, correct?

A. Again, I don't have the data from Westport, so I cannot specifically talk about Westport with regard to the -- the data that you're asking about.

Olson Dep. at 104:15-105:13.

Q. …That is to say that had Monsanto conducted or -- or commissioned to conduct – to conduct studies of ambient dosage levels, you're not saying they would have found anything.

A. Correct.

Olson Dep. at 245:6-10.

33. At all times relevant to this case, there was no legal requirement, government or industry standard, or recommendation from any source that required long-term toxicology tests of

[4] Pl.'s Mem. Opp. to Defs.' Mot. Exclude the Expert Opinions of James R. Olson, Ph.D. (Doc. 184) at 1.

chronic low-level exposures to PCBs prior to its sale. Olson Dep. at 121-22, 143, 229-31, 234-35.

34. All substances, including industrial chemicals, are systemically toxic at some dose, but simply because a product is capable of causing systemic toxicity does not mean that the product should be removed from the market. Olson Dep. at 55-56, 135, 225, 228.

35. Dr. Olson, Westport's toxicologist, admitted that could not testify to whether PCBs caused any adverse human condition:

> Q. …You're assessing the literature in this case, are you not? That's one of your jobs?
>
> A. Yes.
>
> Q. And -- and in assessing that literature, do you rely upon the -- the so-called Hill criteria?
>
> A. In this case, I'm look -- I -- I was not asked to look at causation.

Olson Dep. at 48:4-11.

> Q. Now, sir, I think you've agreed with me earlier that associations can be causal and noncausal, right?
>
> A. Again, the term -- I -- I -- I guess what I'd like to clarify is as a toxicologist, I do not address the issues of causation in -- in what I do for a living, and that is as a professor of pharmacology and toxicology. I -- I just -- I don't --
>
> Q. Fair enough, and you're not --
>
> A. -- talk about causation.
>
> Q. And I just want to be clear that you're not going to be doing it in this case, right?
>
> A. Correct.

Olson Dep. at 50:6-19.

36. During the period of Pharmacia's manufacture of PCBs from the 1930s to the 1960s, the available analytical methods that might be used to detect PCBs in the environment: (1) measured chlorine and could not distinguish chlorine molecules originating from PCBs as opposed to numerous other substances found in the environment that contain chlorine (Dorman Dep. 28-29, 46-47); or (2) could not measure PCBs at the minute air levels found at the Westport Middle School absent modifications that have not been established to be technologically feasible (Dorman Dep. at 79, 83-85, 87-88); or (3) involved techniques that were not demonstrated to be able to measure substances with vapor pressures as low as PCBs during the relevant time period (Dorman Dep. at 137, 146). The first scientific test investigating PCB volatilization from caulk did not occur until the 2000s. Matson Dep. at 188.

37. In the 1940s, 50s, 60s and 70s, there was no requirement for a manufacturer of a component part, such as Pharmacia, to test the volatilization of PCBs from a consumer end product that it did not manufacture. *See* Expert Report of Christine T. Wood, Ph.D., June 30, 2016, at 11-14, attached as Exhibit 25.

IV. WMS BACKGROUND

38. In 1969, the Town of Westport ("Westport") constructed the Westport Middle School ("WMS"). The use of caulks and sealants were specified for use in the construction. *See* Drummey Rosane Anderson (hereinafter "WMS Specifications"), "Specification for Westport Middle School" at Section 7A, December 11, 1968, excerpts attached as Exhibit 26.

39. In the course of the construction of WMS, contractors hired by the Town of Westport used caulks manufactured by PRC. Matson Report at 7; Letter from William Davin, National Waterproofing Co., to Westcott Construction Corporation (Mar. 24, 1969), attached as Exhibit 27; Letter from William J. Shiels, President, National Waterproofing Co., to Westcott Construction Corporation (May 9, 1969), attached as Exhibit 28; PRC Rubber Calk [sic] 5000 Sealant SpecData Sheet, attached as Exhibit 29; Rule 30(b)(6) Deposition of CGKV, Designee Jason Knutson (hereinafter "Knutson Dep.") at 213-17, August 18, 2016, excerpts attached as Exhibit 30. Certain caulks manufactured by PRC contained functional concentrations of PCBs. Deposition of Maureen T.F. Reitman, ScD (hereinafter "Reitman Dep.") at 247, September 23, 2016, attached as Exhibit 31; *see* Reitman Report at 26-27, 34-35.

40. The WMS opened on September 14, 1970. Town of Westport, Annual Reports (Dec. 31, 1970), excerpts attached as Exhibit 32.

41. On September 2009, the EPA issued a pamphlet titled, "Preventing Exposure to PCBs in Caulking Material", which informed schools that "[c]aulk containing high levels of PCBs (polychlorinated biphenyls) has been found in many schools and other buildings built or remodeled before 1978." EPA OFFICE OF POLLUTION PREVENTION AND TOXICS, PREVENTING EXPOSURE TO PCBS IN CAULKING MATERIAL, EPA-747-F-09-005, September 2009, attached as Exhibit 33. Concurrently, the EPA issued a press release titled "Public Health Levels for PCBs in Indoor School Air", in which the EPA published its "calculated prudent public health levels" for PCBs in indoor air. Press Release, Public Health Levels for PCBs in Indoor School Air (September 25, 2009), attached as Exhibit 34. The EPA has explained that its PCB guidance levels "are not meant to be interpreted

or applied as a 'bright line' or 'not-to-exceed' criteria." EPA, "PCBs in Building Materials – Questions and Answers" (July 28, 2015), attached as Exhibit 35. The EPA further stated that "[i]solated or infrequent indoor air PCB measurements that exceed the exposure levels would not signal unsafe exposure to PCBs", but measurements above these levels may trigger the need for further investigation. Id.

42. In December 2009, the Massachusetts Department of Public Health ("DPH") issued a booklet titled, "An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings", whose purpose was to "provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere." P. 2, attached as Exhibit 36. The DPH advised schools, "Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning." Id. at 5.

43. Prior to 2011, the WMS's original building materials, including those that might potentially contain PCBs, remained largely in place. . Deposition of Michael Duarte (hereinafter "Duarte Dep.") at 108, April 21, 2016, excerpts attached as Exhibit 37. Despite numerous state and federal publications recommending school maintenance personnel to building materials, including caulk, that could potentially contain PCBs in their buildings, there was no inspection of the caulking to determine whether it was beyond its useful life or whether it contained PCBs. Duarte Dep. at 105.

44. In 2010, Westport applied to and was accepted into the Massachusetts State Building Authority's Green Repair Program, which offered Massachusetts schools the opportunity to repair or replace windows and roofs. *See generally* Letter from Katherine Craven, Executive Director, Massachusetts School Building Authority, to Steve Ouellette, Chair, Westport Board of Selectmen (November 17, 2010), attached as Exhibit 38. As part of the Green Repair Program, Westport was required to select an MSBA-approved architect to assist with the project. Email from Michael McGurl, Project Assistant, Keville Enterprises, Inc. to Carlos Colley, Superintendent, Westport Community Schools (December 10, 2010), attached as Exhibit 39.

45. On April 6, 2011, Westport met with CGKV Architects, Inc., an MSBA-approved architect, to discuss the Green Repair Project at WMS, among other schools. Presentation, CGKV, Presentation to Westport, MA MSBA Green Repair Program at 37 (April 6, 2011), attached as Exhibit 40. In response to Westport's question, "What is your experience with hazardous materials in roof & window replacement projects?", CGKV answered: "We have worked with Fuss & O'Neill / EnviroScience for many years on several projects with hazardous materials. It is common to find asbestos in sealants for windows and roofs and lead paint at windows, **but we must also be sure to test for PCBs.**" Id. at 37 (emphasis added). CGKV explained to Westport that PCBs were likely within the building products at WMS. Knutson Dep. at 54-56; Duarte Dep. at 153-56. According to maintenance supervisor Duarte, Westport was aware of the relationship between its window project and the presence of hazardous materials prior to April 6, 201. Duarte Dep. at 156.

46. After further discussions between Westport, CGKV and Pinck & Co. (the MSBA-approved Owner's Project Manager), Westport decided voluntarily to test for PCBs. Knutson Dep. at 76-77. In response, Pinck prepared a Feasibility Cost Estimate that included an estimate for the removal of PCBs from the window caulk and glazing. Knutson Dep. at 70; Pinck & Co., "Feasibility Cost Estimate", May 4, 2011, attached as Exhibit 41.

47. Fuss & O'Neill, the hazardous materials consultant, submitted a proposal "to conduct a hazardous building materials inspection and sampling to facilitate the proposed Green Repairs project work necessary" at the Westport Middle School. Letter from Robert L. May, Jr., Vice President, Fuss & O'Neill EnviroScience, LLC, to Jason Knutson, Principal, CGKV Architects, Inc. (May 6, 2011), attached as Exhibit 42; Knutson Dep. at 39. In its proposal, Fuss & O'Neill explained, "Sampling for PCB's in the above matrices [windows and doors] is presently not mandated by the U.S. Environmental Protection Agency (EPA)…" Id.

48. After testing on May 11, 2011 found PCBs in window glazing, exterior window caulking and interior door caulking of the Westport Middle School, Westport began a multi-million dollar PCB remediation project to remove all PCB source material from the school. Fuss & O'Neill, "Limited Hazardous Building Materials Inspection", May 25, 2011, attached as Exhibit 43; *see generally* Fuss & O'Neill, Polychlorinated Biphenyls (PCBs) Source Removal Project Report and Management Plan, April 1, 2013, attached as Exhibit 44.

49. Westport filed the present suit on May 7, 2014. Compl. (Doc. 1).

V. WESTPORT'S VOLUNTARY PCB REMEDIATION

50. The Toxic Substances Control Act and the regulations promulgated thereunder by the EPA are the sole source of authority on what is required in a PCB remediation project. *See* Videotaped Deposition of Robert L. May, Jr. (hereinafter "May (09/07/16) Dep.") at 115, September 7, 2016, excerpts attached as Exhibit 45.

51. The regulations do not require building owners to test for PCBs. Rule 30(b)(6) Deposition of Fuss & O'Neill, Robert L. May Jr., Designee (hereinafter "May Dep.") at 199-200, April 25, 2016, excerpts attached as Exhibit 46; John Woodyard, PE, Expert Report (hereinafter "Woodyard Report") at 5, attached as Exhibit 47.

52. The regulations do not require building owners to remove PCB-containing building products once they are discovered. Videotaped Deposition of Ross Hartman (hereinafter "Hartman (09/08/16) Dep.") at 238, September 8, 2016, excerpts attached as Exhibit 48; May (09/07/16) Dep. at 201, 211, 214; Woodyard Report at 5-6.

53. Finally, the regulations do not require building owners to notify the EPA, conduct air testing, locate source materials, or to monitor PCBs air levels. May (09/07/16) Dep. at 175-78, 180, 200-01; Woodyard Report at 5.

54. While Westport's consultants contend that they relied on EPA guidance documents and advice to direct its PCB remediation (May (09/07/16) Dep. at 147-48), Robert May, Westport's remediation expert, concedes that those EPA guidelines and advice are not regulations, do not have the force of law, and cannot establish regulatory requirements for PCB remediation. May (09/07/16) Dep. at 117, 118, 147-48, 212, 215, 260-61. Thus,

the PCB remediation undertaken by WMS was purely voluntary. May (09/07/16) Dep. at 117, 118.

55. May explicitly admitted that Westport acted voluntarily:

> Q. It's true, isn't it, sir, that these EPA guidance documents are not regulations, correct?
>
> A. No, they are not.
>
> Q. Following guidance and recommendations made by the EPA that goes beyond the TSCA regulations set forth in 40 C.F.R. 761 is voluntary, correct?
>
> A. It is.

May (09/07/16) Dep. at 117:7-20.

> Q. …If someone complies with the authoritative regulations and chooses to not follow EPA guidance, the EPA has no basis for enforcement actions, correct?
>
> A. Correct.
>
> Q. Guidance documents are just that, guidance, correct?
>
> A. Correct.

May (09/07/16) Dep. at 118:14-21.

56. The EPA has not taken any enforcement actions against a town or school system for PCB-containing building products in its schools. Hartman (09/08/16) Dep. at 246; Woodyard Report at 39.

Dated: January 30, 2017

PHARMACIA LLC, SOLUTIA INC.,
AND MONSANTO COMPANY

By its attorneys,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing was served upon all counsel of record via the ECF system on January 30, 2017.

/s/ Richard L. Campbell

EXHIBIT 1

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and)
WESTPORT COMMUNITY)
SCHOOLS,)
)
Plaintiffs,)
)
v.) Civil Action No.
) 1:14-cv-12041
MONSANTO COMPANY,)
SOLUTIA INC., and)
PHARMACIA)
CORPORATION,)
)
Defendants.)

TUESDAY, APRIL 5, 2016

\- - -

Videotaped deposition of Robert G. Kaley, II, Ph.D., held at the offices of HUSCH BLACKWELL, L.L.C., 190 Carondelet Plaza, Suite 600, St. Louis, Missouri, commencing at 9:05 a.m., on the above date, before Carrie A. Campbell, Registered Merit Reporter, Certified Realtime Reporter, Illinois, California & Texas Certified Shorthand Reporter, and Missouri Certified Court Reporter.

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GOLKOW TECHNOLOGIES, INC.
877.370.3377 ph | 917.591.5672 fax
deps@golkow.com

1935.

And then Monsanto also built a plant in Sauget, Illinois, in 1936.

Q. Tell us, what is a plasticizer.

A. What is a plasticizer?

My understanding is that a plasticizer is essentially a solvent for a plastics. Most plastics are hard, brittle materials, and a plasticizer, as well other modifiers, are added to that material to give it desired properties.

Q. And what type of products might plasticizers be utilized in?

A. I mean, they're basically probably utilized in every plastic material that's manufactured.

Q. And also in paints?

A. There would be plasticizers or could be plasticizers in paint.

Q. And sealants?

A. Yes.

Q. And adhesives?

A. Yes.

Q. And caulking?

exterior applications because that's where the PCB properties would be most useful.

But it could be, you know -- I mean, I understand that it was used between building panels in construction. It may have been used for window glazings. Those kinds of applications.

Q. And unlike with paint, caulking utilizing PCB plasticizers were sometimes used indoors around windows; is that true?

A. My understanding is that they have been. I don't know the extent of that use. I think, again, they were primarily used externally, but I'm certainly aware of indoor caulks that have had PCBs measured in them.

Q. And what kind of buildings are we talking about, office buildings?

A. That's primarily office buildings and there are some literature reports on schools.

Q. When utilizing plasticizers with caulk, do you know or do you have a basis to know how the plasticizer gets added to the caulk, in terms of is it the caulk manufacturer that adds it or the applicator?

Do you have any understanding of how that works?

A. My understanding is that would be the formulator of the caulk itself.

Q. So they would purchase the PCB-containing plasticizer, incorporate it into a caulk product, and then sell that product to whatever entity might utilize it?

A. That's my understanding, yes.

Q. And what are you basing that understanding on?

A. Just basic understanding, I guess. I don't really know that I have any specific reference. That's just my understanding.

I know Monsanto was selling PCBs as plasticizers to various manufacturers. I mean, they weren't selling caulk. So to the extent that the PCBs did end up in some caulk products, that would be my understanding.

Q. Have you ever heard of a

situation where a caulk is applied at a building where the caulk product and the PCB product were mixed at the site?

Have you ever heard of that before?

A. I've heard that allegation. I frankly can't conceive of that being true, but I've heard that, yes.

Q. But you've heard that, but in your understanding, that's not accurate?

A. I don't know whether it's accurate or not. In my understanding, it just doesn't make much sense chemically.

Q. Can you tell us, what is a PCB?

A. What is a PCB?

Q. The layman's term. I'm just trying to lay a foundation. I don't need a very big scientific, just give us a little blurb.

What is PCB?

A. Well, PCB is a chemical based on what's called a biphenyl backbone, which is essentially two benzene rings hooked together -- I mean, it's getting very technical very quickly -- and then to that biphenyl backbone, various amounts of chlorine are added to give a product called polychlorinated biphenyls.

Q. And Monsanto sold many different types of plasticizers, yes?

A. Yes. Definitely, yes.

Q. Approximately 80 at least at one point?

A. Yes, 80 to 100 I believe is a reasonable number.

Q. And some of Monsanto's plasticizers contained PCBs?

A. Some of them did, yes.

Q. And some of them did not?

A. That is correct.

Q. Monsanto had a trademark for some of their plasticizers that they called Aroclor, correct?

A. Well, the Aroclor trademark was for their PCB products, but they also sold plasticizers under the Aroclor trademark. So not all Aroclor products were plasticizers.

Q. Okay. Let me try to break it

A. That is correct.

Q. Do you know which ones had PCBs?

A. Not specifically. There were dozens of them with numbers. I don't really know for sure which ones.

Q. I want to make sure I have a understanding of the different players involved in the sale, marketing, promotion and warnings of plasticizers.

Who were the types of customers of Monsanto's with respect to plasticizers?

A. Well, without sounding like a smart aleck, I guess, people that were making plastic products. I don't know how else to answer that.

Q. Okay. So some of Monsanto's customers were the companies that manufactured the end product into which the PCB-containing plasticizer was utilized?

A. Certainly some. And then others were probably manufacturing products containing PCBs that were then sold to other companies manufacturing other products. I don't know specifically the chain. But that would be correct, yes.

Q. And Monsanto also sold PCB-containing plasticizers to distributors, correct?

A. That is correct.

Q. And then those distributors would then sell the product directly to entities that might utilize it in end products?

A. That's my understanding, yes.

Q. Any other types of customers that wouldn't fall into either a direct user, direct manufacture utilizing it or a distributor?

A. Not that I know of.

Q. Okay. In reviewing the documents, there appeared to be to me several instances of research product -- research being done on potential PCB-containing plasticizer usage.

Was there a group that solely did that type of research at Monsanto?

A. Well --

Q. And they made -- they made recommendations to what entity that made the final decision?

A. Well, the final decision would have been at the corporate management committee level or something like that.

Q. Physically how were PCB-containing plasticizers sold?

What types of containers?

A. Certainly probably everything from research samples in small containers to 5-gallon drums to 55-gallon drums, and -- that would be the only ones I know for sure.

It's conceivable they were sold in tank car, railroad tank car, lots or truck lots.

My guess is largely 55-gallon drums for the major customers and major applications.

MS. EVANGELISTI: Okay. We've been going an hour; so let's take a break.

THE WITNESS: That's fine.

VIDEOGRAPHER: The time is

not what the law was?

A. Okay. My -- I believe that Monsanto felt that by warning their customers that were using PCBs that that -- that was what they needed to do, and that's what they did do.

Q. So let's -- I want to get an overview of the information provided to your customers about PCB-containing plasticizers so that we can put our arms around what information was, in fact, provided.

A. Okay.

Q. And I have read every deposition that I was able to get my hands on to try to educate myself on the facts; so I'm going to try to speed things up.

So I understand that there were application bulletins that were provided, correct?

A. That's correct.

Q. Can you tell us what an application bulletin is?

A. Well, basically it was a bulletin describing a potential use of a product that might be of interest to a potential customer. Usually fairly focused rather than a broad, general, "We sell plasticizers, and you might want to use them."

Q. Was one of the purposes of the application bulletin to give potential customers suggestions and ideas on the various ways and products in which Monsanto's plasticizers could be utilized?

A. I think that's a fair characterization, yes.

Q. And then there were also technical bulletins.

Can you tell us what those are?

A. Well, those are more general, I think, than an application bulletin. They basically contain information that's of a broader nature and describing wider uses, but in less detail than something specific to an application.

They would contain also technical information, physical property information, et cetera, about the products.

Q. Going back, am I correct that the application bulletin was given to potential customers?

A. Oh, well, it was probably given to -- primarily given to salesmen to distribute as they saw appropriate. So, yeah, I mean, probably potential customers. I mean, the ongoing customers would already know what their application was.

Q. And the technical bulletins, did they -- I'm trying to get a sense of, did every customer get an application bulletin?

A. I have no idea. You know, I'm having a little trouble distinguishing product bulletin versus technical bulletin versus application bulletin. I know there are specific application bulletins, I'm not sure if you're distinguishing between the product bulletins and technical bulletins.

But would every customer get one? Probably most, and they would probably -- some people that weren't customers would probably get them.

Q. And then you mentioned product

bulletin.

Is that different than a technical bulletin?

A. Well, that's what I was saying. I don't know if you're making that distinguishment -- distinguishment, that's not a word -- distinction or not.

There are a number of bulletins. I would call them product bulletins. If there's something called a technical bulletin, then, you know, I could look at it and see if there's a difference between what I'm talking about. I would put them basically in the same category.

Q. And I have a number of copies of different bulletins, and I'm not going to mark all of them because there's a bunch. But I'm trying to get -- I'll later go through them and get a sense of the different types of documents.

A. Okay. Well, that may clarify what you're asking me for both of us.

Q. And other ways of providing information would be product labels; is that

correct?
A. Well, yes. Primarily, that would be mostly safe handling information for the customers, yes.
Q. And then, in reading through the depositions, I understand that if a customer, potential customer, had questions, they had an opportunity to reach out to Monsanto directly to get information; is that correct?
A. Certainly, that's correct.
Q. And in those instances, I understand that there was a directive that those questions would make their way to the medical department and Dr. Kelly's group; is that accurate?
A. Certainly not all questions would be directed to him. If they were medical questions, they very likely could have been. I don't know that they all -- there was a requirement that there were. There might have been, I don't know.
But certainly that would make sense that if there were a medical question,

it would be directed to Dr. Kelly or someone in his department, yes.

Q. In addition, in reviewing the documents and the depositions, I understand that there were letters sent directly to customers and distributors in 1970 providing certain information about environmental concerns, correct?

A. That's correct.

Q. Okay. And in addition, Monsanto put out advertisements in magazines that might contain some information about their PCB-containing plasticizers?

A. With regard to environmental concerns or --

Q. No.

A. -- just in general?

Q. I started the discussion saying let's try to identify all information provided to customers or potential customers about PCB-containing plasticizers.

A. Yeah.

Q. In general.

A. Okay.

Q. And we identified application bulletins are information provided, correct?
A. Yes.
Q. And technical bulletins?
A. Yes.
Q. And there are labels on the packages?
A. Yes.
Q. And sometimes people, customers, potential customers, reached out to Monsanto and received information back?
A. Right.
Q. And we identified specific letters that were sent out in the 1970s?
A. Right.
And I was -- I was putting those two together. If you're completely off, yes, Monsanto did place advertisements in various documents, certainly.
Q. Okay. And they advertised -- these are some that I read in the documents -- in American Paint Journal?
A. I believe that's correct.
Q. In Rubber Red Book?

languages; so they called it a multi-language label.

Q. Regarding these labels, just so we're clear, that label was affixed to the PCBs or the PCB-containing Aroclors that were sold to either distributors or to the customers that took that product and put it into manufacturing other product, correct?

MR. GOUTMAN: Objection. I think you meant to say containers containing PCBs.

QUESTIONS BY MS. EVANGELISTI:

Q. Let me start over again.

The labels that we've been talking about now, they were affixed to containers that Monsanto -- the containers in which Monsanto sold PCBs, correct?

A. Yes.

Q. So those labels were given to -- with the products that they sold to distributors, correct?

A. Yeah. I mean, the one that I mentioned says it was used on five-gallon cans, these particular labels, so, that's

end product which utilized Monsanto's
PCB-containing plasticizers?
MR. GOUTMAN: As rephrased, the question calls for this witness to speculate as to legal prohibition, which this witness is not an expert in, nor has he been designated to testify to as a 30(b)(6) witness.
You may answer.
MS. EVANGELISTI: I was only following up because the lack of foundation objection, so...
THE WITNESS: Well, I don't know -- frankly, I don't know what regulations or prohibitions or things govern warnings; so I don't know whether -- what kind of requirements they would have had or would not have had.
As far as I know, there was no prohibition that they do such a thing, but I would say that Monsanto's understanding was that they were warning the people that they were

selling the products in its pure form, and that after that, they had no idea what the concentrations or physical properties of those products were; so they might not have even known how to warn, so...

QUESTIONS BY MS. EVANGELISTI:

Q. So that's where it ended, with their own customer?

A. As far as I know, that's correct.

Q. Okay.

A. Well, again, with time frame, after -- after Monsanto was withdrawing from the market and putting the environmental label on, they told their distributors to tell their customers about the prohibitions or the recommendations for proper disposal and stuff. So certainly with regard to that, there was a pass-through.

Q. So exactly.

They could have made such a requirement and did so later?

MR. GOUTMAN: Objection. Calls

they weren't needed for those uses?
A. That's basically correct, yes. I don't know that it was never used, but it was not one that was widely used in the electrical industry.
Q. Switching gears a little bit.
I want to follow the process of plasticizers going into caulk and caulk going into a building. So just bear with me. I haven't asked a question yet. There's the background.
A. Okay.
Q. Monsanto has sold its PCB-containing plasticizers to companies that make caulk, correct?
A. Or make components of caulk, yes.
Q. Educate me a little bit.
When you say "components of caulk," how --
A. Well, again, I don't -- I don't know that -- once it leaves Monsanto, I don't really know the stepwise. But certainly they sold to people who were blending them with

plastics, the base material, that could go into caulk, but it seems logical, if not for sure to me, that those people might not be making caulk. They may be selling their plasticized caulk to a further manufacturer who had his own formula for making particular caulks for a particular application.

Do I have documentation of that? No. But I believe that certainly happened.

Q. Okay. So to companies that were involved in the manufacturing of caulk or caulk ingredients?

A. I would -- yeah, I'll agree with that, sure.

Q. And then, ultimately, a caulk product is created, in our hypothetical, contains PCB-containing plasticizers.

Okay?

A. Okay.

Q. So that product is then presumably purchased by somebody who intends to utilize it in a building?

MR. GOUTMAN: Objection.

Hypothetical. Assumes facts of record. Vague and ambiguous.

QUESTIONS BY MS. EVANGELISTI:

Q. I'm just trying to identify potential parties in the chain of the product making its way to a building.

A. Well, again, I'm kind of creating this in my own mind a little bit.

But, yeah, I think basically that's true, that they would sell it maybe to a distributor, who would sell it to a building contractor, who would then market it as the acceptable caulk to somebody -- a contractor on a specific job.

I mean, I don't know, but I could certainly conceive of all of those steps being in a chain.

Q. Okay. So in the chain of caulk making its way to a building, you have a company that manufactures the -- or companies involved in the manufacture of the caulk product, correct?

A. Yes.

Q. And then you would have people

who purchase that caulk product, correct?
A. Correct.
Q. And they might be the same person.
But you've got the contractor on the site of the building being built, correct?
A. Yes.
Q. And somebody approves the specs for what products should make their way into the building?
A. Presumably, yes.
Q. And then you have somebody who literally applies the caulk on the building, correct?
A. Correct.
Q. Okay. And then you've got the building owner.
Okay?
A. Okay.
Q. Okay. Is it true that with respect to -- unless a company was a direct manufacturer of Monsanto, so --
MR. GOUTMAN: Sorry, direct

EXHIBIT 2

Polymer Science and Materials Chemistry

Exponent®

Expert Report of
Maureen Reitman, Sc.D.

In the matter of Town of Westport and Westport Community Schools v. Monsanto Company, Solutia Inc, and Pharmacia Corporation

Project Number 1400263.001

Exponent

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In the matter of Town of Westport and Westport Community Schools v. Monsanto Company, Solutia Inc, and Pharmacia Corporation

Project Number 1400263.001

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June 30, 2016

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Limitations

Exponent, Inc. ("Exponent") was retained by White and Williams on behalf of Monsanto Company to review documents and testimony, conduct an inspection, perform analysis, and provide opinions related to polychlorinated biphenyls (PCBs) used as plasticizers, including in caulk or sealant compounds and other building materials, the formulation effects on the release of PCBs from these materials during the working lifetime of the caulk or sealant, and the condition and composition of these materials found at Westport Middle School in Westport, Massachusetts. This report summarizes work performed to-date and presents the findings resulting from that work. The findings presented herein are made to at least a reasonable degree of scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available through ongoing discovery and/or through any additional work or review of additional work performed by others.

Summary and Opinions

Westport Middle School of Westport, Massachusetts was constructed in 1969. In 2009, 40 years after the construction of Westport Middle School (WMS), the Environmental Protection Agency (EPA) published a press release with advisory screening levels regarding airborne polychlorinated biphenyls (PCBs). In preparation for building repair in 2011, WMS tested for and found PCB containing materials. WMS then tested for airborne PCBs within the school and, based on the results, decided to undergo remediation to lower the levels of airborne PCBs. The Town of Westport and Westport Community Schools now seek compensatory damages for the costs to investigate, remediate, and monitor PCB contamination of the school's indoor air.

Exponent was retained to review documents and testimony, conduct an inspection, perform analysis, and provide opinions related to the use of PCBs as plasticizers in building materials such as caulk[1] compounds, Monsanto's role in supplying PCB plasticizers to formulators, the effects of formulation on the release of PCBs from caulk during the working lifetime of caulk, and an assessment of the condition and composition of the caulks and other building materials at Westport Middle School in light of function and expected lifetime.

Monsanto was a supplier of a wide range of chemical products, including plasticizers, to the plastics industry. Aroclor PCBs were one type of plasticizer used in industrial applications because of a unique and desirable combination of properties, including low vapor pressure, low water solubility, chemical and oxidation resistance, thermal stability, adhesion promotion, and flame retardancy. Monsanto supplied PCBs as a plasticizer until sales were voluntarily discontinued in August, 1970.

A plasticizer is a raw material used as part of various industrial mixtures. Monsanto provided standard chemical and physical property data and other typical information directed to the chemists and formulators at companies that purchased and used Aroclor PCB plasticizers. These technical staff members determined the type and amount of Aroclor that, when combined with their choice of base resin and other components such as fillers, stabilizers, and curing

[1] For the purposes of this report, the term caulk is used interchangeably with the term sealant.

agents, would provide the specific combination of properties for the particular end use of that company's product. Monsanto's role in the supply chain for caulks and other building materials was as a raw material supplier, and not a formulator or seller of finished products. Monsanto did not determine the formulations or sell the caulks used in Westport Middle School.

Caulk compositions were determined by formulators, and typically included multiple interacting components, including the base resin, one or more fillers, one or more plasticizers, and other additives. In some formulations, PCBs were used as a plasticizer because of the combination of compatibility and desirable effect on the performance and durability of the caulk. The specific composition, including the chemical types and relative amounts of the components, affects physical and chemical properties of the caulk, including durability and lifetime of the caulk. Aging behaviors, such as the rate of release of the plasticizer, depend on the caulk formulation.

Release of PCBs from PCB-containing caulks depends not only on the vapor pressure of the particular Aroclor used, but also on the composition of the original caulk, as well as end use conditions. PCB congeners volatilize at different rates, with higher chlorinated congeners tending to stay in the condensed phase compared to lower chlorinated congeners, especially at room temperature. Monsanto, as the supplier of only one component, (i.e., a PCB plasticizer), would not have enough information about overall composition or specific end use conditions to predict the properties of the formulated product, including the potential release of PCB congeners from the product.

Regardless of composition, the lifetime of commercially available caulks is generally accepted to be less than 30 years. Any caulk from the original construction of Westport Middle School, which was constructed in 1969, is over 40 years old, and should have been replaced during maintenance activities prior to the 2011 testing. To the extent that some of the PCBs volatilize into the air over time, these amounts would be reduced further by generally accepted physical and air quality maintenance activities.

During Exponent's inspection of WMS after remediation, several asbestos-containing materials and at least two examples of PCB-containing caulk had been left in place, one in the interior and one on the exterior. Despite their age, the two products still contained functional levels of PCB plasticizer, demonstrating the permanence of the PCB plasticizer in the formulations. No other products intentionally formulated with PCB plasticizers were identified at WMS.

Based on the information available, inspection of Westport Middle School and testing performed to date, Exponent has determined that:

- PCB plasticizers were selected for use in certain caulks because of a unique and desirable combination of properties, including low volatility.
- Monsanto was not the formulator of the caulk installed in Westport Middle School. Monsanto manufactured PCBs that were only one component of some types of caulk and therefore could not reasonably know the composition, properties, or specific end use conditions anticipated for caulks formulated by its customers.
- When Monsanto withdrew PCB plasticizers from the market, there was no one-to-one replacement, such that products made with PCBs had to be discontinued or reformulated to have different properties and characteristics.
- Release of PCBs in caulk installed at Westport Middle School would depend on caulk formulation as well as end use conditions at the school (e.g., temperature, air circulation, available surface area, etc.) which could not reasonably be defined or controlled by Monsanto.
- To the extent PCBs were released from the caulks, the lower chlorinated homologs are more likely to be released than the higher chlorinated homologs. Additionally, surface depletion over time would further reduce PCB release.
- Caulk in Westport Middle School from original construction was past its useful life. Any caulks formulated with PCBs would be more than 40 years old and should have been replaced prior to the press release published by EPA in 2011.

1 Scope and Qualifications

1.1 Scope of Work

Exponent, Inc. ("Exponent") was retained by White and Williams on behalf of Monsanto Company to review documents and testimony, conduct an inspection, perform analysis, and provide opinions related to Monsanto PCBs used as plasticizers as they relate to the Westport Middle School in Westport, Massachusetts. This report summarizes the results of Exponent's work to date, as well as my qualifications and experience, in relation to the subject matter of the above-referenced investigation. In the course of my analysis, Exponent has reviewed and relied upon documents, testimony, and examination and testing of physical items. My findings are based on information presently provided, and as discovery progresses they may be updated if new information becomes available.

1.2 Qualifications

I am a Principal Engineer, Corporate Vice President and the Director of the Polymer Science and Materials Chemistry Practice at Exponent, the largest engineering firm in the United States dedicated primarily to the analysis and prevention of failures of an engineering or scientific nature. Exponent is a publicly traded company that employs over 900 full-time staff worldwide, including about 700 degreed professionals, more than 425 of whom hold doctorates in their field.

I hold two academic degrees: (1) a Bachelor of Science in Materials Science and Engineering from the Massachusetts Institute of Technology (MIT), and (2) a Doctor of Science in Materials Science and Engineering, with a thesis in the field of polymers, from MIT. I have been practicing in the field of polymer science and engineering for more than 20 years as a researcher at MIT, in a variety of technical roles at the 3M Company, and as a consultant with Exponent. I am a licensed Professional Engineer in the state of Maryland and a Fellow of the Society of Plastics Engineers.

I provide consulting engineering services in all aspects of polymer science and engineering including, but not limited to, material selection, product design and development, mechanical and chemical testing, microscopy and non-destructive imaging, failure analysis, polymer chemistry, polymer physics, and polymer processing. I have experience in evaluation and testing of the physical properties and durability of polymers, in the determination of the formulation and chemistry that control these properties, and in the selection and specification of polymers for different applications. I have experience formulating and evaluating polymer compositions, testing their properties and assessing chemical compatibility. I have been directly involved in product development, product line extensions, transfer of new products to manufacturing, qualification of alternative materials and manufacturing equipment, evaluating customer complaints, and performing root cause investigations. I have lectured on the topics of material selection, plastics failure analysis, and chemically-enhanced failures. I am an active member of two Underwriters Laboratory Standard Technical Panels, STP 746 (Polymeric Materials) and STP 758 (Appliance Wiring), and the UL task force on Long Term Thermal Aging.

My *curriculum vitae* is provided in Appendix A. A list of previous testimony is provided in Appendix B.

1.2.1 Compensation

Exponent currently charges a rate of $550 per hour for my time. Additional Exponent staff members with lower billing rates have assisted me in this project. No portion of our compensation is dependent on the outcome of this matter.

1.3 Information Considered

In the course of my analysis, Exponent has reviewed and relied upon documents, testimony, and examination and testing of physical items. A list of materials considered is provided in Appendix C.

Although I have not prepared trial exhibits at this time, I may use any and all of the information described or referenced in this report. Additionally, I may use existing materials for demonstrative purposes.

2 Background

Westport Middle School (WMS) of Westport, Massachusetts was constructed in 1969. In 2009, 40 years after the construction of WMS, the Environmental Protection Agency (EPA) published a press release with advisory screening levels regarding airborne PCBs. In 2011, in preparation for planned construction, Westport tested for and found PCB containing materials. Westport then tested for airborne PCBs within the school and, based on the results of the tests, decided to undergo remediation to lower the levels of airborne PCBs. Westport hired the civil engineering firm Fuss and O'Neill to coordinate and run the testing and remediation efforts. On May 7, 2014 the Town of Westport and Westport Community Schools ("Westport") filed their original complaint in the United States District Court in the District of Massachusetts.

In the report that follows, I provide an overview of Monsanto's PCB plasticizers, Monsanto's role as a component supplier to formulators, how plasticizers are used in caulks and sealants, and factors impacting performance and durability of these materials. I also provide an overview of Exponent's inspection of WMS and associated materials information that informs my opinions related to the presence of PCB plasticizers at WMS.

2.1 Monsanto Company

Since the early 1900's, Monsanto produced a variety of chemicals for industry, a portion of which were used as additives within the plastics industry. In 1935, Monsanto acquired Swann Chemical Company, a producer of PCBs. PCBs were originally used mainly as a flame retardant dielectric fluid in transformers and capacitors but, as specific uses became needed, a portion of the PCBs were sold to the plastics industry as a plasticizer under the trade name Aroclor.

Monsanto was a major plasticizer producer, offering a wide variety of chemistries and nearly 80 different plasticizers to industrial customers who would combine them with other components to make a range of products.[2] A small portion of Monsanto's plasticizer offerings were Aroclors.

[2] For example, Modern Plastics Encyclopedia Vol. 48: No. 10A October 1971, Plasticizers Chart p.653 – 664 and Suppliers Index p.707.

These were specialty chemicals representing approximately 1% of the total plasticizer market in the 1950's and 1960's.[3] As a supplier of bulk raw materials, Monsanto did not sell Aroclors as end use products. Instead, they were sold as additives for property modification of plastics.

Monsanto provided technical information related to the properties of the raw material in its pure, non-formulated form to its customers.[4] For plasticizers such as Aroclors, this information included physical and chemical data such as density, compatibility, vapor pressure, boiling point, compatibility, flash point, etc., as well as regulatory[5] and industrial health information.[6] The information could be used by Monsanto's customers, or more specifically their formulators, as a guide for their own product development. Monsanto also offered access to internal knowledge of Monsanto's broad plasticizer product lines in the form of its Plasticizer Council, a technical service described as providing knowledge and insight into which plasticizers may be applicable for potential uses. Combined, the Plasticizer Council and product brochures offered a wide range of experience and knowledge that aided customers in navigating the large selection of plasticizers and related materials offered by Monsanto. This expertise assisted formulators in narrowing options, but in no way directed or determined the actual formulations to be used by Monsanto customers. Proper formulation was governed by the material manufacturers and confirmed through testing and experimentation. All formulation, acceptance testing, and sales of formulated products was performed or directed by Monsanto's customers.

Importantly, the chemical and physical properties of mixtures differ from those of pure raw materials. In some cases raw material suppliers, such as Monsanto, would provide sample formulations for generic products to aid in guidance and to demonstrate compositional effects of additives on final product performance. These formulations were not commercial products but could be used by formulators as high-level demonstrations of different additives and plasticizers for broad uses.

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[3] US Tariff Commission - Synthetic Organic Chemicals - US Production and Sales, 1958-1971and ("Polychlorinated Biphenyls and the Environment", Interdepartmental Task Force on PCBs, Washington, DC, May 1972, COM-72-10419.

[4] For example, Plasticizer Blue Book – 1969 MONS077721

[5] For example; STLCOPCB4046288, MONS090481

[6] For example; TOWOLDMON0001620, TOWOLDMON0001622, LEXOLDMON001172, LEXOLDMON001182

Formulators rely on experience, end-use testing, and other information specific to the intended final product as well as an understanding of anticipated end use conditions for the final product when selecting and evaluating raw materials for use. Monsanto's customers determined the types, amounts, usage, co-ingredients, and overall formulation of the end-use products (e.g., caulks) they were selling to finished goods customers. Monsanto did not provide these formulations to their customers, and could not reasonably predict the chemical or physical behavior of the vast number of commercial products that might include Aroclor as a plasticizer.

2.2 Aroclors

Aroclors are one trade name for a family of PCBs and PCTs[7]. A PCB is a molecule containing two benzene rings with a varying number of chlorine atoms attached. Because of the chemical structure of the biphenyl ring, an example of which is shown in Figure 1, a PCB can contain 1 to 10 chlorine molecules. The chlorine atoms can be arranged along the biphenyl ring in various configurations. There are 209 unique combinations of the number and arrangement of chlorines, which are referred to as congeners. Congeners containing the same number of chlorines (i.e. having the same molecular weight) are referred to as homologs. Table 1 lists the chemical formula, molecular weight, and number of homologs of the various PCBs.

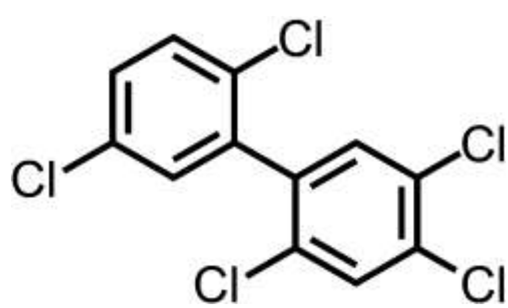

Figure 1 Chemical structure of a polychlorinated biphenyl

[7]PCTs are polychlorinated terphenyls and therefore contain an additional benzene ring compared to PCBs.

Table 1. Empirical formula, molecular weight, and number of homologs for each PCB.

Empirical Formula	Homolog MW ($g\ mol^{-1}$)	# Congeners With This Formula
$C_{12}H_9Cl$	189	3
$C_{12}H_8Cl_2$	223	11
$C_{12}H_7Cl_3$	258	24
$C_{12}H_6Cl_4$	292	42
$C_{12}H_5Cl_5$	326	46
$C_{12}H_4Cl_6$	361	42
$C_{12}H_3Cl_7$	395	24
$C_{12}H_2Cl_8$	430	12
$C_{12}HCl_9$	464	3
$C_{12}Cl_{10}$	499	1

2.2.1 Aroclor Uses

Aroclors, which were sold as a mixture of congeners with a specific 4-digit naming system,[8] were recognized for their use as flame retardant insulating fluids in transformers and capacitors. However, due to the flame retarding properties of the material, combined with other beneficial attributes including low vapor pressure, miscibility with a wide range of materials, adhesive promotion, fire retardant properties, and thermal, chemical, oxidation, weather, mold and water resistance, the Aroclor family of compounds found use as additives in certain plastics to impart specific properties desired by formulators for particular applications. Moreover, Aroclors were known to impart substantial improvements in extending cure time, making previously difficult to work-with building materials much more available to the construction industry.[9] Aroclors were used as a plasticizer to modify physical, chemical and durability performance in paints, coatings, caulks, sealants, and bulk plastics.

[8] Within the naming convention, the first two digits described the molecule type and the second two digits described the weight percent chlorine. Thus, the 1200 series indicated only biphenyl rings, the 2500 series indicated a blend of 75:25 biphenyl:triphenyl, the 4400 series indicated a 60:40 biphenyl:triphenyl mixture and the 5400 series indicated all triphenyls. For example, Aroclor 1254 consisted of all biphenyl rings and contained and average of 54% by weight chlorine.

[9] US Patents 3,331,782 and 3,455,854

In the United States, Aroclors were used in industrial paints and coatings because of their valuable attributes such as compatibility, low volatility, low water solubility, heat stability and fire retardant properties and antimicrobial resistance. They were not, however, recommended for use as household paints.[10] Further, despite the unique uses of Aroclors, they were not used in food packaging.[11]

Aroclor plasticizers were used to meet military specifications, especially for specialty coatings and wire insulation.[12] They were important enough that the United State Secretary of War deemed PCBs "…necessary in the interests of national defense."[13] Further, the U.S. government awarded Monsanto commendations for the manufacture and supply of PCBs to the government.[14]

2.2.2 Aroclor Technical Information

Monsanto offered nearly 100 different plasticizers and related materials in the 1960s,[15] 8 of which were PCB containing Aroclors.[16] To aid customers and formulators in determining which plasticizers may be appropriate for each application, Monsanto provided many technical bulletins describing the uses and properties of all their manufactured plasticizers, including their Aroclor line of plasticizers. Information presented in these bulletins included the chemical make-up of the plasticizers (the Aroclors were identified as chlorinated biphenyls and chlorinated polyphenyls[17]) as well as information on density, vapor pressure, solubility, corrosivity, dielectric properties, flammability, and toxicity, among other attributes. Aroclors were unique and specialty plasticizers. No direct, one to one replacement existed for most applications that utilized Aroclors.

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[10] MONS 0951888-MONS 095191

[11] STLCOPCB4046288, MONS090481

[12] STLCOPB0022834, STLCOPCB0022824-STLCOPCB0022833, STLCOPCB0022838

[13] HAGOV0001391-HAGOV0001403

[14] HAGOV0000159, HAGOV0000160, HAGOV0000192-HAGOV0000194

[15] MONS080640 – Monsanto Plasticizers

[16] MONS077721 – MONS077781, (MONS077728-MONS077730) The Plasticizer Blue Book

[17] MONS0019629-MONS0019673, (MONS019631) – The Aroclors Compounds

2.3 Plasticizers

Plasticizer selection is but one choice of many that must be made by a formulator when developing a new material for a specific application. The complicated nature of formulation requires the knowledge of experienced personnel to control the material specifications being manufactured and sold to their customers.

2.3.1 Historical Sales and Growth of Polymers and Plasticizers

Sales of polymers and plasticizers were increasing at a rapid rate in the 1960s. (Figure 2) Between 1960 and 1969 (the year Westport Middle School was constructed) sales of polymers within the United States increased over 150%, from approximately 8.7 billion lbs in 1960 to over 23 billion lbs in 1969.[3] Plasticizer demand, and subsequent sales, increased similarly from 600 million lbs to 1.4 billion lbs, [3] an increase of approximately 130%.

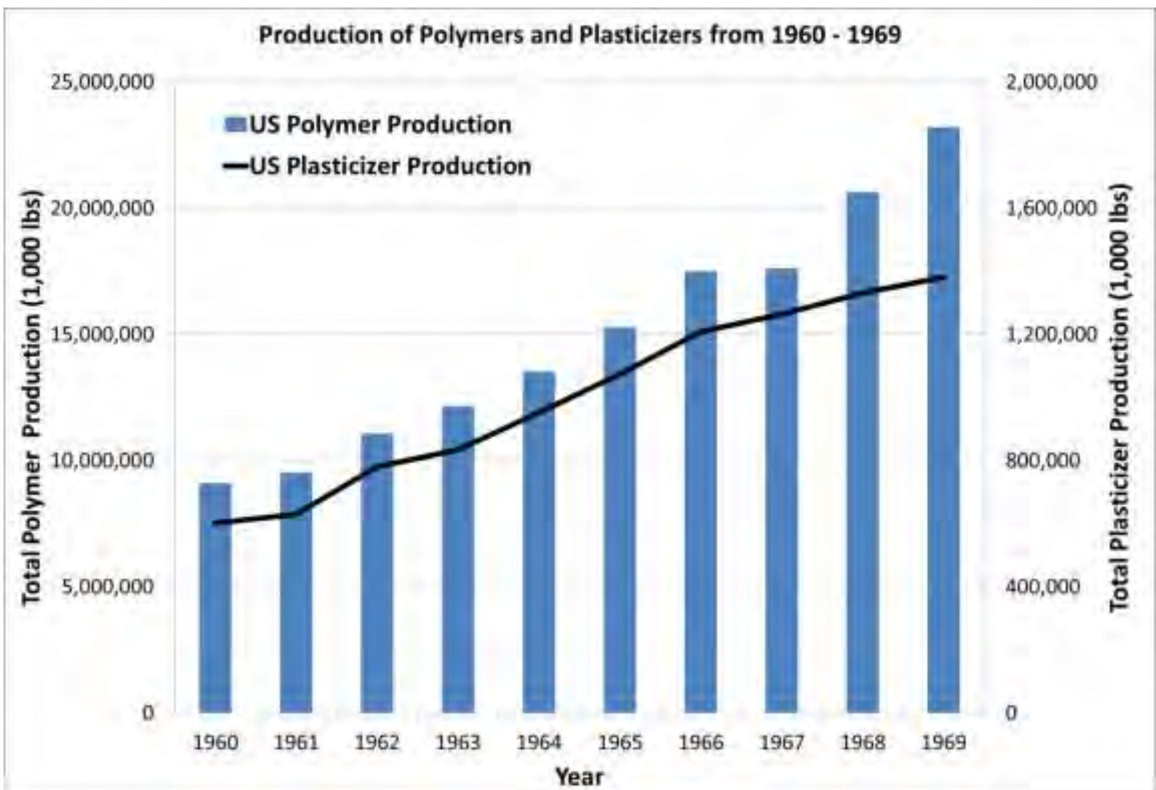

Figure 2. Polymer and plasticizer production in the US (all manufacturers and all types) between 1960 and 1969.

To keep up with increasing demand and increasing uses of polymers, the number of type of plasticizers increased rapidly during this time. In 1960, 70 different companies reported selling over 880 plasticizers in the US, but by1969 at least 85 different companies reported selling over 1360 plasticizers, a greater than 50% increase. However, the number of Aroclor PCB plasticizers did not increase. Despite their unique properties, Aroclors were only a specialty plasticizer, accounting for only slightly more than 1% of total plasticizer sales in the US during this time.[3]

2.3.2 Plasticizer Effects

Plasticizers are ubiquitously used in the polymer industry, and thousands have been commercially available since at least the 1940's.[18] The primary function of this additive class is to increase plasticity or fluidity of a material, though other material properties will be affected and these must be balanced. Examples of the effects of plasticizer type and amounts on physical properties important in caulks are shown in Figure 3.

This figure graphically depicts the plasticizing action unique to different plasticizer options; two different phthalates and an Aroclor are incorporated in an example formulation for comparative purposes. These three plasticizers were commercially offered by Monsanto and others during the time of Westport Middle School's construction. These graphs show the change in each of 4 different properties as the amount of three different plasticizers increases in DPM-1002, a type of polysulfide. Figure 3 shows that the mechanical properties of the sealant are sensitive to plasticizer concentration. This is true for all components of a sealant formulation and is the basis for the wide range of products encountered in the sealants, adhesives, coatings and other plastics markets.

[18] Handbook of Plasticizers, 2nd Edition, G. Wypych, Chemtech Publishing, Toronto 2012. Handbook of Plastics by Simonds and Ellis

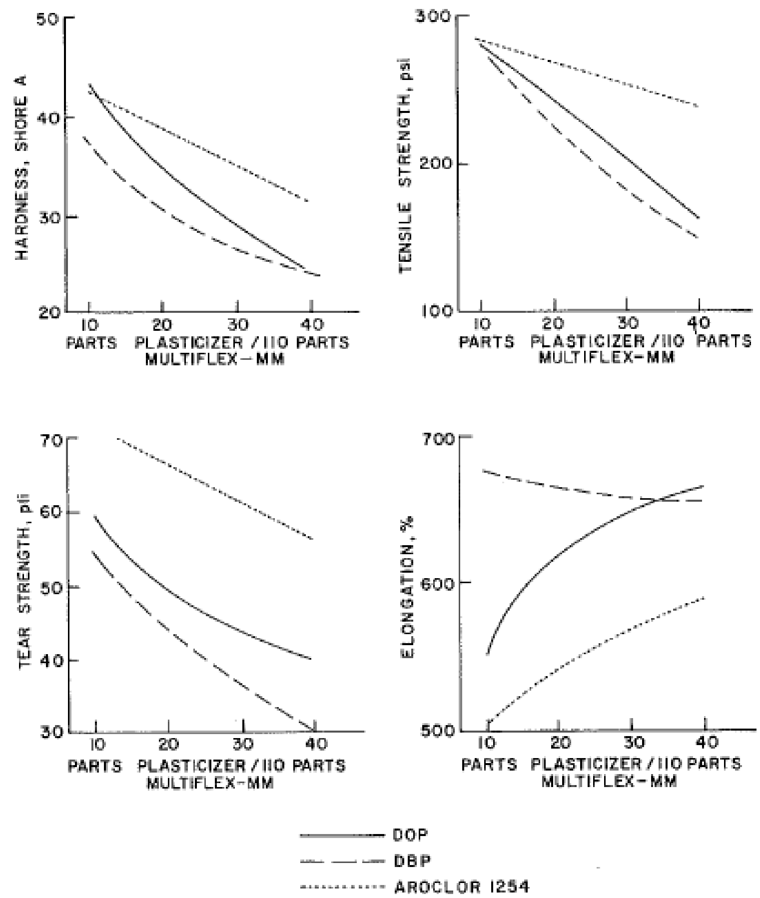

Figure 3. Effect of plasticizer concentration on initial mechanical properties of a polysulfide based sealant (LP-2 polymer - table 6.4) and a polymercaptan based sealant (DMP-1002 - figure 7.5).[19]

Additionally, each property changes at a different rate depending on the plasticizer added. Even with this type of information, though, a formulator would have to prepare the full planned commercial formulation for testing of the full range of characteristics. For example, these graphs do not address other important characteristics of caulks, such as film forming tendencies, flowability related to application, mixture stability, pot life, adhesion to various surfaces, stability during high and low temperature cycling, resistance to chemical attack, leaching by water, oxidation, burning, fire spread, and so on. These properties are affected by aging, which is related to the environmental conditions encountered in use (e.g., heat, humidity, airflow, sunlight, etc). It is not unusual for formulations to appear similar in short term testing but differ significantly after aging.

[19] Sealants, Adolfas Damusis, Reinhold Publishing Corp. 1967

2.3.3 Aging Effects

One type of aging results from plasticizer loss, which leads to local hardening, embrittlement or other changes. Compatibility, vapor pressure, diffusion behavior and water solubility are factors that impact plasticizer loss, with higher compatibility, lower volatility or vapor pressure, slower diffusion and minimal external solubility (e.g., in water) leading to more stable compositions. PCBs exhibit a unique and desirable combination of these factors for minimizing plasticizer loss.

Volatility is a measure of how quickly a material will evaporate and be released into the atmosphere, and depends on chemical structure and molecular weight, as well as interaction with the environment.[20] Typically, loss of plasticizer within a resin is slower than loss of plasticizer as a pure material.[21] The more complex the formulation, however, the more difficult it will be to predict the vapor pressure of any component. Because the composition and use conditions affect volatility, the rate of evaporation of Aroclors in a sealant is dependent on formulation[22] and use conditions that are not and cannot be controlled by Monsanto.

The speed at which a plasticizer migrates through a caulk is specific to the type of caulk, and this migration is related to diffusivity. Diffusion of the molecules within the compound is affected by temperature,[23] the initial concentration in the sealant/caulk, and, many times, the antagonistic effects of fillers.[24] As exemplified in Figure 4, the diffusion rate is formulation dependent and cannot be predicted based on the knowledge of a single component. Indeed the diffusion coefficient can vary by orders of magnitude using different polymers.[25] Thus, a raw material supplier cannot reasonably predict diffusion behavior for an undefined formulation.

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[20] K Denbigh, The Principles of Chemical Equilibrium, Cambridge University Press 1981

[21] Handbook of plasticizers, 2nd edition, 2012 Pg 253-4

[22] HF Payne, Organic Coating Technology, Vol 1, 1954 Wiley.

[23] Brandrup, Immergut, and Grulke, Polymer handbook 4th edition volume 2 Permeability and Diffusion Data, page VI-545,Table 3 Permeability coefficients of various organic compounds through low-density poly(ethylene)

[24] Handbook of Plasticizers, Effect of plasticizers on other components of formulation – Plasticizer consumption by fillers.pg 187

[25] WR Brown, GS Park, J. Paint. Tech. 1970; 42:16. and AC Newns, J. Poly. Sci.:Part C 22 927-937 (1969), P Dole et al, Food Addit. and Contam. 2006, 23(2): 202-211

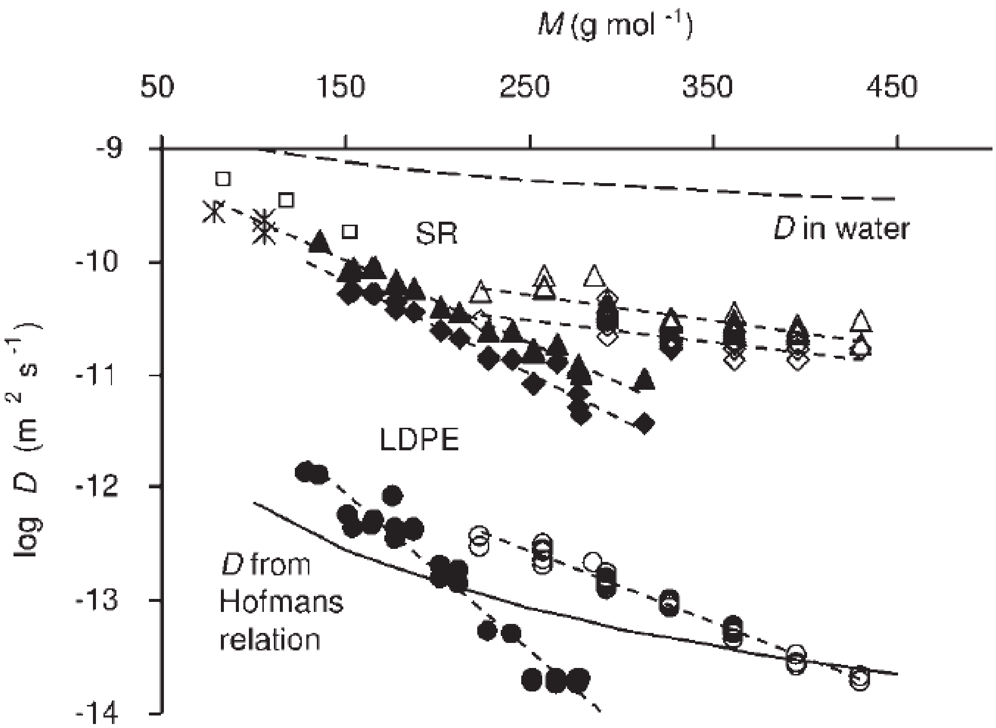

Figure 4. Diffusion coefficient of PCBs [open symbols] and polycyclic aromatic hydrocarbons (PAH) [closed symbols] in low density polyethylene (LDPE) and polysiloxane as a function polymer molecular weight.[26] Triangles [▲] and squares [■] represent polysiloxane, circles [●] represent LDPE.

2.4 Caulks and Sealants

Caulk is a term for elastomeric compositions used to fill gaps and seal joints or seams in structures. Caulks are provided by manufacturers in a pourable or easily extrudable form. Upon curing, the caulk adheres to the adjacent substrates and forms a barrier. In present industry, caulk is most commonly used in building construction wherever a structural unit requires thermal insulation, control of water penetration, and noise mitigation.[27]

Each additive incorporated into the formulation has a unique or synergistic function to impart desired material properties to the sealant. For example, fillers are a common additive used to

[26] TP Rusina, F Smedes, J Klanova, J. App. Polym. Sci. 116, 1803-1810 (2010)

[27] K. L. Mittal, A. Pizzi, Handbook of Sealant Technology, CRC Press 2009

control properties such as structural integrity, refractive index, cost, and color control.[28] A second common additive is a plasticizer. A plasticizer is defined as an additive that increases plasticity or fluidity of a material – as such, the number of materials available for use as a plasticizer for caulking/sealant applications are vast.[29] Plasticizers are primarily used to reduce embrittlement and prevent chipping/flaking; however, other properties, such as improved adhesion, enhanced flow, pot life regulation, and increased flame retardant properties can also be imparted.[30] The plasticizer used can have an important effect on material durability and other attributes related to function and safety.

Caulks/sealants are used in multiple applications and the caulk performance standards vary depending on the application as well as environmental exposure. For each situation, a sealant is required to achieve different performance standards and the formulator must prioritize the desired properties and choose appropriate additives based on performance, cost, and the synergistic effects of mixing with other additives. Literature available during the timeframe surrounding the construction of Westport Middle School demonstrates the range in industrial uses and caulking formulations available.[31] Formulations varied by type of ingredient and quantity of any given component relative to the curable polymer.[32,33]

The number of additives used in a caulk/sealant and final formulation is dependent on the application and desirable physical properties, as well as the experience and preferences of the formulator. As such, the formulation can be as simple as a 4-component system to something as

[28] Examples of commonly used fillers are carbon black, titanium dioxide, calcium carbonate, or silica. Sealants, Adolfas Damusis, Reinhold Publishing Corp. 1967.

[29] Handbook of Plastics by Simonds and Ellis p 251 lists the number of plasticizers to be close to 20,000 in 1943

[30] Plasticizers can increase film forming tendencies, soften the film, impart flow (improve gunning), allow for homogeneous blending all components, and regulate pot life US Patent #s 3276870,3455854, 3267063.

[31] For example, US Patent No. 3717617 states "The curable compositions of the present invention can also contain various types of inert materials commonly employed in polysulfide based sealant and caulking compositions such as fillers, plasticizers, pigments, ultraviolet light stabilizers, cure accelerators, and the like. Representative examples of the above type of compounds include calcium carbonate, titanium oxide, silica, tris-(dimethylamino)phenol, carbon black, dibutyl phthalate, chlorinated hydrocarbons, sulfur, alumina, polyethylene, polystyrene, zirconia, and the like."

[32] For example, US Patent No. 3770678 states "A polysulfide latex based caulking composition consisting essentially of… (c) from about 50 to about 300 parts by weight per 100 parts by weight of total polymer solids in the composition of special purpose additives selected from the group consisting of fillers, plasticizers, whiteners, adhesive additives, and latex stabilizers."

[33] US Patent 3,348,351

complex as a 16-component system.[34] The formulation of any commercially available caulk is determined by trained experts (i.e., formulators) at the specific company selling the caulk. The manufacturers of the additives in the caulk, which are raw material suppliers such as Monsanto, are rarely aware of the formulation, and cannot reasonably predict the specific composition or behavior of the formulated end-use products. Raw material suppliers, such as Monsanto, would provide technical literature containing data (i.e. density, compatibility, vapor pressure, boiling point, compatibility, flash point, etc) directed for use by chemists and formulators at the manufacturer for product development.

2.4.1 Aging of Caulks and Sealants

Caulks and sealants have finite lifetimes. Exposure to environmental conditions and, to a lesser extent, migration of components within and out of caulk will change the overall properties of the material, causing it to lose its defined functionality. Once a sealant/caulk can no longer perform its function it must be replaced. Typically, for building caulk/sealants, failure is defined as when the seal allows moisture to penetrate due to cracking or debonding.[35] It is understood that sealant degradation and eventual failure are due to a number of factors during a product's lifetime, including: cyclic mechanical strain (due to thermal expansion/contraction of building parts with seasonal temperature change), and environmental degradation factors such as sunlight, temperature variations, and moisture.[36] Sealing can also be affected by overcoating with paints or other materials (e.g., due to incompatibilities, or imposed damage from aging and cracking of the over-material.)

Predicting the service life of building joint sealants exposed to service environments in less than real time has been a need of the sealant community for many decades.[37] The primary reason for this difficulty is due to the synergistic effect that different environmental factors have on the

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[34] US Patent # 3282902, Sealants, Adolfas Damusis, Reinhold Publishing Corp. 1967

[35] CC White et al, A Systematic Approach to the Study of Accelerated Weathering of Building Joint Sealants, Journal of ASTM International, Vol. 9, No. 5.

[36] AT Wolf, Durability of Building Sealants, Taylor and Francis Group 1997; AT Wolf, Durability of testing sealants, Dow Corning, http://www.dowcorning.com/content/publishedlit/durability_testing_of_sealants_10132004.pdf

[37] CC White et al, Durability of Building Joint Sealants, Chapter 8 Service Life Prediction of Polymeric Materials 2009, pp 115-128

degradation of a sealant/caulk. Because of this, even today, it is very difficult to predict the service life of a caulk/sealant compound.

Studies in the construction industry have shown a 50% failure rate within 10 years and a 95% failure rate within 20 years after installation.[38] Reports identified by Exponent that address life expectancies and service lifetimes of caulks fall in line with these failure rates.[39] Although there are likely a significant number of other examples in the literature, Table 2 highlights the breadth of applications where caulk is used as well as the diversity in performance. None of the sealants listed in this table have an upper bound life expectancy over 30 years.

38 CC White et al, A Systematic Approach to the Study of Accelerated Weathering of Building Joint Sealants, Journal of ASTM International, Vol. 9, No. 5

39 Sealants, Adolfas Damusis, Reinhold Publishing Corp. 1967 and Case study window sealing systems by Henkel AG & Co. KGAA (http://www.pcf-projekt.de/files/1298483592/pcf_henkel_sealant.pdf).

Table 2. Expected lifetimes of various caulks/sealants.[40]

Sealant type	*Movement Accommodation Factor (%)*	*Character*	*Life expectancy (years)*	*Joint suitability*
Oil-based	10	Plastic	1–10	Perimeter pointing.
Butyl-based	10	Plastic	15–20	Concealed joints. (not UV resistant.)
Acrylic				
Water-based	15	Plastic	10–15	Internal joints, plaster cracks, etc.
Solvent-based	20	Plastic	15–20	Perimeter pointing, concrete, stone cladding, etc.
Polysulphide				
One-part	20–25	Elasto-plastic and elastic	20–25	Perimeter pointing, structural joints, stone cladding, etc.
Two-part	25–30	Elasto-plastic and elastic	20–25	Structural joints, stone and cladding, joints subject to early high movement.
Two-part high modulus	10–20	Elasto-plastic and elastic	20–25	Paving, traffic, floor joints, etc.
Polyurethane				
One-part	10–30	Elastic and elasto-plastic	20–25	Light cladding, curtain walling, structural joints, stone cladding etc.
Two-part	20–30	Elastic	20–25	Light cladding, curtain walling, paving, etc.
Silicone				
Low modulus	50–70	Elastic and elasto-plastic	25–30	Perimeter pointing, curtain walling, stone and concrete cladding, structural joints, etc.
High modulus	20–30	Elastic	25–30	Glazing, sanitary ware, etc.
Flexible epoxy	5–15	Elasto-plastic	10–20	Floor joints, traffic areas, etc.

[40] Resealing of Buildings, a Guide to Good Practice, Oxford Brookes University 1994

3 Inspection

3.1 Westport Middle School Inspection

WMS had been inspected and subjected to testing prior to and during the litigation. Extensive testing was performed at WMS to determine overall air concentrations of PCBs and some testing to determine the amounts of PCBs in caulks and other building materials. The majority of air and solid samples were identified as containing Aroclor 1254, with a small fraction identifying Aroclor 1248. Prior to remediation, Westport identified multiple caulks containing formulation relevant amounts of PCBs. Further, they tested the Tectum ceiling panels, finding less than 2 ppm PCBs in the Tectum and, generally, less than 10 ppm PCBs in the layer above the Tectum. Westport and their contractors incorrectly identified the layer behind the Tectum as a mastic used to support the panels, when the material was actually a felt backing used as a barrier between the Tectum panels and building materials from above. Following testing, the subsequent remediation of Westport, such as removal of old caulk, cleaning of air vents and surfaces, etc., resulted in the airborne levels of PCBs dropping below EPA's exposure levels for middle school children.

Exponent inspected Westport Middle School from October 13 to October 15, 2015. The inspection included a visual inspection of the entire building with photo documentation of the overall building state. Samples of building materials were obtained, including window caulk, joint sealants, mastic, paint, ceiling material, roofing tar, adhesive, and other building materials. When available, digital photographs were taken of the interior and exterior rooms as well as close-up images of the building material. Each room was visually inspected, including each classroom, the cafeteria, gymnasium, music room, auditorium, offices, basement, art room, storage spaces, and other accessible areas.

The majority of the interior and exterior building materials, such as caulk and sealants, had been remediated in some form, either by removal and replacement or covering with a new material. Most of the window sealants appeared to have been applied within the last few years, but some of these covered older, degraded and cracked caulk material. Tectum ceiling panels had been removed from the majority of the rooms, leaving behind some of the underlying felt and plastic coverings, as well as exposed concrete ceilings and beams.

Exponent collected a total of 112 samples during the inspection. Generalized categories of the samples obtained are show in in Table 3.

Table 3. General categories of samples collected by Exponent during inspection of Westport Middle School.

Sample Type	Collected by Exponent
Caulk/Sealant Materials	77
Ceiling Materials	22
Other Materials	13

3.2 Caulk at Westport Middle School

Caulk, as described in greater detail above, is a building material used as a barrier between joints within a structure. The inspection at Westport Middle School and subsequent chemical analysis of samples at Exponent indicated at least 11 types of caulk were present on the school. A comprehensive list of sampling locations, testing results, and corresponding images are listed in Appendices D and E. Colors of the caulk ranged from clear, white, grey to black. The majority of the interior caulk was found along window joints, although a fair amount of interior caulk was located within internal joints and seams. The exterior caulk was split between use along window joints, and use between other joints and seams, such as door frames to brick joints and the seams between building joints.

The majority of the interior caulk appeared to have been applied within the past 2-5 years, which is consistent with documentation provided by Westport regarding the school remediation plans. Remediation consisted of either removing older caulk and replacing with new material, or by encapsulating (i.e., covering) existing caulk. Most of the caulk within interior joints was removed and replaced, while caulk around windows appeared to have been either replaced or simply covered with newer caulk. Some of outdoor caulk appeared to have been replaced, such as the caulk around air vents and exterior joints, while the majority of the caulk on the exterior windows appeared weathered, degraded, and was essentially non-functioning as a sealant.

Representative images of caulk found at Westport Middle School are shown below in Figure 5 through Figure 7.

Figure 5. Typical joint sealing caulk found at Westport Middle school located outside storage room 12

Figure 6. Typical indoor window caulk at Westport Middle School as seen in room 102

Figure 7. Typical weathered, degraded and non-functioning caulk on the outside of the Westport Middle School. Yellow highlighted areas indicate examples of deteriorated caulk

3.3 Other building materials at Westport Middle School

Westport Middle School historically contained Tectum ceiling panels with an oil or asphalt impregnated felt backing layer in every room. After remediation, many of these panels had been removed, with only a few panels remaining throughout the school. The Tectum panels were a fibrous non-woven material held in place by metal brackets. Above the Tectum panels was an impregnated felt layer that acted as a barrier between the concrete and Tectum. Figure 8 shows a typical Tectum panel with some of the underlying felt exposed.

Figure 8. Image of Tectum ceiling panel (white fibrous material) found above drop ceiling in hallway, that has been cut open to expose the underlying felt layer (black material).

Tectum was and is a common material for ceiling paneling due to its structural and noise-dampening properties. Tectum panels, which were held in place by physical methods[41] (i.e. not

[41] Gold Bond Tectum form plank information, National Gypsum Company 1968

mastic or other adhesives), were often supplied with a roofing felt layer adhered on the back side to prevent infusion of concrete onto the panel. The felt layer was often infused with a petroleum material, such as oil, asphalt or other resinous materials, which aided in the manipulation of the material as well as increased its weather resistance.[42] Although Westport identified the felt backing layer as a mastic that was used to adhere the Tectum to the concrete ceiling, our research, inspection and testing indicates otherwise. Exponent measured 7.96 to 52.4 ppm PCBs in the ceiling materials tested, including the felt backing.

Exponent also observed asbestos insulation at the school. As an example, Figure 9 below shows a pipe in the mechanical room of the gym clearly marked as asbestos but the outer lining not fully adhered to the pipe insulation.

Figure 9. Piping containing asbestos insulation in the gym mechanical room.

[42] US Patents 3292334, 3365322, 2490430

4 Analysis

In addition to visual inspection, Exponent performed or directed microscopic and chemical analysis of samples to assess basic composition, asbestos content and PCB content.

4.1 Fourier Transform Infrared (FTIR) Spectroscopy

To determine the types of caulk, sealants and other materials used at Westport Middle School, samples of the materials were analyzed using Fourier Transform Infrared (FTIR) spectroscopy.[43] Exponent tested 77 caulk and glazing samples, 22 ceiling samples, and 13 other samples that were obtained from Westport Middle School. 11 different types of caulk were identified via FTIR spectroscopy. These materials are show in Table 4.

Table 4. Types of caulk and caulking material removed from Westport Middle School by Exponent.

Resin	Number identified
Silicone	37
Polyolefin	14
Silicone blend	9
Poly vinyl acetate	1
Acrylate	3
Polysulfide	2
Polyvinyl chloride	1
Nitrile foam	1
Urethane foam	2
Ethyl vinyl acetate	3
Styrene copolymer	3

[43] Fourier Transform Infrared Spectroscopy was performed in general accordance with ASTM E573 on a Nicolet 6700 spectrometer using a DLaTGS detector. The IR-range was 4000-400 cm^{-1} at a resolution of 4 cm^{-1}. Data was analyzed using the OMNIC-Atlμs 8.3 software package and each of the presented spectra represents the average of 128 sequentially collected scans. FTIR is a spectroscopic technique that identifies chemical groups present at the top few microns of a sample surface. FTIR can assist in the identification of materials and can provide a comparative assessment of chemical differences between samples. FTIR spectra are compared to reference spectra to identify components in a mixture, however, identifications are not intended to be specific to a brand or grade of a material.

Overall, a significant portion of the caulk and joint sealants found inside of Westport Middle School appeared to have been installed within the previous 5 years, which is consistent with documentation regarding the remediation plan for the school. Some of the caulk encapsulated older caulk, while other caulk and sealants replaced prior materials. At least 11 caulk types were observed. Older, encapsulated caulk was not separately identified because the majority of the material/caulk found under newer material was old, hardened and identified mainly as calcium carbonate ($CaCO_3$), one of the most common fillers for caulk.

Caulk and sealant materials on the outside of the building were found in various functional states. Some of the caulk appeared to have been replaced within the past 5 years, while other caulk was old, weathered and non-functioning. The majority of the degraded or non-functioning caulks were based on silicone, polyolefin and ethyl vinyl acetate chemistries.

4.2 Asbestos Content

A total of 84 samples obtained during Exponent's inspection of Westport Middle School were evaluated for asbestos content according to EPA method 600/R-93/116 using polarized light microscopy. The results, shown in Table 5 indicate that 12 samples contained between 3% - 5% of chrysotile type asbestos.

Table 5. Asbestos test results of 41 samples acquired from Westport Middle School using EPA method 600/R-93/116.

Caulk Identification	Number of Samples containing Asbestos	% and Type of Asbestos Identified
Polyolefin	6	0 – 5% Chrysotile
Silicone and Silicone Blend	3	0 – 3% Chrysotile
General Building Materials	2	2% Chrysotile
Ceiling Materials	1	3% Chrysotile

4.3 PCB Content

Samples obtained by Exponent during its inspection of Westport Middle School were analyzed for total PCB content according to EPA method 8082. 76 samples[44] were sent for testing and results indicated varying levels of PCBs in the caulking and other materials. Of the 76 samples tested two contained formulation-relevant amounts of PCBs that indicated they had been formulated with an Aroclor. No evidence of formulated amounts of PCBs was detected in plasticized paint by Exponent or Fuss and O'Neill.

Of the samples tested, 32 were found to contain a concentration of PCBs greater than or equal to 50 ppm, 11 contained concentrations higher than 1,000 ppm, 1 sample contained 84,500 ppm,[45] and 1 sample contained 239,000 ppm. Results are tabulated in Table 6, and grouped based on caulk identification where possible. Of the 11 samples of caulk found with PCB levels greater than 1,000 ppm, 2 were found to be on the inside of the school. The highest PCB concentration was a polysulfide caulk, which was obtained on an outside wall of the school.

[44] 75 samples were tested for the presence of PCBs using EPA method 8082. 12 samples were sent for full congener analysis, 11 of those evaluated for full congener analysis had been tested previously using EPA 8082, while 1 sample (Exponent ID 152320) was tested only for the full congener analysis.

[45] Total PCB concentrations determined by EPA method 8082 and full congener analysis had slight differences in overall PCB concentration reported. For reporting purposes in the body of the report, all values are taken from the EPA 8082 testing, but Appendix E reports all PCB concentrations obtained from testing.

Table 6. PCB concentration ranges measured for samples acquired by Exponent at Westport Middle School for samples that measured ≥ 50 ppm total PCBs.

Caulk Identification	Number of Samples Identified with ≥50ppm PCBs	Range of Total PCBs measured in ppm (w)
Polysulfide	2	84,500-239,000
Silicone Based	17	50-15,600
Polyolefin	9	50-475
Polyacrylate	2	272-558
Polystyrene based	1	129
Ceiling material	1	52

The two polysulfide samples contained PCBs in amounts consistent with intentional formulation, indicating a complete remediation of all PCB containing caulk was not accomplished. One sample was found on the exterior (Figure 10), and the other was found on the interior, inside room 28 (Figure 11). These caulks are likely over 45 years old and still contain PCB levels consistent with formulations that might have been used for these purposes, confirming that the PCB plasticizers have low volatility and tend to stay in the caulk over time.

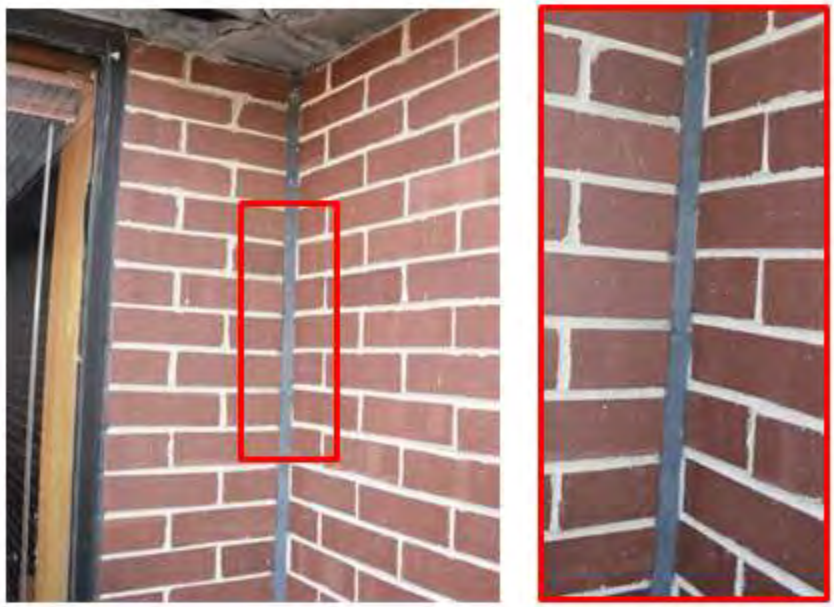

Figure 10 Joint sealant found on exterior of school containing 239000 parts per million PCBs

Figure 11. Joint caulk found in room 28 containing 84,500 ppm PCBs.

Aroclor containing polysulfide caulks were not manufactured beyond the early 1970s, indicating the caulk samples obtained from Westport Middle School are over 40 years old, which is older than the expected working life of the caulk. Polysulfide caulks, which contained PCBs during this time frame, have one of the longest life expectancies of all caulk material, but the unremediated caulk at Westport was still long past its useful life.

Exponent also tested 12 samples for total congener analysis. A review of this data shows a relative consistent distribution of homologs between 3 subsets of samples; interior caulk samples, exterior caulk samples, and ceiling materials

5 Response to Dr. Matson's Report

Dr. Matson's report opined on multiple aspects of PCB use and toxicity, as well as what Monsanto knew prior to the construction of Westport Middle School. For the purpose of this report, I will discuss Dr. Matson's opinions from the standpoint of the chemical functionality of PCBs, and specifically Aroclors, used in construction materials as well as the knowledge during the timeframe in question regarding acceptable use and needed use of Aroclors.

Dr. Matson's report discusses the ability of Aroclor PCBs to volatilize from formulated product, though his analysis appears to lack understanding of Monsanto's role in the supply chain, chemical and physical principals related to formulation, and the relevance of certain statements or articles to materials and conditions actually present at WMS.

Materials can be characterized by their vapor pressure, which is a measure of volatility under specific conditions. Thus, materials do not have a single vapor pressure applicable to all situations. Vapor pressure is related to the material's chemistry, size and temperature. Interaction forces due to chemical attraction and physical limitations on mobility are also factors. Perhaps more importantly, the concentration that actually develops in the airspace around a material depends further on factors such as surface area, concentration gradients due to diffusion limitations, air quality, temperature, effective air volume and ventilation. For example, volatiles from painting will be at a maximum when the liquid is sprayed during application, and will decrease as the surface area is reduced (e.g., when the spray droplets become a film), and the materials dries and/ or cures to a solid material (e,g., a condensed form with increased molecular interactions that slow diffusion). With a low volatility PCB plasticizer in a cured paint, normal ventilation prevents PCB buildup in the air. Saturation conditions are unlikely to be reached in this situation. Thus, simple determinations of vapor pressures of a pure material cannot be used to reliably predict air concentrations of that material released from a mixture in a ventilated space, especially for a material with low enough volatility that measurements are typically extrapolated from elevated temperatures. Dr. Matson has suggested that paint is a source of PCBs at WMS, though the data indicates that is not the case. Notably, Monsanto did not recommend Aroclor PCBs for interior latex paints,[10] which were the types of paints used at Westport.

Monsanto provided information related to Aroclor PCBs including chemistry, handling, and properties such as vapor pressure, as well as comparative information for pure materials and non-commercial example formulation made with different plasticizers to its customers, the formulators. The chemical information provided Monsanto's technically trained customers with details that would inform their subsequent use and handling.[4] All plasticizers have a vapor pressure, and Monsanto's data showed that Aroclor PCB plasticizers beneficially offered low vapor pressure along with desirable properties for modifying polymer formulations performance.

The volatility of PCB plasticizers from formulated materials such as caulk, will depend on numerous factors that Monsanto cannot reliably know or control. Indeed, Dr. Matson references various weight loss tests associated with end-use markets rightly noted in report that, "The volatilization losses were determined not only by the plasticizer alone, but by the plasticizer resin combination and the thickness of the finished product (Reed, 1943; Craver, 1948; Boyer, 1949; Doolittle, 1954; MONS 080627, 1961; American Chemical Society, 1965; Mellan, 1961)."[46] Thus, Monsanto's customers decided if an Aroclor PCB was appropriate for a particular use, and assessed the performance and limitations of their specific products. For example, as Dr. Matson noted,[47] several customers assessed formulations containing Aroclor 1254 for sealing doubled paned windows and found that the windows fogged over time. While fogging can be the result of offgassing from sealants, other factors can also create this visual defect. Regardless, these examples demonstrate that the formulators, not the raw material suppliers, were assessing their compositions and making decisions about which formulations to commercialize.

Dr. Matson has suggested that Monsanto's technical communications to potential customers and internal communications related to potential new markets demonstrate that Monsanto was

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[46] Matson report, p. 11

[47] Matson report, p 15-16

making independent decisions about applications and formulated products sold by its customers. This is not true. Monsanto provided reference and comparative information and customer-driven technical support related to its plasticizer products in a variety of forms, including tables of standardized data, technical brochures, and other typical chemical information. Aroclors were used in industrial application requiring particular combinations of properties that were determined and assessed by Monsanto's customers in light of their particular applications. Various communications and formal documents confirm that Monsanto did not recommend Aroclor plasticizers for food contact applications, and contrary to Dr. Matson's assertion there is no evidence that Aroclor PCBs were used in commercial chewing gums.

Dr. Matson goes on to discuss that there were suitable substitutes for Aroclors in nearly all products, and references Broadhurst[48] as his example. Dr. Matson fails to recognize that the Broadhurst paper is merely discussing chemical compatibilities within his 1972 paper and not discussing the functionality of the plasticizers. Broadhurst discusses chemical compatibility and physical characteristics such as density, dielectric strength, thermal conductivity, etc., but does not discuss any resulting resin properties such as plasticizer efficiency, elongation, strength, toughness, weatherability, etc. Dr. Matson is confusing compatibility with functionality. Merely because a plasticizer is compatible does not make it functional for a particular end use. This is one reason why discontinuation of a raw material can be disruptive for product manufacturers. In the case of materials with unique attributes, it is not unusual to stockpile a certain amount of material when notified of a pending change in order to mitigate the risk associated with finding a replacement. Multiple documents exist in which Monstanto customers state that they cannot find suitable alternatives to the Aroclor PCBs for their products.[49]

[48] Broadhurst, M.G., Enviro Health Persp, pg.80-102, October (1972)

[49] For example, TOWOLDMON0053042, TOWOLDMON0054001, TOWOLDMON0054003

EXHIBIT 3

MATSON & ASSOCIATES

Expert Report

PCB-containing Aroclors as Plasticizers in Polysulfide Sealants and other Building Materials used in Westport Middle School

Westport, Massachusetts

United States District Court, District of Massachusetts
Town of Westport, et al. v. Monsanto Company, et al.
Civil Action No. 14-12041-DJC

Prepared for:
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May 27, 2016

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I. Qualifications

I am Emeritus Professor of Environmental Engineering at the Pennsylvania State University and the founder of Matson & Associates, Inc. My academic background includes a B.S. and M.S. in Chemical Engineering from the University of Toledo and a Ph.D. in Environmental Engineering from Rice University. My relevant experience includes working as a process chemical engineer in an oil refinery and a chemical plant, and as an environmental engineering consultant to the chemical industry. I have taught courses at the University level in topics such as environmental engineering, environmental chemistry, engineering design and hazardous waste management. I have conducted and supervised research in areas including environmental chemistry, chemical engineering, and chemical emissions and releases from manufacturing facilities. I have published papers in peer reviewed journals, and worked with environmental regulatory agencies on permitting issues. From 1991 to 1993, I served on the Texas Air Control Board as Chair of the Enforcement and Regulation Development Committee in which corporate ethics and responsibilities were an important part of the judicial process in determining fines and other regulatory actions.

I also have experience with product safety. In the 1990s, I invented and patented Towerbrom, a commercial cooling tower water treatment chemical, and was intimately involved in the process for determining its safe application and use in order to generate the Material Safety Data Sheet.

I have been qualified to testify at trial in Federal and State Courts in a number of cases involving the releases of polychlorinated biphenyls (PCBs) into the environment. My CV and four-year case history are attached in Appendix A.

II. Basis of Opinions

I have formed my expert opinions based upon [a] documents supplied through discovery[1], [b] scientific literature, and [c] my education, training and experience, to a reasonable degree of engineering certainty. I reserve the right to supplement or modify my opinions as additional information becomes available and is provided to me.

III. Compensation

My hourly rate for preparing this expert report is $450 per hour. My hourly rate for testimony is $900 per hour.

IV. Methodology

I was retained on behalf of the Town of Westport, et al to determine Monsanto's role, conduct, and duties with respect to the PCB contamination of Westport Middle School. To formulate my expert opinions, I reviewed materials produced during discovery to: (1) determine Monsanto's knowledge on the toxic effects of PCBs; (2) determine Monsanto's knowledge on the migration of PCB

[1] Appendix B contains a list of these documents.

plasticizers from polymers; (3) identify how Monsanto communicated knowledge externally (4) track the evolution of technical knowledge on environmental impacts from PCBs; and (5) determine what actions, if any, were taken by Monsanto to protect humans and the environment from exposure to PCB-containing materials.

I obtained authoritative industry reference materials on plasticizer technology and the behavior of plasticizers in commercial products. This information was reviewed along with Monsanto's knowledge on plasticization.

Lastly I reviewed industry standards and Monsanto's policies with respect to corporate responsibilities to protect consumers, communities and the environment.

V. Summary

By the time building materials formulated with Aroclor (PCBs) compounds as the plasticizer were approved for use in the construction of Westport Middle School in 1969, Monsanto knew the following information:

- PCBs were known to cause systemic toxic effects resulting in physiological harm;
- PCB-containing Aroclors were sold as plasticizers for polysulfide sealants used in applications for building construction;
- PCBs volatilized from polymer products including polysulfide sealants and persisted in indoor environments, thus exposing occupants to PCBs;
- PCBs volatilizing out of polymer products in indoor environments could present a danger to the building's occupants; and;
- PCBs and PCB-containing Aroclors were persistent, bioaccumulative, and toxic environmental contaminants.

Monsanto knew PCBs could present a danger to occupants of buildings in which PCB-containing Aroclors were used in building materials. Monsanto should have conducted tests to determine the PCB exposures likely to occur from the extended release of PCBs from polysulfide sealants and other building materials, and should have determined whether those exposures caused toxic effects prior to producing and selling PCB-containing Aroclors as plasticizers for building materials, including polysulfide sealants for which it sold significant amounts of PCB-containing Aroclors.

Monsanto should not have sold PCB-containing Aroclors as plasticizers for polysulfide sealants and other materials used in buildings, such as Westport Middle School. By doing so, Monsanto did not meet its corporate responsibility to protect consumers, communities and the environment from dangers associated with exposure to PCBs.

VI. Background on Polychlorinated Biphenyls (PCBs) and Aroclors

PCBs also referred to as "chloro biphenyls," "chloro diphenyls," and "chlorinated diphenyls," are a class of synthetic organic chlorinated compounds. The basic chemical structure of PCBs is two bonded benzene rings (the biphenyl) with chlorine atoms, ranging from 1 to 10 attached, as shown below in Figure 1.

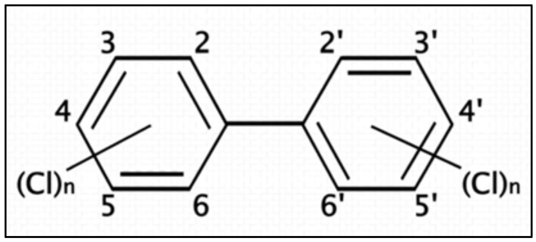

Figure 1. Generic structure of a PCB molecule showing the placement of 1 to 10 chlorines.

The varying combinations of the number and location of chlorine atoms attached to the benzene rings theoretically allows the formation of 209 different PCB compounds, commonly referred to as congeners. The 209 congeners grouped by the number of chlorines attached to the biphenyl are referred to as homologs. For example, the "penta" homolog has 42 PCB congeners containing five chlorines of which two are shown below in Figure 2.

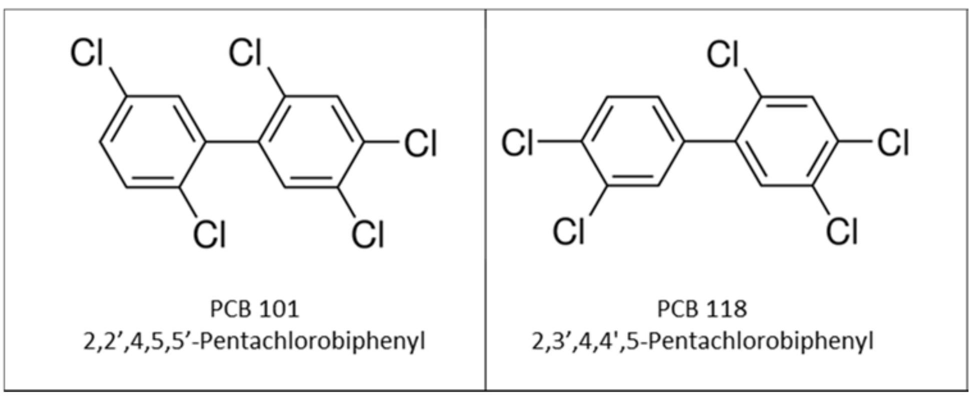

Figure 2. Chemical structure of two different PCB congeners containing 5 chlorines.

Swann Research Inc. (Swann) began producing PCBs in the United States in 1929. When Monsanto purchased Swann and its Anniston plant in the early 1930s it became the producer of PCBs in the United States and remained as such until it ceased production of PCBs in 1977. Monsanto manufactured and sold PCBs as mixtures of congeners with different degrees of chlorination. The manufacturing process began with the formation of the biphenyl, which was produced by heating benzene to over 800°C in a closed reactor in the absence of air. The reaction gases were then transferred to a series of columns and cooled to separate out the purified biphenyl (DSW 001279, 6/1935).

To manufacture PCBs, biphenyls were pumped into a chlorinator in which chlorine gas was bubbled up the cylindrical column. The reaction, in the presence of a catalyst, continued until the correct density (an indicator of chlorine content) was reached, and then the crude chlorinated mixture was distilled to a finished product. The final PCB product resulted in mixtures of chlorinated biphenyls with an overall composition defined by the percent chlorine. For example, Figure 2 shows a PCB compound with 54% chlorine content as a mixture of several PCB homologs. As shown in the figure, the most abundant homolog in this particular mixture is the penta-chlorinated biphenyl, or five chlorine atoms attached to the biphenyl molecule. PCB mixtures with a lower percentage of chlorine will have more of the lower chlorinated congeners; and the converse is true for the mixtures with a higher percentage of chlorine. (DSW 001279, 6/1935).

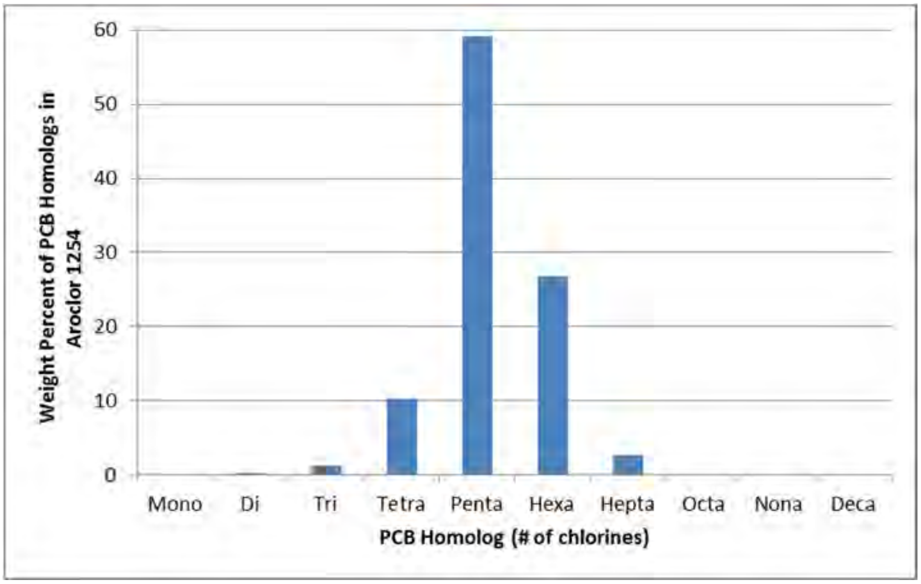

Figure 3. Typical Aroclor 1254 composition by homologue (ATSDR, 2000, Table 4-4).

PCB's are characterized by semi-volatile, high viscosity, low solubility in water, high solubility in most organic solvents, low flammability, and having good dielectric properties. The chemical and physical properties vary depending on the congener makeup and degree of chlorination. For example, PCB mixtures with 54% chlorine or less are oily liquids and PCB mixtures with 60% chlorine and above are resins or waxes. In addition, the different PCB mixtures imparted different properties when in use on their own or combined with other materials into final products.

Monsanto sold PCB mixtures under the trade name "Aroclor", followed by a four digit number. The first number denoted the raw material, the second number indicated whether it was distilled, and the last two digits identified the percentage of chlorine (DSW 001279, 6/1935).

Using Aroclor 1254 as an example:

- 1 = raw material was 100% biphenyl
- 2 = distilled
- 54 = 54% chlorine by mass

The Aroclor 1200 series signified products that contained only mixtures of PCBs. Monsanto also manufactured polychlorinated terphenyls (PCTs) which were comprised of three benzene rings joined together with chlorine atoms attached to the benzenes. PCTs were sold as the Aroclor 5400 series[2]. Monsanto sold blends of PCBs and PCTs as the Aroclor 2500 and Aroclor 4400 series[3]. The Aroclor 1200 series sold by Monsanto are listed below in Table 1[4].

Table 1. Aroclor 1200 series sold by Monsanto (DSW 532590)

Aroclor 1221
Arcolor 1232
Arcolor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1250
Aroclor 1262
Aroclor 1268

Monsanto sold the Aroclor 1200 series for many different applications. In electrical equipment, such as transformers and capacitors, they were a preferred dielectric fluid due to their low flammability and good electrical insulating properties[5]. The Aroclor 1200 series were also widely used in "semi-closed" applications (that were prone to leakage) such as hydraulic systems because of their low flammability, and in heat transfer systems as a good conductor of heat for high temperature processes.

Monsanto also sold the Aroclor 1200 series (as well as Aroclors 4465 and 5460) as plasticizers, solvents, and modifiers for applications such as coatings, adhesives, sealants, and inks. Monsanto's Plasticizer Division serviced all of its customers using Aroclors in these applications and knew the ultimate uses of many of these Aroclor products. For example, Monsanto knew the "primary end use [of polysulfide sealants was] in sealing compounds for aluminum windows, industrial applications, curtain wall construction, etc." (LEXOLDMON005375, 2/1961). Therefore, Monsanto recognized that PCB-containing Aroclors would be in products sold for indoor applications.

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[2] Aroclor 5460 was a distilled PCT made from 100% high boiler, which was a byproduct of the biphenyl production process, as the starting material, that was chlorinated to 60% chlorine.

[3] Aroclor 2565 was a distilled Aroclor made from a starting material comprised of 75% biphenyl and 25% high boiler that was chlorinated to 65%. Similarly, Aroclor 4465 was a distilled Aroclor made from a starting material of 60% biphenyl and 40% high boiler that was chlorinated to 65% (DSW 001279, 6/1935; TOWOLDMON0024978, 10/31/1966).

[4] Monsanto also made Aroclors 1270 & 1272. These Aroclors were primarily comprised of the decachlorobiphenyl (10 chlorines on the biphenyl). No sales information for these Aroclors was shown on DSW 532590.

[5] From 1957 through 1977 Monsanto sold over 400 million pounds of Aroclor 1242 for use in capacitors and approximately 200 million pounds of Aroclors (1242, 1254, 1260) for transformer fluids (calculated from DSW 532590, which only listed sales data since 1957).

PCBs are persistent, and do not readily biodegrade in the natural environment. PCBs can enter the human body through exposure by inhalation, ingestion, and the skin. Also, PCBs can enter the ecological food chain and bio-magnify to elevated levels in food for human consumption.

Monsanto discontinued sales of the Aroclor 1200 series for "open" uses such as plasticizers on September 1, 1970. Monsanto referred to these applications as "open" uses because the PCBs were in direct contact with the environment (e.g. soil, water air). Monsanto also discontinued sales of the Aroclor 1200 series for "semi-closed" uses in hydraulic and heat transfer systems in 1971/1972 and all PCB-containing products in 1977. Congress specifically banned the manufacture of new PCBs, and prohibited the processing, distribution in commerce and use of PCBs "in any manner other than in a totally enclosed manner" under Section 6(e) of the 1976 Toxic Substances Control Act (15 U.S.C. § 2605(e)(2)(A))

VII. Background on Plasticizer Performance and Polysulfide Sealants

A. Plasticizer Performance

Plasticizers are chemicals added to rubbers and resins[6] to impart flexibility, workability or stretchability (Merriam-Webster, 2016). The performance of a plasticizer is evaluated on the performance and properties of the plasticizer-polymer combination (Craver, 1948; Doolittle, 1954). Three important characteristics considered when evaluating plasticizer-polymer suitability are compatibility, efficiency, and permanence. Compatibility refers to the maximum amount of plasticizer that can be added to a polymer without causing phase separation. Efficiency is a measure of how much a given amount of plasticizer alters a desired property of the polymer, e.g. brittle point, hardness, stiffness, etc. Permanence refers to how well a plasticizer is retained in the polymer matrix under specified aging conditions (Craver, 1948; Mellan, 1961).

Plasticizers are not permanently bonded to or encapsulated in the final polymer products. During the lifetime of a plasticized polymer, losses (or problems with permanence) occur when the plasticizer molecules diffuse from the interior of the polymer to the surface, and undergo volatilization. The plasticizer will volatilize or leach into the adjacent media with which it is in contact, e.g. air, liquids or solids (Reed, 1947; Small, 1947; Mellan, 1961).

The compositions of many plasticizers such as Aroclors were not commonly known because manufacturers of the plasticizers did not divulge this information or because the methods of production did not yield products that were pure compounds (Doolittle, 1954). Therefore, it was important for the manufacturer of the plasticizer to communicate important properties (such as vapor pressure and toxicity) of the material to the compounders of the plasticizer/polymer products. In the book *Construction Sealants and Adhesives* (1970), the author commented, "the consumer has no way of knowing the ingredients of any particular sealant."

[6] In this text resin, plastic, and polymer are used interchangeably to reference an organic material that is flexible, and can be formed into a wide variety of products at various thicknesses.

B. Polysulfide Sealants

Sealants[7] are defined as any material used to seal joints or openings against the intrusion or passage of any foreign substance such as water, gases, air, or dirt. With the introduction of curtain wall construction in 1952, flexible building sealants became necessary for the "permanent sealing of moving joints."(Peterson et al, 1976). Polysulfide base joint sealant became popular for curtain wall construction because it functioned well as the joints expanded and contracted during temperature changes (Peterson et al, 1976). Polysulfide sealants were used in general construction for sealing and caulking of metal, wood, and masonry joints, and also for window glazing.

Thiokol Chemical Company held the basic patents to the liquid polysulfide polymer (Thiokol LP) and was the primary supplier to the polysulfide sealants formulators in the United States. There were approximately 35 different formulators of polysulfide sealants including Products Research & Chemical Corporation (PRC), Sonneborn, Essex, and W.R. Grace (Cook, 1970).

Polysulfide sealants were made from the liquid polysulfide polymer to which plasticizer, fillers and other materials are added. The "plasticizer [was] used to extend the liquid polymer and to soften the cured compound for some applications."(Peterson et al, 1976). PCB-containing Aroclors were one of the plasticizers used in polysulfide sealants because of acceptable compatibility with the polysulfide polymer. Monsanto issued a technical bulletin in 1962 titled, "Monsanto Modifiers for Thiokol® polysulfide liquid polymers" with Thiokol's cooperation in its preparation. For joint-sealant compounds, the bulletin stated that Aroclors had "long been used as cost-reducing modifiers for polysulfide polymers in [curtain-wall construction] and other construction applications." (TOWOLDMON0034340, 4/1962).

In 1968, Monsanto's sales of PCB-containing Aroclors for use as plasticizers in polysulfide sealants were 1.4 million pounds. Its largest customer in that year was PRC, the manufacturer of the polysulfide sealant used in Westport Middle School (TOWOLDMON0052394, 3/12/1969; DSW 164905, 10/15/1969; WSTPRTSCHL005477, 5/9/1969). Monsanto discontinued sales of PCBs as plasticizers effective August 30, 1970 (DSW 318071, 5/14/1970). PCB-containing polysulfide sealants have been found in many buildings built or renovated between the 1950's and the 1970's, including schools, universities, and commercial and public buildings, as well as large scale apartment buildings (Herrick et al, 2004; US EPA, 2010).

In the "Use and Replaceability of Polychlorinated Biphenyls," the Federal Interdepartmental Task Force concluded it found "no evidence that PCB's are indispensable to a particular plasticizer" and in most cases there were alternatives "which did not appear to be detrimental to the application" (Broadhurst, 1972). Monsanto reported selling phosphate ester plasticizers (which are also flame retardants) as replacements for PCB-containing plasticizers (FDA014180, 1/26/1972). Specific to polysulfide sealants, several suitable substitutes for plasticizers included dibutyl phthalate, dioctyl phthalate, propylene glycol dibenzoate, ortho nitro biphenyl and chloroparaffins (Boller, 1976).

[7]Reference books on construction materials and plasticizers use overlapping terminology when referring to sealant, caulk, mastic and glazing. For simplicity, the term sealant in this report represents all of these materials.

VIII. PCB Contamination in the Westport Middle School

A. EPA guidelines on PCB contamination in schools

In early to mid-2000s, high levels of PCBs in building materials (particularly caulks/joint sealants) that dispersed into air and dust indoors, and soils surrounding these buildings were reported in the literature (US EPA, 2010). On September 25, 2009, in response to Public Health concerns, EPA released a series of best management practices recommended to building owners and school administrators in order to reduce exposure to PCBs found in caulk in buildings constructed between 1950 and 1979. EPA also announced that it would continue to do more research in this area to determine the best mitigation strategies. Since then the guidelines continued to be updated with the most current version released on July 28, 2015. The guidelines also include air exposure levels (calculated based on PCB oral reference dose) for different age levels that should be considered when evaluating mitigation strategies (US EPA, 2015a; US EPA, 2015b).

B. PCB Contamination in Westport Middle School

In May, 2011, as a result of pre-renovation inspection procedures at the Westport Middle School, PCB levels ≥ 50 ppm (identified as Aroclors 1248 and 1254) were found in interior window glazing compound, exterior window caulking, and interior and exterior door caulking. These findings led to more complete investigations over the next several months. The additional test results identified Aroclors 1248 and 1254 at levels ≥ 50 ppm in the caulking and glazing on the interior and exterior of all tested window and door systems, as well as in mastic/felt on concrete above ceiling panels, caulking between brick and a concrete column in the cafeteria, and in compressible filler between a concrete column and gypsum. PCBs at levels > 1 ppm were found in adjacent substrate materials (brick and concrete), soil surfaces below windows, and interior wipe (dust) samples. Air test results revealed PCB concentrations above the EPA recommended exposure levels in some areas of the school (WSTPRTSCHL013667, 8/4/2011).

The December 1968 construction related documents revealed that the city's bid package for construction of the Westport Middle school required the use of a "one-part, non-sag, polysulfide base sealant" compliant with the Federal specification for polysulfide sealants for the caulking to be applied in many locations throughout the building, including masonry surfaces and windows (WSTPRTSCHL010419, 010601-606, 010609-621, 010641-646, 12/11/1968).

National Waterproofing Co., one of the subcontractors for the construction project, selected "PRC Rubber Caulk® 5000 Sealant" as the caulking material, which was approved for use in the school in May, 1969. It was a "one-part, nonsagging, polysulfide, sealing compound" patented by Products Research & Chemical Corporation (PRC) that met the requirements of the federal specification for polysulfide sealants (WSTPRTSCHL005477, 5/9/1969). The patent for this sealant stated that "chlorinated diphenyl compositions" were common plasticizers used in polysulfide sealant and Aroclors 1242 and 1254 were listed for different polysulfide sealant compositions (U.S. Patent No. 3225017, 12/21/1965).

IX. Monsanto produced and sold PCB-containing Aroclors as plasticizers for polysulfide sealants and other building materials, which were approved for use in the construction of Westport Middle School in 1969, knowing that volatilization of PCBs would result in PCB contamination in indoor air, and did not inform its customers or the public of the dangers associated with products containing PCBs as plasticizers.

A. Monsanto knew that PCBs caused systemic toxic effects in animals and humans at concentrations representative of workplace conditions shortly after PCBs were commercially produced and sold.

1. In the 1930s, a number of workers exposed to PCBs in industrial settings suffered from disfiguring dermatitis, symptoms of systemic poisoning, and liver jaundice that resulted in three fatalities (DSW 002969, 5/25/1934; MON-MT-003090, 1936; DSW 001279, 6/1/1935; Schwartz, 1936a; Schwartz, 1936b; Fulton et al, 1936; Drinker et al, 1937[8]; Bennett et al, 1938).

2. Researchers at the Harvard School of Public Health conducted experiments with rats as surrogates for humans to observe the effects at various concentrations of chlorinated compounds (including PCBs) that mirrored worker exposures. The tests involved the heating of waxes and liquids to vaporize the chlorinated compounds, and then exposing the rats to air at ambient temperatures containing the vapors at various concentrations (Drinker et al, 1937; Bennett et al, 1938; Drinker, 1939).

3. Liver damage occurred in rats exposed to PCBs in air (Drinker, 1939). Dr. Drinker assigned a permissible limit of 0.5 mg/cu. meter (approximately 50 parts per billion) in the workroom air for most of the chlorinated compounds with which he experimented including Aroclor 1254, and recommended that adequate ventilation be provided to prevent exceedance of that limit (Drinker, 1939).

4. The maximum allowable concentration (MAC) for Aroclors (in general) in air was set by the American Conference of Governmental Industrial Hygienists (ACGIH) at 1.0 mg/cu. meter. This value appeared in publications concerning exposure of workers to PCBs in industrial settings (Brown, 1947; MONS 046928, 1949; Sax, 1951).

5. Von Wedel et al (1943) reported on the systemic toxic effects of PCBs in the workplace at ambient temperatures. Their results indicated that liver damage occurred in animals regardless of whether PCB exposure was by inhalation, ingestion or skin adsorption. Furthermore, the authors noted that "none of the animals showed recognizable systemic

[8] Dr. R. Emmett Kelly of Monsanto Chemical Corporation was present at the symposium. His comments during the discussion period appeared after the published article in The Journal of Industrial Hygiene and Toxicology. He stated that, "it has been our observation that although on one occasion we did have a more or less extensive series of skin eruption…we have never had any systemic reactions at all in our men." (Drinker et al, 1937). This statement did not account for Monsanto's 1935 precautionary measures for operators that included: removing all affected men from the operation and new men substituted as rapidly as they could be trained and those with dermatitis tendencies were not permitted to be employed in the Aroclor Department (DSW 001279, 1935).

effects until a few days before death." This article indicates that exposure to PCBs can cause serious harm to the liver even if there are no observable signs of illness (VonWedel et al, 1943).

6. A 1950 incident at the Monsanto Anniston PCB production facility involving Aroclor 1270 or 1272 was detailed[9]. Workers exposed to dust and fumes developed sores on their faces, necks, arms, and bodies. Medication did not have much effect. The workers were transferred to other plants but their condition did not improve much. "After possibly three or four years, several of these people sued the company and they were [paid] several thousand dollars each. The handwritten memo concluded that Dr. Kelly "might possibly have some record of this case in his file." (MONS 099489, 1/20/1971)

7. In 1954 Yale University professors authored a paper on chloracne in seven chemical plant workers exposed to PCBs at levels of 0.1 mg/cu. meter, an order of magnitude below (or 1/10) the ACGIH recommended maximum allowable concentration of 1.0 mg/cu. meter. An unusual feature of this chloracne outbreak was the long period of low level exposure (up to 19 months) before any cases were recognized, leading the authors to conclude that "negligible amounts of chlorinated hydrocarbons indicates that this type of intermittent but fairly long continued 'mild' exposure is not innocuous." (Meigs et al, 1954).

    a. Monsanto was displeased with the findings and attempted to blame a chemical other than PCBs as the causative agent even though Meigs' response linked the PCBs to the workers' chloracne outbreak, and not the chemical being made at the facility. Monsanto attempted to minimize any negative publicity with a suggested follow up bulletin stating that Dr. Meigs' "article presents a distorted picture of the possible hazards when aroclor is used as a heat transfer agent" because "the product which was being manufactured, is a skin irritant by itself; it causes a dermatitis when it comes in contact with the skin. . ." (MONS 037711, 4/28/1954). This statement was not supported by Meigs' findings or his communications with Monsanto.

    b. Monsanto Chemicals Limited (MCL), Monsanto's British subsidiary, upon only seeing an extract of this paper was also concerned about the Meigs' findings of worker exposure to 1/10th the permissible limit resulting in toxic effects. Worried that the future of Aroclor in the heat transfer market was "bleak," MCL was prepared to question the information in the paper upon seeing a full copy (MONS 095182, 6/17/1954).

    c. The Kettering Laboratory was retained by Monsanto to investigate toxic effects in animals from exposures to Aroclors 1242 and 1254 in part to "demonstrate the relationship between the extent of their chlorination and their toxicity." The studies showed that Aroclor 1254 was more toxic than Aroclor 1242 because Aroclor 1254 vapors of 1.5 mg/cu. meter caused positive signs of injury to test animals as compared

[9] Aroclors 1270 and 1272 were the highest chlorinated PCB products that Monsanto made, consisting primarily of decachlorobiphenyl (10 chlorines on the biphenyl). These Aroclors were in the solid phase at room temperatures.

to similar effects for Aroclor 1242 at 1.9 mg/cu. meter (MONS 088809, 6/22/1955; TOXSTUDIES0314, 6/28/1955, MONS 096370, 6/1956). Treon et al (1956) recommended tentatively the ACGIH threshold concentration of 1.0 mg/cu. meter of air for safe industrial practice[10]. However, no studies were conducted to determine the concentrations of Aroclors 1242 and 1254 that showed no signs of injury to test animals.

B. <u>Prior to the use of PCB-containing polysulfide sealants and other building materials in Westport Middle School, Monsanto knew that PCB-containing Aroclors slowly volatilized from polymers, such as polysulfide sealants, and persist in an indoor environment. Monsanto should have determined safe levels for consumers under chronic, long-term, low-dose conditions prior to selling PCB-containing Aroclors for such applications.</u>

1. Monsanto was the expert in plasticizer technology and provided technical expertise to its customers.

    a. Monsanto asserted that it “pioneered the technology of plasticization” in the 1930’s (MONS 080627, 1961). In 1947, Mr. J. Kenneth Craver, Monsanto’s Plasticizer and Resin Coordinator presented on “The Mechanism of Plasticization in Plastics” at the Symposium on Plastics at a meeting of the ASTM Committee D-20 on Plastics. The presentation was reproduced in the ASTM Bulletin (Craver, 1948).

    b. The explanation of plasticizer technology in Monsanto’s 1961 Plasticizer catalog was consistent with the information discussed by Craver (1948) (MONS 080627, 1961).

    c. According to its Plasticizer catalog, Monsanto “provide[d] much more than simply the products: specifically adroit, expert guidance in their use.” “Many large resin processors look upon Monsanto's PLASTICIZER COUNCIL as an extension of their own technical facilities,” and “regularly consult with Monsanto's technical service whenever they have a new product in view or an improvement [was] sought in an existing product.” (MONS 080627, 1961).

2. Monsanto understood that plasticizers including PCBs would volatilize from polymer compounds.

    a. Monsanto knew that during the lifetime of a plasticized polymer, the plasticizer was lost through contact with air, liquids or adjacent solids. The rate of plasticizer loss through volatilization was a function of the molecular weight and vapor pressure of the plasticizer. The volatilization losses were determined not only by the plasticizer alone, but by the plasticizer resin combination and the thickness of the finished product (Reed, 1943; Craver, 1948; Boyer, 1949; Doolittle, 1954; MONS 080627, 1961; American Chemical Society, 1965; Mellan, 1961).

[10] Based on the findings of The Kettering Laboratory, Monsanto considered petitioning the ACGIH to increase the permissible limits to 1 mg/cu. meter for Aroclor 1254 and 2 mg/cu. meter for Aroclor 1242. There is no indication this change occurred since years later Monsanto continued to refer to 0.5 for Aroclor 1254 in its technical bulletins.

b. Monsanto and other industry experts understood that plasticizer loss is a function of both the diffusion rate through the polymer to the surface and the volatilization rate from the surface into the environment (air, water or adjacent solids). The following studies demonstrated that Monsanto should have understood that plasticizers volatilize from polymers, regardless of whether the polymer is a thin coating like paint or a thicker material like a joint sealant.

- When loss of plasticizers from resin sheets were studied, the percent loss over time decreased with sheet thickness, and increased with increasing temperature. Small (1947) also found that the relationship between amount of plasticizer lost and time was linear until around 20% to 30% of the plasticizer was lost.

- The rate of plasticizer loss in resin sheets of varying thickness at constant temperature after the first day remained constant up to the time when half of the plasticizer had escaped (Mellan, 1961).

- One of the tests Monsanto performed to evaluate the performance of Aroclor plasticizers in various plastic compounds was a "Volatility" test which measured the percent of plasticizer lost from the compound after heating to 86°C for 24 hours (DSW 352447, 12/1960). Monsanto used this test to compare the performance of its plasticizers, including Aroclor 1254, to a competitive product in polysulfide sealants (TOWOLDMON0053111, 8/12/1971).

c. Federal specifications for sealant compounds included a test for weight loss after heat aging at 180°F for 14 days (Fed. Spec. TT-S-230a, 5/5/1967). Thiokol's certification specification also included a 180°F weight loss test to verify "aging stability" and "lack of excessive volatiles". In an effort to establish reasonable limits for the Thiokol Building Trades Performance Specification (issued 6/1/1965), Thiokol studied weight loss of over 80 sealants exposed to natural conditions and compared the results to heat aging tests (Boller, 1976; Peterson et al, 1976).

3. Monsanto knew volatilization of PCBs into indoor air had the potential to create unsafe conditions.

a. The Southern Research Institute (SRI) was retained by Monsanto to determine the vapor pressures of Aroclor over the temperature range of 25 to 100°C (MONS 095188, 12/6/1955). SRI experimentally determined the vapor pressures of Aroclors 1242, 1248, and 1254 at four different temperatures (37.5, 54, 71, and 98°C) to obtain a relationship between temperature and vapor pressure in the desired temperature range (TOWOLDMON0048965, 2/4/1954).

b. Monsanto knew PCBs volatilized into air at room temperature. In fact, using the information provided by SRI, MCL (Monsanto's British subsidiary) stated, "With reference to the impression generally given that cold Aroclors are safe. . .air saturated with cold Aroclor is at or above the maximum permissible concentration." (MONS 095188, 12/6/1955).

- For example, the calculated saturated air concentration for Aroclor 1254 at 77°F was 1.5 mg/m^3. This value was fifty percent higher than the ACGIH's MAC of 1.0 mg/m^3 and equal to the PCB concentration reported by the Kettering Laboratory that showed liver damage in animals. Thus, Monsanto knew unsafe saturation levels of PCBs were conceivable for workers in enclosed spaces at room temperatures[11].

c. MCL's position was that future applications of Aroclors "must be governed" by the finding that prolonged exposure to Aroclor vapor at 1.5 mg/cu. meter "can produce damage to the liver and kidneys of test animals." (MONS 095215, 8/19/1955).

d. MCL stated that "[i]n translating this finding to the human being it is the recognized practice to employ a safety factor of 10 [12] . . ." For Aroclor 1254, MCL indicated the maximum safe level for the public would be below 0.15 mg/cu. meter, and this value would be applicable to all Aroclors since they are similar in chemical composition (MONS 095215, 8/19/1955).

4. Monsanto recognized when PCBs volatilized from surfaces painted with Aroclor plasticizer containing paint the PCBs persisted in indoor air at unsafe concentrations.

a. Monsanto conducted two studies to evaluate plasticizer loss and resulting air concentrations when surfaces were painted with Lustrex Latex paint containing Aroclor 1248, which was similar in composition to Aroclor 1254. In the first study, five of the air samples collected from the painted rooms with temperatures between 70 and 100 degrees F had Aroclor 1248 concentrations between 1 mg/cu. meter and 5 mg/cu. meter (MONS 061753, 12/31/1952).

b. In the second study, "[t]he [Aroclor 1248] concentration remained in the 1.0 – 2.0 mg. per cu. meter range over a period of about one month [the length of the study]." (MONS 095193, 2/12/1954; MONS 095186, 3/15/1954; DSW 147758, 3/15/54). This study led Monsanto to conclude that the PCB vapor concentration "was sufficiently high . . . to make the room unusable for about 3 days." (DSW 147758, 3/15/54).

[11] In the mid-1950s, the Navy conducted experiments on animals exposed to air *__saturated__* with Pydraul 150 (25% Aroclor 1242) and found that liver damage was caused by skin adsorption without any sign of injury prior to autopsy. The Navy reported to Monsanto its position that "Pydraul 150 [was] just too toxic for use in a submarine." (DSW 148006, 6/7/1956; MONS 095639, 12/19/1956; MONS 095640, 1/21/1957; MONS 095645, 9/11/1957).

[12] In January 1954, an article in the quarterly bulletin of the Association of Food and Drug Officials of the United States was titled, 100-Fold Margin of Safety. The article stated that animals generally are "more resistant to toxic chemicals than man", and that "man is about 10 times as sensitive to poisons as the rat". Since humans cannot be used as experimental subjects, the toxicity of a substance must be based on studies in laboratory animals. The article also pointed out that a "safe dose" for chronic toxicity is "that dose just short of causing an observable effect." (Lehman et al, 1954). This safety factor is supported in the literature (Dourson et al, 1983). The maximum permissible limits set in the 1930s and 1940s did not take into account the 1/10 factor.

c. When reporting the results of the paint tests to MCL, Monsanto (U.S.) stated "As I'm sure you know, Aroclors cannot be considered non-toxic." It informed MCL that "[w]e do not recommend that they be used in paints which might be applied in confined or unventilated areas, particularly if the paints might be used on heated surfaces." (MONS 095187, 9/1/1953).

d. MCL had also collected air samples after painting a room with latex paint containing Aroclor 1248 and reported concentrations were around 0.5 mg/cu. meter for a month. MCL pointed out that if this paint was used, a person would be exposed to a concentration far exceeding the 0.15 mg/cu. meters (based on the 1/10 safety factor). Therefore MCL recommended following Monsanto (U.S) in "withdrawing our recommendation that Aroclors be used as a plasticizer in Lustrex Latex paints." The MCL memo noted that the use of Aroclors in ordinary paint still required examination knowing that "a hazardous concentration could be attained in a room in which a large area is painted with Aroclor-containing paint." (MONS 095215 @095218, 11/26/1954; MONS 095215, 8/19/1955).

e. Monsanto recognized that the rate of volatilization of PCBs from the paint was governed by the rate of migration within the dry paint (MONS 095215, 8/19/1955).

f. Monsanto understood that PCB-containing Aroclors were used as plasticizers in products sold for household uses, and chose not to conduct any studies representative of all the possible exposures from such uses.

- Monsanto's position was "[w]e know Aroclors are toxic but the actual limit has not been precisely defined. . . .our main worry is what will happen if an individual develops any type of liver disease and gives a history of Aroclor exposure." (MONS 095196, 9/20/1955).

- If "it is distributed to householders where it can be used in almost any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict." Monsanto decided no more toxicity testing was "justified" (MONS 095196, 9/20/1955). This document demonstrates Monsanto did not know what PCB exposure level was safe for the public and was unwilling to find out.

- A 1967 memo indicates Monsanto still had not conducted tests on "the action of nanograms of Aroclor in the human body over a lifetime (MONS 096495, 2/21/1967).

- According to the US EPA (2015b), the "Exposure Levels for Evaluating PCBs in Indoor School Air range from a low of 100 [nanograms per cubic meter] for toddlers age 1 to <2 years and children 2 to <3 years, to a high of 600 [nanograms per cubic meter] for high school students, age 15 to <19 years."

5. Monsanto knew or should have known that volatilization of PCBs from final products, such as polysulfide sealants, would result in secondary contamination that would contribute to the persistence of PCBs in the indoor environment, resulting in long term exposures.

   a. Monsanto understood that PCBs had an affinity to dust. In its Technical Bulletin, Aroclor Plasticizers, under the sub-heading Dust Prevention and Dust Catching, "Aroclor 1254 is a low-cost dedusting agent that holds down the dusting of a variety of chemical materials." Since Aroclor compounds are not-drying and tacky, they make excellent coatings to capture dust, lint, and other airborne particles." (DSW 35447 @352487, 12/1960).

   b. With specialized understanding of the chemical and physical properties of PCBs, Monsanto knew or should have known that PCBs as hydrophobic, non-polar molecules will also attach to dust particles when volatized into air in enclosed spaces. Also, Monsanto knew or should have known that PCBs do not breakdown. Therefore, the PCB-contaminated dust would circulate in the air, a fraction of which would land on surfaces: walls, floors, furniture, and humans. A fraction of the PCBs attached to the dust particles or on surfaces would volatilize back into the air, and reattach to dust particles or resettle onto surfaces. This cycling of PCBs represents a long-term reservoir indoors and increases potential exposure to PCBs in indoor environments (Whitehead et al, 2014; Dodson, 2015; US EPA, 2015b).

6. Monsanto knew that Aroclor 1254 plasticizer volatilized from polysulfide sealants and caused problems in certain polysulfide sealant applications because its volatility was too high.

   a. Presstite Division, "a very large manufacturer of polysulfide sealants for the construction industry. . .were having problems with the Aroclor 1254 volatility." Presstite was "anxious" to use a plasticizer with a lower volatility than Aroclor 1254 in its sealant when it entered the dual pane windows market[13] (TOWOLDMON0053421, 10/27/1967).

   b. Essex discussed its concerns on volatility and migration issues of Aroclor 1254 in polysulfide sealants with Monsanto (TOWOLDMON0053307; 11/10/1967; TOWOLDMON0053306, 12/7/1967).

   c. TREMCO informed Monsanto it had a "fogging problem with Aroclor 1254" and was seeking an alternative for the Twindow market, which had rigid fogging requirements. It also needed a plasticizer that was similar in cost to Aroclor 1254 with better fogging characteristics for other sealant applications (TOWOLDMON0054094, 11/1/1968).

[13] Dual pane windows, also known as thermal windows or insulated glass windows are two window panes separated by a space filled with gas to reduce heat transfer between indoors and outdoors. The window panes require a sealant. In this context, when Aroclor 1254 (the plasticizer) volatilized from the sealant and was trapped in the space between the windows, it condensed and formed a fog. PPG developed Twindow® double-paned insulating glass in 1945, and Andersen began selling its Welded Insulating Glass in 1952.

d. Thiokol, the major producer of the polysulfide polymer, was not recommending Aroclor 1254 for insulated window glass because it was too volatile (TOWOLDMON0052394, 3/12/1969).

e. PRC also contacted Monsanto concerning the need for substitutes for Aroclor 1254 for use in sealants for the thermal windows "because of the high volatility" (TOWOLDMON0053030, 1/5/1970; TOWOLDMON0053039, 2/6/1970).

C. <u>Monsanto marketed and sold PCB-containing Aroclors as plasticizers without providing sufficient information on the dangers to the public, end users and the environment from exposure to PCBs from open use applications at ambient conditions.</u>

1. In 1930, shortly after PCB production began an article by Swann Chemicals, which was acquired by Monsanto several years later, highlighted the physical and chemical characteristics of PCBs and describing a diversity of potential uses for PCBs such as protective coatings like varnishes and lacquers, printing inks, artificial leather, and rubber cement which would expose consumers or the environment to PCBs through plasticizer loss. The only toxicity information provided was worker exposure to "concentrated vapors were irritating to the nasal passages and caused violent headaches to certain persons . . . but no toxic effects were noted." (Penning, 1930).

2. A 1931 article by Swann employees discussed the compatibility of Aroclors and nitrocellulose lacquers. Experiments evaluating the permanence of Aroclors in the lacquers showed that all three Aroclors tested (1242, 1254, 1262) experienced some degree of migration. Aroclor 1242 had a "greater volatility" and Aroclors 1254 and 1262 were as permanent as, or more so, than dibutyl phthalate (Jenkins et al, 1931).

3. Monsanto's product information starting in 1940 recommended the same applications for PCBs as plasticizers as discussed in Penning (1930) as well as chlorinated rubber coatings for wood, metal, brick, stone, concrete and fabric surfaces (TOWOLDMON0039017, 5/1940; MONS 092643, 10/1/1944; MON-MT-001598, 6/18/1945; DSW 150418, 1/1/1948; MONS 078331, 4/4/1949). These applications allowed PCBs to migrate into the environment, whether that environment was indoor or outdoor air, water or another solid. The toxicity warnings were solely focused on workers with no mention of dangers to the ultimate consumers, the public, and the environment.

   a. The 1940 "Plasticizers and Resins" bulletin stated that "The Aroclors…should not be used in connection with the food industry and continuous exposure in the liquid or vapor phase should be avoided." This statement was in contradiction to Monsanto's selling of PCBs as a chewing gum plasticizer - once a "prized application," in which the PCBs were in direct contact with the human body (MONS 094551, 2/29/1952).

   b. The "Toxicity" section in the 1945 bulletin stated "[e]xperimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures. . .will lead to systemic toxic effects" and that "suitable draft ventilation to control the vapors evolved at elevated temperatures…should prevent any untoward effect."[14] The first sentence of the section following toxicity stated, "Aroclors have low vaporization losses," with the graphs showing vapor pressure as a function of temperatures all above 125°C (257°F) (MON-MT-001598, 6/18/1945). The information presented in these sections was misleading because it insinuated that harm only occurs at elevated temperatures when in fact the experimental work on animals was conducted at ambient temperatures (Drinker only heated the PCBs to accelerate the buildup of vapors to the concentrations needed for the tests).

c. Monsanto's Technical Bulletin titled "Aroclor resins and plasticizers for Chlorinated Rubber" issued in 1948, specifically recommended uses that had the potential for PCBs to come in contact with humans, wildlife, and the environment, such as concrete swimming pools, traffic paints, coatings for cloth, and marine finishes. The toxicity information only addressed worker exposure to Aroclors over an 8-hour day (DSW 150418, 1/1/1948).

d. Another example of Monsanto's promotion of PCBs in products with end-user exposure was illustrated in the Technical Bulletin titled "Aroclor 1254 Lubricant and Plasticizer in the Manufacture of Paper Draperies" issued in 1949. It promoted PCBs and "the popularity of paper draperies in this country. . . ." A section was devoted to worker health with respect to dermatology and toxicology, but contained no warnings about household exposures to PCBs volatilizing from the draperies into the indoor air (MONS 078331, 4/4/1949).

4. Monsanto promoted PCB-containing Aroclors as being "virtually non-volatile" as well as inexpensive for waxes, sealants and mastics. Applications included floor waxes, furniture and shoe polishes, dental casting waxes which had the potential for direct human exposures to the PCB vapors (LEXOLDMON006711, 1964).

5. Monsanto's product information throughout the early 1960s continued to recommend applications for PCB-containing Aroclors as plasticizers that had the potential for PCBs to migrate out of the final product without mention of risks by PCB exposure to the public, end users and the environment. Also, the toxicity statements directed concern away from applications at ambient temperatures by incorrectly stating "[a]t ordinary temperatures the Aroclor chlorinated polyphenyls have not presented industrial toxicological problems." The warnings focused only on worker protections at elevated temperatures (DSW 352447, 12/1960; TOWOLDMON0005563, 1960; MONS 080627, 1961; LEXOLDMON003993, 4/1962; TOWOLDMON0024978, 10/31/1966). During this time period, Monsanto was aware of the

[14] The statements in the toxicity section were copied directly from a 1937 memo written by Monsanto employee L.A. Watt. The memo stated that he and Dr. Kelly agreed that the statements were written for Monsanto's Aroclor booklet and as well as for correspondence with customers (MONS 219708, 10/11/1937).

earlier tests on PCB-containing coatings which painted a very different picture of potential dangers to the public as discussed previously in Section X.B.4.

a. For example, the 1960 technical bulletin written specifically for the plasticizer market "Aroclor Plasticizers PL-306[15]", in which all applications were open uses, had a separate section on "Thiokol's polysulfide liquid rubber," which described the benefit of using Aroclors as a plasticizer for this resin for many uses including "joint-sealant compounds used in construction. . . ." The "Dermatology and Toxicology" section regarding inhalation tests on animals and skin patch tests was similar to the bulletins from the 1940s. When PCBs were used at elevated temperatures, it recommended effective local-exhaust ventilation together with general workroom exhaust (DSW 352447, 12/1960).

b. The "Safe Handling" section informed about avoiding breathing vapors at room temperatures in confined spaces, the statement was written for "liquid Aroclor compounds" not products containing Aroclor compounds. The context was limited to factory / manufacturing operations but not the ultimate applications that exposed the public to PCBs (DSW 352447, 12/1960).

c. The same plasticizer bulletin had a chart of vaporization rates for various Aroclors and other competing plasticizers, with a summary statement that read "the vaporization rates of Aroclor plasticizers – especially the most widely used 1254 and 1260 – compared most favorably with the similar constants of other plasticizers selected specifically for these tests because of their low vaporization rates." (DSW 352447, 12/1960). This information was misleading in that it appeared to place all the plasticizer compounds in the same category without regard to toxicity.

d. Monsanto's 1960 catalog, "The Aroclor Compounds" had a section devoted to "Aroclors in Plastics", which suggested similar uses as in the previous bulletins. The Dermatology and Toxicity section focused only on worker conditions: "local exhaust ventilation together with general workroom exhaust is recommended." (TOWOLDMON0005563, 1960). PCB vaporization rates and vapor pressures were included in the bulletin, but not in context of what the public would be exposed to, even though Monsanto had that information based on the paint tests it had conducted a few years earlier. Once again, Monsanto limited the dangers of its PCBs to factory / manufacturing operations.

e. In 1961, Monsanto's Plasticizer Sales Department published a salesmen's manual titled "Plasticizer Patter" with information "useful to you in suggesting new uses or applications for the Aroclors and increasing your sales of these products." Many of the uses listed for PCB-containing products had the potential of PCB exposure to the public. A partial list of products included (LEXOLDMON005375, 2/1961):

[15] Technical Bulletin PL-306 was revised in 1966 and contained the same statements in the toxicity and safe handling section as the 1960 bulletin (TOWOLDMON0024978, 10/31/1966).

- Concrete and stucco paints, paper coatings, Christmas trees, icicles for Christmas trees, varnishes, floor wax, paperback novels, Reader's Digests, bookbinding adhesives, rug backings, flooring adhesives, sealing compounds for aluminum windows, curtain wall construction, building sealants, leather and shoe adhesives, epoxies, wall tile adhesives, paper base, wax paper coatings, hair brushes, carbonless carbon paper, insecticide carriers, printing inks, ceramic slurry, and water soluble soil-poison concentrate.

- For "Rubber (Thiokol)" the salesmen's manual stated, "Here is another sleeper. The quantity that we are moving in this field once again caught us by surprise. . . . The primary end use is in sealing compounds for aluminum windows, industrial applications, curtain wall construction, etc."

f. Monsanto specifically marketed to polysulfide sealant manufacturers using Thiokol's polysulfide liquid polymer. Technical Bulletin No. PL-331 "Monsanto Modifiers for Thiokol polysulfide liquid polymers" described a variety of Monsanto's plasticizers compatible with polysulfide rubber, including PCB-containing Aroclors (LEXOLDMON003993, 4/1962). The Aroclors were featured as the plasticizer for polysulfide joint sealants used in curtain-wall construction, a "rapidly growing" area that required "large quantities of permanently flexible, strongly adhering sealants." (LEXOLDMON003993, 4/1962).

- Monsanto understood PCB-containing polysulfide sealants would be used in the construction of buildings, including schools, which would allow for volatilization of PCBs in indoor environments.

- In the table of physical properties, unlike the other plasticizers, no vapor pressures were listed for the Aroclors (1221, 1242, 1254, 5460), even though Monsanto possessed this information since at least the early 1950s. Monsanto referred to its other technical bulletins for complete details on its modifiers with no mention of toxicity and hazard information (LEXOLDMON003993, 4/1962).

6. Monsanto incorrectly and repeatedly under-reported the vapor pressure of Aroclor 1254 in its technical bulletins, which had the effect of minimizing the dangers of PCB volatilization.

   a. As discussed previously, SRI's research in 1955 resulted in the determination of vapor pressures for several of the PCB-containing Aroclors, including Aroclor 1254, and Monsanto understood that at ambient temperatures, the saturation concentration could reach or exceed the permissible limit.

   b. In some of the technical bulletins, Monsanto provided tables and charts of vapor pressures of some Aroclor products. In the table of "Approximate Vapor Pressures," the vapor pressure of Aroclor 1254 was reported as 0.00006 mmHg ($6x10^{-5}$mmHg) at 100°F (37.8°C) (TOWOLDMON0005563, 1960; DSW 352447, 12/1960; TOWOLDMON0024978, 10/31/1966). This vapor pressure was an ***order of magnitude less*** than that determined by SRI for Monsanto. Using the lower, incorrect vapor pressure, the saturation concentration of Aroclor 1254 vapor in air at 100°F matched precisely the ACGIH's maximum allowable concentration of 1.0 mg/ cu. meter. The exact match may not have been fortuitous.

c. When the correct vapor pressure based on the SRI data and equation is used, the resulting saturation concentration in air is actually 4.8 mg/m^3, ***almost 5 times higher***. Furthermore, the saturation concentration at 100°F is ***nearly 10 times higher*** than the permissible limit of 0.5 mg/m^{3}as set by Drinker (1939). A comparison of the vapor pressures presented in Monsanto's product information with the vapor pressure calculated using SRI's equation is presented in Appendix C.

d. Monsanto knew the permissible limits and included them in the technical bulletins. In the toxicity section it stated "[t]he threshold limit values (maximum allowable concentration for an 8-hour working day) set by the American Conference of Government Hygienists are 1.0 milligram per cubic meter of air for the lower-chlorinated Aroclor compounds and ***0.5 milligram per cubic meter*** of air for the more-highly-chlorinated compounds, such as **Aroclor 1254**."(DSW 352447, 12/1960; TOWOLDMON0024978, 10/31/1966).

e. The incorrect and much lower vapor pressure at 100°F reinforced Monsanto's position that at "ordinary temperatures" PCBs did not present a toxicological problem to workers and likely would not have raised concern from its direct customers.

f. By misreporting the vapor pressure for Aroclor 1254 at 100°F, Monsanto mislead plasticizer customers from understanding the full potential of Aroclor 1254 to volatilize out of end products at ambient temperatures in indoor environments. Furthermore, by not taking into account the factor of 10, Monsanto mislead plasticizer customers from understanding the toxicity limits of Aroclor 1254 for humans.

7. Monsanto downplayed and denied concerns about exposure to Aroclors at ambient temperatures and in final applications.

   a. When Monsanto responded to customer requests on Aroclor toxicity in the workplace and for end users, it focused on the potential for injury by the inhalation of fumes at elevated temperatures (M33081, 12/30/1947; MONS 097894, 2/8/1960; MONS 090360, 5/6/64; TOWOLDMON0054172, 2/7/1967).

      - For example, Monsanto's Manager of Environmental Health, Elmer Wheeler, told Raytheon, "there is little vapor inhalation hazard when [Aroclors 1242 and 1254] are handled in a closed system or when handled at room temperature." (MONS 090360, 5/6/64).

- To W.R. Grace, Monsanto wrote "with the exception of instances where prolonged breathing of the fumes evolved at high temperatures occurred, we have had almost no complaints referable to systemic damage. . . . Local exhaust ventilation should be provided if Aroclor fumes are evolved during the process." (TOWOLDMON0054172, 2/7/1967).

b. Monsanto's Jack Garrett and Elmer Wheeler assisted the Industrial Hygiene and Clinical Toxicology Committee of I.M.A. with preparing the section on "chlorodiphenyls" (PCBs) for the "Hygienic Guide Series," dated Jan/Feb 1965. In the "Hazards and Their Recommended Control" section it stated, "[w]here chlorinated diphenyls are used at room temperatures, the hazard of inhalation is considered slight or absent." (MONS 076148, 1965). This statement had no scientific basis. Monsanto knew that exposure to PCBs at ambient temperatures could cause harm based on the published works of Von Wedel et al (1943) and Meigs et al (1954).

D. <u>Monsanto knew that PCBs were persistent, bioaccumulative, toxic environmental contaminants to humans and wildlife.</u>

1. In 1968, approximately 1800 people in Yusho, Japan had consumed rice oil contaminated with Kanechlor (a Japanese brand of PCBs) over a period of several months with hundreds requiring medical treatment for chloracne and systemic toxic effects. The rice oil had become contaminated when the PCB fluid leaked out of equipment used for the heating the rice[16]. (MONS 090070, 1/23/1969; MONS 097691, 2/18/1969; Kuratsune et al, 1971).

   a. When Monsanto became aware of the "Yusho Incident," internal memos focused on the potential impact to the world-wide market for PCBs, and its need to protect it (MONS 090070, 1/23/69; MONS 097691, 2/18/69).

2. Exposure to chlorinated compounds from direct contact with the environment was known to harm wildlife.

   a. In 1962 Rachel Carson published *Silent Spring*, a book that described how pesticides comprised of chlorinated hydrocarbons (e.g. DDT) entered the food chain and accumulated, potentially endangering wildlife and even humans. The scientific research cited in the book had showed that in experimental animals these chemicals were toxic and bioaccumulated in the food chain. Carson related this research with the earlier work of Drinker et al (1937) to demonstrate the similarities of the chlorinated compounds and their harm to humans and wildlife.

   b. Carson's book put Monsanto on notice that its PCB-containing Aroclor products had the potential to cause similar impacts as those chlorinated compounds specifically identified as pesticides. It was marketing PCBs as a pesticide extender during this time.

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[16] The illnesses were later primarily attributed to polychlorinated dibenzofurans (PCDFs) which were formed when the PCBs were heated to high temperatures in the heat transfer equipment (Masuda, 1985; Schecter, 1994).

c. Monsanto was also a producer of the insecticide DDT when *Silent* Spring was published. It responded to *Silent Spring* by publishing a parody "The Desolate Year," which predicted a future of devastation in a world where famine, disease, and insects ran wild because pesticides had been banned rather than a thoughtful consideration of its scientific findings with respect to PCBs (Monsanto, 1962).

3. Monsanto learned that PCBs were detected in the environment in Europe and the United States.

a. On November 22, 1966, Dr. Soren Jensen, a Swedish researcher at the Institution of Analytical Chemistry, Stockholm University reported that PCBs were found in fish throughout Sweden, in a dead Bald Eagle, and even in his wife's, and baby daughter's hair. "She got her dose of PCB with her mother's milk." PCBs were as poisonous as DDT, but much harder to break down and biodegrade in the ecosystem. He concluded, "[PCBs] can therefore be presumed to be widespread through the world. " (New Scientist, 1966).

b. Monsanto's European office in Brussels informed Monsanto Headquarters of Dr. Jensen's research. PCBs were found in paints and as pigments in various plastics as part of finished products and "[a]ccording to Mr. Jensen, products containing PCB should have this openly declared," and indicated that Jensen would increase his cooperation with scientists to find the sources of the PCB contamination (MONS 090520, 11/28/66).

c. A science publication, LKB, issued a press release in January 1967 titled, "Swedish firm produces instrument that detects a previously unobserved poison in fish, fowl and mammal." The article provided depth to the methods Jensen used to detect the PCBs as separate from DDT. It was noted, "The effect of this poison on man is not yet fully known." (MONS 062162, 1/10/1967).

d. Shell Chemicals informed Monsanto that its laboratory also identified PCBs (Aroclors) and confirmed the "soundness" of Jensen's work (Plaintiff's Ex. 2A09, 1/12/67).

e. Following up on Jensen's work on PCB environmental contamination, Dr. Robert Risebrough (a biology professor at the University of California, Berkley) detected PCBs and chlorinated pesticides (e.g. DDT) in a number of species of fish and birds along the coasts of the Western United States and Central America. He reported on his findings at a science conference, and also in a subsequent publication titled "Polychlorinated Biphenyls in the Global Ecosystem." His research connected PCBs with the thinning of egg shells and to possible extinction of several species of birds (MONS 097123, 10/21/1968; DSW 280820, 12/14/68).

f. More of Professor Risebrough's work was published with the title of "Chlorinated Hydrocarbons in Marine Ecosystems." He wrote, "The polychlorinated biphenyls (PCB) occurring in fish and other marine organisms are assumed to be industrial pollutants.

They are used extensively in industry as plasticizers and in the manufacture of paints, resins, electrical insulators and other products, and are available in railway car amounts. Since they are very stable, resist degradation, have significant vapor pressures, and are poorly soluble in water and highly soluble in lipid, it is inevitable that they should be concentrated in biological systems." He concluded, "These which are non-polar, water-insoluble and which have finite vapor pressures will eventually appear in marine food chains. The DDT compounds and the polychlorinated biphenyls have already done so to an alarming degree." (MONS 083014, 10/9/1968).

4. Monsanto's reacted to the findings of PCBs as an environmental contaminant by denying the validity of the research results, and directed its efforts to protect and expand its Aroclor production and sales.

   a. Monsanto's response to "adverse publicity in Europe," was to characterize it as propaganda. Monsanto's objective was to "make sure our Aroclor business is not affected by this evil publicity." (MONS 097089, 2/13/1967). Monsanto questioned whether the concentrations found in the environment were toxic, and decided to "fight the battle of the analytical method first before we get too involved with toxicology." (Mons 097694, 2/27/1967).

   b. Despite the scientific research implicating PCBs as a global contaminant, Monsanto's Board of Directors unanimously voted in a favor of an appropriation request of $2.9 million to expand its Aroclor production facilities at its two production plants to improve quality and capacity (DSW 013006, 11/22/1967).

   c. At a 1968 Monsanto Corporate Development Committee meeting that centered on Aroclors, the key issue was "how to significantly increase the sales growth while maintaining the domestic supply position and profitability." (TOWOLDMON0001287, 4/22/1968).

   d. In response to Risebrough's findings, Dr. Scott Tucker, an analytical chemist hired by Monsanto, was directed to assist in "fighting the analytical battle. [He] is going to scrutinize the analytical aspects and particularly the validity of some of the assumptions made by the author," rather than collaborate with Risebrough to further the research efforts (MONS 097123, 10/21/1968).

   e. Monsanto expressed concern about future sales if Risebrough's assertions that PCBs were "a toxic substance endangering man himself" and were "causing the extinction of the peregrine falcon, an indicator of things to come." Monsanto stated, "If chlorinated biphenyl is shown to have some long term enzyme or hormone activity in the ppm range, the applications with **consumer exposure** would cause difficulty. . . .Here there is no question of identification. Therefore, **"[e]ither his position is attacked and discounted or we will eventually have to withdraw product from end uses which have exposure problems**" (emphasis added) (MONS 096509, 3/6/69).

5. Monsanto released misleading information to the public and government agencies about PCBs while withholding publicity from its customers to protect its PCB market when adverse publicity highlighting PCBs as an environmental contaminant began to appear in U.S. media in 1969.

   a. The press informed the public of Risebrough's research findings on PCBs. The San Francisco Chronicle published an article with the headline, "A Menacing New Pollutant" in February 1969 (Perlman, 1969). The LA times and a local TV station also had stories (MONS 097499, 3/3/1969).

   b. Monsanto responded by issuing a press release with several arguments to refute the claims made by Risebrough and the media about the widespread use of PCBs and its ubiquity in the environment (MONS 097499, 3/3/1969).

      - Although Monsanto stated that PCBs were not "used in tires, house paint, household products, epoxy resins or major vinyl plastics," it knew PCB-containing Aroclors as plasticizers were incorporated into a number of household products.

      - It also stated that PCBs as plasticizers were "incorporated into the polymer as an integral part of the solid material. This applies whether the polymer is used as an adhesive, an elastomer (sealant) or a surface coating." However, as discussed previously, Monsanto knew that PCBs as plasticizers escaped through volatilization and migration from the polymer products.

      - Concerning toxicity, the press release stated "PCBs are not hazardous when properly handled and used." Monsanto did not define proper handling and use of consumer products because it hadn't conducted the necessary research to find out.

      - With regard to its presence in the environment, Monsanto stated that PCBs "are not sprayed or dusted on crops, woodlands, or any other areas, as are pesticides." The press release challenged the science and soundness of Jensen's and Risborough's findings, questioning whether PCBs was the chemical that was even detected. The statement concluded with "[t]he source of the marine life residue identified as PCB is not yet known." (MONS 097499, 3/3/1969). However, Monsanto knew that PCBs were sold for use as insecticide carriers / pesticide extenders.[17]

[17] Monsanto knew it sold PCBs to pesticide producers for use as an extender (e.g. Lindane) starting in the 1950s. Monsanto knew the pesticides (with PCBs as the extender) had the potential for broadcast use (MONS 072095; MONS 092048; TOWOLDMON0043718). However, it withheld this information on sales and usage when it wrote to Mr. Robert Z Rollins, Chief, California Department of Agriculture that, "To the best of our knowledge, Aroclors are not used as solvents in pesticide formulations." (TOWOLDMON0003805 @3810). One year later, in a confidential memo, Monsanto wrote, "Effective immediately, Monsanto will discontinue the sale of PCBs to any customer using or intending to use PCB as an insecticide/pesticide carrier." Several customers were listed with the advice to call and inform them of the decision, and to avoid adding new customers (MONS 099535, 4/23/1970).

c. Monsanto provided other misleading statements in response to public and government inquiries.

- Monsanto claimed PCBs were used in closed systems like transformers and capacitors; their use was restricted and they not" widely used" in household products (MONS 088331, 3/14/69; NCR-FOX-0575899, 7/23/1969).

- Monsanto claimed the use of PCBs as plasticizers in product such as adhesives, coatings, and specialized elastomers were an integral part of the material and could not be washed away (MONS 088331, 3/14/1969; NCR-FOX-0575899, 7/23/1969).

- Monsanto claimed Risebrough may have misidentified PCBs as the chemical present in the environment (MONS 088331, 3/14/69)

- Monsanto claimed PCBs were not "broadcast in the same fashion" as chlorinated pesticides (e.g. DDT) (NCR-FOX-0575899, 7/23/69).

- Monsanto claimed that PCBs were not hazardous or "seriously" toxic if handled properly and only to avoid exposures at elevated temperatures (MONS 088331, 3/14/69; GPFOX00045446, 7/15/69; NCR-FOX-0575899, 7/23/69).

- Monsanto claimed that PCBs presented "little vapor inhalation hazard at ambient temperatures." (NCR-FOX-0575899, 7/23/69).

d. A Monsanto plan for PCB-containing Aroclors was developed "if the worst were to happen and [it] began to lose sales rapidly as [its] customers take the easy way out and discontinue using them." With regard to communications on Aroclor publicity, this plan recommended that Monsanto "not bring this publicity to the attention of our Aroclor customers" including the ***sealants***, coatings and adhesives customers. PRC, the formulator of the polysulfide sealant used at Westport Middle School, was on the list of customers not to inform at that time (DSW 593169, 3/12/1969).

e. In "Future Plans for Aroclor Plasticizers" Monsanto stated, "[t]he adverse publicity on Aroclors may have little impact or it may be very damaging, particularly if customers decide to play it safe and formulate around Aroclors." (DSW 593169, 3/12/1969).

6. Monsanto's Papageorge who was managing the PCB issues from a corporate perspective, gave a speech titled, "Monsanto's PCB Program," to the 1971 American National Standards Institute Committee meeting. Highlights from his talk outline Monsanto's continuing desire to minimize the PCB situation (ADM 007693, 9/14/1971).

a. Monsanto downplayed the use and its knowledge of PCBs in household products, referring to such uses as "so small, we Monsanto were not aware of [them]."

b. Monsanto downplayed the toxicity aspects stating the popular press was responsible for the unsubstantiated claim of PCBs being referred to as "hazardous poisons."

c. Monsanto detracted sole responsibility for the ubiquity of PCBs by attempting to indict all PCBs customers: "A thought we must all keep in mind, too, is that we've got to live with the PCB's we introduced into the environment for the past 40 years. They have not disappeared overnight; they will not disappear overnight."

X. <u>Monsanto's delay in providing information to its employees, customers, end-users, governmental and regulatory agencies, and the public permitted continued sales of PCB-containing Aroclors for "open" use applications including polysulfide sealants and prevented timely inquiries into past PCB-containing Aroclor uses and legacy PCB contamination.</u>

A. <u>Monsanto minimized the information it disseminated to its customers and salesmen on the problems with PCBs in order to protect its PCB-containing Aroclor markets.</u>

1. Monsanto was informed by Robert Metcalf, head of Zoology at University of Illinois and consultant to Monsanto, that "the evidence regarding PCB effects on environmental quality is sufficiently substantial, widespread, and alarming to require immediate corrective action on the part of Monsanto". Metcalf recommended "[s]erious consideration of curtailing sales of PCB for uses such **as plasticizers, adhesives** and no carbon paper where waste is certain to enter environment" (emphasis added) (NEV 027182, 4/2/69).

2. During a meeting with Professor Widmark (Jensen's supervisor) concerning the presence of PCBs in environmental samples, Widmark "wanted Monsanto to restrict the sale to those closed system applications." Widmark was concerned with PCB-containing Aroclors used as plasticizers in products such as marine paints as a source of the environmental contamination to the aquatic environment (MONS 098104, 05/13/1969).

3. Monsanto knew open uses could lead to, and had already led to PCB environmental contamination. Despite the accumulation of scientific data showing the dangers of bioaccumulation and bio-magnification of PCBs through the food chain of predatory birds, the Organics Division "has a concerted effort underway to protect continued sales and uses." (MONS 036714, 1969).

4. Monsanto formed a PCB Committee to make initial recommendations on how to proceed given the negative publicity on PCB contamination of the environment. Handwritten notes from the PCB Committee meeting revealed its growing concern about its PCB sales (MON-MT 003311, 8/25/69):

   "Subject is snowballing…Where do we go from here…Alternatives: 1.) Go out of Business 2.) Sell (The Hell out of) them as long as we can and do nothing else"

5. A Monsanto document titled "The death of Aroclor" illustrated the company's decision making process with regard to its two alternatives cited above. On a graph showing sales

versus time, the "Let it die" option resulted in a rapid decrease in sales in the shortest amount time whereas the "delay the death" option resulted in a slow decrease in sales over time until sales reached a plateau (MONS 045497, no date).

6. Monsanto then formed a corporate Aroclor "Ad Hoc Committee" to figure out future steps. It convened the first meeting on September 5, 1969. The three objectives of the Committee were to: (MONS 030483, 9/5/1969):

   "1. Permit continued sales and profits of Aroclors and Terphenyls.
   2. Permit continued development of uses and sales.
   3. Protect image of Organic Division and of the Corporation."

7. The Aroclor Ad Hoc Committee considered several alternatives to mitigate the negative publicity of PCBs, given that PCBs were being identified as contaminants of the environment, the chemical stability (persistence) of the higher chlorinated Aroclors (1254, 1260) and the existence of significant toxicological effects in wildlife species. The alternatives included (DSW 164905, 10/15/69):

   "1) Say and do nothing – making the governmental agencies prove their case…

   2) Take action to create a smoke screen hoping to delay any restrictive action by governmental agencies.

   3) Immediately discontinue manufacture and sale of Aroclors 1254 and 1260.

   4) Discontinue manufacture and sale of <u>all polychlorinated biphenyls</u>.

   5) Respond responsibly admitting that there is growing evidence of environmental contamination by the higher chlorinated biphenyls and take action to resolve the problem…such a course of action would postpone precipitous action by governmental agencies for a few months and then limit any restrictions to Aroclors 1254 and 1260."

8. Soon thereafter, Monsanto issued its PCB Environmental Pollution Abatement Plan based on the Ad Hoc Committee's work and recommendations. This report presented Monsanto's short term goals: "reduce the exposure in terms of liability," and "publicize actions where believed advantageous" by portraying to the public positive actions at correcting the contamination problem (MONS 035310, 11/10/1969).

   a. Monsanto expressed concern about the plasticizer market because it knew that plasticizers had the potential to cause contamination – the findings "affects a wide range of plastics and adhesives because PCB serves as the plasticizer. A wide range of paints and coatings are affected." (MONS 035310, 11/10/1969)

   b. Monsanto listed swimming pools and traffic paints as sources of environmental contamination from washing the coated surfaces, and identified the lining of tanks with PCB-containing coatings as a source of product contamination (MONS 035310, 11/10/1969).

c. Monsanto stated for example that one million pounds per year of PCBs were used in highway paints and that it "can assume that nearly all of this Aroclor winds up in the environment." (MONS 030483, 9/5/1969).

9. A draft PCB Presentation was prepared for the Corporate Development Committee in late 1969. Its express purpose was to acquaint the Committee "with the PCB (Aroclor) pollution problem and to secure [the Committee's] guidance and approval on a recommended plan of action (MONS 058730, *circa* Dec 1969/Jan 1970).

   a. The Committee was informed that the PCB market was "one of Monsanto's most profitable franchises", which was "being threatened" by PCB "pollution problems."

   b. The Committee was apprised of a number of alternatives considered in light of the recent findings of PCBs in the environment, the potential for adverse legal and public relations problems, and the desire to maintain the PCB market. Monsanto admitted it could not go out of the Aroclor business because "there is too much customer/market need and selfishly too much profit. . . ."

   c. The Committee was informed that PCB-containing Aroclors sold as plasticizers could cause contamination from leaching and vaporization. For example, sealants used in automotive, construction and joint sealants were identified as possible PCB contamination sources due to "long-term leaching."

      - In 1968 and 1969 sales of Aroclors were 33 and 34 million pounds, respectively, and in 1968, 3 million pounds of Aroclors were sold to the sealants market.

10. In line with its objective of portraying a positive image, Monsanto sent letters to its U.S. distributors and customers of plasticizer-grade Aroclors 1254 and 1260 informing them of the publicity surrounding PCBs as "potential" environmental contaminants. Monsanto informed its distributors and customers that the lower chlorinated Aroclors presented no problem to the environment. Monsanto attached an article concerning water quality standards for each state (pH, temperature and dissolved oxygen, only) and referred its distributors and customers to the section regarding the need for good manufacturing practices to prevent the discharge of any materials in waterways but made no reference to PCBs. (DSW 318242, 2/19/1970; DSW 318245, 2/27/1970). No details were provided on how PCB-containing Aroclors used as plasticizers in their customer's products were causing environmental contamination.

    a. Monsanto's distributors were told it was their responsibility to notify their customers of the information provided in Monsanto's letter even though it contained no PCB specific information on how to prevent environmental contamination (DSW 318242, 2/19/1970).

b. There was no indication that Monsanto checked on whether its PCBs distributors alerted their customers even though Monsanto sold 4.5 million pounds of PCBs to distributors of plasticizers in 1968 alone (DSW 593170, 3/12/1969).

11. Monsanto knew that households and tradesman could buy PCB-containing polysulfide sealants from stores but did not inform them about the presence of PCB-containing Aroclors in these sealants nor the extended release of the PCB vapors from the sealants after installation in buildings.

    a. A handwritten graphic traced the sale of PCB-containing Aroclors in polysulfide sealants from Monsanto. One branch illustrated Monsanto selling to distributors who then sold to the sealant manufacturers. Another branch showed Monsanto selling directly to the sealant manufacturers. The arrow from the sealant manufacturers to the store had the notation “distribution chain unknown.” The arrow from the store went to “householder or tradesman”, followed by another arrow to building, and the last arrow to dump. The notation on this last arrow was “years.” (MONS 060750, *circa* 1969-70).

    b. Above the last arrow from building to dump, the notation read “years,” which indicated Monsanto knew polysulfide sealants would remain in buildings for a long time, allowing for the continued volatilization and cycling of PCBs in the indoor air.

12. In a presentation to its sales personnel, Monsanto stated the purpose of the letters was to “minimize and, hopefully, eliminate claims made against us for environmental pollution damage.” It was “merely fulfilling what [it] consider[ed] to be our moral and our legal responsibility to our customers”. Monsanto did not intend for the letter to “imply guilt” or its agreement with any of the published articles on PCB contamination. The water quality standards article was included so as to minimize the attention on just PCBs. It strongly encouraged the salesmen by stating “Aroclor sales have increased every year for ten years – in boom or recession. We want 1970 to be no different.” Since its goal was to continue selling all Aroclors, Monsanto expected its sales personnel to downplay any replacements (TOWOLDMON0046386, *circa* 2/1970).

13. Talking points for sales personnel on how to handle plasticizer customers after they received the letter demonstrated how Monsanto intended to downplay the publicity of PCB environmental contamination and minimize any customer concerns associated with continuing to use PCB-containing Aroclors as plasticizers (TOWOLDMON0046386, *circa* 2/1970).

a. For example, the salesmen were to state that PCB-containing Aroclors 1221, 1232, 1242, 1248, 1262, and 1268 were NOT persistent contaminants and posed NO long-term threat, which Monsanto knew not to be correct for Aroclor 1242[18].

b. In response to a hypothetical question of whether or not "Aroclor 1254/1260 could escape from my sealant/adhesive/coating" into the environment, Monsanto only provided the statement, "This will depend entirely on the final use to which your product is used—its ultimate disposition." As discussed previously in Section X.B. Monsanto had known that PCBs would escape from those products independent of the final use.

c. For a question regarding loss of Aroclor 1254 and 1260 vapors from a customer product, Monsanto suggested ignoring the concern on Aroclor volatility and deflect it by stating, "Articles on PCB interference with pesticides analysis have mentioned the possibility of loss to atmosphere from vaporizations when Aroclor are heated. We find this hard to believe and it warrants considerable investigation." As discussed previously in Opinion 1, Monsanto understood that PCBs as plasticizers volatilized from final polymer products at both ambient and elevated temperatures.

d. In response to a question about toxicity, the document suggested the misstatement, "The amounts being found in the environment are not considered a danger to humans or fish. The whole question on chlorinated pesticides relates to birds."

e. If asked what they should tell their own customers, the sales personnel were told to avoid a direct answer by, "Tell your customer—We want to advise you of a possible environmental problem. Without knowing what your customer does with product X, this is hard to answer."

14. Monsanto, referring to the presentation made to its sales personnel, reiterated Monsanto's strategy at the time: downplay the PCB notification letter and alleviate customer concerns in order to continue selling Aroclors (DSW 318257, *circa* 2/1970).

15. An example of Monsanto's unwillingness to inform its salesmen and customers about on-going PCB contamination involved silos. Monsanto had become aware of incidents of milk contaminated with PCBs in Ohio, Georgia and Florida. The contamination was traced back to cows consuming feed stored in silos painted with a surface coating containing Aroclor 1254.The PCB plasticizer in the paint had leached into the silage. It was estimated that over 40,000 silos had been coated with the PCB containing paint, and as of that time Monsanto

[18] Dr. Vodden, a PhD Chemist working for MCL in 1969, testified he was tasked to identify issues associated with PCBs in the environment in the UK. He headed the effort to define the degree of biodegradation of PCBs and found that after some degradation, Aroclor 1242 "look[ed] very much like Aroclor 1254, the product that people were claiming that they had found in the environment." He also testified that in 1969 he informed Monsanto's Dr. Kelly that "even though Aroclor 1242 was not identified as an environmental contaminant, there was no doubt that degradation of this product would eventually appear as a residue in the environment." (AMH Dec. - Dkt. 667, Ex. 22 [Vodden Deposition] 8/25/09).

had not committed to notifying all the silo paint manufacturers of the situation. Even after Aroclor 1254 was no longer available for surface coatings, Monsanto questioned whether silos were still being painted with previously purchased PCB containing paint, but there was no indication that follow up investigations took place (MONS 099541, 3/30/1970; MONS 087409, 7/28/1970; DSW 170864, 11/19/1970; DSW 325765, 10/29/1970).

B. <u>Monsanto stopped sales of PCB-containing Aroclors to "open" use applications including plasticizers, but only after notifying those customers to stock up prior to discontinuance of the products.</u>

1. Monsanto decided to terminate PCB sales "to a number of industrial users where there are inadequate possibilities of control, for such uses as pesticide extenders, medicinal, dental and cosmetic, and cutting oils. In addition, we are terminating all sales through distributors to ensure better control of end uses." (TOWOLDMON0001319, 4/20/1970).

2. In a May 14, 1970, memo titled "1200 Series Aroclors; Removal of Products from Market," Monsanto set a timetable to "phase out of all non-biodegradable PCB products where control is not possible", which included the plasticizers because "none of our applications are considered to be of a controllable nature." Monsanto's timeline was to notify its key distributor accounts and Thiokol (the company that licensed the polysulfide liqiuid polymer) by early May 1970, followed by all distributors in late May, 1970 and then direct customers on June 1, 1970 (DSW 318071, 5/14/1970).

3. Internal documents reveal that Monsanto was fully aware of increasing reports of PCB contamination from plasticizer uses and the inability to control the release of PCBs into the environment from such applications. However, Monsanto continued to withhold what it knew by informing its customers and distributors that its decision to discontinue the sale of PCB-containing products for modifier and plasticizer applications was based on "*allegations* that certain . . . PCBs had been found in the environment", and that their use as plasticizers "*may* be a source of the *alleged* environmental contamination" (emphasis added) (MON-MT-003771, 6/1/1970).

4. Monsanto informed its plasticizer customers that it would continue to "accept orders [of PCB-containing Aroclors] through July 31, 1970 and [would] make every effort to meet these commitments and to complete shipment as of August 31, 1970" (MON-MT-003796, revised 8/14/1970).

5. By setting the cutoff date for Aroclor shipments to its plasticizers customers at the end of August, 1970 Monsanto encouraged customers to stockpile PCB-containing Aroclors before the products were discontinued. The polysulfide sealants formulators purchased large amounts of PCB-containing Aroclors, allowing for continued use of PCBs in applications that Monsanto knew were uncontrollable and caused further contamination.

a. Pecora typically bought around 100,000 pounds per year of primarily Aroclors 1254, 1260, and 1262 for the light construction industry. While working on reformulating, "they will stock up as much as they can." (TOWOLDMON0053377, 6/5/1970).

b. Sonneborn indicated that they "would be ordering substantial quantities of all the Aroclors they had been using as a hedge until such time as they could develop replacements, something like 250 M lbs. of mixed product." (TOWOLDMON0053987, 5/25/1970; TOWOLDMON0053982, 6/3/1970; TOWOLDMON0053986, 6/17/1970).

c. "Intercoastal produces polysulfide sealants and caulks for light construction, using about 10,000 lbs. Aroclor 1254 per year at most. They have purchased a year's supply of Aroclor to be used during reformulation." (LEXOLDMON006714 @006717, 6/3/1970)

d. Monsanto contacted Sonneborn near the end of August 1970 to "[r]emind them of cut-off date", and was informed that they now had a huge stock of Aroclors on hand and would not be ordering more (TOWOLDMON0053985, 8/26/1970). In October 1971, a follow up call indicated that they were still using "remnants of the large A-1254/A-1268 stock they had." (TOWOLDMON0047364, 10/4/1971).

e. In an October 1970 call report, Monsanto stated that W.R. Grace "purchased 200,000 lbs. of Aroclor 1254 in August [1970] which represents a stock-pile for usage until late 1971." (TOWOLDMON0054521, 10/15/1970). Over a year later, W.R. Grace was reported to have enough Aroclor 1254 to last until Jan-Feb 1972. (TOWOLDMON0054537, 11/1971),

f. PRC's California location "bought what they thought was a one year supply of Aroclors but because of increased business that supply would only last 8 months." (TOWOLDMON0053051, 2/23/1971). The stockpile at PRCs New Jersey location was expected to last until June of 1971 (TOWOLDMON0053052, 4/15/1971).

6. A review of Monsanto's PCB manufacturing and sales records indicates that despite the publicity on PCBs being a global contaminant, despite the letters that Monsanto sent to its customers and distributors, Monsanto produced and sold more PCBs than it ever had before in 1970. In fact, PCBs sold for open uses, the one area of the market that Monsanto specifically targeted at discontinuing because the applications could not be controlled with regard to releases to the environment, peaked in 1970 (DSW 532590, no date).

7. Monsanto's customer letters were not adequately educating its customers, including the polysulfide sealants formulators, on the dangers associated with using PCBs as plasticizers as revealed by customer communications in 1970 and 1971.

a. Monsanto's communications with the polysulfide sealants industry after the February "notification" letter was sent makes no mention of the letter (TOWOLDMON0053031, 3/9/1970; TOWOLDMON0053345, 4/30/1970).

b. In a June 2, 1970 call report, Monsanto noted that PRC inquired if "…PCB Aroclors [would] be manufactured anywhere in Western Hemisphere" since it has "plants in Canada and Mexico." (TOWOLDMON0053036, 6/2/1970). Monsanto's response to PRC was that it was "the only producer in this hemisphere. No others are expected." (TOWOLDMON0053035, 6/8/1970).

c. Two months later a sales call report stated that PRC "…continues to be antagonistic towards Monsanto for the posture we assumed regarding Aroclors. However, [the] attitude seems to have mellowed slightly, due to information [it] recently received from the New Jersey Board of Health concerning the use of Aroclors and wrote PRC "a letter describing Aroclors as having extremely toxic effects on the human body thru the liver, when absorbed thru skin contact . . . it served to emphasize to [PRC] the seriousness of the pressure to which Monsanto has been submitted to recently regarding Aroclors." (TOWOLDMON0053038, 8/11/1970).

d. A year after Monsanto notified its customers of the Aroclor discontinuation for open uses, PRC was "confused concerning Monsanto's worldwide approach to selling [PCBs]." Europe was still getting PCBs from Monsanto and had not been informed of discontinuation. PRC's Technical Director wanted "…to know the story so he can get them changed over if PCBs are done." (TOWOLDMON0053054, 5/18/1971).

e. Koppers accused Monsanto's action as being "unjustified and precipitous". Monsanto finally shed some light on the situation by informing Koppers that PCBs were ubiquitous in the environment, and that their use in plasticizers could not be tightly controlled so as to prevent environmental contamination. In addition, Monsanto admitted that the plasticizer market had to be sacrificed in order to continue using PCBs in other applications (MONS 089525, 7/1/1970; MONS 087409, 7/28/1970).

f. Monsanto noticed a sale of 12,000 pounds of Aroclor 1242 to Essex in 1971 through their functional fluids division as a "capacitor fluid" even though Essex wasn't in the dielectric business. Monsanto suspected Essex was trying to use it as a replacement for Aroclor 1254 in its polysulfide sealants and contacted them to reassert that this was not an authorized purchase (TOWOLDMON0053131, 11/7/1971; TOWOLDMON0053293, 11/16/1971; TOWOLDMON0053295, 12/2/1971).

C. Monsanto refused to disclose its customers and sales of PCB-containing Aroclor products to government, scientists and the public in a timely manner, which prevented any investigations into applications including polysulfide sealants in schools that were continuing to release PCBs into indoor and outdoor environments.

1. An April 13, 1970 internal memo listed customers using PCB-containing Aroclor plasticizers in "a number of questionable applications." The list includes customers and their applications and the distributor from which they were purchasing the Aroclor. Some notable applications indicated that despite consistently stating otherwise when responding to government officials (Congressman Ryan) and the public, Monsanto knew that PCB-containing Aroclors were being used in household products such as Kiwi Shoe Polish, Florasynth Labs and Perry Brothers Perfumes, and Halvorson Tree Co. "Xmas Tree Flameproofing and Sealing," as well as in fabric coatings and in dental labs. Another attached table listed the use of PCB-containing Aroclors in Curad Bandages (MON-MT-003143, 04/13/1970).

2. Monsanto rejected numerous requests by Congressman Ryan in early 1970 to disclose vital PCB information. Specifically, it refused to provide the names of the PCB-containing products and the manufacturers of PCB-containing products, refused to provide production and sales figures of PCBs, and identification of all the uses of PCBs (DSW 526533, 4/21/1970; MONS 098443, 4/28/1970; DSW 203821, 6/18/1970; DSW 526543, 6/30/1970).

   a. A Monsanto memo described Mr. Ryan's "total interest in the matter was to safeguard the health of the public. . . ." Ryan was clear that his primary concern was that, "PCBs are being used in the manufacture of household products which are handled by the public and could have an adverse effect on their health. Monsanto responded, "Aroclors were not used to any extent in these articles." (DSW 526533, 4/21/1970).

   b. Monsanto informed Ryan that its production and sales figures were confidential information and would only release that information to Ryan "or any responsible government agency when we receive assurance that these figures will be kept confidential." (MONS 098443, 4/28/1970).

   c. Ryan countered, "I am most disturbed by the PCB danger and what I consider Monsanto's unwillingness to deal candidly with a dangerous situation. Despite your assurances that PCBs are only used in closed systems, independent researchers have found them in the environment. I wonder if it surprises you to learn that Dr. Risebrough has discovered PCBs in paints bought at a Berkeley, California hardware store. Have you issued any warnings to all potential users of PCBs? " (DSW 203821, 6/18/1970).

   d. Monsanto replied, to Ryan "[w]e have not issued warnings to all potential users of chlorinated biphenyls, but we have more than covered this point by refusing to sell for applications where control cannot be established." Monsanto concluded the letter, "I hope that you will see fit to withdraw your allegations that Monsanto is unwilling to deal candidly with this issue." (DSW 526543, 6/30/1970).

- As discussed above in Section IX.B.4., during this same time period Monsanto had encouraged its plasticizer customers to stockpile PCB-containing Aroclors so they could continue using them, specifically in applications "where control cannot be established."
- As described in Section IX.B.5., its polysulfide sealant customers did purchase large quantities of PCB-containing Aroclors.

3. Monsanto continued to deny requests by the media and Dr. Risebrough to disclose PCB production information (DSW 203242, 12/8/1970; DSW 432285, 12/10/1970; DSW 432274; 12/10/1970; MONS 093213, 11/4/1971).

   a. Papageorge wrote a letter to Risebrough that stated, "Monsanto has been repeatedly accused of callously refusing to divulge usage data. On the contrary, we have on many occasions expressed our willingness to disclose to responsible members of governmental agencies on a confidential basis to enable them to correctly establish the present and future levels of PCB are escaping to the environment," Actually Congressman Ryan had previously agreed to keep the information confidential but had been turned down by Monsanto. (MONS 093213, 11/4/1971).

4. At the end of 1971, Monsanto finally released its total production and sales figures on PCB-containing Aroclors through 1971, but refused to divulge customer names, and quantities purchased by its customers (DSW 369806, 3/3/1972). Without this information, the sales figures alone did not permit the government and scientists to investigate sources of PCBs and legacy PCB contamination such as PCB containing sealants in school buildings.

5. A letter to Mr. Legro of the USEPA from Edwin Putzell of Monsanto stated, "In accordance with your request of yesterday and in the national interest, I violate our and the industry's usual practice by handing you herewith a copy of Monsanto's present customer list with respect to its sale of PCB's," which by that time were customers purchasing PCB-containing Aroclors for "closed" use applications, including transformers and capacitors (DSW 011799, 8/8/1975). The list was of little value because it did not include Monsanto's past customers that purchased PCB-containing Aroclors for "open" uses such as polysulfide sealants for building construction.

6. Monsanto was aware that the lack of information on PCB products and uses resulted in numerous industries unknowingly handling products contaminated with PCBs. For example, in 1979, Monsanto was found partly responsible in a Federal Court case concerning PCB contaminated minks. The source of the PCB contamination was bakery meal processed into poultry feed fed to ducks that were then fed to the minks. With regard to its responsibility, Monsanto admitted that it had not communicated to the mink journals the potential for PCB

contamination from mink food (MONS 011143, 6/11/1979). This case demonstrated the ubiquity of PCBs and Monsanto's understanding of its responsibility to alert users of products that may have contained or were contaminated by PCBs.

XI. Monsanto had responsibility to protect workers, consumers, communities, the public and the environment from dangers associated with manufacture, use, and disposal of PCB-containing its products.

A. Authoritative books on social responsibility defined the role of corporations.

1. Theodore Houser, chairman of Sears, Roebuck and Company, stated in "Big Businesses and Human Values" Houser (1957):

> "Businesses, no matter how big are accountable to many groups beyond the confines of their own organizations. . .customers, the community, the public at large. . . .The relationships of the corporation with the community, the public and the government are less direct but not less real, and need to be given thought as part of the broad spectrum of management responsibility.
>
> "The responsibility of a business to the community in which it operates is primarily social in character. This responsibility is comparable to that of any private citizen, and is not essentially altered by the fact of corporate rather than individual personality. In many ways the obligations of the corporate citizen are greater and more far-reaching than those of individual citizens simply because of the corporation's greater resources, in terms not merely of money but of special skills and experience."
>
> "It can see its customers not as objects of exploitation, an inanimate resource, but as people who will be better customers the better informed they are. It can show in its relations with other businesses dependent upon it a willingness to develop independent self-generating entities and thus engender a healthy increase in the social and the economic potential of the community. And while paying the necessary respects to facts, figures, and profit-and-loss statements, every business can see itself not only as a producer of goods and services but as a citizen as well."

2. In the book, "Managing The Socially Responsible Corporation", entrepreneur, Dan Lufkin, head of the Connecticut Department of Environmental Protection at the time, wrote a chapter titled "Some Financial Implications of Corporate Social Responsibility." He stated (Lufkin, 1974):

> "Industry will be charged not only with the responsibility for providing goods and services, but also for assuring goods that are safe and well constructed and services whose latent effects are not harmful. If in the process of manufacture, industry pollutes the air and fouls the water, industry will be expected to bear the major costs of

cleansing the air and water and restoring and returning them to the public in usable if not mint condition."

"It is not enough for top management to want to do good. The corporate system is designed to thwart activities which divert resources from short-term profitability unless they are given sufficient funding, unless they are assigned enough skilled people, and unless the socially responsible activity becomes a standard of evaluation against which staff and line executives can expect to be measured, compensated, and advanced."

3. In the same book in a chapter titled "Creating a Management Environment for Socially Responsible Performance" Carl Gerstacker, Dow Chemical Company's Chairman of the Board from 1960 to 1976 made the following statements concerning socially responsible corporations (Gerstacker, 1974):

Under the section, "Creating the Socially Responsive Environment," he defined three "critical postulates for creating a socially responsible management environment within a corporation":

- "Social responsibility must be a firm, deep seated belief of the management. It must be soundly and deeply a part of the on-going goals and strategy of the corporation. Unless there is a genuine commitment on the part of the management this is not going to happen."
- "Management must be consistent in its support of social responsibility."
- "Management commitment must be long-term."

"Dow makes some 1,100 different products, many of them highly hazardous, and in making. . .these products. . .some are bound to spill and some to spoil, creating pollution problems of a major magnitude. . . .The silver lining. . . is that because we have so many problems we also know more than most about handling pollution. . . .Our background in environmental matters, in short, was soundly based and solidly established by the time environmental contamination became a front page topic about ten years ago."

"Much of our current effort is being devoted to what we call "product stewardship." This is an important aspect of social responsibility. As we define the concept, it means that we have a responsibility for a product every step of the way, in manufacture, in shipping and distribution, in its use, and on to its final disposal. Our marketing people work with our customers so that safe handling, safe use, and safe disposal are hallmarks of our activities, and so that our products are not used in ways not intended or tested for. Our manufacturing people are concerned not only with meeting our pollution control standards but with safety in the packaging and movement of goods. Our research and development personnel emphasize safe products, environmentally sound products, and part of their responsibility is to develop information for safe handling, use, and disposal of our products."

4. Clark Abt, described as "an engineer, environmentalist, entrepreneur, educator and social scientist" also authored a chapter in Managing The Socially Responsible Corporation[19]. In, "The Social Audit Technique for Measuring Socially Responsible Performance" he outlined the "five publics most affected by the activities of corporations", which were "the employees, the owners , the customers, the residents of the corporation's local environments, and the general public." In defining corporate social responsibility, he made several relevant points that had either widespread or major agreement among corporate managers with respect to corporate responsibility (Abt, 1974):

   - "honest, truthful, and fair dealings with other enterprises, consumers, and employees"
   - "complete truthfulness in advertising"
   - "nonharmfulness of products and services"
   - "obeying all laws, including those weakly enforced ones against pollution, unsafe practices… ,etc."

B. <u>Monsanto's corporate position statements defined its responsibilities to consumers, communities, the public and the environment.</u>

1. Monsanto established business principles to live by, which were updated and supplemented in the 1950s, 1960s and 1970s.

   a. The 1954 Guide for the Medical Department stated it "shall coordinate the air and stream pollution aspects of waste disposal activities." (TOWOLDMON0016531, 1954). The Medical Department was deeply involved in PCB product toxicity related to worker issues starting in the 1930s and took the lead in handling PCB environmental issues in the late 1960s.

   b. In 1966, Monsanto's guide stated that "[i]n relations with plant communities, we will…cooperate with all properly constituted authorities to reduce air and stream pollution." (TOWOLDMON0020039, 1966).

   c. Concerning communities, Monsanto was "to be a substantial contributor to the general welfare of society." (TOWOLDMON0017349, 7/15/1960; TOWOLDMON0018008, 4/1962; TOWOLDMON0018192, 4/1963)

   d. In 1970, Monsanto stated, "[i]n our growth, we will strive to . . . develop products and services which will provide value and safety for the ultimate consumer and will not adversely affect the ecological balance of our planet." (TOWOLDMON0018399, 2/1966).

[19] Dr. Abt founded Abt Associates and served as the President from 1965 to 1985. The Abt Associates website has a full career profile for him. http://abtassociates.com/About-Us/50th-Anniversary/Presidents/Clark-C--Abt.aspx

2. Monsanto issued a number of policy statements beginning in 1971. Mr. Michael Pierle, Monsanto's Corporate Representative testified that the 1971 policy was in place during the entire time Monsanto manufactured and sold PCBs (TOWOLDMON0046444, 7/10/2006).

   a. The 1971 policy stated Monsanto "has always recognized its responsibility to the public, to its shareholders, to its employees, to its customers and to the communities in which it operates." These responsibilities included concern for the public interest, environmental pollution, and cooperation with the government and regulatory bodies. (DSW 117325, 7/1971).

   b. Under "Environmental Evaluation of Proposed New Products and Processes", "Monsanto, recognizing the need for control and reduction of environmental degradation, diligently and systematically assesses the impact of proposed new products and processes on the environment." (DSW 117325, 7/1971).

   c. The pollution control policy stated: "A. Always be concerned for the public interest. . . . F. Cooperate with appropriate government agencies, including participation in the development of rules and regulations." (DSW 117325, 7/1971).

3. Monsanto's position in 1974 emphasized product quality and safety through research and testing, and maintaining "open communications with all national and local authorities, employees, customers and publics". The 1974 policy statement specifically noted that Monsanto "will market products under conditions which promote safe handling and use." DSW 117818, 7/1/1974).

4. Monsanto's executive, Mr. Papageorge, who was plant manager at its PCB manufacturing facility in Alabama from 1965 to 1970, Manager of Environmental Control in 1971, and Head of Monsanto's Ad Hoc Committee knew that chemicals such as PCBs should not be released into the environment. He testified (Papageorge Deposition, 1993):

   > "At a minimum, it is just not prudent to discharge knowingly any kind of industrial chemical, whether it be PCBs or any other material…you wouldn't want to discharge out into the environment. It just wasn't a practice that was considered to be responsible."

5. Monsanto issued Social Responsibility Policy Statements in 1977 in which it stated, "[w]e will adhere to all laws governing corporate conduct, but we will not hesitate to go beyond legal requirements, if, in our prudent judgement, a higher level of performance is in order. . . We will regularly modify and refine our corporate posture in these public policy areas to remain responsive to the legitimate demands of the world in which we do business." (TOWOLDMON0047829, 11/1977).

6. The 1990 Pledge stated Monsanto's promise to "reduce all toxic and hazardous releases and emissions, working toward an ultimate goal of zero effect; ensure no Monsanto operation

poses any undue risk to our employees and our communities . . . ." (no Bates #, January, 1990)

C. Monsanto had the expertise and opportunity to investigate the impacts of PCBs on the environment.

1. In 1951, Monsanto hired Mr. Jack Garrett, an industrial hygienist, as an air and water pollution specialist in the Medical Department.

2. In 1957 Garrett wrote an article, "Toxicity Considerations in Pollution Control," which explained Monsanto's methods of determining if waste products in discharges from its chemical manufacturing facilities "adversely affect human life." He noted that toxicity data was available through animal feeding studies, but the "most serious toxicity problem" was the effects on aquatic life.

   a. A detailed case history on Monsanto's acrylonitrile production facility and the installation of a waste treatment plant to control discharges of chemical wastes into a bay was presented. Experiments on fish to determine acute toxicity were described which included various concentrations of chlorinated compounds.

3. He explained the tests had limitations because they did "not take into consideration the effect on the predatory cycle" in the receiving waters. Garrett lamented "the lack of comprehensive data on the effects of industrial waste on living organisms." (Garrett, 1957).

XII. Conclusion

Monsanto should not have sold PCB-containing Aroclors as plasticizers for polysulfide sealants and other materials used in buildings, such as Westport Middle School. By doing so, Monsanto did not meet its corporate responsibility to protect consumers, communities and the environment from dangers associated with exposure to PCBs.

XIV. Literature References

Abt, C., 1974. “The Social Audit Technique for Measuring Socially Responsible Performance “ in Managing the socially responsible corporation: the 1972-1973 Paul Garrett lectures, edited by M. Anshen, Macmillan, New York.

ATSDR. 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). U.S. Department of Health and Human Services.

American Chemical Society. 1965. Plasticization and Plasticizer Processes; A Symposium Sponsored by the Division of Industrial and Engineering Chemistry at the 147th Meeting of the American Chemical Society, Philadelphia, Pa., April 6–7, 1964. Advances in Chemistry Series 48. American Chemical Society, Washington.

Lehman, A.J. and O.H. Fitzhugh. 1954. “100-Fold Margin of Safety.” Association of Food & Drug Officials of the US Quarterly Bulletin XVIII (1): 33–35.

Bennett, G.A., C.K. Drinker, and M.F. Waren. 1938. “Morphological Changes in the Livers of Rats Resulting from Exposure to Certain Chlorinated Hydrocarbons.” The Journal of Industrial Hygiene and Toxicology 20 (2): 97–123.

Boller, L. 1976. “Polysulfide Sealants.” In Building Seals and Sealants, edited by J Panek, 40–53. ASTM International: West Conshohocken, PA.

Boyer, R.F. 1949. “The Compatibility, Efficiency and Permanence of Plasticizers.” Journal of Applied Physics 20 (6): 540–52.

Boyer, R.F. 1951. “Effect of Plasticizers on Some Physical Properties of Polymers.” Tappi 34 (8): 357–62.

Broadhurst, M.G. 1972. “Use and Replaceability of Polychlorinated Biphenyls.” Environmental Health Perspectives 2: 81–102.

Brown, R.M. 1947. “On the Toxicity of the ‘Aroclors’.” The Chemist Analyst 36(2): 33–35.

Bruins, P.F. 1965. Plasticizer Technology. New York: Reinhold Pub. Corp.

Carson, R., Darling, L. and Darling, L. 1962. Silent Spring. Cambridge, Mass; Boston: Houghton Mifflin.

Cook, J.P. 1970. Construction Sealants and Adhesives. Wiley Series of Practical Construction Guides. New York: Wiley-Interscience.

Craver, J.K. 1948. “Mechanism of Plasticization in Plastics.” American Society for Testing Materials – Bulletin No. 152: 90–92.

Dodson, R.E., D.E. Camann, R. Morello-Frosch, J.G. Brody, and R.A. Rudel. 2015. “Semivolatile Organic Compounds in Homes: Strategies for Efficient and Systematic Exposure Measurement Based on Empirical and Theoretical Factors.” Environmental Science and Technology 40: 113–122.

Doolittle, A.K. 1954. The Technology of Solvents and Plasticizers. New York: Wiley.

Dourson, M.L. and J.F. Stara. 1983. "Regulatory History and Experimental Support of Uncertainty (Safety) Factors." Regulatory Toxicology and Pharmacology 3:224-238.

Drinker, C.K., M.F. Waren, and G.A. Bennett. 1937. "The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons." The Journal of Industrial Hygiene and Toxicology 19 (7): 283–311.

Drinker, C.K. 1939. "The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons." The Journal of Industrial Hygiene and Toxicology 21 (5): 155–159.

FDA014180, 1/26/1972. Memo to Edward Burger, OST from W. Muir, Executive Office of the President Council on Environmental Quality.

Federal Specification TT-S-230A. May 5, 1967. "Sealing Compound, Synthetic-Rubber Base, Single Component Chemically Curing (for Calking, and Glazing in Building Construction)." http://everyspec.com/FED_SPECS/T/TT-S-230A_11260/.

Fulton, W.B. and J.L. Matthews. 1936. "A Preliminary Report of the Dermatological and Systemic Effects of Exposure to Hexachloro-Naphthalene and Chloro-Diphenyl." Bureau of Industrial Standards – Special Bulletin No. 43: 3–15.

Lufkin, D., 1974. "Some Financial Implications of Corporate Social Responsibility" in Managing the socially responsible corporation: the 1972-1973 Paul Garrett lectures, edited by M. Anshen, Macmillan, New York.

Garrett, J.T. 1957. "Toxicity Considerations in Pollution Control." Industrial Wastes 2 (1): 17–19

Gerstacker, C., 1974. "Creating a Management Environment for Socially Responsible Performance " in Managing the socially responsible corporation: the 1972-1973 Paul Garrett lectures, edited by M. Anshen, Macmillan, New York.

Herrick, R.F., M.D. McClean, J.D. Meeker, L.K.B., and G.A. Weymouth. 2004. "An Unrecognized Source of PCB Contamination in Schools and Other Buildings." Environmental Health Perspectives 112 (10): 1051–53.

Houser, T.V. 1957. Big Business and Human Values. New York: McGraw-Hill Book Company, Inc.

Jenkins, R.L. and R.N. Foster. 1931. "Compatibility Relationships of Aroclors in Nitrocellulose Lacquers." Industrial and Engineering Chemistry 23 (12): 1362–1365.

Kuratsune, M., T. Yoshimura, J. Matsuzaka and A. Yamaguchi. 1971. "Yusho, a Poisoning Caused by Rice Oil Contaminated with Polychlorinated Biphenyls." Technical Reports 86 (12): 1083–1091.

Manufacturing Chemists' Association 1961. Guide to Precautionary Labeling of Hazardous Chemicals. Manual L-1. 6th Edition.

Martens, C.R. 1968. Technology of Paints, Varnishes, and Lacquers. New York: Reinhold Book Corp..

Masuda, Y. 1985. "Health Status of Japanese and Taiwanese After Exposure to Contaminated Rice Oil." Environmental Health Perspectives 60: 321–325.

Meigs, J.W., J.J. Albom, and B.L. Kartin. 1954. "Chloracne from an Unusual Exposure to Aroclor." Journal of the American Medical Association 154 (17): 1417-1418.

Mellan, I. 1961. The Behavior of Plasticizers. New York: Pergamon Press.

Monsanto. 1962. "The Desolate Year." Monsanto Magazine, pp 4-9.

New Scientist. 1966. "Report of a New Chemical Hazard." In Notes on the News. New Scientist, p 612.

Penning, C.H. 1930. "Physical Characteristics and Commercial Possibilities of Chlorinated Diphenyl." Industrial and Engineering Chemistry 22 (11): 1180-1182.

Perlman, D. 1969. "A Menacing New Pollutant." San Francisco Chronical 105 (55): 1, 20.

Peterson, E.A., B.W. Pozniak, D.J. Smith, and A.D. Yazujian. 1976. "Polysulfide Rubber." In Building Seals and Sealants, edited by J Panek, 11–39. ASTM International: West Conshohocken, PA.

Reed, M.C. 1943. "Behavior of Plasticizers in Vinyl Chloride-Acetate Resins." Industrial and Engineering Chemistry 35 (8): 869–904.

Reed, M.C. 1947. "Survey of Plasticizers for Vinyl Resins." Journal of Polymer Science 2 (2): 115–20.

Sax, N.I. 1951. Handbook of Dangerous Materials. New York: Reinhold Publishing Corporation.

Schecter, A. 1994. Dioxins and Health. New York: Plenum Press.

Schwartz, L. 1936a. "Dermatitis from Synthetic Resins and Waxes." American Journal of Public Health 26: 586-592.

Schwartz, L. 1936b. "Dermatitis in the Manufacture of Synthetic Resins and Waxes." Skin Hazards in American Industry, Part II. Public Health Bulletin No. 229, pp 1-12.

Small, P.A. 1947. "The Diffusion of Plasticisers from Polyvinyl Chloride." Journal of the Society of Chemical Industry 66 (1): 17–19.

US EPA, 2010 - https://www.epa.gov/sites/production/files/2015-08/documents/research-plan.pdf

US EPA, 2015a - https://www.epa.gov/pcbs/fact-sheet-practical-actions-reducing-exposure-polychlorinated-biphenyls-pcbs-schools-and-other

US EPA, 2015b - https://www.epa.gov/pcbs/questions-and-answers-about-polychlorinated-biphenyls-pcbs-building-materials

Von Wedel, H., W.A. Holla, and J. Denton. 1943. “Observations on the Toxic Effects Resulting from Exposure to Chlorinated Naphthalene and Chlorinated Phenyls with Suggestions for Prevention.” Rubber Age 53 (5): 419-426.

Whitehead, T.P., F.R. Brown, C. Metayer, J-S. Park, M. Does, J. Dhaliwal, M.X. Petreas, P.A. Buffler and S.M. Rappaport. 2014. “Polychlorinated Biphenyls in Residential Dust: Sources of Variability.” Environmental Science and Technology 48 (1): 157-164.

APPENDIX A

MATSON & ASSOCIATES

Updated 11/2015

Jack V. Matson, Ph.D., P.E.

Matson & Associates, Inc
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EDUCATION

Ph.D., Environmental Engineering, Rice University, 1974
M.S., Chemical Engineering, University of Toledo, 1968
B.S., Chemical Engineering, University of Toledo, 1965

PROFESSIONAL EXPERIENCE

<u>Founder, Principal Engineer, Testifying Expert and Consultant</u>
Matson & Associates, Inc., 1980 - present

<u>Professor of Environmental Engineering (Emeritus)</u>
The Pennsylvania State University, 1992-2009 (2010)

<u>Chairman of the Regulation Development & Enforcement Committees</u>
Texas Air Control Board, 1991-1993

<u>Adjunct Professor of Environmental Health</u>
University of Texas School of Public Health, 1986-1992

<u>Assistant, Associate Professor of Civil and Environmental Engineering</u>
University of Houston, 1974-1992

<u>Manager of Environmental Engineering Design Section</u>
S & B Engineers, Houston, Texas, 1970-1971

<u>Chemical / Environmental Engineer</u>
Enjay Chemicals (now Exxon), Baytown, Texas, 1968-1970

<u>Process Chemical Engineer</u>
Sun Oil Refinery, Toledo, Ohio, 1964-1965

LICENSES

<u>Registered Professional Engineer</u>
Texas (32623)
Ohio (34696)
Pennsylvania (71657)

SUMMARY OF QUALIFICATIONS

Dr. Matson has nearly fifty years of experience in the field of chemical and environmental engineering. He has extensive experience working for industry as a process chemical engineer at both an oil refinery and a chemical plant, and as an environmental engineering consultant for chemical manufacturing facilities. As a professor, he taught courses on environmental engineering, environmental chemistry, engineering design, hazardous waste management, and environmental law and regulation. In addition, he conducted research and supervised research of master's students and doctoral candidates in areas including environmental chemistry, chemical engineering, and chemical emissions from industrial facilities. Dr. Matson has provided expert opinions in over 100 cases involving chemical contamination of the environment. His expertise is in chemical emissions, historical industry knowledge and environmental regulations. Chemicals of concern include PCBs, dioxin, hexavalent chromium, arsenic, lead, chlorinated solvents, pesticides, PAHs, benzene, ammonium perchlorate and constituents associated with petroleum.

DIRECT EXPERIENCE WITH PCBS

Dr. Matson began researching the status of PCBs in the environment in 1974 for a paper titled "The Effects and Fate of PCBs in the Environment" written for a course in Chemical Contamination of the Environment at the University of Texas' School of Public Health. Since that time he has been a consultant to industry and the community on PCB environmental issues, and an expert witness in a number of cases concerning PCB emissions from various industrial facilities. Dr. Matson has reconstructed PCB emissions to the air, water and land from industrial sources and has testified on standard of care issues pertaining to PCB discharges into rivers and releases to the land throughout the U.S. He has also testified on expected / intended issues in insurance recovery cases relating to the presence of PCBs in the environment. In cost allocation cases, Dr. Matson has provided testimony on the source or contributor of PCBs to contaminated sites requiring cleanup efforts.

Toxic Tort, Property Damage, Nuisance

- Opined on continuing sources of PCB discharges and on standard of care issues associated with the disposal of PCBs at a nylon facility in Pensacola, Florida.
- Opined on standard of care issues pertaining the manufacture and sale of PCBs for paint associated with PCB contamination of Big Spring Creek (Lewistown, MT) from paint used at a fish hatchery.
- Opined on standard of care issues in three cases involving the handling and disposal of PCBs at a transformer manufacturing facility resulting in PCB contamination in the city-owned lake, and residential and commercial properties in Crystal Springs, MS.
- Opined on standard of care issues pertaining to Monsanto's practices concerning the manufacture and release of PCBs from its plant in Anniston, AL. Reconstructed historical PCB emissions to the air, water and soil.
- Opined on PCB emissions from the French Limited Superfund dump site in Crosby, TX.

Insurance Recovery

- Opined on expected / intended issues concerning PCB contamination of the Lower Fox River. Analyzed operations and discharges from a number of PRPs including a paper manufacturing plant, a coating plant and a paperboard manufacturing facility.

- Opined on expected / intended issues concerning the use and discharge of PCB-containing hydraulic fluid at an aluminum die cast facility that resulted in sediment contamination of Cedar Creek (Cedarburg, WI).

Cost Allocation

- Opined on whether PCBs found on the site of a former truck washing facility (St. Louis, MO) posed an imminent and substantial endangerment as defined under RCRA 7002.
- Opined on whether the source of PCBs found at the site of a former asphalt manufacturing plant came from PCB-contaminated waste transformer oil, Seattle, WA.
- Opined on whether a manufacturing facility contributed to the PCBs found in a waterway connected to the Duwamish River from the historical use of PCB-containing hydraulic fluid (Seattle, WA).

Consulting

- Provided litigation support for a client involved in a lawsuit concerning PCBs found in the environment at an aluminum die-cast facility and neighboring properties. Researched and evaluated the historic operations concerning the use, handling and disposal of PCB-containing / contaminated hydraulic fluids to identify sources and timing of releases, and whether the facility anticipated harm to the environment due to its handling and disposal practices
- Provided litigation support for clients involved in a lawsuit concerning remediation of the sediments in the Hudson and Housatonic Rivers from the use, handling, and disposal of PCBs during the manufacture of transformers and capacitors. Contamination of the groundwater by chlorinated solvents and PCBs were also an issue in the case.
- Consultant to the Catholic Diocese on a church site adjacent to the Geneva Superfund Site on the potential ramifications of PCB contamination, Houston, TX.

OTHER CONSULTING PROJECTS

- Predictive modeling tool for chemical additions to maintain cooling water chemistry in natural draft and mechanical draft cooling towers, Air Liquide, Delaware, 2005-2010
- Indoor air quality analysis and source identification for the presence of TCE, Luzerne Intermediate Unit, Pennsylvania, 2004
- Member of the Rutgers Chemical Advisory Committee for the Rutgers Superfund Site, State College, Pennsylvania, 2003-2004
- Review of expert reports concerning community exposure to PAHs from coke dust emissions in Long Beach and Los Angeles, CA, 2003.

- Source identification of specific chemicals present in an historical dump site used by multiple parties, Petrolia, Pennsylvania, 2002-03
- Zero Discharge Feasibility Study, Alcoa, Point Comfort, Texas, 1995-96
- Zero Discharge Feasibility Study, Formosa Chemicals, Point Comfort, Texas, 1994-98
- Heavy Metals in Municipal Sludge, HouTurf, Houston, Texas, 1992
- Member of the Health, Safety, and Environment Task Force retained by Westinghouse to inspect and make recommendations with respect to mixed wastes including **PCBs** at the Hanford Nuclear facility (Washington), 1993
- Maximum Recycle Design at the Unocal Santa Maria, CA Refinery, 1992
- Evaluation of Site Assessment, Perry, Houston, Texas, 1991
- Sources and Fate of Dioxin, Houston, Texas, 1990-91
- Cooling Water Discharges, Aristech, Houston, Texas, 1990-91
- Environmental Assessments, Tom Gray, Houston, Texas, 1990-91
- Dynamic Filter Study, Ashbrook-Simon-Hartley, Houston, Texas, 1990
- Produced Water Discharge, Eaton, Houston, Texas, 1989
- Evaluation of RCRA Violations at Baytank, Houston, Texas, EPA, 1988
- Industrial Waste Treatment, Seatex Corporation, Houston, Texas, 1988
- STAR Consultant for United Nations Industrial Development Organization to lecture and assist Sinopec Oil in the Peoples Republic of China in industrial water recycle, July 14-August 1, 1988 in Beijing, China.
- Process Design of the City of Houston 69th Street Sewage Treatment Plant; Lockwood Andrews, and Newman, Houston, Texas, 1975-76
- Methane Gas Generation from a Landfill, City of Beaumont, Texas, 1975
- Process Design, Instrumentation and Control of a Sidestream Softener for Zero Discharge, Arco Polymers, Inc., Houston, Texas, 1973-78

PATENTS

Matson, J.V, and Kennon, D.S., "Green Biodiesel," US Patent No. 7563915, Issued on May 25, 2009.

Co-inventor with Hight, T.V., et al., "Biocidal Methods and Compositions for Recirculating Water Systems, U.S Patent No. 5,464,636, Issued on November 7, 1995; U.S. Patent No. 5,476,670, Issued on December 19, 1995; U.S. Patent No. 5,527,547, Issued on June 18, 1996; and U.S. Patent No. 5,662,940, Issued on September 2, 1997.

Matson, J.V., "Industrial Wastewater Reuse by Selective Silica Removal over Activated Alumina," U.S. Patent No. 4,296,180, Issued on June 30, 1981.

ROYALTY AGREEMENT

University of Houston with Monsanto for Exclusive Rights to produce and market "Towerbrom." 1989-1992; transferred to Occidental Chemical Corporation.

MATSON & ASSOCIATES

RECOGNITION OF TEACHING

Zell/Lurie Award and Fellowship for the Teaching of Innovation, University of Michigan.

The University of Houston Teaching Excellence Award, 1991, Amoco Foundation.

General Electric Learning Excellence Award, Penn State College of Engineering, 2003.

Garrey Carruthers Chair in Honors at the University of New Mexico for 2007-08 academic semester

PUBLICATIONS

Book
Matson, J.V. Effective Expert Witnessing, 5th Ed., CRC Press, 2012

Articles

- Matson, J.V., and R.J. Schuhmann, "Natural Attenuation as a Remedy Not an Excuse," Journal of Soil Contamination, 8(1) 29-33, 1999.
- Ballard, C., and J.V. Matson, "Precise Prediction of pH in Cooling Water," Journal of the Cooling Tower Institute, Vol. 12, pp. 30-38, 1992.
- Zhang, Z. H., and J.V. Matson, "Organic Halogen Stabilizers," Journal of the Cooling Tower Institute, Vol. 10, No. 2, 1989, pp. 26-34.
- Matson, J. V., "The Concern over Minifund Hazardous Waste Sites," The Environmental Forum, Vol. 4, No. 11, March, 1986.
- Matson, J. V., "Sidestream Softening at USS Chemicals," Oil and Gas Journal, May 20, 1985, pp. 76-78.
- Spear, K. F., and J. V. Matson, "Cooling Water Reuse with Sidestream Softening," Power, Vol. 128, No. 12, December, 1984.
- Matson, J. V., "Energy Conservation through Cooling Water Treatment," Energy Progress, Vol. 3, No. 3, 1983, pp. 182-185.
- Matson, J. V., "Reduction in Chlorine Requirements by Control of Nitrification in an Oxygen Activated Sludge Process," Water Research, Vol. 16, 1982
- McGaughey, L. M., and J. V. Matson, "Prediction of the Calcium Carbonate Saturation pH in Cooling Water," Water Research, Vol. 14, November, 1980, pp. 1729-1735.
- Matson, J. V., Clifford, D. A., and Mouche, R. J., "Advances in the Treatment of Cooling Tower Blowdown," ASME, 80-IPC/Pwr-6, 1980
- Matson, J. V., "Zero Discharge of Cooling Water by Sidestream Softening," Journal of the Water Pollution Control Federation, Vol. 51, No. 11, 1979, pp. 2602-2614.
- Matson, J. V., "Design Concepts of the New City of Houston 69th Street Advanced Waste Treatment Plant," Progress in Water Technology, Vol. 8, 1977.
- Matson, J. V., "Treatment of Cooling Tower Blowdown," Journal of the Environmental Engineering Division, ASCE, February, 1977.

- Matson, J. V. and Coneway, C. R., "Economics of Disinfection," Forum on Ozone Disinfection, International Ozone Institute, 1977.
- Matson, J. V., "AWT at Woodlands, Texas," Water and Wastes Engineering, December, 1976.
- Matson, J. V. and Characklis, W. G., "Diffusion into Microbial Aggregates," Water Research, Vol. 10, 1976
- Kessick, M. A., Pipes, D. M., and Matson, J. V., "A Simple Drift Measurement Technique for Industrial Cooling Towers," Environmental Letters, Vol. 8, 1975
- Kessick, M. A, and Matson, J. V., "Co-distillation of Boric Acid with Water under Ambient Conditions," Tellus, 1975.
- Matson, J. V., and Characklis, W. G. "Diffusion of Oxygen through Microbial Aggregates," Water AICHE Symposium Series, 1974., vol.71.
- Matson, J. V., et al., "Mathematical Model of Biological Reactor Design Incorporating Characteristics of Cell Aggregates," Water AICHE Symposium Series, 1973, Vol. 70.
- Matson, J. V., and Bennett, G. T., "Cost of Industrial and Municipal Waste Treatment in the Maumee River Basin," ASME, 69-PID-4, 1970

Conference Proceedings

- Matson, J.V, and E.A. Goreham, "Zero Emissions Discharge, the Ultimate Solution to Sustainable Industrial Development," Proceedings of the Woodlands-DeLange Conference, Rice University, Houston, Texas, March, 1997.
- Matson, J.V., et. al., "Zero Discharge Technology: A Case Study," Proceedings of the EPA Region 3 Pollution Prevention Conference, Philadelphia, Pa. June, 1996.
- Matson, J.V., and Lamancusa, J.S. "Stimulating Change in Engineering Education Through the Leonhard Center at Penn State University" Proceedings of the Annual ASEE Conference, University of Illinois, June, 1993.
- Thomas, K.B., and J.V. Matson, "Maximum Removal of Heavy Metals from the Wastewater of a Proposed Copper Processing Plant," Proceedings of the 47th Annual Purdue Waste Conference, W. Lafayette, Ind., May, 1992.
- Matson, J.V., "Teaching the Creative Process in the Engineering Classroom," 1987 ASEE Annual Conference Proceedings, June, 1987.
- Matson, J. V. et al., "Energy (Cost) Savings by Zero Discharge in Cooling Towers," Proceedings of the Fourth Annual Industrial Energy Conservation Technology Conference, April 1982.
- Matson, J. V., et al., Oxygen Supply Limitations in Full Scale Biological Treatment Systems, Proceedings of the 27th Industrial Waste Conference, May, 1972.

Dr. Jack V. Matson
Four Year Case History
May, 2016

1. Menasha Corporation v. Employers Insurance Company et al. Case No. 07CV1406. Circuit Court of Winnebago County. Jeremy Schultz. December 2011, January 2012. D

2. Commissioner of the Department of Planning and Natural Resources, et al. v. Century Alumina Company, et al. Case No. 1:05-cv-00062-HB. District Court of the Virgin Islands, Division of St. Croix. Jack Dema. July 2012. P

3. Board of Supervisors of Fairfax County, Virginia v. Equity Homes, LLC., et al. CL. 2012-03600. Circuit Court for Fairfax County. Robert Hesselbacher, Jr. January 2013. D.

4. John Allen, et al, v. Monsanto Company, et al. Case No. 2008-CA-172. Circuit Court of the First Judicial Circuit, In and For Escambia County, Florida. March 2014. P

5. The City of Crystal Springs v. BorgWarner, Inc., et al. Civil Action No. 2012-0251. Circuit Court of Copiah County, Mississippi. Farrest Taylor. August 2014. P

Notes:
D on behalf of Defendants; P on behalf of Plaintiffs; Trial testimony where stated

APPENDIX B

Facts and Data Considered

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Deposition of Robert G. Kaley, II, Ph.D. in Town of Lexington v. Pharmacia Corporation et al.
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Deposition of Robert G. Kaley, II, Ph.D. in Town of Westport v. Monsanto Company et al. (4.5-6.2016)

"Polychlorinated Biphenyls and Polybominated Biphenyls," IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 107, 2016

Chlorodiphenyl (54% chlorine),NIOSH Pocket Guide, http://www.cdc.gov/niosh/npg/npgd0126.html, 2016

NIOSH criteria for a Recommended Standard …. Occupational exposure to Polychlorinated Biphenyls (PCBs), 1977

Nisbet and Sarofim, "Rates and Routes of Transport of PCBs in the Environment, Environmental Health Perspectives, April 1972, pp. 21-38

APPENDIX C

VAPOR PRESSURE CALCULATIONS

Southern Research Institute (SRI) provided equations to estimate the vapor pressure of Aroclors 1242, 1248 and 1254 within the temperature range of 25 to 100°C (TOWOLDMON0048965, 2/4/1954). The relationship of temperature and vapor pressure for Aroclor 1254 was given by

$$\log P = -\frac{3{,}780}{T} + 8.62$$

where:
P = the vapor pressure of Aroclor in mmHg
T = the temperature in K

For example, at 100°F (37.8°C) the vapor pressure is 2.87×10^{-4} mmHg. The ideal gas law was used to calculate the saturation concentration of Aroclor 1254 vapor in air be 4.8 mg/m^3 at 100°F. It is in the same range of other values reported for Aroclor 1254 at 100°F as shown in Table 1.

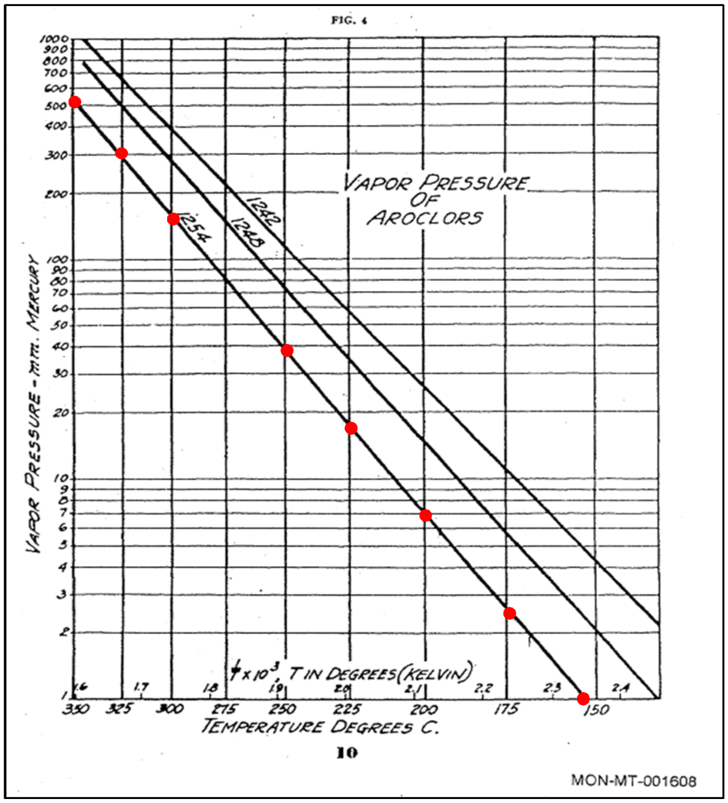
Monsanto's reported vapor pressure in tables given in its 1960 bulletins was 6×10^{-5} mmHg at 100°F. This number is an order of magnitude lower than the values extrapolated from the vapor pressure charts in Monsanto's 1945 technical bulletin (MON-MT—001618, 1945) as well as from the chart given in the 1960 bulletin (DSW352447, 12/1960). The incorrect value from the Monsanto product bulletins of the 1960's was then repeated throughout other technical literature including Material Safety Data Sheets (MSDSs) from 1988 and 1995 and an Environmental Science and Pollution Research article published in 2010 that cites a Monsanto MSDS from 2004 (Erickson et al, 2010).

Table 1. Vapor pressures for Arcolor 1254 from SRI and Monsanto documents.

Source	Temperature	Vapor Pressure (mmHg)	PCB Saturation in Air (mg/m^3)
Monsanto Tables[1]	100°F (37.8C)	6×10^{-5}	1.0
SRI Data (1954)[2]	99.5°F (37.5°C)	2.87×10^{-4} 2.76×10^{-4}	4.8 4.7
SRI Equation/Calc[2]	100°F (37.8°C)	2.9×10^{-4}	4.8
Extrapolation from Monsanto Graph[3]	100°F (37.8°C)	6×10^{-4} (1945) 9.3×10^{-4} (1960)	10.0 15.6

[1] TOWOLDMON0029987, no date; DSW 352447, 12/1960
[2] TOWOLDMON0048965, 2/4/1954
[3] DSW352447, 12/1960; MON-MT-001598, 1945

The estimated vapor pressure of Aroclor 1254 at 100 deg F extrapolated from the values shown in Figure 4 (MON-MT-001598, 1945 The Aroclors)

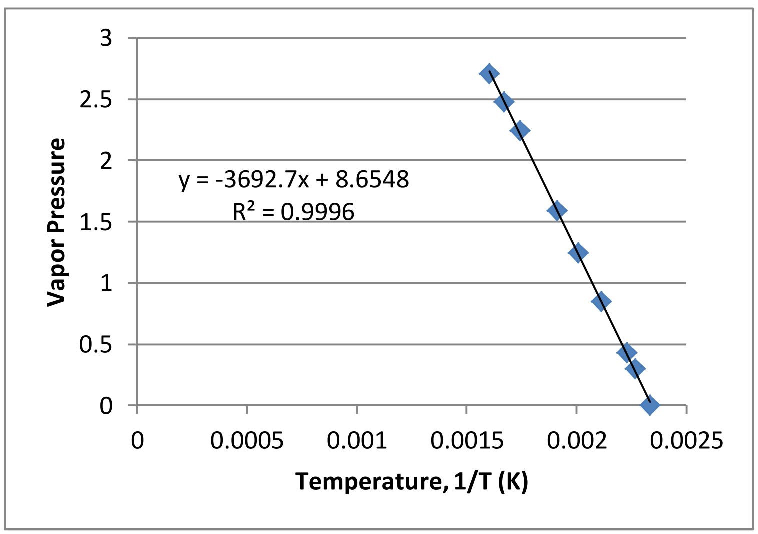


T [C]	1/T [K]	Pv [mmHg]	logP
155	0.002336	1	0
168	0.002267	2	0.30103
175	0.002231	2.7	0.43136376
200	0.002113	7	0.84509804
225	0.002007	17.5	1.24303805
250	0.001911	39	1.59106461
300	0.001745	175	2.24303805
325	0.001672	300	2.47712125
350	0.001605	510	2.70757018

Calculate vapor pressure at 100 deg F

$y = -3692.7x + 8.6548$

T [C]	1/T [K]	logP	Pv [mmHg]
37.8	0.003216	-3.22074	$\boxed{6.02E-04}$



The estimated vapor pressure of Aroclor 1254 at 100 deg F extrapolated from the values shown in Figure 3 (DSW 352447, 1960 Aroclor Plasticizers Technical Bulletin No. PL 306)

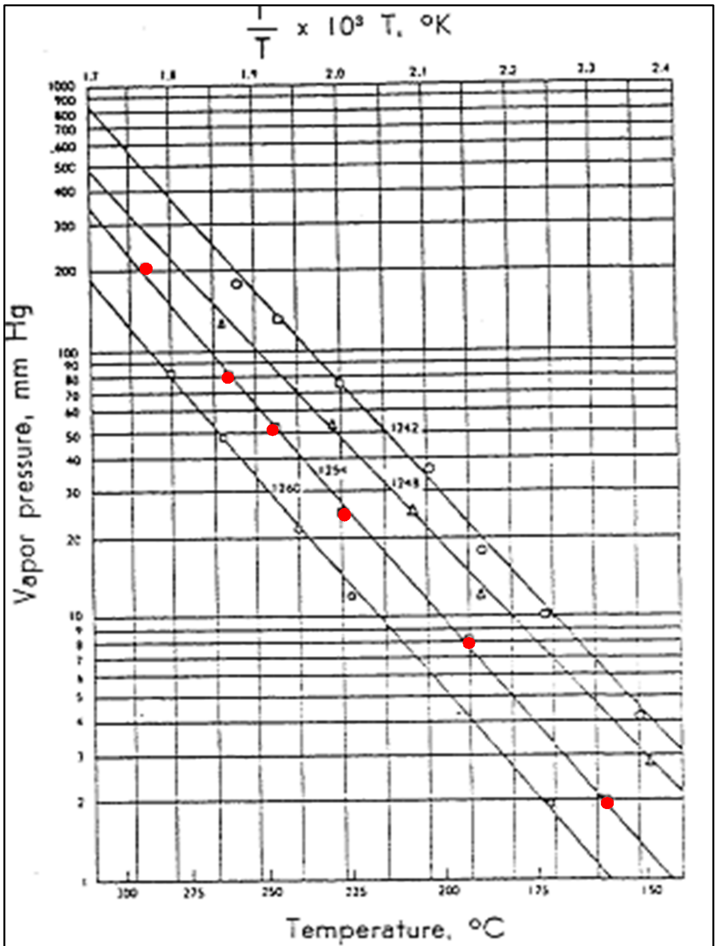


Fig. 3—VAPOR PRESSURES OF AROCLORS

$1/T * 10^3$[K]	1/T [K]	Pv [mmHg]	logP
2.31	0.00231	2	0.3010
2.15	0.00215	8	0.9031
2	0.002	25	1.3979
1.93	0.00193	51	1.7076
1.87	0.00187	80	1.9031
1.77	0.00177	200	2.3010

Calculate vapor pressure at 100 deg F

$y = -3675.7x + 8.7887$

T [C]	1/T [K]	logP	Pv [mmHg]
37.8	0.003216	-3.03217	$\boxed{9.29E-04}$

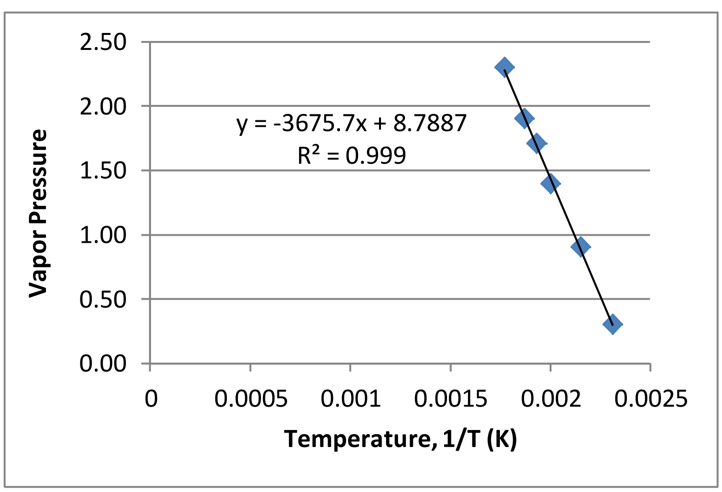


Figure 1 shows vapor pressures as a function of temperature for Aroclor 1254. The line was drawn based on the equation in SRI's final report to Monsanto (TOWOLDMON0048965, 2/4/1954). The other data points were obtained from a number of sources including Monsanto's bulletin and internal communications, USEPA's estimation, and the American Industrial Hygiene Association guide sheet. The vapor pressure provided in the 1960s Monsanto bulletins was incorrect as compared to other sources.

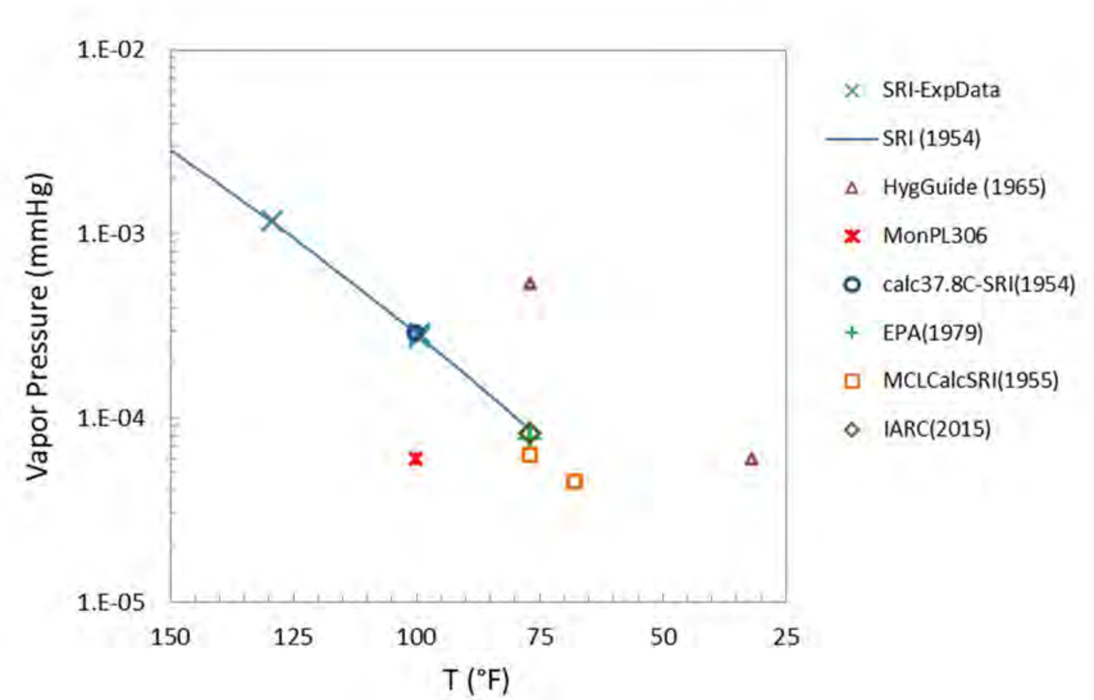


Figure 1. Vapor Pressure (mmHg) as a function of Temperature (°F) over the range 30 to 150°F.

MonPL306 = DSW 352496, 12/1960
SRI-ExpData and SRI (1954) = TOWOLDMON0048965, 2/4/1954
MCLCalcSRI = MONS 095191, 12/6/1955
HygGuide (1965) = MONS 076148, Jan-Feb 1965
EPA (1979) = Callahan et al, 1979

Literature References

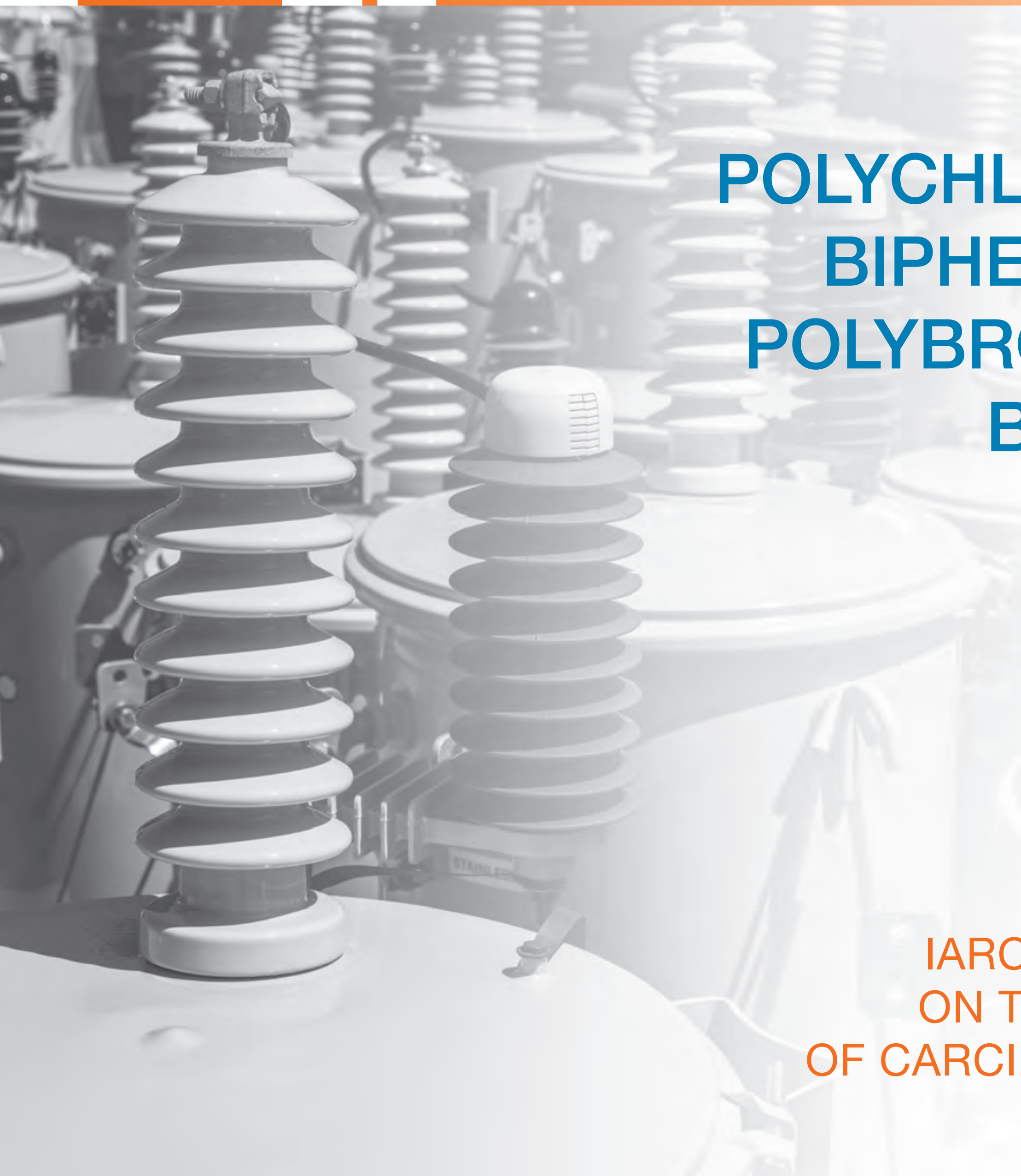
Erickson, M. D. and R. G. Kaley II. 2010. "Applications of Polychlorinated Biphenyls." *Environmental Science and Pollution Research* 18 (2): 135–51.

Callahan, M, et al. 1979. "Water-Related Environmental Fate of 129 Priority Pollutants." EPA-440/4-79-029. US EPA.

International Agency for Research on Cancer (IARC). 2015. Polychlorinated Biphenyls and Polybrominated Biphenyls. *IARC Monographs* on the Evaluation of Carcinogenic Risks to Humans v107.

EXHIBIT 4

IARC MONOGRAPHS



POLYCHLORINATED BIPHENYLS AND POLYBROMINATED BIPHENYLS

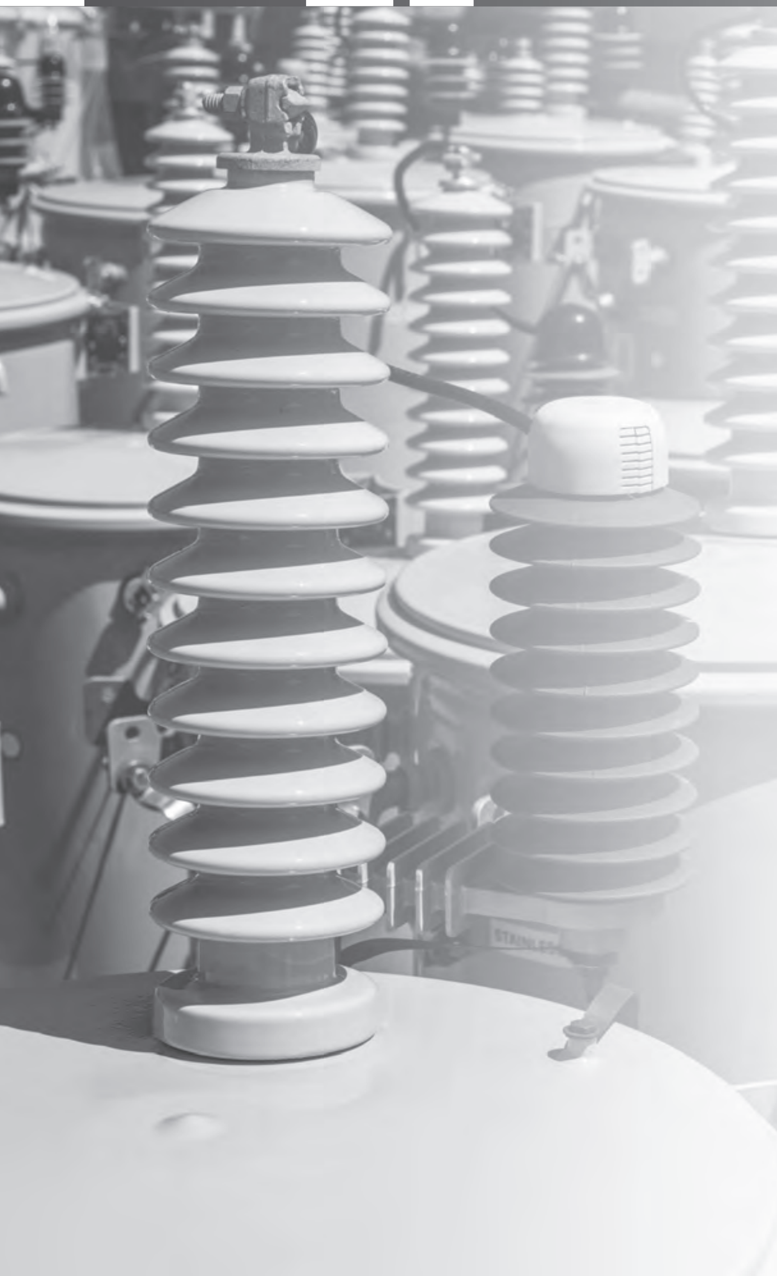
VOLUME 107

IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

World Health Organization

IARC MONOGRAPHS



POLYCHLORINATED BIPHENYLS AND POLYBROMINATED BIPHENYLS

VOLUME 107

This publication represents the views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, which met in Lyon, 12–19 February 2013

Lyon, France - 2016

IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

World Health Organization

IARC MONOGRAPHS

In 1969, the International Agency for Research on Cancer (IARC) initiated a programme on the evaluation of the carcinogenic risk of chemicals to humans involving the production of critically evaluated monographs on individual chemicals. The programme was subsequently expanded to include evaluations of carcinogenic risks associated with exposures to complex mixtures, lifestyle factors and biological and physical agents, as well as those in specific occupations. The objective of the programme is to elaborate and publish in the form of monographs critical reviews of data on carcinogenicity for agents to which humans are known to be exposed and on specific exposure situations; to evaluate these data in terms of human risk with the help of international working groups of experts in carcinogenesis and related fields; and to indicate where additional research efforts are needed. The lists of IARC evaluations are regularly updated and are available on the Internet at http://monographs.iarc.fr/.

This programme has been supported since 1982 by Cooperative Agreement U01 CA33193 with the United States National Cancer Institute, Department of Health and Human Services. Additional support has been provided since 1986 by the European Commission Directorate-General for Employment, Social Affairs, and Inclusion, initially by the Unit of Health, Safety and Hygiene at Work, and since 2014 by the European Union Programme for Employment and Social Innovation “EaSI” (2014–2020) (for further information please consult: http://ec.europa.eu/social/easi). Support has also been provided since 1992 by the United States National Institute of Environmental Health Sciences, Department of Health and Human Services. The contents of this volume are solely the responsibility of the Working Group and do not necessarily represent the official views of the United States National Cancer Institute, the United States National Institute of Environmental Health Sciences, the United States Department of Health and Human Services, or the European Commission.

Published by the International Agency for Research on Cancer,
150 cours Albert Thomas, 69372 Lyon Cedex 08, France

On-line publication, 29 June 2015 (see Corrigenda)

Distributed by WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland
(tel.: +41 22 791 3264; fax: +41 22 791 4857; email: bookorders@who.int).

Corrigenda to the IARC Monographs are published online at http://monographs.iarc.fr/ENG/Publications/corrigenda.php
To report an error, please contact: editimo@iarc.fr

Co-funded by the European Union

IARC Library Cataloguing in Publication Data

Polychlorinated biphenyls and polybrominated biphenyls / IARC Working Group on the Evaluation of Carcinogenic Risks to Humans (2013: Lyon, France)

(IARC monographs on the evaluation of carcinogenic risks to humans ; volume 107)

1. Polychlorinated Biphenyls – adverse effects 2. Polychlorinated Biphenyls – metabolism 3. Polychlorinated Biphenyls – toxicity 4. Polybrominated Biphenyls – adverse effects 5. Polybrominated Biphenyls – metabolism 6. Polybrominated Biphenyls – toxicity 7. Carcinogens 8. Neoplasms – chemically induced
I. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans
II. Series

ISBN 978 92 832 0173 1 (NLM Classification: W1)
ISSN 1017-1606

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POLYBROMINATED BIPHENYLS

NOTE TO THE READER

The term 'carcinogenic risk' in the *IARC Monographs* series is taken to mean that an agent is capable of causing cancer. The *Monographs* evaluate cancer hazards, despite the historical presence of the word 'risks' in the title.

Inclusion of an agent in the *Monographs* does not imply that it is a carcinogen, only that the published data have been examined. Equally, the fact that an agent has not yet been evaluated in a *Monograph* does not mean that it is not carcinogenic. Similarly, identification of cancer sites with *sufficient evidence* or *limited evidence* in humans should not be viewed as precluding the possibility that an agent may cause cancer at other sites.

The evaluations of carcinogenic risk are made by international working groups of independent scientists and are qualitative in nature. No recommendation is given for regulation or legislation.

Anyone who is aware of published data that may alter the evaluation of the carcinogenic risk of an agent to humans is encouraged to make this information available to the Section of IARC Monographs, International Agency for Research on Cancer, 150 cours Albert Thomas, 69372 Lyon Cedex 08, France, in order that the agent may be considered for re-evaluation by a future Working Group.

Although every effort is made to prepare the *Monographs* as accurately as possible, mistakes may occur. Readers are requested to communicate any errors to the Section of IARC Monographs, so that corrections can be reported in future volumes.

Table 1.14 Volume and duration of PCB production in countries with known production (by production volume)

Producer	Country	Duration		Volume (tonnes)	Reference
		Start	Stop		
Monsanto	USA	1930	1977	641 246	de Voogt & Brinkman (1989)
Bayer AG	Germany, western	1930	1983	159 062	de Voogt & Brinkman (1989)
Orgsteklo	Russian Federation	1939	1990	141 800	AMAP (2000)
Prodelec	France	1930	1984	134 654	de Voogt & Brinkman (1989)
Monsanto	United Kingdom	1954	1977	66 542	de Voogt & Brinkman (1989)
Kanegafuchi	Japan	1954	1972	56 326	Tatsukawa (1976)
Orgsintez	Russian Federation	1972	1993	32 000	AMAP (2000)
Caffaro	Italy	1958	1983	31 092	de Voogt & Brinkman (1989)
2.8 Vinalon and the Sunchon Vinalon Complex	Democratic Republic of Korea	1960[a]	2012[b]	30 000[c]	NIP Korea DPR (2008)
SA Cros	Spain	1955	1984	29 012	de Voogt & Brinkman (1989)
Chemko	Former Czechoslovakia	1959	1984	21 482	Schlosserová (1994)
Xi’an	China	1965	1980	10 000	Jiang *et al.* (1997), NIP China (2007)
Mitsubishi	Japan	1969	1972	2 461	Tatsukawa (1976)
Electrochemical Co.	Poland	1966	1970	1 000	Sułkowski *et al.* (2003)
Zaklady Azotowe Tarnow-Moscice	Poland	1974	1977	679	Sułkowski *et al.* (2003)
Geneva Industries	USA	1972	1974	454	EPA (2008b)
Total		*1930*	*2012*	*1 355 810*	

[a] During the 1960s

[b] “The Ministry of Chemical Industry will, by 2012, take measures to dismantle the PCBs production process and establish a new process of producing an alternative.”

[c] Estimated from Republic of Korea 2008, National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants.

PCB, polychlorinated biphenyl

Adapted from Breivik *et al.* (2007)

galvanized corrugated sliding panels in various industrial and military applications.

(a) Closed applications

The predominant applications for PCBs were in dielectric fluids in capacitors and transformers. These applications are considered to be closed applications, since PCBs are not expected to leak out of the system. However, transformers had occasionally to be topped up with PCBs so that these systems were not completely closed.

While applications in hydraulic and heat transfer, and cooling systems are also usually considered to be closed applications, there have been reports of accidental leaks from such systems, and thus these applications are often referred to as “normally closed.”

During the 1960s, dielectric fluid in capacitors and transformers represented 50–60% of the sales of PCBs in the USA (IARC, 1978). In 1972, Monsanto restricted its sale of PCBs to capacitor and transformer applications (Erickson, 2001); after this date, these applications represented some 99% of the total use of PCBs in the USA (Durfee *et al.*, 1976). In China, PCB_3 [similar to Aroclor 1242] was used primarily in power capacitors applied in electricity production, distribution and transmission, while PCB_5 [similar to Aroclor 1254] was used mainly as a paint additive (see Table 1.8).

EXHIBIT 5

COM-72-10419

Polychlorinated Biphenyls and the Environment

Interdepartmental Task Force on PCBs

Washington D.C.

May 1972

OSW 010011

DSW 010012

Distributed by the **National Technical Information Service**, U.S. Department of Commerce, Springfield, Virginia 22151. Price $6.00

BIBLIOGRAPHIC DATA SHEET	1. Report No. ITF-PCB-72-1	2.	3. Recipient's Accession No. COM-72-10419
4. Title and Subtitle PCBS AND THE ENVIRONMENT			5. Report Date 20 Mar. 72
			6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Interdepartmental Task Force On PCBs			10. Project/Task/Work Unit No.
			11. Contract/Grant No.
12. Sponsoring Organization Name and Address Departments of Agriculture, Commerce, Health, Education, and Welfare, and Interior; and Environmental Protection Agency; plus other participating agencies.			13. Type of Report & Period Covered Final
			14.

15. Supplementary Notes

16. Abstracts

This report is the product of a six month review of the chemicals known as PCBs--polychlorinated biphenyls--by five Federal agencies, with participation by other agencies. The Interdepartmental Task Force on PCBs had as its goal the coordination of the scientific efforts of the Government aimed at understanding PCBs and the strengthening of the Government's ability to protect the public from actual or potential hazards associated with them. The task force made nine findings, conclusions, and recommendations, primarily pointing out that PCBs should be restricted to essential or nonreplaceable uses which would minimize the likelihood of human exposure or leakage to the environment. Supplementing the 20-page report are eight appendices detailing current knowledge about various aspects of PCBs, including their use and replaceability; occurrence, transfer, and cycling in the environment; occurrence and sources in food; and PCBs effects on man and animals.

17. Key Words and Document Analysis. 17a. Descriptors

*Pollution,
*Chlorine aromatic compounds,
*Biphenyl/chloro,
Environmental surveys,
Insulating oil,
Economic factors,
Government policies,
Toxicology,
Public Health.

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13B, 6T

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 192
	20. Security Class (This Page) UNCLASSIFIED	22. Price PC $6.00

FORM NTIS-35 (REV. 3-72) USCOMM-DC 14952-P72

DSW 010013

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PREFACE

On September 1, 1971, representatives of several agencies of the Federal Government established an interdepartmental task force to coordinate the scientific efforts of the Government aimed at understanding the family of chemical compounds known as polychlorinated biphenyls (PCBs), and to strengthen the Government's ability to protect the public from actual or potential hazards from PCBs. On September 5 it was announced that the task force would "coordinate a government-wide investigation into PCB contamination of food and other products". On September 13 the task force, made up of qualified specialists from a range of disciplines, held the first of a series of meetings. Appropriate spokesmen on various problems associated with PCBs were assigned to prepare a series of background papers, drawing on the resources of their own and other agencies.

The task force included operating units of five Executive Branch departments: Department of Agriculture; Department of Commerce (Assistant Secretary for Science and Technology and National Oceanic and Atmospheric Administration); Environmental Protection Agency; Department of Health, Education, and Welfare (Food and Drug Administration and National Institute of Environmental Health Sciences of the National Institutes of Health); and Department of the Interior (Bureau of Sport Fisheries and Wildlife).

The report which follows represents the results of the task force's review and reflects the position of the operating agencies of the Federal Government which have major responsibilities concerning such chemicals as PCBs in food and in the environment. The task force had the advantage of some additional sources of information and review on PCBs. For example, during the course of the study, the National Institute of Environmental Health Sciences sponsored an international scientific meeting on PCBs on December 20-21, 1971, at the Quail Roost Conference Center, Rougemont, North Carolina. One hundred persons--from Government, universities, industry, and the press--attended. The proceedings of this conference soon will be published by the Institute. The task force also met from time to time with a group of scientific advisors from outside the Federal Government, which was already at work prior to September 1971 examining a number of hazardous trace substances, one of which was PCBs.

The individuals who served on the task force included: Dr. John E. Spaulding and Dr. Harry W. Hays (Department of Agriculture), Dr. Robert W. Cairns and Dr. William Aron (Department of Commerce), Dr. John Buckley (Environmental Protection Agency), Dr. Lawrence Fishbein, John R. Wessel, and Dr. Albert Kolbye (Department of Health, Education, and Welfare), Dr. Lucille Stickel (Department of the Interior), Dr. Edward J. Burger, Jr. (Office of Science and Technology), and Dr. Terry Davies (Council on Environmental Quality). Many others participated in some of the meetings and lent assistance in a variety of ways including authorship of background papers published as appendices in this report. The task force is grateful for this assistance.

The task force will continue to assess new information that comes to its attention.

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Polychlorinated biphenyls (PCBs) have been used in the United States and elsewhere over the past 40 years, for many industrial and consumer applications. During the past three years evidence has accumulated to indicate that PCBs are widely dispersed throughout the environment and that they can have adverse ecological and toxicological effects.

The principal uses for PCB fluids are in the electrical industry. PCBs have superior cooling, insulating, and dielectric properties and hence are widely used in various electrical devices. Transformers and capacitors filled with PCBs can be used in inside locations where failures of oil-insulated equipment would present a potential danger to life and property. Because PCBs are relatively nonflammable, apparatus containing them is essentially free from the fire and explosion hazards associated with oil-insulated and oil-cooled electric devices. Stability at high temperatures is another major factor in the attractiveness of these compounds. The principal advantage of PCBs over substitutes is the relative freedom from flammability in some applications that previously had been plagued by serious fires. PCBs also give electrical equipment the critical advantages of reliability, long life, and compactness. PCB impregnated capacitors, for example, are markedly more reliable and long-lived, and 1/6 the size, 1/5 the weight, and 1/4 the cost of comparable oil impregnated capacitors. Small capacitors with PCBs have a use-life expectancy of 10 to 15 years, and large capacitors 20 to 25 years. PCBs in transformers are replaced only every 25 to 30 years.

PCBs have been discovered to have a widespread distribution in the environment, and some environmental occurrences have been associated with adverse effects on certain forms of animal life. Beginning in 1971, the Monsanto Company, the sole U. S. producer, has reported taking voluntary actions to reduce the volume of PCB production and to limit its distribution to industries concerned with the manufacture of electrical apparatus. Similar restrictions have been put into effect by statute in Sweden and voluntarily in Great Britain.

A large use of PCBs had been in carbonless duplicating paper. This use has been discontinued. The Food and Drug Administration and the food industry have increased their surveillance to assure that PCBs are not used in food plants, products, or packaging.

The task force has reviewed all of the available scientific information on various aspects of the PCB problem. It has found much data that it regards as inadequate and many questions that remain unanswered. But on the basis of available information, the task force concurs on the following findings, conclusions, and recommendations:

DSW 010022

1. PCBs should be restricted to essential or non-replaceable uses which involve minimal direct human exposure since they can have adverse effects on human health. There currently are no toxicological or ecological data available to indicate that the levels of PCBs currently known to be in the environment constitute a threat to human health, but additional experiments are underway to evaluate the impact of low level, long-term exposure to PCBs.

2. PCBs have been used so widely over such a long period that they are ubiquitous. Even a total cessation of manufacturing and use of PCBs would not result in the rapid disappearance of the material, and ultimate disappearance from the environment will take many years. The elimination of non-essential uses and prohibition of discharges from essential uses will result in gradual elimination from the environment.

3. PCBs were first identified as potential food contaminants in 1966. Three principal sources or routes of contamination of food have been identified. General environmental contamination has resulted in PCB residues in some fresh water fish. Prohibition of PCB discharges into water will result in the reduction of such residues. Another route occurs from the presence in food packaging materials of PCB residues, some of which migrate into packaged food. The FDA has proposed regulations for food packaging materials and foods to deal with this problem. The third route involves accidental contamination of food from leakage or spillage of PCBs into feed or directly into food. The dietary intake of PCBs is of low order and does not present an imminent health hazard. To date, all of the high levels of PCBs encountered in human or animal foods have been associated with accidents, for which Government agencies have exercised necessary regulation and control to minimize the distribution of contaminated foods.

4. The sole domestic producer of PCBs, Government agencies, and key user industries are taking appropriate steps to cut off further introduction of PCBs into the food supply and to reduce the current levels of PCBs as food and environmental contaminants. The Food and Drug Administration (FDA) has acted, under the authority of the Food, Drug, and Cosmetic Act, to preclude the accidental PCB contamination of food. It has also proposed a prohibition on the use in food packaging materials of pulp from reclaimed and salvaged fibers that contain poisonous or deleterious substances that may migrate into the food if the contamination by such substances is deliberate or avoidable. It has proposed temporary tolerances for unavoidable PCB residues in food packaging materials and in certain foods. The Department of Agriculture has acted under the Wholesome Poultry Act and other statutes to prevent accidentally contaminated foods from reaching the market.

The major gap in the regulatory system to deal with PCBs is the absence of any broad Federal authority to restrict use or distribution of the chemical, to control imports, and to collect certain types of information. The task force believes that such authority is needed. This authority would be provided by the Toxic Substances Control Act proposed by the Administration and now pending before Congress.

5. Housekeeping is particularly important in the manufacture, use, and disposal of PCBs. Under a program of limitation on the sale of PCBs, the electrical industry will continue to be the principal user of PCBs; it, as well as industries now holding inventories of PCBs, have a special responsibility for monitoring and controlling their wastes. In this connection, the Environmental Protection Agency will restrict industrial liquid discharges of PCBs from PCB users. To keep levels in fish as low as possible, and in any case below FDA's interim action level of 5 parts per million, concentrations in rivers or lakes from all sources should not exceed 0.01 parts per billion.

6. The use of PCBs should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCBs in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCBs to all except manufacturers of electrical transformers and capacitors.

Pending passage of the Toxic Substances Control Act, the Federal Government does not have the legal authority to impose restrictions corresponding to the actions reported by Monsanto. Although some Federal enforcement authority is available, the Federal Government does not have the authority to control PCBs at their source.

7. Most capacitors presumably have been disposed of in landfills. PCB containing material buried in soil is not expected to migrate but should remain in place. In the past, many fluids containing PCBs have been disposed of in sewers. More appropriate means of disposal such as high-temperature (at least 970°C) incineration must be used instead.

8. PCBs are manufactured in countries other than the United States. Importation of PCBs as a chemical or as a component in products remains legally possible because the Toxic Substances Control Act has not yet become law. Electrical products imported from abroad may contain PCBs. The task force looks to international agreements to bring about some multi-national understanding on the sale and use of PCBs globally. Importation of PCBs for uses other than those singled out in the present pattern of voluntary limitations should be avoided by users.

As an additional measure, the United States has asked the Organization for Economic Cooperation and Development (OECD) through its Environment Committee to make a special review of member states' national policies concerning PCBs and also to identify products moving in international trade which contain PCBs. OECD, whose membership includes all major Western industrialized states plus Japan and Australia, has been giving priority attention to the problem of PCBs over the past year.

9. More scientific information about PCBs is needed, and several Government agencies are seeking it through research. The task force recognizes that the scientific basis of much of our knowledge must be

strengthened through research. The total exposure of a human being to a given substance from all sources--air, water, and food--must be considered, and interactions of PCBs and other substances within and outside the body must be evaluated. Similar consideration must be given to the other body organisms.

Current scientific knowledge gained from laboratory animal experiments is often inadequate to allow reliable interpretation of the data in terms of possible effects on man. The scientific basis for interpreting such tests must be improved.

The situation regarding PCBs is not significantly different from the problem of other toxic susbstances which cause concern when they come into contact with man, his food, and his environment. Continuing vigilance on the part of Government agencies, industry, universities, and many other agencies both within and outside the Government will be necessary to achieve an effective system for assessing and controlling the hazards of toxic substances, including PCBs.

The task force, by reviewing research needs and the present Federal research effort, has helped to insure that these efforts of the agencies are well planned and coordinated. Certain Government laboratories as well as a number of non-Government scientists recently have embarked on additional research on PCBs, and the results will be communicated to the scientific public completely and promptly through normal channels such as meetings and journals.

I. PRODUCTION, DISTRIBUTION, AND USE OF PCBS

Polychlorinated biphenyls (PCBs) were first manufactured commercially in 1929. By virtue of their unusual chemical and physical properties, they achieved widespread use in a variety of applications. PCBs are now manufactured in Great Britain, France, Germany, the USSR, Japan, Spain, Italy, and Czechoslovakia, as well as in the United States.

In the United States, PCBs have been manufactured by a single producer, the Monsanto Company, and marketed under the tradename "Aroclor". Table 1 gives a breakdown, by category of use and by type of PCB, of the total U. S. production, domestic sales, and U. S. export sales from 1957 to the present. Figure 1 and Figure 2 summarize these data for the years 1963 through 1971.

Both production and domestic sales of PCBs roughly doubled between 1960 and 1970. If one assumes a constant rate of growth of domestic sales since 1930, the cumulative sales in North America by 1970 would be of the order of 500,000 tons. (1) Corresponding data on production and use of PCBs outside the United States are not available. Current estimates suggest that total U. S. production represents roughly one-half of the total world production.

As can be seen in Table 1, the majority of the PCB material produced in the U. S. was marketed domestically. Between 1963 and 1971, the proportion of the production which was exported averaged 13 percent. In 1971, the Monsanto Company reportedly undertook a variety of voluntary restrictions on the distribution of PCBs to various categories of industries. Both

TABLE 1
PCB MANUFACTURING AND SALES
DATA FROM MONSANTO INDUSTRIAL CHEMICALS CO.
1957 THROUGH 1971
(Thousands of Pounds)

	1957	1958	1959	1960	1961	1962
TOTAL PRODUCTION (For Domestic Sales)(1)				37919	36515	38353
DOMESTIC SALES	32299	26061	31310	35214	37538	38043
DOMESTIC SALES BY CATEGORY						
Heat Transfer	-	-	-	-	-	157
Hydraulics/Lubricants	1612	1549	2685	2523	4110	3915
Misc. Industrial	704	755	1569	1559	2114	1681
Transformer	12955	5719	5984	7921	6281	7984
Capacitor	17028	14099	16499	16967	15935	15382
Plasticizer Applications(2)		3939	4573	6244	9098	8924
Petroleum Additives	-	-	-	-	-	-
Total	32299	26061	31310	35214	37538	38043
DOMESTIC SALES BY PCB GRADE						
Aroclor 1221	23	16	254	103	94	140
Aroclor 1232	196	113	240	155	241	224
Aroclor 1242	18222	10444	13598	18196	19827	20654
Aroclor 1248	1779	2559	3384	2827	4023	3463
Aroclor 1254	4461	6691	6754	6088	6294	6325
Aroclor 1260	7587	5982	6619	7330	6540	6595
Aroclor 1262	31	184	359	326	361	432
Arcolor 1268	-	72	102	189	158	210
Total	32299	26061	31310	35214	37538	38043

NOTE: (1) Production amounts prior to 1960 are not available.
(2) Amounts for plasticizer applications prior to 1958 are not available.

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TABLE 1 (cont.)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	Prospect 1972
U.S. PRODUCTION	44734	50833	60480	65849	75309	82854	76387	85054	40471	25-30 m
DOMESTIC SALES (LBS.)	38132	44869	51796	59078	62466	65116	67194	73061	37635	25-30 m
U.S. EXPORT SALES	3647	4096	4234	6852	8124	11231	10624	13651	9876	?
U.S. DOMESTIC SALES BY CATEGORY										
Heat Transfer	582	929	1237	1766	2262	2529	3050	3958	3480	-
Hydraulics/Lubricants	3945	4374	4616	4258	4643	5765	8039	7403	1643	-
Misc. Industrial	1528	1692	1841	1779	1426	1283	1079	1627	578	-
Transformer	7290	7997	8657	8910	11071	11585	12105	13828	11528	25-30 m
Capacitor	15606	19540	23749	28884	29703	29550	25022	26708	17305	25-30 m
Plasticizer Applications	9181	10337	11696	13481	13361	14404	16460	19537	3102	-
Petroleum Additives	-	-	-	-	-	-	1439	-	-	-
U.S. DOMESTIC SALES BY PCB GRADE										
Aroclor 1221	361	596	369	528	442	136	507	1476	1600	300
Aroclor 1232	13	13	7	16	25	90	273	260	211	300
Aroclor 1242	18510	23571	31533	39557	43055	44853	45401	48588	21000	4000
Aroclor 1248	5013	5238	5565	5015	4704	4894	5650	4073	261	-
Aroclor 1254	5911	6280	7737	7035	6696	8891	9822	12421	5800	6000
Aroclor 1260	7626	8535	5831	5875	6417	5252	4439	4890	1750	600
Aroclor 1262	414	446	558	768	840	720	712	1023	-	-
Aroclor 1268	284	190	196	284	287	280	300	330	-	-

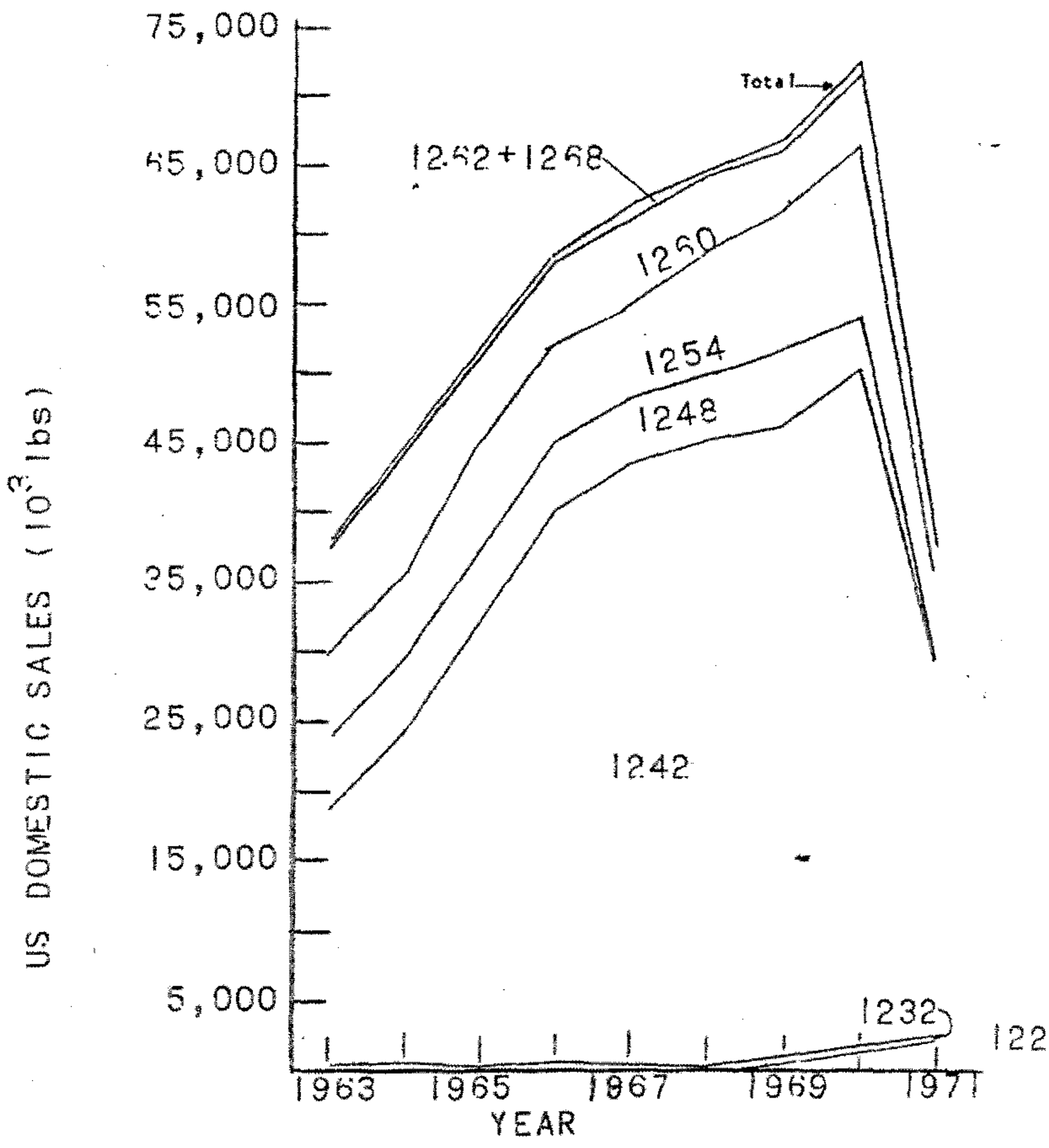

FIGURE 1. US DOMESTIC SALES OF PCBs BY GRADE The uppermost curve represents the total sale

From Nisbet, I.C.T., and Sarofim, A.F. (1)

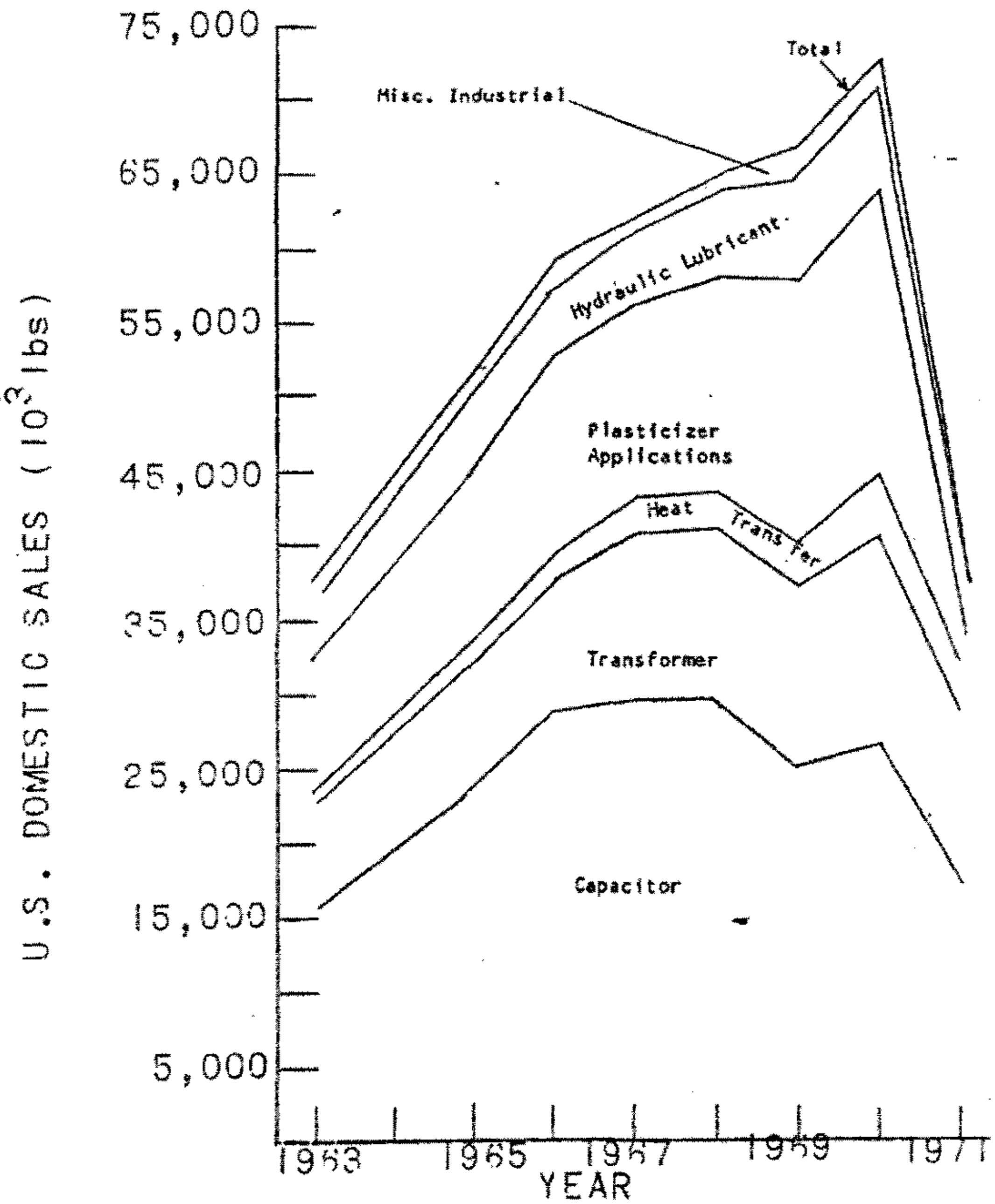

FIGURE 2. US DOMESTIC SALES OF PCBs by Category (The uppermost curve represents the total sales.)

From Nisbet, I.C.T., and Sarofim, A.F. (1)

production and sales figures for 1971 were roughly half of those for 1970, when these volumes were at their peak (Table 1 and Figures 1 and 2). Projections for 1972 indicate an even lower volume.

Prior to 1971, about 40 percent of the PCB material in the United States was used in applications where containment was difficult and losses into the environment were probable. These uses included plasticizers, hydraulic fluids and lubricants, surface coatings, inks, adhesives, pesticide extenders, and microencapsulation of dyes for carbonless duplicating paper. The remaining 60 percent of domestic sales was used mainly in electrical applications (transformers and capacitors). In 1971, this fraction is expected to have reached approximately 90 percent of the total use, only about half of the total use in 1970.

In terms of the grade or family of PCB manufactured, the lower chlorinated species have generally made up the majority of the products produced. From the figures in Table 1 it can be seen that Aroclor 1242 and grades with lower percentages of chlorination characteristically composed one half or more of the total production between 1963 and 1970.

The largest categories of use of PCBs have been in capacitors and transformers and in certain "plasticizer" applications including carbonless duplicating paper. A large percentage of the production of Aroclor 1242 went into these three categories of products. (2) The major uses for PCBs prior to 1970 (in the order of importance as a reflection of the volume of material used) were:

Capacitors
Plasticizer applications
Transformer fluids
Hydraulic fluids and lubricants
Heat transfer fluids

II. CHEMICAL AND PHYSICAL PROPERTIES AND IMPURITIES

Chemical and Physical Properties of PCBs

Theoretically, there are 210 possible PCB compounds, but only about 100 are likely to occur in commercial products. The degree of chlorination determines the chemical and physical properties of the Aroclors; the first two digits of the numbered Aroclor represent the molecular type, the last two digits the average weight percent of chlorine. Their physical state thus varies from colorless, oily liquids to more viscous and increasingly darker liquids to, in the higher series, yellow and then black resins. The PCBs are not readily biodegradable. They resist breakdown by water, acids, and alkalis and have boiling points ranging from 278 to 475°C.

Analytical Techniques

Whereas in the past it was difficult to identify PCBs in the presence of other organochlorine compounds such as DDT and DDE, they can now be separated from interfering compounds and identified and measured by means of thin layer and gas liquid chromatography at levels less than 1 part per million in food and at significantly lower levels in air and water. Confirmation of their presence and molecular structure is possible by mass spectrometry. Various chromatographic columns and GLC detectors have been most useful in the analyses. Increased precision of residue detection in biological materials has also been made possible through the choice of chlorine specific detectors such as the microcoulometric detectors.

Contaminants and Impurities

The starting materials used in synthesis of PCBs determine to a large degree the type of impurity or contaminant in the commercial product. The contaminant variation, of course, renders some divergence in the LD 50 values or other toxicologic response of the PCBs. Fractionated samples of some PCBs of foreign manufacture have shown them to contain as contaminants the tetra- and pentachlorodibenzofurans, the hexa- and heptachloronaphthalenes. Further work is needed to ascertain whether additional impurities or contaminants are present in the various U. S. and foreign PCB products. Also, variance in biological response to the various PCB products should be correlated with analytical data obtained on the actual or likely presence of contaminants.

III. BENEFITS, UTILITY, AND ESSENTIALITY

The task force reviewed the several categories of uses to which PCBs had been put in the past to determine what was known of their utility and to ascertain if alternate or substitute materials were available or whether any of the present applications were essential.

The four major types of applications examined were:

1. Dielectric fluids for capacitors and transformers.
2. Industrial fluids for hydraulic, gas turbine, and vacuum pump uses.
3. Heat transfer fluids.
4. Plasticizers and miscellaneous uses.

This review of utility was undertaken by the National Bureau of Standards. The review was materially aided by information from the National Industrial Pollution Control Council and from certain professional independent testing and evaluation associations.

A major value of the PCB liquids is that those with four or more substituted chlorines per molecule are nonflammable as are their decomposition products, both vapors and arc-formed gaseous products. Thus they can be used as fluids at temperatures up to 700°F without the danger of explosions and fire. The major disadvantage of the PCBs is their toxicity and environmental contamination. The other comparable class of non-flammable fluids is the fluorocarbons, which typically have a lower vapor pressure and lower boiling point than the chlorinated compounds.

APPENDIX D

Occurrence, Transfer, and Cycling of PCBs in the Environment

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APPENDIX D

Occurrence, Transfer, and Cycling of PCBs in the Environment

PCBs have been in use for more than four decades, not only in the United States but throughout the developed world. They were not recognized as environmental contaminants until (Jensen, 1) in Sweden identified a series of unknown peaks on gas chromatograms of pesticide analyses as these substances. These first identifications were in fish and bird tissues; examination of other samples soon revealed that PCBs were widespread in biological materials. Existing data suggest that although the greatest concentrations of residues are found in the vicinity of industrial and municipal areas in the Northern Hemisphere, residues exist in areas remote from civilization and in both the Northern and Southern Hemispheres.

Data on sales of PCBs are available only for the United States from 1957-1971, with sales reaching a high of 36,000 tons in 1970, Table 1. Sales doubled 1960-1970; assuming the same growth rate from 1930 to 1970, about 500,000 tons have been sold in the United States. Data from outside the United States are few. It is estimated that Japan manufactured 13,000 tons per year (2). PCBs are also produced in West Germany, the United Kingdom, Spain, France, Italy, Russia, and possibly new producers in Brazil, Argentina, India, and East Germany. Assuming that the United States used half of the world total, world production would have been about one million tons--approximately half the estimated total production of DDT. Monsanto's 1971 sales dropped to half the 1970 level, and 1972 sales are expected to be 12 - 15,000 tons. Prior to 1971, when Monsanto (the sole U.S. manufacturer) curtailed sales to non-closed system uses, about 40 percent was used in plasticizers, hydraulic fluids and lubricants, surface coatings, inks, pesticide extenders, and micro-encapsulation of dyes for carbonless duplication paper--uses that potentially result in environmental contamination.

If the same percentages held worldwide, 40,000 tons might have been used in ways that could easily reach the environment; accidents and careless disposal practices would have increased this amount considerably, perhaps to 50,000 tons or more.

(Nisbet and Sarofim, 3) provided rough estimates of the losses of PCBs to the North American environment in 1970: 1500 to 2000 tons to the atmosphere (mostly Aroclor 1254 to 1260 from plastics and 1242 from burning dumps); 4000 to 5000 tons to fresh and coastal waters (Aroclor 1242-1260); 22,000 tons into dumps and landfills (mostly Aroclor 1242). Other losses were judged to be small, but often locally significant. The total loss to the North American environment from 1930 to 1970 was estimated to be:

Atmosphere	-	30,000 tons
Water - fresh and coastal	-	60,000 tons
Dumps and landfills	-	300,000 tons

The total of 390,000 tons is within a factor of two of the estimate above of 500,000 tons that might have reached the world environment. They further

EXHIBIT 6

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The Science of the Total Environment 290 (2002) 181–198

the Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Man

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Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 1. Global production and consumption

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Received 15 May 2001; accepted 15 October 2001

Abstract

Information on the historical global production and consumption of polychlorinated biphenyls (PCBs) is urgently needed for estimating PCB fluxes to the environment and for interpreting global contamination patterns by these pollutants. This study presents the methodology, principal uncertainties and selected results from an inventory, aiming to quantify the global production and consumption of total PCBs as well as 22 PCB congeners. The available data on the historical production of PCBs and the chemical composition of various technical mixtures have been compiled from the literature. For some producers with less detailed information, the production of individual PCB constituents has been estimated to derive a global estimate for individual homologues and selected congeners. Information on imports, exports and consumption, as well as restrictions on production and imports, has further been compiled for individual countries. These data, along with assumptions on the trade between countries and regions, have been utilised to derive an estimate of the global historical consumption pattern. Although there are substantial uncertainties involved in these estimates, important aspects governing the large scale temporal and spatial patterns are most likely captured in these estimates. In particular, the information on imports and exports for the principal users of PCBs around the time of peak production is considered to be fairly reliable. The estimates account for a reported historical global production of ~1.3 million t PCBs, more than 70% of which are tri-, tetra- and pentachlorinated biphenyls. The results further suggest that almost 97% of the global historical use of PCBs have occurred in the Northern Hemisphere.

Keywords: POPs; PCBs; Homologues; Congeners; Sources; Production; Consumption; Global; Historical

1. Introduction

Environmental contamination by polychlorinated biphenyls (PCBs) was recognised more than 30 years ago when Sören Jensen detected PCBs in pike from Sweden (Jensen, 1966). Since then, numerous studies have detected PCBs in various compartments of the environment (e.g. Edwards, 1971; Kalmaz and Kalmaz, 1979; Waid, 1986) and the occurrence of PCBs in remote areas, such

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0048-9697/02/$ - see front matter
PII: S0048-9697(01)01075-0

as the Arctic (e.g. AMAP, 1998) is evidence for the long-range atmospheric transport of these contaminants (Oehme and Manø, 1984; Oehme, 1991; Harner et al., 1998). Today, PCBs are considered an environmental problem of global proportions.

Even though the production of these contaminants has stopped, PCBs continue to be detected in environmental samples from around the world (e.g. Iwata et al., 1994; AMAP, 1998). Many studies have sought to understand historical PCB contamination trends through the analysis of dated sediment (e.g. Christensen and Lo, 1986; Sanders et al., 1992; Bruckmeier et al., 1997) and peat cores (Rapaport and Eisenreich, 1988). Several of these studies have indicated that the trends in environmental concentrations have followed the trends in production and use of PCBs. Historical data on the global production and usage of PCBs are, thus, urgently needed for the interpretation of historical, present and future contamination levels around the world (Cummins, 1988; Tanabe, 1988; Voldner and Li, 1995; Wania and Mackay, 1996; Vallack et al., 1998). Furthermore, quantitative knowledge of the global historical consumption is a prerequisite for estimating atmospheric emissions and eventually establishing source–receptor relationships for intentionally produced PCBs on a global scale. Due to differences in lifetime and fate of individual PCBs in the environment, estimates of the historical production of PCBs have to be done on a congener specific basis. The overall aim of this study was to present a quantitative estimate of the historical consumption of selected PCB congeners. Specifically, we set out to:

1. estimate the historical global production of selected PCB congeners (*temporal pattern*);
2. estimate the historical global pattern of consumption (*spatial pattern*); and
3. provide input for a global PCB emission model, presented in an accompanying paper (Breivik et al., 2002).

2. Methods

The general molecular formula for the PCBs is $C_{12}H_{10-n}Cl_n$, where n could be any number from 1 to 10. There are, thus, 10 different PCB homologues, dependent on the number of chlorines and 209 different PCB congeners, dependent on the position of the chlorines on the molecule. Not all congeners have been identified in commercial products or technical mixtures. The numbering system proposed by Ballschmiter and Zell (1980) has been adapted by the International Union of Pure and Applied Chemists (IUPAC), and is frequently used to refer to various congeners. In this system, individual PCB congeners are assigned a number, ranging from PCB-1 (2-CB) to PCB-209 (2,2′,3,3′,4,4′,5,5′,6,6′-CB). This numbering system is also used here, although with minor revisions (Hillery et al. 1997). In this work, 22 individual PCB congeners were studied. These are the same congeners as selected in the EU Global-SOC project (ENV4-CT97-0638), or more specifically PCB-5 (2,3-DiCB), PCB-8 (2,4′-DiCB), PCB-18 (2,2′,5-TriCB), PCB-28 (2,4,4′-TriCB), PCB-31 (2,4′,5-TriCB), PCB-52 (2,2′,5,5′-TetCB), PCB-70 (2,3′,4′,5-TetCB), PCB-90 (2,2′,3,4′,5-PenCB), PCB-101 (2,2′,4,5,5′-PenCB), PCB-105 (2,3,3′,4,4′-PenCB), PCB-110 (2,3,3′,4′,6-PenCB), PCB-118 (2,3′,4,4′,5-PenCB), PCB-123 (2′,3,4,4′,5-PenCB, PCB-132 (2,2′,3,3′,4,6-HexCB), PCB-138 (2,2′,3,4,4′,5′-HexCB), PCB-149 (2,2′,3,4′,5′,6-HexCB), PCB-153 (2,2′,4,4′,5,5′-HexCB), PCB-158 (2,3,3′,4,4′,6-HexCB), PCB-160 (2,3,3′,4,5,6-HexCB), PCB-180 (2,2′,3,4,4′,5,5′-HepCB), PCB-194 (2,2′,3,3′,4,4′,5,5′-OctaCB) and PCB-199 (2,2′,3,3′,4,5,5′,6′-OctaCB).

We proceeded by first collecting from the literature data on the production of total PCBs as well as of various technical PCB mixtures. Secondly, these data were combined with data on the composition of these technical mixtures to estimate the production of individual homologues and congeners. To fill gaps in the data, assumptions had to be made sometimes concerning the homologue and congener composition (Section 3.1). The global consumption pattern was assessed by compiling information on imports, exports and consumption of PCBs for individual countries and years. Reliable information is available only for countries with a historically high consumption of PCBs. For

Table 1
Total PCB production in t as reported in the literature

Producer	Country	Start	Stop	Amount	Reference
Monsanto	USA	1930	1977	641 246	de Voogt and Brinkman (1989)
Geneva Ind.	USA	1971	1973	454	de Voogt and Brinkman (1989)
Kanegafuchi	Japan	1954	1972	56 326	Tatsukawa (1976)
Mitsubishi	Japan	1969	1972	2461	Tatsukawa (1976)
Bayer AG	West Germany	1930	1983	159 062	de Voogt and Brinkman (1989)
Prodelec	France	1930	1984	134 654	de Voogt and Brinkman (1989)
S.A. Cros	Spain	1955	1984	29 012	de Voogt and Brinkman (1989)
Monsanto	U.K.	1954	1977	66 542	de Voogt and Brinkman (1989)
Caffaro	Italy	1958	1983	31 092	de Voogt and Brinkman (1989)
Chemko	Czechoslovakia	1959	1984	21 482	Schlosserová (1994)
Orgsteklo	USSR (Russia)	1939	1990	141 800	AMAP (2000)
Orgsintez	USSR (Russia)	1972	1993	32 000	AMAP (2000)
Xi'an	China	1960	1979	8000	Jiang et al. (1997)
Total		1930	1993	1 324 131	

other countries, assumptions had to be made on the trade between various countries and regions, using the Gross Domestic Product as a surrogate parameter (Section 3.2).

3. Results and discussion

3.1. Global production

3.1.1. PCB production process

The production of PCBs involves the chlorination of biphenyl in the presence of a catalyst. Depending on the reaction conditions, the degree of chlorination varies between 21% and 68% chlorine on a weight-by-weight basis (e.g. Ahlborg et al., 1992). The homologue profile for most technical formulations shows a normal distribution around the mean chlorine content (e.g. Takasuga et al., 1996, see also Table 2). This implies that these mixtures generally contain only a certain 'range' of PCB homologues and congeners as indicated by the chlorine content. However, some other technical formulations, such as Aroclor 1232, do not show this typical distribution, suggesting that they consist of more than one technical mixture (Frame, 1997).

3.1.2. Total global PCB production

A review of the literature data was undertaken to obtain the most reliable production figures for the major producers of PCB in various countries. A previous study had estimated the cumulative global production to be on the order of 1.5 million t (de Voogt and Brinkman, 1989). Most of the information presented in Table 1 is adapted from this compilation of data. The figures shown in Table 1 add up to a reported total global production of 1.324 million t between 1930 and 1993. Most likely the true cumulative global production has been higher, as there were factories in Poland (Falandysz et al., 1992), Eastern Germany (de Voogt and Brinkman, 1989) and Austria (Fiedler, 1997) that produced PCBs in unknown amounts. Although the data presented here might be lower than the real figure, it seems likely that most of the global historical production is accounted for in these estimates. For most producers within the OECD countries, data on the total amounts produced are generally reported for 5-year periods from 1955 to 1984. In addition, annual production data are available for the same countries from 1973 to 1980 (de Voogt and Brinkman, 1989). For producers outside the OECD, there is only limited information on the annual production from various plants. Production data reported for a period in excess of one year (e.g. a 5-year period) were uniformly distributed over that period (*temporally flat distributed*, see also Fig. 3a). These data show that Monsanto (USA) has been responsible for

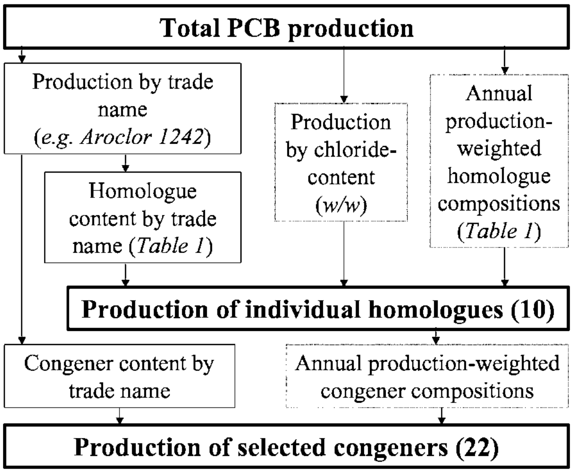


Fig. 1. Overview of the relationship between the annual production of total PCBs and the production of individual homologues and congeners from various producers. Details of the approach are discussed in Section 3.1.3.

almost 50% of the known reported historical production of PCBs. Bayer (West Germany), Prodelec (France) and Orgsteklo (Russia) have each contributed individually with more than 10% of the historical production.

3.1.3. Estimated production of individual homologues and congeners

The overall methodology for estimating the production of individual PCB homologues and congeners is depicted in Fig. 1. Whenever possible, information on the production of individual technical mixtures (e.g. Aroclor 1242), and their chemical composition was used to determine the homologue and congener production over time. However, as this information was not available for many producers, the annual production of individual homologues and congeners could only be estimated in this manner for Monsanto (USA) and Bayer (West Germany) (see below and Fig. 1). For other cases, we estimated a set of annual production-weighted default compositions (i.e. a fraction between 0 and 1). These default compositions or fractions take into account the temporal shift in homologue and congener production that occurred during the period of peak production (i.e. they were varying from 1955 to 1983).

The homologue composition (by wt.%) of various technical mixtures is given in Table 2, along with the estimated maximum and minimum default homologue composition. The annual production-weighted congener default compositions were estimated in a similar manner based on data of the technical mixtures produced by Monsanto (USA) and Bayer (West Germany) (data not shown).

As the availability of data for the different producers varied immensely, an individual approach was necessary to maximise the utilisation of available information and to minimise the use of uncertain assumptions. For the sake of transparency, details of the approach adopted for each individual producers are given in the following paragraphs. Although this might appear unnecessary, we hope that such detailed documentation will eventually facilitate future improvements to these estimates.

3.1.3.1. USA. The data compiled by de Voogt and Brinkman (1989) account for a total production of 641 699 t of PCBs in the USA. Monsanto was by far the most important producer, while the only other PCB-producing company in the USA (Geneva Industries) has a reported production of only 454 t.

The two last numbers in the names of the technical Aroclor mixtures by Monsanto refer to the weight percentage of chlorine (Table 2). For example, Aroclor 1260 should contain approximately 60 wt.% chlorine. Two notable exceptions to this numbering system are Aroclor 1016, which is a technical mixture derived by distillation of Aroclor 1242, and Arcoclor 1232 which is a blend of approximately equal proportions of Aroclors 1221 and 1242 (Frame, 1997). The congeneric composition of Aroclors 1016, 1221, 1232, 1242, 1254, 1260 and 1262 were based on data compiled by Frame (1997), who reported the results of a collaborative study in which the composition of six Aroclor mixtures (1016, 1221, 1242, 1254, 1260 and 1262) was determined using 18 gas chromatographic systems. Nine systems employed ECD detection, and the remaining half-used MS-

Table 2
Content of the 10 homologues of PCBs in various technical mixtures as used in the calculations (in wt.%)

Technical mixture		Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-
Aroclor 1221		43.8	27.9	4.4	2.6	0.5	0.2
Aroclor 1232		26.5	23.9	27.0	18.7	3.5	0.3
Aroclor 1016		0.7	17.1	53.6	27.7	0.8	0.1
Aroclor 1242		0.3	14.7	42.1	33.9	8.1	0.8
Aroclor 1248		0.2	2.5	22.8	51.7	20.5	2.0
Aroclor 1254		–	0.5	0.7	18.3	55.6	22.0
Aroclor 1260		–	0.1	0.3	0.9	9.9	43.5
Aroclor 1262		–	0.2	1.2	1.1	3.9	28.1
Clophen A30		–	19.6	48.1	25.0	6.2	1.2
Clophen A40		–	0.2	17.3	50.5	25.8	5.0
Clophen A50		–	–	0.2	17.6	51.2	26.8
Clophen A60		–	–	–	0.7	16.2	49.1
Sovol		–	–	1.0	23.0	53.0	22.0
TCB		–	14.0	49.0	32.0	4.0	1.0
Delor 123		9.0	63.0	26.0	2.0	–	–
Delor 103		1.0	10.0	60.0	26.0	3.0	–
Default compositions	Min	0	6.6	19.5	22.9	6.2	1.2
	Max	1.0	19.6	48.1	28.4	22.5	17.0

Technical mixture		Hepta-	Octa-	Nona-	Deca-	Notes
Aroclor 1221		-	–	–	–	A
Aroclor 1232		0.1	–	–	–	A
Aroclor 1016		–	–	–	–	A,B
Aroclor 1242		0.1	–	–	–	A,B
Aroclor 1248		0.3	0.1	–	–	A
Aroclor 1254		2.5	0.4	–	–	A,B
Aroclor 1260		36.1	8.3	0.9	–	A,B
Aroclor 1262		45.3	18.5	1.7	–	A
Clophen A30		–	–	–	–	B
Clophen A40		1.2	–	–	–	B
Clophen A50		3.6	0.6	–	–	B
Clophen A60		27.8	5.8	0.5	–	B
Sovol		1.0	–	–	–	C
TCB		–	–	–	–	C
Delor 123		–	–	–	–	D
Delor 103		–	–	–	–	D
Default compositions	Min	0	0	0	0	E
	Max	9.3	2.1	0.2	0	E

The original data from the literature were scaled to yield 100%, except Aroclor 1221 (see text). [A] Frame (1997); [B] Schulz et al. (1989); [C] Ivanov and Sandell (1992); [D] de Voogt and Brinkman (1989); [E] Annual production-weighted compositions (or ratios) are based on the estimated production from Bayer AG (West Germany) and Monsanto (USA). Only the minimum and maximum compositions are shown.

SIM or full-scan MS ion-trap measurements (see Frame, 1997 for details). Average weight percentage of individual congeners in each of these Aroclors was given for both ECD and MS systems. Frame (1997) also reported data on the composition of Aroclor 1232 and 1248, analysed by one of the participating laboratories in his study (referred to as JWC). In addition, data for Aroclor 1016, 1242, 1254 and 1260 from a previous study (Schulz et al. 1989) were included.

We used a weighted average of these data to calculate the congeneric composition of the Aroclor production. These compositions, reported in Table 2, are thus based on 19 different measurements for Aroclor 1016, 1242, 1254 and 1260, 18 different determinations for 1221 and 1262, and a single determination for 1232 and 1248. These data were also used to estimate the homologue composition of each individual mixture and scaled to yield a total of 100%. The composition of the lighter chlorinated Aroclor 1221 was not scaled this way, because it presumably contains significant amounts of biphenyl due to incomplete chlorination.

The amounts of various Aroclors (1016:1242:1248:1254:1260 and 'Other Aroclors') sold in the USA from 1957 to 1975 are available from de Voogt and Brinkman (1989). These data were used to estimate and scale the production of individual Aroclors, assuming that the production of various Aroclors was equal to the annual fraction of sold amounts. For the years prior to 1957 and after 1975, we used the estimated fractions for 1957 and 1975, respectively. The sold amounts of the 'Other Aroclors' (1221 + 1232 + 1262 + 1268) was generally below 3% during the investigated time-period (de Voogt and Brinkman, 1989). In the absence of information on the chemical composition of Aroclor 1268, we assumed that 'Other Aroclors' was a mixture of 1221, 1232 and 1262 (1:1:2). As the 'Other Aroclors' include the heavily chlorinated mixture 1268 in unknown relative amounts, it is likely that we are underestimating the produced amounts of some of the more chlorinated PCB homologues and congeners. Monsanto also produced a technical mixture called Aroclor 1270 (de Voogt and Brinkman, 1989). Due to the lack of data on both production and chemical composition, it could not be included in this estimate.

For the production of PCBs by Geneva Industries we relied on the default homologue and congener composition (see Fig. 1).

3.1.3.2. West Germany. PCBs were produced in West Germany by Bayer AG as Clophens (A30, A40, A50, A60). The data presented by de Voogt and Brinkman (1989) account for a historical production of 159,062 t PCB. According to this reference, the approximate wt.% of chlorine in various trade mixtures were: A30 (40–42%), A40 (48%), A50 (52–54%) and A60 (60%). Fiedler (1997) presented production data by degree of chlorination (39, 42.5, 47, 48.5, 54, 55 and 60% Cl (w/w)) for the period from 1974 to 1983. As the amounts of individual Clophens produced were not available to us, we assigned the data presented by Fiedler (1997) to the corresponding Clophen-mixture, based on the degree of chlorination in order to estimate fractions of the technical mixtures produced annually. For data prior to 1974, we assumed that the various mixtures were produced in the same relative quantities as in 1974. The homologue and congener production could then be estimated based on the homologue and congener content of A30, A40, A50 and A60 reported by Schulz et al. (1989).

3.1.3.3. Japan. Approximately 96% of the total Japanese PCB production was by Kanegafuchi Chemical Co. Ltd (Tatsukawa, 1976), which produced a series of PCB mixtures called Kanechlors (KC). According to Tatsukawa (1976), the chlorine content of KC-300, KC-400, KC-500 and KC-600 corresponds to the Aroclors 1242, 1248, 1254 and 1260, but the homologue composition is different. Although the chemical composition of Kanechlors has been at least partly determined (Kannan et al. 1992; Takasuga et al., 1996), this information could not be used because the individual amounts of Kanechlors produced are unknown to us. Therefore, we used annual production data for various homologues reported by Tatsukawa (1976) for the years 1961 to 1971 as tri-CBs and lower, tetra-CBs, penta-CBs and hexa-CBs and higher. For the two clustered homologue groups (tri-CB and lower, hexa-CB and higher), we assumed that the internal homologue production was determined by the percentage of possible congeners. For example, the group of tri-CB and lower includes 39 possible congeners, while there are three possible congeners within the group of mono-CB. Thus, 7.7% of the clustered tri-CBs and lower was assumed to be mono-CB, etc.

The production of individual congeners was estimated using the congeneric default composition (Fig. 1). These percentages were multiplied by the reported or estimated annual production of individual homologues as described above. This procedure clearly introduces high uncertainties to the estimated annual production of individual congeners, but it seems reasonable to assume that this approach avoids emphasis on congeners that are rarely formed during the production process. For the other producer in Japan (Mitsubishi), we applied default homologue and congener compositions to total PCB production figures reported by Tatsukawa (1976).

3.1.3.4. Czechoslovakia. Schlosserová (1994) reported that 14 140 t of PCB was produced in Czechoslovakia as Delor 103. In addition, 4381 t of Delor 106 (similar to Aroclor 1260) and 2961 t of other PCB mixtures were produced from 1959 to 1984. de Voogt and Brinkman (1989) reported that approximately 6000 t were produced annually before 1968, suggesting higher production figures than those reported by Schlosserová (1994). However, we have chosen to use the more detailed and recent information provided by Schlosserová (1994), assuming a uniform annual production of 826 t total PCBs throughout the period.

To estimate the homologue production, we used the homologue composition of Delor 103 as reported by de Voogt and Brinkman (1989) and assumed that Delor 106 has the same composition as Aroclor 1260 (Table 2). For the remaining 4381 t, we assumed that its composition is that of Delor 123, a very light PCB formulation described by de Voogt and Brinkman (1989). We further used the congeneric default composition for estimating the production of individual congeners.

3.1.3.5. United Kingdom. In the UK, PCBs were manufactured under the trade name Pyroclor (de Voogt and Brinkman, 1989). As we did not have reliable information on the relative production volume, or chemical composition of the Pyroclors, we applied the default homologue and congener compositions. The UK factory was owned by Monsanto Industrial Chemicals Co., which also was the major producer of PCBs in USA. Similarities with the production process at Monsanto in the US are thus likely.

3.1.3.6. Soviet Union. Estimates of the historical production of PCBs in the former Soviet Union are available from Ivanov and Sandell (1992) and more recently from AMAP (2000). According to this latter source, PCBs were produced under three different brand names (Sovol, Sovtol and TCB) at two different factories in the vicinity of Moscow (Orgsteklo and Orgsintez).

Sovol is reported to have a chemical composition fairly close to that of Aroclor 1254 (Ivanov and Sandell, 1992; Takasuga et al. 1996). However, another study suggests that it only resembles Aroclor 1254 to a limited extent (Kannan et al. 1992). According to AMAP (2000), 43 000 and 9500 t of Sovol were produced at Orgsteklo (1939–1990) and Orgsintez (1972–1993), respectively.

Sovtol (Soviet oil) has been characterised as a mixture of Sovol and trichlorobenzene (Ivanov and Sandell, 1992; AMAP, 2000). In particular, Sovtol-10 is a mixture of 90% Sovol and 10% trichlorobenzene (AMAP, 2000). Although other Sovtol-mixtures are known (Ivanov and Sandell, 1992), we assumed that all Sovtol contained 90% Sovol. According to AMAP (2000), a total of 32 000 t of Sovtol were produced at Orgsteklo (1939–1987) and another 25 000 t at Orgsintez (1972–1990). This results in an estimated total production of Sovol-based PCBs of 103 800 t. This figure corresponds well with the 100 000 t previously estimated by Ivanov and Sandell (1992).

Ivanov and Sandell (1992) also refer to another formulation produced in the former USSR, named 'Trichlorodiphenyl' (TCDP), stating that this was only a product name and that its chemical composition was fairly close to that of Aroclor 1242. We assume this to be the same formulation as TCB; Trichlorobiphenyl in AMAP (2000). This assumption seems reasonable in light of the fact that both sources list the same production period and use as a dielectric fluid. According to AMAP (2000), 70 000 t of TCB were produced at Orgsteklo during 1968–1990. This value is also used here, although it is considerably higher than the previous uncertain estimate of 25 000 t given by Ivanov and Sandell (1992).

The homologue composition of Sovol and TCB was taken from Ivanov and Sandell (1992) and is given in Table 2. For the congener production, we assumed Sovol to be equal to Aroclor 1254 and TCB to be equal to Aroclor 1242.

3.1.3.7. China. PCBs were neither produced nor used in large amounts in China (Xu et al., 2000). According to Jiang et al. (1997), only 8000 t of PCB were produced in China during the 1960s and 1970s. The two principal technical formulations are said to be similar to Aroclor 1242 and Aroclor 1254 (Jiang et al., 1997). In order to estimate the homologue and congener production, we assumed that these two technical mixtures were produced in equal amounts and had the chemical composition of the above mentioned Aroclors.

3.1.3.8. France, Spain and Italy. The data from France, Spain and Italy include total production figures and detailed annual records for the years 1973–1984. Otherwise, only the factories and trade names, as well as a few data on the homologue and congener content of some of the technical mixtures were found in the literature (de Voogt and Brinkman, 1989; Kannan et al. 1992). As no data on annually produced amounts of various mixtures or constituents were available to us, the estimated production of individual homologues and congeners had to rely on the default homologue and congener compositions.

3.1.4. Uncertainties in the global production pattern

The methods applied to estimate production rates of individual homologues and congeners rest on a number of critical assumptions. The use of the default homologue and congener composition (e.g. for France, Spain and Italy) introduces uncertainties that are difficult to quantify. Obviously, the use of these default values implies that there were similarities in the production process between various producers, and implicitly, that there is a different propensity among the congeners to be formed during the production process. For some countries (e.g. China, USSR, Czechoslovakia), similarities have been noted in the chemical composition of technical mixtures from different producers. It thus seems reasonable to assume that there have indeed been similarities in the production process between different producers, resulting in similarities in the composition of the mixtures, at least at the homologue level (see, e.g. Takasuga et al. 1996). We are aware that there are substantial variations in the propensity of congeners to be formed during the manufacturing process (Frame, 1997). As the selected approach based on default compositions was designed to capture this variation, we only estimated production-weighted compositions based on technical mixtures that had been completely characterised (Schulz et al. 1989; Frame, 1997).

In any case, the available data make it difficult, if not impossible to quantify *all* of the uncertainties in a quantitative and meaningful way. For example, it is likely that the composition of the same technical mixtures varied, at least to some extent, from batch to batch (de Voogt and Brinkman, 1989; WHO, 1993). Secondly, the relative production rates of various mixtures were in many cases extrapolated based on reported data available for a few years only (e.g. Bayer AG).

However, the impact of the use of homologue and congener compositions can be addressed in a simplified manner. The same applies for the variability between Aroclor compositions determined with either ECD or MS systems (see Frame, 1997). Therefore, we tried to quantify and depict these two sources of uncertainty. Table 3 summarises how uncertainty was addressed for the production by various producers. Details are explained in the following.

At the *homologue level* (Table 3), the analytical variability (i.e. the difference between the homologue content of the Aroclors determined by ECD and MS) is estimated for the Aroclor production at Monsanto (USA). For most producers, the maximum and minimum homologue compositions are used to estimate some of the anticipated variations at the homologue level. Kanegafuchi (Japan) was treated as a special case, accepting the estimates for tetra- and penta-CBs as reported, and applying max/min compositions as determined specifically for this particular producer. The uncertainties at the homologue level for Bayer AG, Chemko, Orgsteklo, Orgsintez and Xi'an were not addressed because we anticipate that the assumptions made are of less quantitative importance than the variability in these compositions.

Table 3
Overview of the selected approach to estimate the uncertainties associated with the use of homologue and congener compositions as well as the variation in the characterised mixtures of Aroclors

	Analytical variability	Max/min compositions	Not addressed
Homologue level	Monsanto (USA)	Geneva Industries Kanegafuchi Mitsubishi Prodelec S.A. Cros Caffaro Monsanto (UK)	Bayer AG Chemko Orgsteklo Orgsintez Xi'an
Congener level	Monsanto (USA) Orgsteklo Orgsintez Xi'an	Geneva Industries Kanegafuchi Mitsubishi Prodelec S.A. Cros Caffaro Monsanto (UK) Chemko	Bayer AG

At the *congener level*, we used the analytical variability for Monsanto (USA) as well as for other producers for which the congeneric composition of the production was deduced from the Aroclors (Orgsteklo, Orgsintez and Xi'an). For most other companies, we used the maximum and minimum congener compositions multiplied with the corresponding max/min homologue compositions. The uncertainties at the congener level somehow represents a 'worst case' (max/max and min/min compositions). For Bayer AG, the uncertainty has not been addressed, due to lack of useful quantitative information for this purpose.

Fig. 2 presents results for the estimated total global production of individual homologues (A) and 22 selected congeners (B). The results indicate that of the 1324-kt total PCBs accounted for 566 kt (42.7%) can be attributed to the 22 selected congeners. Fig. 2 also indicates that tri-CBs have been the most important PCB homologue produced historically. Whereas there are theoretically 24 trichlorinated congeners, ranging from PCB-16 to PCB-39, a closer inspection reveals that approximately 50% of this homologue group can be attributed to only three congeners: PCB-18, PCB-28 and PCB-31. Similarly, the relative contribution of the other selected congeners to their respective homologue groups are 49% (Di-CBs), 24% (Tetra-CBs), 50% (Penta-CBs), 59% (Hexa-CBs), 22% (Hepta-CBs) and 43% (Octa-CBs). Table 4 presents the estimated global production rates of individual homologues for various time-periods (in percent). As can be seen from Table 4, the global homologue production pattern has changed over time. Notably, there was a reduction in the relative contribution of PCBs with seven or more chlorines over the last few decades that PCBs were produced. This is easily explained as the production of heavier technical mixtures decreased in the USA and West Germany in the last years of production (USA from 1970, West Germany from 1974) as a result of an increased environmental awareness towards the heavier (more persistent) homologues and congeners. For example, the estimated relative importance of Hexa-CB produced by Monsanto (USA) decreased by approximately 50% from the 1960s to the 1970s. Furthermore, the production of Hepta-CBs and Octa-CBs by Monsanto (USA) essentially ceased after 1973. This has profound influence on the applied homologue and congener compositions and their time dependence. Thus, Table 4 reflects the assumption that a similar decrease in the production of the more chlorinated

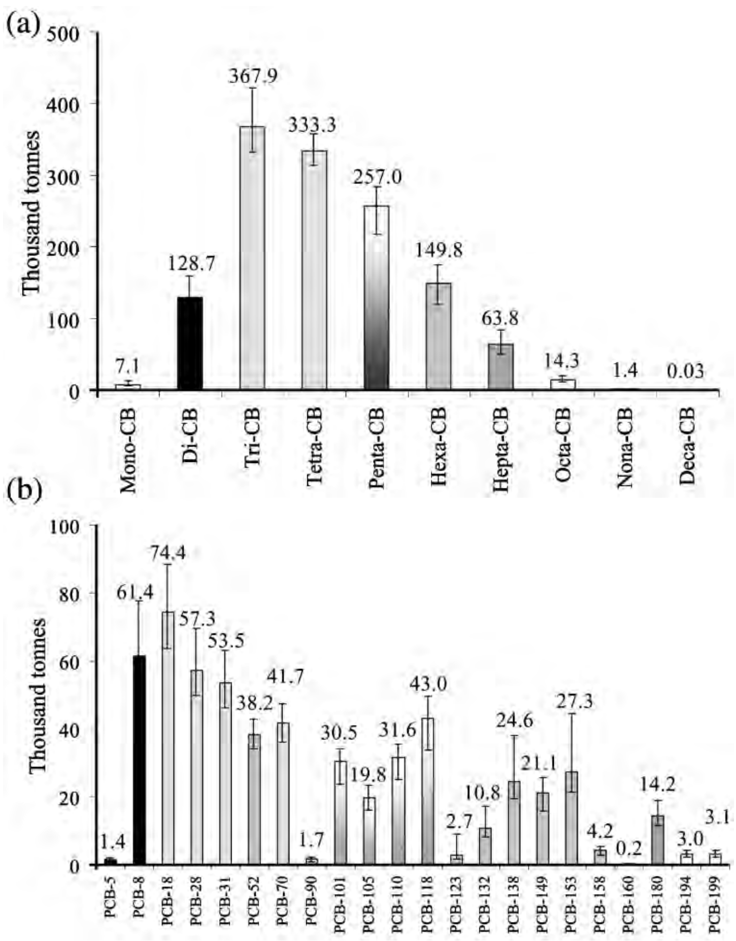


Fig. 2. Estimated global production of individual PCB homologues (A) and congeners (B) in thousands of tons.

congeners occurred worldwide around the same time. Unfortunately, this cannot be verified with the available information.

Fig. 3 presents results for the estimated temporal pattern in the global production of total PCBs (A), PCB-28 (B), PCB-52 (C), PCB-101 (D), PCB-118 (E), PCB-138 (F), PCB-153 (G), PCB-180 (H) from 1930 until 1993. The compiled data suggest a peak annual production of 75.5 kt total PCBs for the year 1970. Presumably, worldwide production of PCBs ended in 1993 when the production of Sovol ceased in Russia (AMAP, 2000). The results indicate further that the time trend of the production of individual congeners resembles that of the total PCBs. There are, however, notable exceptions when the uncertainties are taken into consideration. For the heavier congeners (Fig. 3F–H), the uncertainty is relatively high for the years after 1970. Again, this is a reflection of the use of the (*default*) homologue and congener compositions and their time dependence. As a result, the uncertainty for the later years of production increases. The negligible uncertainty depicted for individual congeners prior to 1955 are *not* due to the availability of more reliable data for this period. Rather, these historical data reflect that there were only a few producers worldwide and the production was dominated by Monsanto (USA) and Bayer (West Germany). The possibility to present any meaningful quantitative estimate of the uncertainties during that time period is considered limited.

Table 4
Estimated global production rates of individual homologues (in percent) and sum of all homologues (in kt) for various time-periods

Period	Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-
1930–1934	0.3	8.6	25.0	24.5	16.0	14.3
1935–1939	0.3	8.2	24.1	24.4	17.4	14.6
1940–1944	0.3	7.2	21.1	24.2	22.0	15.5
1945–1949	0.3	7.2	21.1	24.2	22.0	15.5
1950–1954	0.3	7.2	21.1	24.2	22.1	15.5
1955–1959	0.5	7.5	21.5	23.5	21.4	15.3
1960–1964	0.7	8.3	23.4	24.2	20.5	13.8
1965–1969	0.8	10.3	28.7	26.9	18.2	9.4
1970–1974	0.8	11.1	32.0	24.9	17.5	9.4
1975–1979	0.2	10.3	29.8	24.9	21.3	10.7
1980–1984	<0.1	13.7	37.2	26.0	16.0	6.2
1985–1989	0	7.3	26.0	27.7	27.5	11.1
1990–1993	0	6.3	22.5	27.0	31.0	12.6

Period	Hepta-	Octa-	Nona-	Deca-	Sum homologues (kt)
1930–1934	9.1	2.1	0.2	<0.1	36.4
1935–1939	8.8	2.0	0.2	<0.1	37.8
1940–1944	7.8	1.7	0.2	<0.1	43.5
1945–1949	7.8	1.7	0.2	<0.1	43.5
1950–1954	7.7	1.7	0.2	<0.1	43.8
1955–1959	8.2	1.9	0.2	<0.1	97.7
1960–1964	7.3	1.7	0.2	<0.1	168.4
1965–1969	4.4	1.0	0.1	<0.1	285.6
1970–1974	3.4	0.8	<0.1	<0.1	274.7
1975–1979	2.3	0.4	<0.1	<0.1	169.5
1980–1984	0.7	0.1	<0.1	<0.1	86.6
1985–1989	0.5	0	0	0	29.2
1990–1993	0.6	0	0	0	6.8

3.2. Global consumption

The global consumption of PCBs has been estimated based on information about import, export and national consumption, as well as restrictions on imports of PCBs in various countries and regions.

In the absence of detailed information, which would facilitate an analysis for individual technical mixtures, we generally assumed that the import and consumption of individual congeners are determined by the production within representative countries or regions. This seems to be the only approach feasible with respect to the available data. Perhaps the most serious limitation in this methodology is that PCBs were exported as technical mixtures, rather than as individual congeners, as it is well-known that PCBs were sold according to the physical properties of the technical mixtures (WHO, 1993). Hence, some countries most likely had a relatively high import of one type of technical mixture (or product containing one type of a mixture). However, by treating groups of countries as closed markets, potential important regional variations in the spatial and temporal patterns of homologue and congener consumption can be addressed.

An overview of the method to address the global consumption pattern is given in Fig. 4, while details of the approach are discussed below.

3.2.1. OECD countries — consumption and export

Detailed data on imports and exports from OECD-countries, along with data on exports to OECD and non-OECD countries, are available for the period 1973–1980 from de Voogt and Brinkman (1989). Tatsukawa (1976) reported annual data on import and export for the entire period of

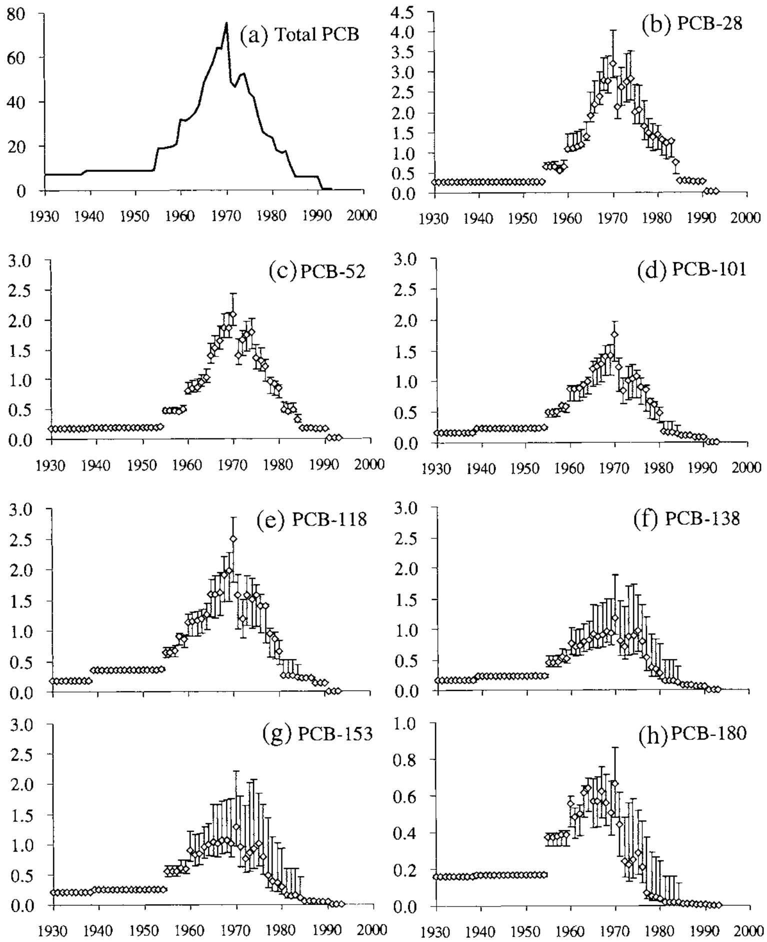


Fig. 3. Estimated temporal trend in the global production of total PCBs (A); PCB-28 (B); PCB-52 (C); PCB-101 (D); PCB-118 (E); PCB-138 (F); PCB-153 (G); and PCB-180 (H) in thousands of tons.

the PCB production in Japan. A key assumption for the national consumption within the OECD countries was that the OECD was a closed market. Whereas export from OECD was allowed to occur, import of PCBs into the OECD from non-OECD-countries was considered negligible. This should be a valid assumption in terms of quantitative importance, even though exceptions are likely. Furthermore, we assumed that prior to 1946, no export from producing countries occurred. For example, PCBs have been imported and used in Norway since approximately 1950, according to the national environmental protection authorities (SFT, 1996).

The annual national consumption of PCB-congeners in OECD-countries in the 1970s was estimated in the following way. de Voogt and Brinkman (1989) reported the annual exports from producing countries within the OECD to both OECD and non-OECD countries (see Fig. 4). The total annual export amount was thus divided into two sums, one for distribution to OECD countries and one for non-members. Next, we utilised information on annual imports of PCBs for specific countries within OECD for the same time-period (de Voogt and Brinkman, 1989). For all producing OECD-countries, there were data on imported amounts for most reference years of the given

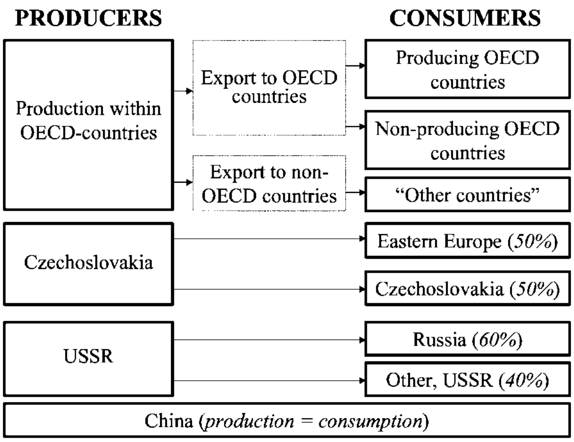


Fig. 4. Overview of the spatial distribution of global PCB consumption. Details of the approach are discussed in the text.

time-period, except for a few years for which we estimated the import with linear interpolation. Imports to all non-producing OECD-countries were based on annual reported imports whenever possible. The 'excess export amount' to OECD countries that could not be accounted for, was distributed to the remaining OECD countries based on gross domestic products (reference year 1983) (United Nations, 1994). An easy approach to evaluate this assumption would be to compare our estimates with independently derived estimates on national PCB consumption from e.g. national environmental agencies (see discussion later). Finally, for producing OECD-countries, we utilised either national consumption data *or* added the sum of import plus the amounts produced but not attributed to export, to estimate the national annual consumption.

For the years from 1946, up to the time when unifying statistical data became available, we had to make some simple assumptions, except for Japan where detailed data are available (Tatsukawa, 1976). We assumed that producing OECD-countries were exporting the same relative amounts of the total production as reported for the early 1970s. We used the gross domestic products of the OECD countries to distribute the estimated total export to OECD-countries. Canada was treated differently as its total cumulative import had been previously estimated to be approximately 40 kt (de Voogt and Brinkman, 1989). In our calculation we assumed a steady linear increase in the import from 1946 until 1972, withdrawing the amount imported to Canada in the 1970s.

Concerning the export to non-OECD countries (see Fig. 4), we assumed a linear increase in the fraction of export from 1946, until export-figures from OECD-producing countries to non-OECD countries became available for the early1970s.

This approach leads to uncertainties in the estimated national consumption data, and it is difficult to validate the results. However, the estimated data are comparable to some other independently derived national estimates. A national survey estimated the cumulative use in Austria to be between 2300 and 2800 t (Maderner and Hobiger, 1996), while our approach-which relies on GDP as a surrogate parameter-suggest a cumulative consumption of 3075 t. In a similar survey for Norway, the cumulative consumption has been estimated to be approximately 1230 t (SFT, 1996), while our data suggest 944 t.

3.2.2. Export from OECD to other countries

The amount of PCBs reported or estimated as being exported to non-OECD countries equals 148.3 kt or 11.2% of the total global production. We generally assumed that no PCBs were exported from OECD to China, the USSR or Eastern Europe. For the sake of simplicity, we further assumed no export to countries with a Gross Domestic Product (GDP) of less than US$ 1000 per capita or total GDP of less than one billion US$. The export to non-OECD countries includes 69 different countries. While the criteria to exclude some countries are somewhat arbitrary, these countries (i.e. approx. 70) would have accounted for a potential consumption of only 6.3% of the total export to non-OECD countries (or 0.7% of the total global production) — if included. This suggests that this simplification introduces minor uncertainties into the overall inventory at the scales of interest.

3.2.3. Eastern Europe

According to Šabata et al. (1993), approximately half of the amounts of PCBs produced in

Czechoslovakia was exported to other Eastern European countries. Hence, 50% of the annual Czechoslovakian production of PCBs was distributed among the countries of Eastern Europe, according to the Gross Domestic Product of the countries within the region. For comparison, the total export from the Czechoslovakia adds up to 21.5 kt or 1.6% of total global production.

3.2.4. Countries within the former Soviet Union

According to AMAP (2000), 60% of the Sovtol produced was used in Russia, and the rest in the former republics of the USSR. Similarly, 60% of the industrial capacitors containing PCBs were used in Russia. As a general assumption, we thus assumed that the former Soviet Union was a closed market where 60% of the total production was used in Russia. The remaining 40% were distributed among the other states of the former USSR according to Gross Domestic Product. Altogether, it is estimated that 173.8 kt or 13.1% of the global production have been used in the former Soviet Union.

3.2.5. China

Only a minor quantity of PCBs is reported to have been produced in China (8000 t or 0.6% of the total global production). We assume that all of the PCBs produced has been used within China.

Fig. 5 shows the estimated cumulative global consumption pattern for total PCBs, and includes estimates for 114 individual countries. It is estimated that USA has been responsible for as much as approximately 46% of the total historical global PCB consumption. Other major consuming countries include Russia (7.9%), Germany (7.1%), Japan (4.1%), France (4.1%), Canada (3.0%), Ukraine (2.4%), Spain (2.4%), Italy (2.1%) and UK (2.0%). The data at the national level should be interpreted with great caution. Particularly for the countries relying entirely on the assumptions related to GDP. It is, however, imperative to keep in mind that the overall objective of this study is to try to capture the overall spatial pattern of PCB consumption at a global scale. If the emphasis was at the national level, a different approach would be required.

In Fig. 5, the spatial distribution of the total historical national consumption is based on population densities within each country by use of the GEIA grid system of 1° by 1° (Dr Yi-Fan Li, Environment Canada). Population density is considered a suitable surrogate parameter, as the consumption of PCBs is generally linked with the use of electrical equipment. Overall, the results suggest that almost 97% of the intentionally produced PCBs have been used in the Northern Hemisphere. Furthermore, approximately 18% of the total have been used between 40 and 42° Northern latitude.

The results also show that there are temporal changes in the latitudinal distribution of PCB consumption. Fig. 6 shows how the latitudinal consumption patterns changed in time for total PCBs. As can be seen from this figure, the highest peak occurred in the 1960s (Fig. 6D). In the last period considered, the figure reflects the continuing consumption of PCBs in countries of the former Soviet Union (Fig. 6F).

The resulting dataset reveals that there are temporal and spatial variations in the homologue and congeneric consumption pattern. Fig. 7 exemplifies the regional differences in the historical consumption pattern for selected PCB congeners. The regions were selected in a way that is reflecting the method used to estimate the global consumption (see Fig. 4). We observe from Fig. 7 that PCB-101 and PCB-118 appear to be of limited significance in the consumption estimates for Eastern Europe as compared to the other regions. Furthermore, PCB-180 has been of relatively minor importance among the selected congeners in the former Soviet Union and China. However, these differences should be interpreted with care. For example, according to Takasuga et al. (1996), the technical mixture produced in Poland resembles Aroclor 1260. Hence, the estimates presented here for consumption in Poland are likely biased towards the lighter congeners as the production rates are lacking and hence not included in this inventory. The information may, however, be more reliable in other countries. For example, the available information would suggest that homologues with more than eight chlorines have not been used in the former Soviet Union (see also Table 2).

4. Final remarks

The global spatial and temporal consumption pattern of individual PCBs is considered essential

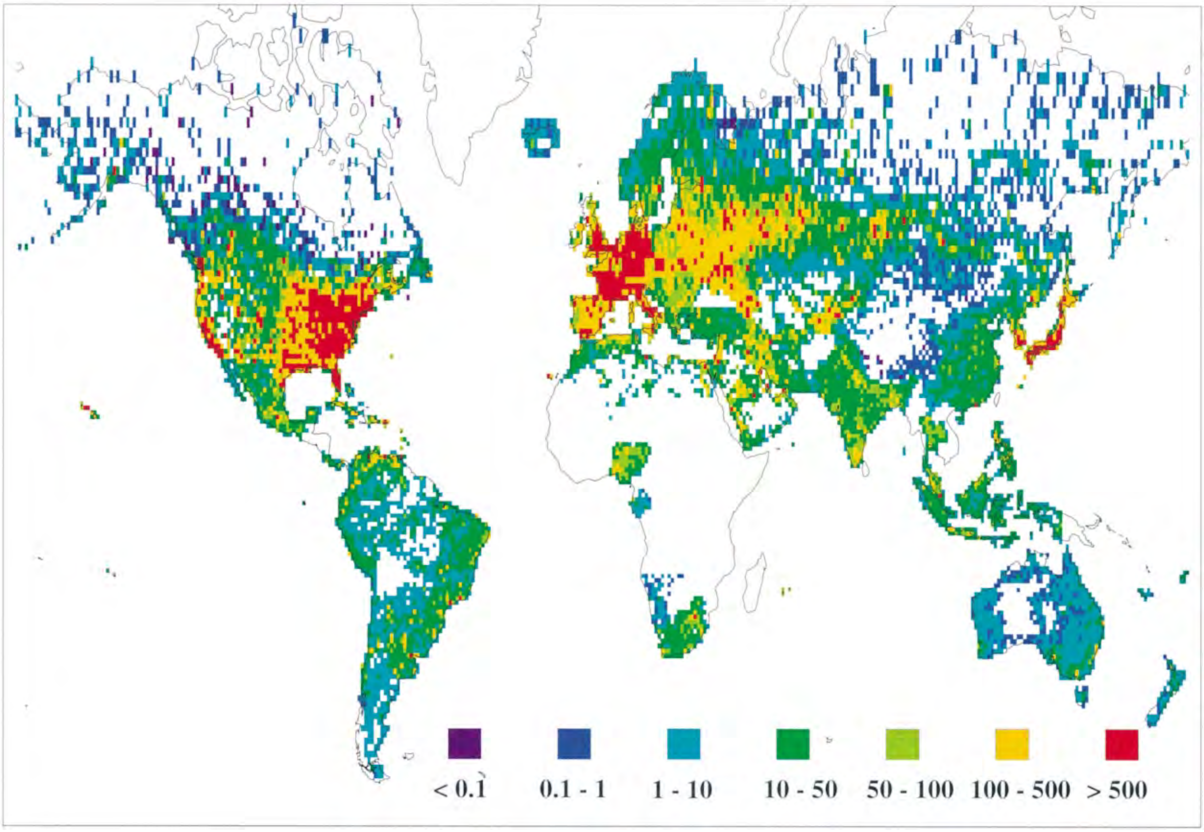


Fig. 5. Estimated cumulative global usage of PCBs (legends in t) with 1°×1° longitude and latitude resolution.

information for the interpretation of global PCB contamination patterns. Considering the large temporal and spatial scales of this approach, it is difficult to ensure that all relevant information has been considered. Indeed, we expect that for certain countries and years, more reliable data are available than those included in this study. Furthermore, only selected aspects of the involved uncertainties could be addressed here in a meaningful and quantitative way. We can presently only recognise other sources of uncertainty in a qualitative manner. For example, we are certain that there has been some production of PCBs in other countries, and that the compiled production data may be underestimated. Another source of uncertainty is that the estimated production of individual homologues and congeners for the first decades essentially remains unknown, but these data are obviously of less relative importance for current environmental levels. In spite of these uncertainties, we are confident that important aspects of the temporal and spatial pattern of global consumption are reflected in this inventory, although the uncertainties may be significant at a more detailed level, e.g. for single consuming countries, year and for some individual congeners. The availability of information for major producing companies and consuming countries around the time of their peak production indicates that the recent data are more accurate than the data from the past.

5. Additional information

Selected data from this study are available through internet as Microsoft Excel spreadsheets at www.nilu.no/projects/globalpcb/.

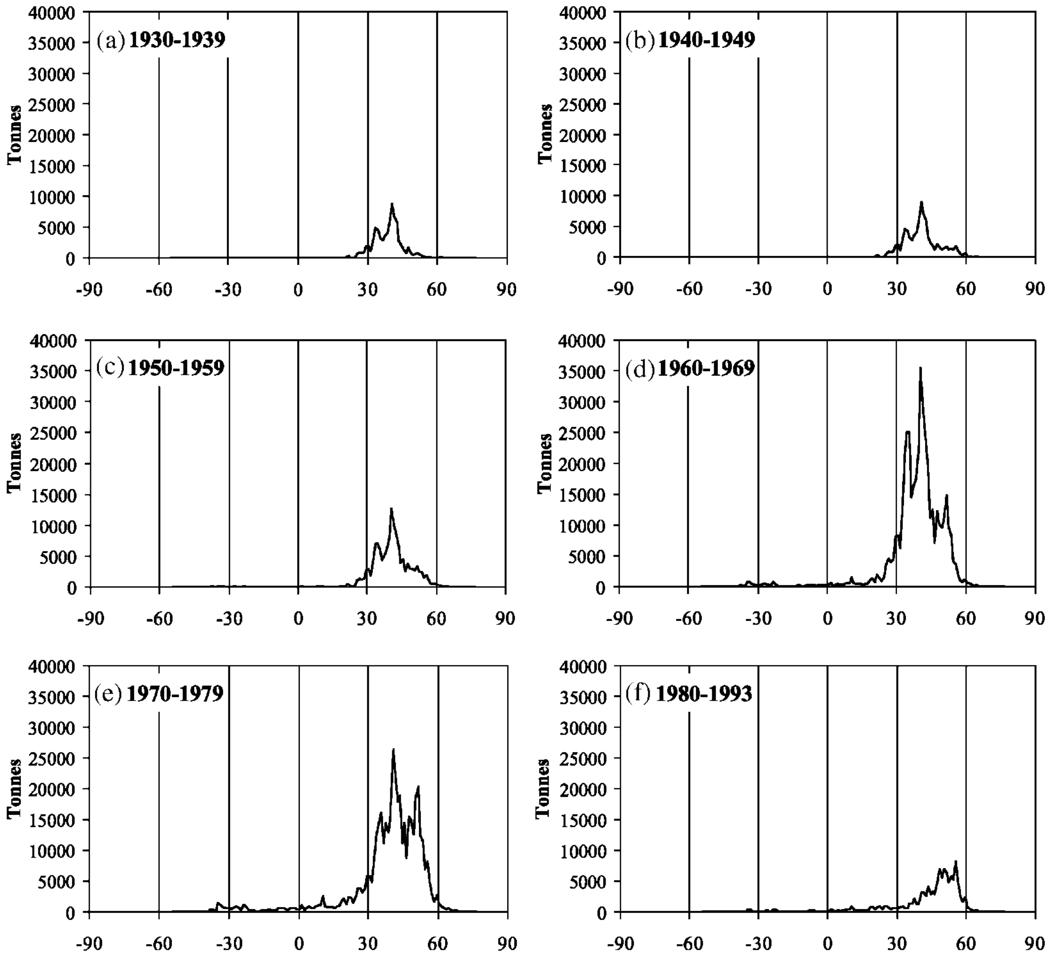


Fig. 6. Global consumption of total PCBs for six different time-periods (by latitude).

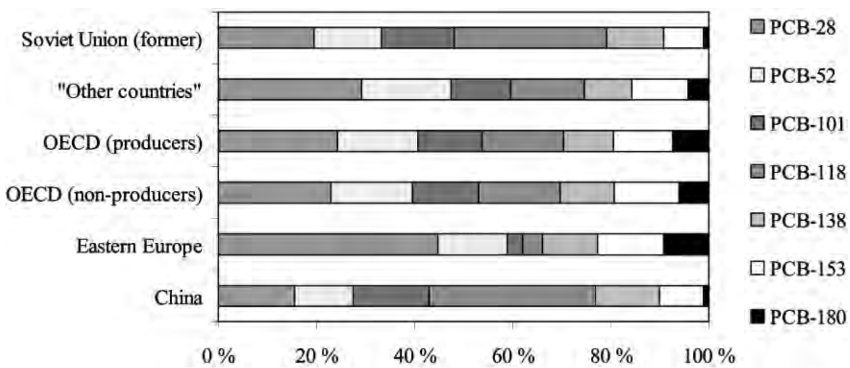


Fig. 7. Regional differences in the cumulative consumption of selected PCB congeners (in percent).

Acknowledgments

We acknowledge financial support from the EU research project Global SOC (ENV4-CT97-0638). We are also grateful to other members of the Global SOC project for many stimulating discussions. Technical assistance from Sverre Solberg and Finn Bjørklid in the preparation of the map is further appreciated. Finally, we are indebted to Dr Frank Wania for valuable comments and constructive criticism on this paper.

References

Ahlborg UG, Hanberg A, Kenne K. Risk Assessment of Polychlorinated Biphenyls (PCBs). Nord 1992:26. ISBN 92 9120 075 1. Nordic Council of Ministers. Copenhagen, Denmark. 1992. (p. 99).

AMAP. AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Program (AMAP), Oslo, Norway, 1998, xii+ 859 pp. ISBN 82-7655-061-4.

AMAP. PCB in the Russian Federation: Inventory and Proposals for Priority Remedial Actions. Executive Summary. AMAP Report 2000: 3, 2000. ISBN 82-7971-008-6. 27 pp.

Ballschmiter K, Zell M. Analysis of polychlorinated biphenyls (PCB) by glass capillary gas chromatography. Composition of technical Aroclor- and Clophen-PCB mixtures. Fresenius Z Anal Chem 1980;302:20–31.

Breivik K, Sweetman A, Pacyna JM, Jones KC. Towards a global historical emission inventory for selected PCB congeners — a mass balance approach. 2 Emissions. Sci Total Environ 2002;290:167–184.

Bruckmeier BFA, Jüttner I, Schramm K-W, Winkler R, Steinberg CEW, Kettrup A. PCBs and PCDD/Fs in lake sediments of Grosser Arbersee, Bavarian Forest, South Germany. Environ Pollut 1997;95:19–25.

Christensen ER, Lo C-K. Polychlorinated biphenyls in dated sediments of Milwaukee Harbour, Wisconsin, USA. Environ Pollut (Series B) 1986;12:217–232.

Cummins JE. Extinction: the PCB threat to marine mammals. Ecologist 1988;18(6):193–195.

de Voogt P, Brinkman UATh. Production, properties and usage of polychlorinated biphenyls. In: Kimbrough RD, Jensen AA, editors. Halogenated biphenyls, terphenyls, naphtalenes, dibenzodioxins and related products. Topics in environmental health. ISBN 0-444-81029-3Elesevier, 1989:3–45.

Edwards R. The polychlorobiphenyls, their occurrence and significance: a review. Chem Ind 1971;47:1340–1348.

Falandysz J, Yamashita N, Tanabe S, Tatsukawa R. Composition of PCB isomers and congeners in technical Chlorofen formulation produced in Poland. Int J Environ Anal Chem 1992;47:129–136.

Fiedler H. Polychlorinated biphenyls (PCBs): use and environmental releases. Proceedings of the Subregional Meeting on Identification and Assessment of Releases of Persistent Organic Pollutants (POPs). St. Petersburg, Russian Federation, 1–4 July 1997. Inter-Organization Programme for the Sound Management of Chemicals 1997:81–103.

Frame GM. A collaborative study of 209 PCB congeners and 6 Aroclors on 20 different HRGC columns. Part 2. Semi-quantitative Aroclor congener distributions. Fresenius J Anal Chem 1997;357:714–722.

Harner T, Kylin H, Bidleman TF, Halsall C, Strachan WMJ, Barrie LA, Fellin P. Polychlorinated napthalenes and coplanar polychlorinated biphenyls in Arctic air. Environ Sci Technol 1998;32:3257–3265.

Hillery BR, Girard JE, Schantz MM, Wise SA. Characterisation of three Aroclor mixtures using a new cyanobiphenyl stationary phase. Fresenius J Anal Chem 1997;357:723–731.

Ivanov V, Sandell E. Characterization of polychlorinated biphenyl isomers in sovol and trichlorodiphenyl formulations by high-resolution gas chromatography with electron capture detection and high-resolution gas chromatography — mass spectrometry techniques. Environ Sci Technol 1992;26:2012–2017.

Iwata H, Tanabe S, Sakai N, Nishimura A, Tatsukawa R. Geographical distribution of persistent organochlorines in air, water and sediments from Asia and Oceania, and their implications for global redistribution from lower latitudes. Environ Pollut 1994;85:15–33.

Jensen S. Report of a new chemical hazard. New Scientist 1966;32:312.

Jiang K, Li L, Chen Y, Jin J. Determination of PCDD/Fs and dioxin-like PCBs in Chinese commercial PCBs and emissions from a testing PCB incinerator. Chemosphere 1997;34:941–950.

Kalmaz EV, Kalmaz GD. Transport, distribution and toxic effects of polychlorinated biphenyls in ecosystems: review. Ecol Model 1979;6:223–251.

Kannan N, Schulz-Bull DE, Petrick G, Duinker JC. High resolution PCB analysis of Kanechlor, Phenoclor and Sovol mixtures using multidimensional gas chromatography. Int J Environ Anal Chem 1992;47:201–215.

Maderner W, Hobiger G. PCB–Stoffbilanz–Österreich (in German) Zusammenfassung (Abstract only). Monographie, Band 79. Umweltbundesamt, Wien, 1996.

Oehme M, Manø S. The long-range transport of organic pollutants to the Arctic. Fresenius Z Anal Chem 1984;319:141–146.

Oehme M. Further evidence for long-range air transport of polychlorinated aromates and pesticides: North America and Eurasia to the Arctic. Ambio 1991;20(7):293–297.

Rapaport RA, Eisenreich SJ. Historical atmospheric inputs of high molecular weight chlorinated hydrocarbons to eastern North America. Environ Sci Technol 1988;22:931–941.

Šabata S, Friesova A, Rericha R, Hetflejš J. Limits to the use of KOH/PEG method for destruction of PCB liquids of

Czechoslovak production. Chemosphere 1993;27(7):1201–1210.

Sanders G, Jones KC, Hamilton-Taylor J, Dörr H. Historical inputs of polychlorinated biphenyls and other organochlorines to a dated lacustrine sediment core in rural England. Environ Sci Technol 1992;26:1815–1821.

Schlosserová J. 'Kontrolle ausgewählter Böden in der Tschechischen und Slowakischen Republik auf ihre Kontamination mit chlorierten Kohlenwasserstoffen (In German). In: Heinisch E, Kettrup A, Wenzel-Klein S, editors. Schadstoffatlas Osteuropa. ISBN 3-609-69540-4 Germany: Ecomed Verlagsgesellschaft AG & Co, 1994:54–59.

Schulz DE, Petrick G, Duinker JC. Complete characterization of polychlorinated biphenyl congeners in commercial Aroclor and Clophen mixtures by multidimensional gas chromatography — electron capture detection. Environ Sci Technol 1989;23:852–859.

SFT, PCB i Norge–Forekomst og forslag til tiltak. (In Norwegian). Norwegian Pollution Control Authority, Oslo, Norway, 1996. Report 96:08. 51 pp. ISBN 82-7655-352-4.

Takasuga T, Inoue T, Ishida T, Ireland P. Determination of the composition of the commercial PCBs, Kanechlor, Clophen, Aroclor, Chlorofen, and Sovol, by HRGC-HRMS. Organohalogen Compound 1996;27:391–396.

Tanabe S. PCB problems in the future: foresight from current knowledge. Environ Pollut 1988;50:5–28.

Tatsukawa R. PCB pollution of the Japanese environment. In: Higuchi K, editor. PCB poisoning and pollution. ISBN 0-12-347850-2 Kodansha Ltd. Tokyo: Academic Press, 1976:147–179.

United Nations. Statistical yearbook. Thirty-ninth issue. New York, USA. ISBN 92-1-061159-4 1994.

Vallack HW, Bakker DJ, Brandt I, Brorström-Lunden E, Brouwer A, Bull KR, Gough C, Guardans R, Holoubek I, Jansson B, Koch R, Kuylenstierna J, Lecloux A, Mackay D, McCutcheon P, Mocarelli P, Taalman RDF. Controlling persistent organic pollutants — what next? Environ Toxicol Pharmacol 1998;6:143–175.

Voldner EC, Li Y-F. Global usage of selected persistent organochlorines. Sci Total Environ 1995;160/161:201–210.

Waid JS, editor. PCBs and the environment. Volume 1, 2 and 3. ISBN 0-8493-5923-6 (V.1) 0-8493-5924-4 (V.2) and 0-8493-5925-2 (V.3) Boca Raton, Florida: CRC Press, Inc, 1986.

Wania F, Mackay D. Tracking the distribution of persistent organic pollutants. Environ Sci Technol 1996;30(9):390A–396.

Wh O. Polychlorinated biphenyls and terphenyls. Second Edition. Environmental Health Criteria 140 Geneva: World Health Organization. ISBN 92 4 157140 3, 1993.

Xu S, Jiang X, Dong Y, Sun C, Feng J, Wang L, Martens D, Gawlik BM. Polychlorinated organic compounds in Yangtse River sediments. Chemosphere 2000;41:1897–1903.

EXHIBIT 7

PCBs in Municipal Products

REVISED

Pg. 12 Revised
July 21, 2015

Ecology Municipal Stormwater Grants of Regional or Statewide Significance
Grant No. G1400545

Prepared by:

City of Spokane
Wastewater Management Department

Contents

PCBs in Municipal Products

INTRODUCTION

Polychlorinated biphenyls (PCBs) are a toxic manmade chemical found ubiquitously in the environment. Historically, PCBs were primarily used in coolants and lubricants in electrical equipment, such as transformers and capacitors. In the United States, PCBs were largely sold under the trade name Aroclor. Direct production of PCBs was halted in the US in the 1970's due to evidence of human toxicity and persistence in the environment. Since that time, however, PCBs have been incidentally produced in a multitude of manufacturing processes as an unintended byproduct of processes that use heat, chlorine, and carbon.

The Washington State 2008 303(d) list holds 113 Category 5 listings for PCBs, covering 59 waterbodies. Several segments of the Spokane River are included in this list. The City of Spokane has performed stormwater sampling in several of its outfalls that drain to the Spokane River. PCBs were detected in each sample, with a typical sample in the range of 7,000 picograms per liter (pg/L), or parts per quadrillion (ppq).

Once thought to be only a legacy contaminant, PCBs have been found in numerous commercially available products. These PCBs are not intentionally produced, but are rather unintended byproducts of the manufacturing process. Materials containing less than 50 parts per million (ppm) are not considered "PCB-contaminated" under the Toxics Substances Control Act (TSCA) (40 CFR 761.3). For comparison to water quality considerations, 50 ppm is equivalent to 50,000,000,000 ppq. The current Washington State human health surface water quality standard for PCBs is 170 ppq (derived from the National Toxics Rule, 40 CFR 131.36). The Spokane Tribe adopted a water quality standard of 1.3 ppq due to higher fish consumption rates used to derive the standard.

Many products can easily come into contact with rain water and contribute to PCB concentrations in stormwater runoff. Municipalities are concerned about the presence of PCBs in commonly used products such as road paint, asphalt sealers, pesticides, and de-icer, to name a few. However, limited data is available as to the concentration of PCBs in products used for road and facility maintenance.

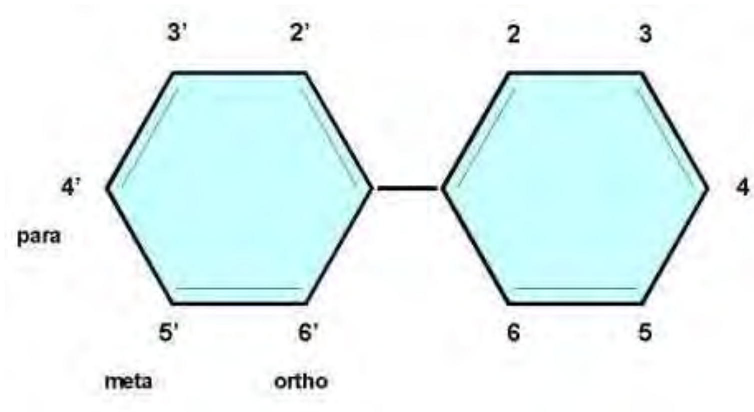
Nearly 50 product samples were collected and analyzed for PCBs using EPA Method 1668C. This method is capable of detecting low concentrations of PCBs for all 209 congeners. The majority of samples were composed of roadway, pipe, and vehicle maintenance products. Because PCBs are also ubiquitously detected in sanitary wastewater samples, five personal care products were sampled as well.

PCB 101

Chemical Structure

PCB molecules are composed of two joined benzene rings with varying degrees of chlorination, as depicted in Figure 1. PCBs can have between one and ten chlorine atoms. There are 209 different arrangements of this molecule, each known as a congener. Congeners are named PCB-1 through PCB-209, with greater numbers corresponding to greater degrees of chlorination. Homologues are the group of PCB molecules having the same degree of chlorination. For example, monochlorobiphenyls (monoCB) is the group of PCBs having one chlorine, dichlorobiphenyls (diCB) are the group of PCBs having two chlorines, etc.

MonoCBs =	1 chlorine
DiCB =	2 chlorines
TriCB =	3 chlorines
TetraCB =	4 chlorines
PentaCB =	5 chlorines
HexaCB =	6 chlorines
HeptaCB =	7 chlorines
OctaCB =	8 chlorines
NonaCB =	9 chlorines
DecaCB =	10 chlorines (PCB-209)



Structure of Polychlorinated Biphenyl (PCB) Molecule

Figure 1. (EPA, 2010b)

During the laboratory analytical process, some congeners cannot be distinguished from one another and are quantified as a complex of more than one congener. These are known as coeluting congeners, and are denoted with a slash in the figures in this report (e.g. 5/8).

Aroclors

Monsanto was the major US manufacturer of PCBs, and sold them under the trade name Aroclor until 1977 (Erickson, 1986). Aroclors were made of standard PCB mixtures to achieve the desired chemical properties. Each type of Aroclor was given a 4-digit identification number, with the second two digits indicating percentage of chlorine by weight (ASTDR, 2000). For example, Aroclor 1254 contains about 54% chlorine by weight. Homologue patterns for standard Aroclor mixes are shown in Appendix A. Homologue patterns for environmental and product samples can be compared to homologue patterns for Aroclors to give clues as to whether the PCB content may be a legacy Aroclor or not.

METHODOLOGY

Product Selection

Municipalities use numerous products in the roadway environment for construction, traffic safety, and maintenance purposes. Little is known about the PCB content in these products. To help guide product sampling, a literature search was performed to determine the potential for products to contain PCBs. In general, processes that involve chlorine, carbon, and high temperatures have the potential to inadvertently produce PCBs (Munoz, 2007).

Numerous studies have associated pigments with inadvertent PCB production (Christie, 2014; Ecology, 2014; Hu and Hornbuckle, 2010; Rodenburg, 2012). In particular, yellow pigments and white pigments (titanium dioxide) are associated with PCB-11, 206, 208, and 209. Yellow, orange, and red products that are derived from azo pigments (monoazo (Hansa Yellows and azonaphthols) and diarylide yellows) are associated with inadvertent PCB production, as are phthalocyanine blues and greens. Therefore, many items sampled for this study contained colored items. Various yellow and white road paints were sampled as well as hydrant paint and utility locate paint. Personal care products were selected that contain pigments.

Inadvertent PCB production is also associated with the manufacture of a multitude of various other chlorinated chemicals. Table 1 shows chemicals associated with various products that can be exposed to stormwater or enter the wastewater system:

Table 1. Example of Chemicals Associated with Inadvertent PCB Production

Chemical	Associated Products
Ethylenediamine	Surfactants, fungicides, fuel additives, EDTA, hair care products, soaps
Ethylene dichloride	Polyvinyl chloride (PVC), solvents
Phenylchlorosilanes	Silicones: lubricants, adhesives, coatings, hoses
Chlorinated benzidines	Pigments
Chlorinated paraffins	Flame retardants in plastics, paints, adhesives, sealants, and caulks
Glycerol/Glycerin (synthesized by epichlorohydrine)	Toothpaste, numerous personal care products, antifreeze, resins

(Information in this table adapted from Munoz, 2007)

One of the most consistent illicit discharge complaints received by the City of Spokane is vehicles dripping fluids onto the roadway. In 2011, the City sampled various off-the-shelf motor oils and transmission fluid to assess the potential for PCBs to enter stormwater through this pathway. PCBs were detected in appreciable concentrations in each of the samples, as shown in Table 2. Because PCBs are known to be present in these materials, additional motor oils and other petroleum products were sampled for this product sampling study.

Table 2. Oil and Transmission Fluid Sample PCB Concentrations (City of Spokane, 2011)

Sample	Total PCB, micrograms per kilogram (ppb) (EPA Method 1668)
Pennzoil SAE5W-30	37.8
Quaker State SAE5W-30	14
Valvoline Mercon V	49.5
Red Line D4 Automatic Transmission Fluid	8.8
Valvoline Full Synthetic 5W-30	116

One of the objectives of this project is to inform municipalities across the state. To gain a better understanding of which products and brands are most widely used, a survey was distributed across the state to willing participants. Ten jurisdictions responded, 6 from eastern Washington and 4 from western Washington. Results of the survey showed that one traffic paint brand is commonly used on both sides of the state under a state contract with WSDOT. Other product brands varied widely across the region, and the brand names used by the City of Spokane were not uncommon, so the products available at the City of Spokane were sampled.

Quality Assurance Project Plan (QAPP)

A QAPP was prepared for this project and approved by Ecology prior to the collection of samples (LimnoTech, 2014). A copy of the QAPP is available upon request.

Experimental Design

Ultra clean sampling techniques were followed to reduce the chance of sample contamination from ambient sources. Samples were collected August to October, 2014. Products were placed directly into laboratory-prepared sample jars whenever possible. Where equipment was necessary to remove the sample from its container and place it into the sample jar, clean decontaminated equipment was used.

Each product was assigned a three-digit Product ID number. Liquid and gel samples were placed in 40-milliliter glass vials. Solid samples were placed in 4-ounce glass jars. Pipe samples were wrapped in aluminum foil. Spray paint samples were sent to the laboratory in the original spray cans. All readily available product information was recorded at the time of sampling, including product type, brand name, lot number, manufacture date and country of origin in addition to standard sampling information such as time and date, sampler, and sample location.

Four field replicate samples were collected for field sampling quality control purposes. Replicate samples were collected for product ID 001, 003, 008, and 018.

A chain of custody form was filled out for each sample batch. Samples were packed into coolers, chilled to a maximum of four degrees Celsius, and shipped to Pacific Rim Laboratories for analysis. Samples were analyzed using EPA Method 1668C for all 209 PCB congeners.

Laboratory Quality Control

The laboratory maintains internal quality control procedures, including method blanks, laboratory control samples, laboratory duplicates, and labeled compound, cleanup, internal, and injection standards. In addition, data verification was performed by the City's project quality assurance (QA) officer. Data was validated by both the laboratory and the QA officer and was found to be acceptable.

EPA Method 1668 detects PCBs at very low concentrations. PCBs are truly ubiquitous and can be detected in even the most pristine laboratory environment. Therefore, PCBs are frequently detected in blank samples. To account for this, any congener that was detected in a product sample that was within three times the concentration detected in the associated blank sample were removed from the total PCB value. These congeners are also not included in the graphs in this report.

RESULTS AND DISCUSSION

The results of PCB product sampling are summarized in Table B-1 of Appendix B and in more detail in the following sections. PCBs were detected in all but two of the products that were sampled in the parts per trillion to parts per million range. The units reported by the laboratory are in micrograms per kilogram (ug/kg), or parts per billion. Note that Spokane water quality standards are 1.3 picograms per liter, or parts per quadrillion. One part per billion is 1,000,000 times greater than one part per quadrillion. Therefore, products detected at these concentrations are of concern to water quality practitioners.

Traffic Marking Samples

Several traffic paint samples were collected due to the association between yellow and white pigments and PCBs. One brand of traffic paint is predominantly used by municipalities and agencies throughout the state, sold by Ennis-Flint. Various types of this paint brand are available. Product numbers 983711 and 983712, low VOC, 100% acrylic waterborne traffic line paint, were sampled from the end of a spray nozzle in a City of Spokane shop. A liquid sample, replicate liquid sample, and a dried sample were analyzed (each for white and yellow). The paint was collected in a clean glass beaker and then immediately distributed to each of the sample vials. Dried paint samples were created by City of Spokane staff by pouring a small amount of paint onto a clean Teflon liner and allowing it to dry before sending it to the laboratory for analysis. The purpose of analyzing the dried sample was to determine if some PCB congeners are volatilized after paint application. Ennis-Flint PreMark thermoplastic road striping was also sampled, both in yellow and white.

For comparison, a lesser-used brand of road paint was sampled. Sherwin-Williams Promar solvent based acrylic traffic marking paint is used by some municipalities in southeast Washington. Samples were collected for both yellow and white paint. Replicates of all of the traffic marking samples (except the dried paint) were shipped to Ecology for their own product sampling study. Results of Ecology's analysis will be reported by Ecology. Total PCBs are shown in Tables 3 and 4 along with the percentage of the three most prevalent congeners, PCB-11, 77, and 209.

Table 3. Yellow Traffic Marking

Type	Total PCB (ug/kg)	PCB-11	PCB-77	PCB-209
Ennis	0.73	7%	35%	36%
Ennis (replicate)	2.69	17%	58%	8%
Ennis (dried)	0.565	9%	39%	35%
Promar	64.88	98%	1%	0%
Thermoplastic	10.78	79%	1%	0%

Table 4. White Traffic Marking

Type	Total PCB (ug/kg)	PCB-11	PCB-77	PCB-209
Ennis	0.41	18%	0%	61%
Ennis (replicate)	0.4	23%	0%	57%
Ennis (dried)	0.38	17%	0%	69%
Promar	0.28	41%	1%	0%
Thermoplastic	3.33	22%	0%	0%

Figure 2 shows the congener patterns for both the wet and dried Ennis yellow traffic marking paint samples. Generally the same congeners were detected in each of the samples, with slightly lower concentration in the dried sample than the liquid paint sample. This suggests that some congeners may be volatilizing into the air. However, as the difference in the liquid and duplicate liquid sample show, further study would be warranted to better determine volatilization rates. The Material Safety Data Sheet (MSDS) indicates that the paint composition contains methyl alcohol, titanium dioxide, propylene glycol, 2-butyoxyethanol, and quartz. Pigment content is not listed.

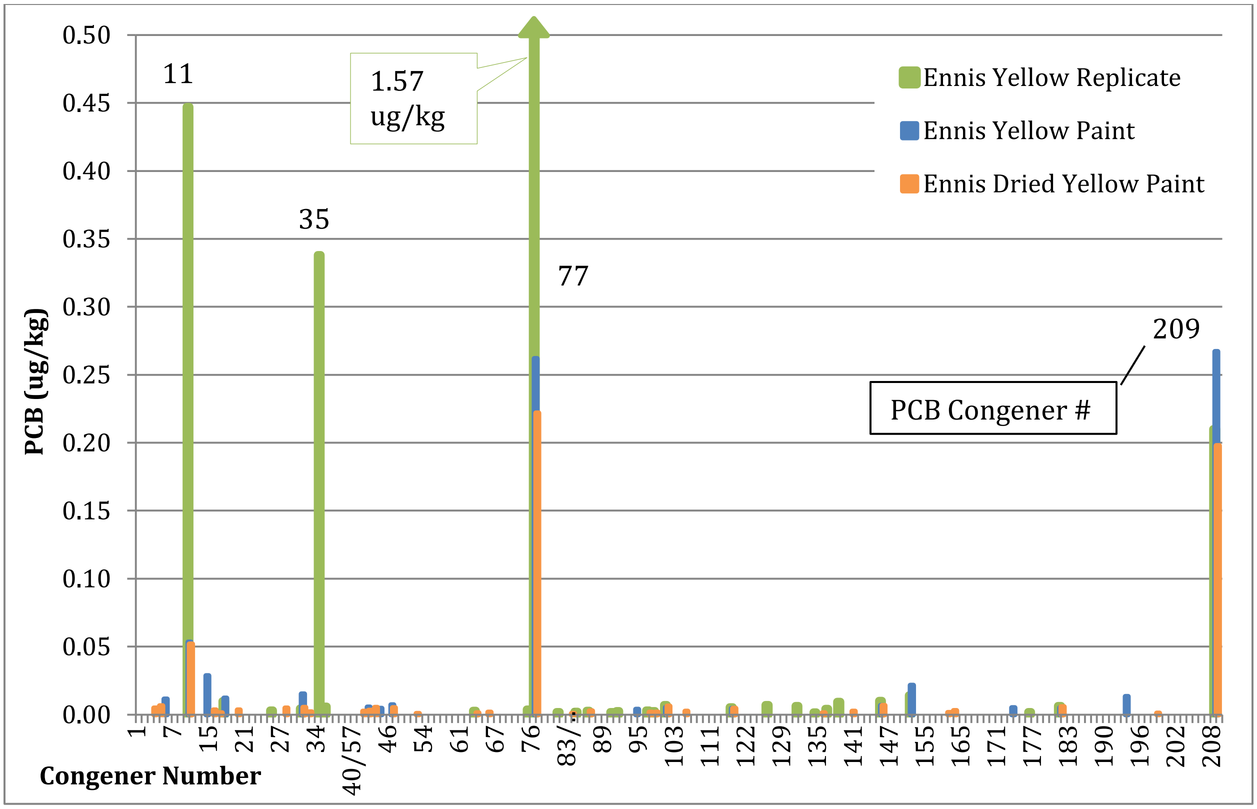


Figure 2. Ennis Wet and Dried Yellow Paint PCB Congeners

Figure 3 shows the congener patterns for the wet and dried Ennis white paint samples. The congener patterns are similar between the three samples. There is no discernible difference between the liquid and dried samples. Interestingly, PCB-11 was detected in the white paint samples in greater concentration than two of the yellow paint samples, although PCB-11 is usually associated with yellow pigment. The concentration of PCB-209 is similar between the yellow and white samples. The MSDS sheets for these products indicate that the yellow paint contains 3-7% titanium dioxide and the white paint contains 7-13% titanium dioxide.

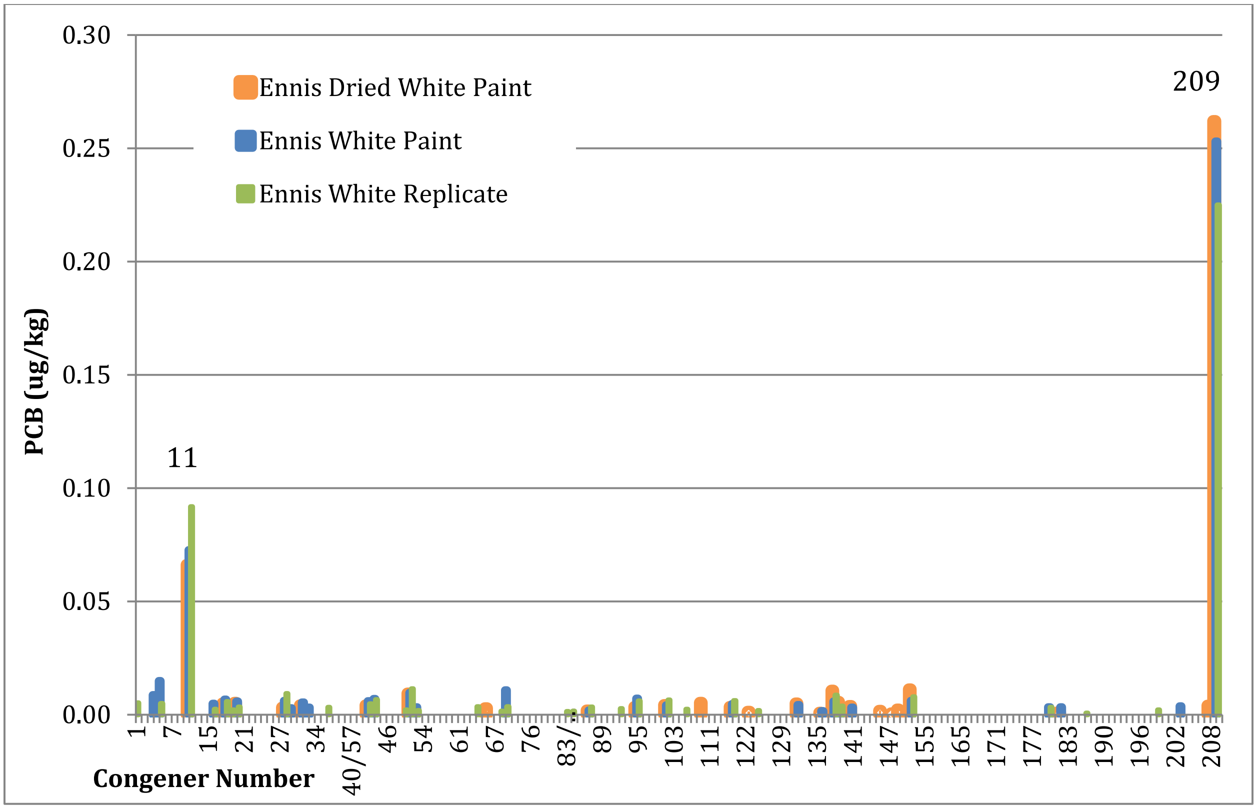


Figure 3. Ennis Wet and Dried W Paint PCB Congeners

Sherwin-Williams Promar yellow and white paint samples are shown in Figure 4. PCB-11 was detected in the yellow paint sample at a significant concentration of 63.8 ug/kg. PCB-35 and 77 were detected similar to the Ennis paint, but PCB-209 was not detected. The MSDS indicates that both white and yellow paints contain ethylbenzene, xylene, acetone, quarts, and titanium dioxide (2% titanium dioxide by weight for yellow and 4% for white). Both yellow and white paints contain approximately 55% pigment by weight.

Figure 5 shows congener patterns for the yellow and white Ennis-Flint PreMark thermoplastic tape samples. Total PCBs are greater than the paint samples (see Table 4 and 5), and there are more congeners detected. Most of the congeners are in the mono-CB through tetra-CB range (having one through four chlorine atoms). The MSDS for this product indicates that it contains the following components in increasing order of concentration: pigments, alkyd resins, polymers, fillers, and glass beads.

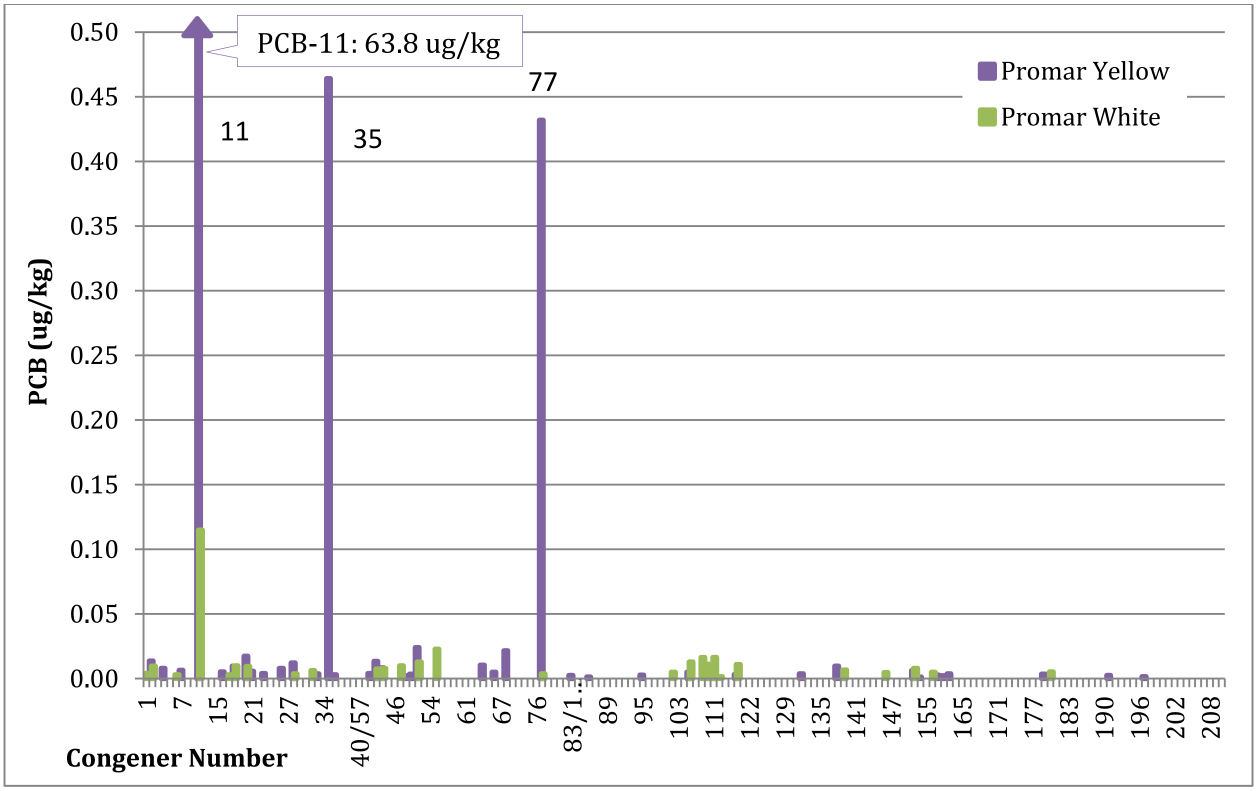


Figure 4. Sherwin-Williams Promar Yellow and White Paint Congeners

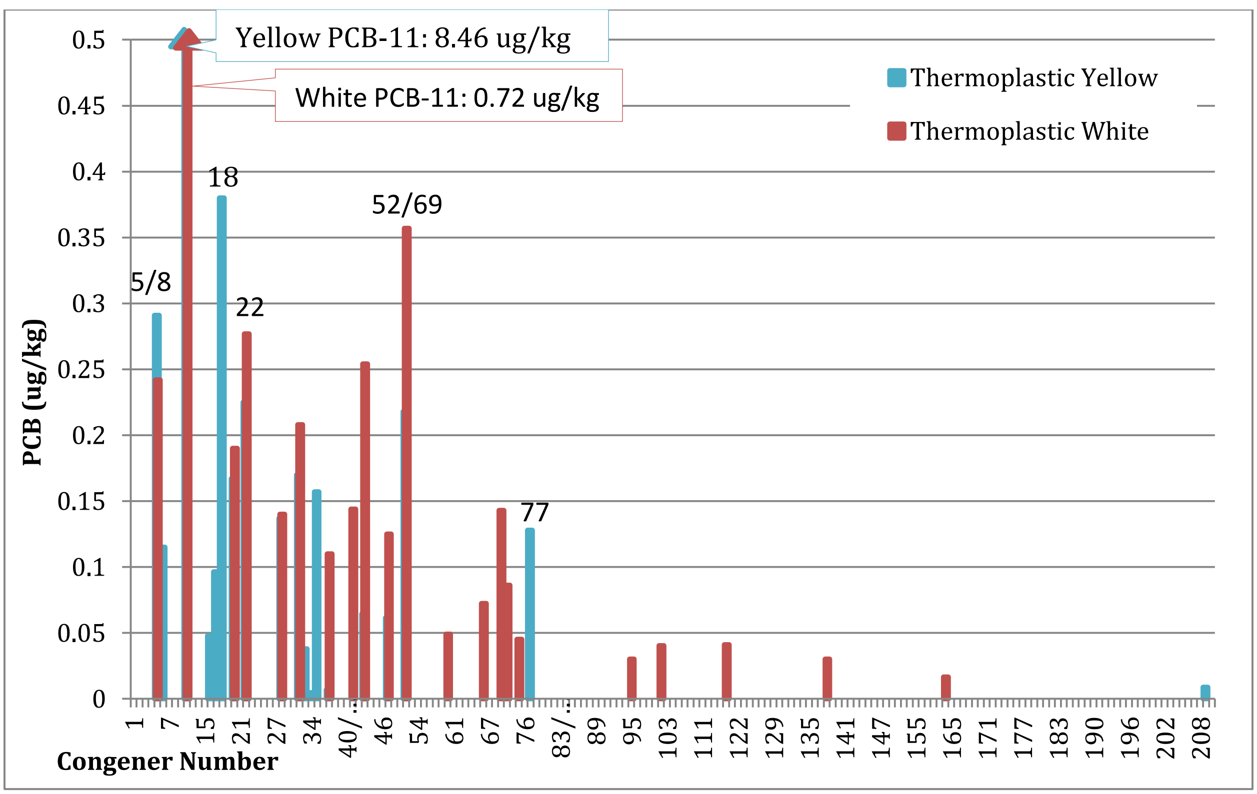


Figure 5. Ennis PreMark Thermoplastic Tape Congners

For samples that have a wide array of PCB congeners, such as the white thermoplastic tape sample, a homologue pattern graph can be a useful tool. These graphs depict the percentage of various homologues that make up the total PCB sample. Figure 6 shows the homologue patterns for both the yellow and white thermoplastic tape samples. The white thermoplastic tape, in particular, has a similar homologue and congener pattern to Aroclor 1016 (Appendix A). Yellow thermoplastic tape also has a similar pattern, but is dominated by PCB-11, a diCB. Aroclor 1016 was one of the lesser used Aroclor mixtures and was used in capacitors.

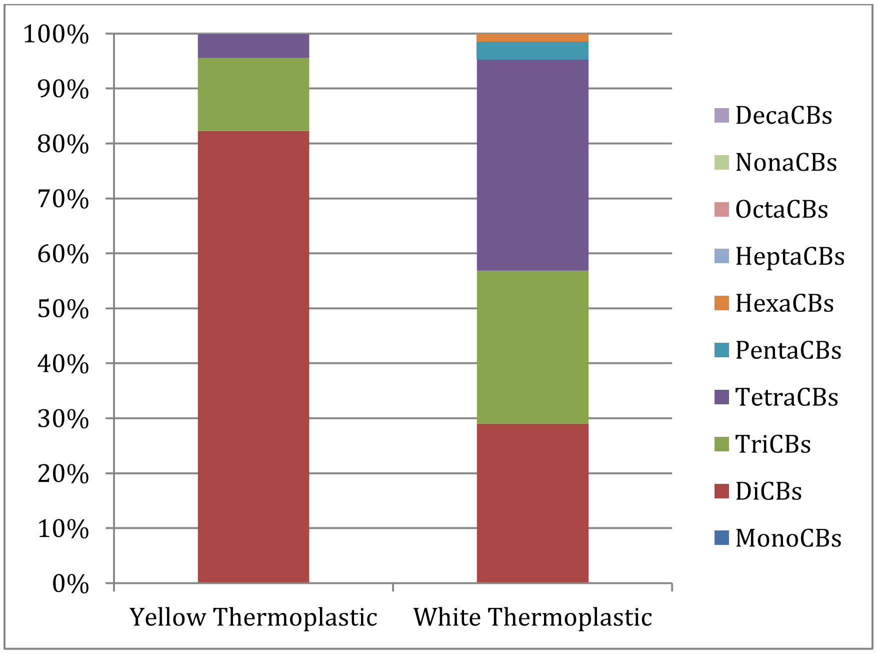


Figure 6. Thermoplastic Tape Homologue Patterns

Hydrant and Utility Locate Paints

Two additional types of paint commonly used on or near roadways were sampled. Fire hydrants are re-painted periodically using spray cans, typically in an aluminum color on the barrel and red on the nozzles. Rustoleum Professional High Performance Enamel Fast-Dry spray paint in Silver Aluminum was sampled. The product contains acetone, liquefied petroleum gas, toluene, xylene, aluminum flake, and ethylbenzene. Total PCBs detected in the sample were **0.0032 ug/kg**, consisting of only the congener PCB-19.

Utility locate paint is sprayed on or near the roadway frequently to mark underground utilities in a variety of colors, including pink, white, green, blue, purple, yellow, orange, and red. The green color denoting sewer utilities was sampled. The product sampled was Rustoleum Industrial Choice Solvent-Based Precision Line inverted marking paint in safety green. The total PCBs detected were **21.527 ug/kg**.

Ingredients listed on the green utility locate paint MSDS include acetone, liquefied petroleum gas, aliphatic hydrocarbon, limestone, xylene, modified alkyd, barium sulfate, talc, naptha (petroleum, hydrotreated light), titanium dioxide, ethylbenzene, and toluene. Most of the ingredients listed on the MSDS (with the exception of titanium dioxide) are not specifically listed as having the potential to inadvertently produce PCBs in the Munoz (2007) paper, although there may be unlisted intermediate compounds that may produce PCBs. The most likely source of PCB is the pigment, and is most likely a phthalocyanine green based on the presence of PCB-11, 206, 207, 208, and 209. Titanium dioxide may also be contributing to the PCB-206, 208, and 209. On the Rustoleum product website, "phthalo green" is a common pigment used in various paint products, although not specifically listed for this product. The pigments used are proprietary information and would not be shared by the company.

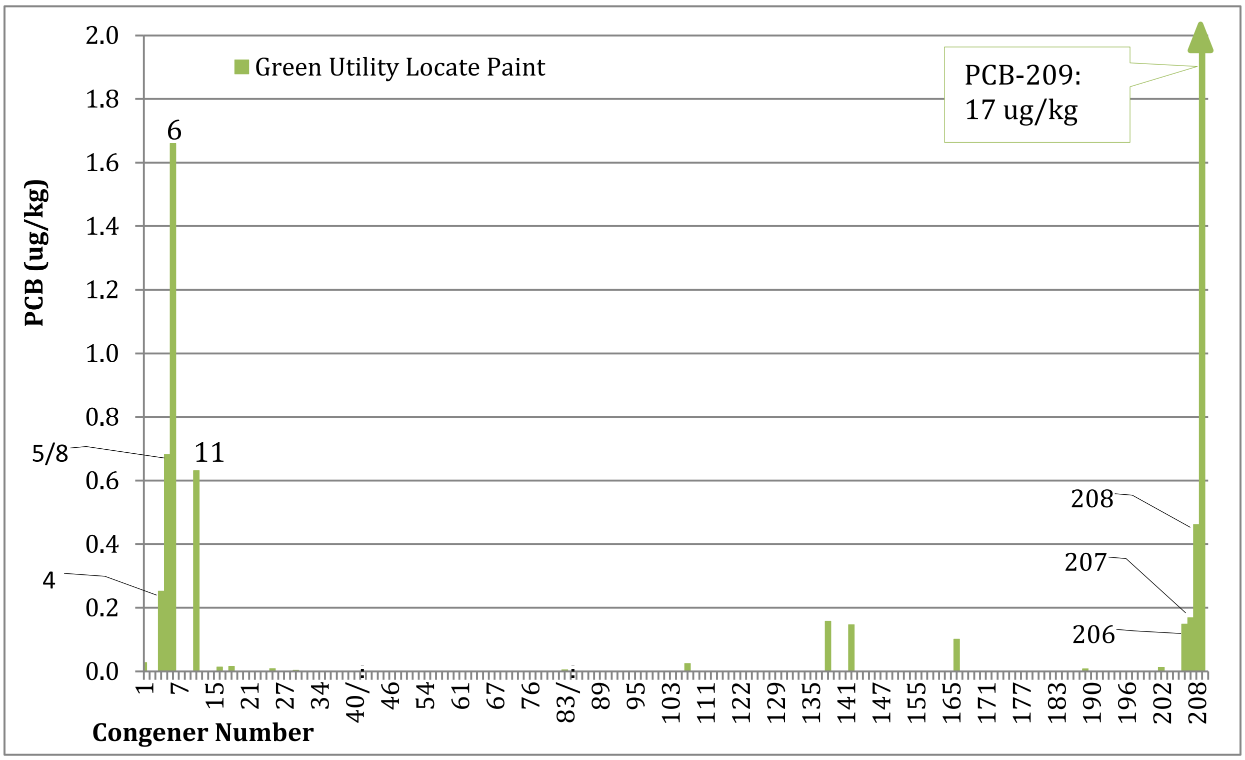


Figure 7. Green Utility Locate Paint Congeners

Deicer

The City of Spokane uses FreezeGard magnesium chloride for roadway deicing. Of the municipalities surveyed, most in eastern Washington use magnesium chloride while most in western Washington use calcium chloride. The Washington State Department of Transportation (WSDOT) Eastern Region uses an enhanced salt brine with sugar beet boost. Both the City of Spokane and WSDOT deicers were sampled. Total PCBs are shown in Table 5.

Table 5. Deicer Total PCB

Sample	Total PCB (ug/kg)
Magnesium Chloride	1.332
Magnesium Chloride Replicate	1.952
SB Boost	0.038

The magnesium chloride is sourced from naturally occurring minerals in the Great Salt Lake.

The magnesium chloride samples were dominated by tetraCBs, while the SB Boost sample congeners were distributed between the triCB to heptaCB range. Homologue patterns are shown in Figure 8 and congener patterns are shown in Figure 9.

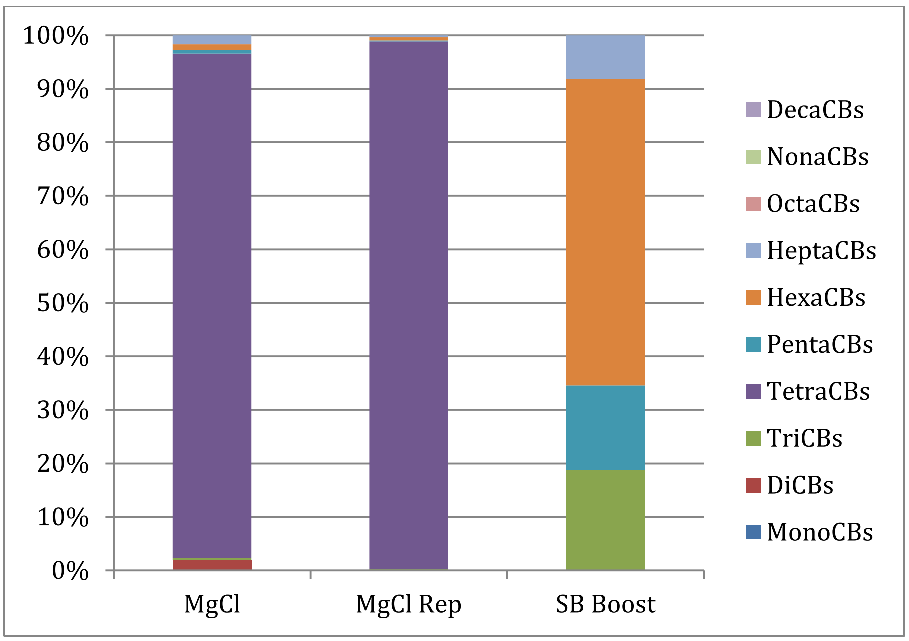


Figure 8. Deicer Homologue Patterns

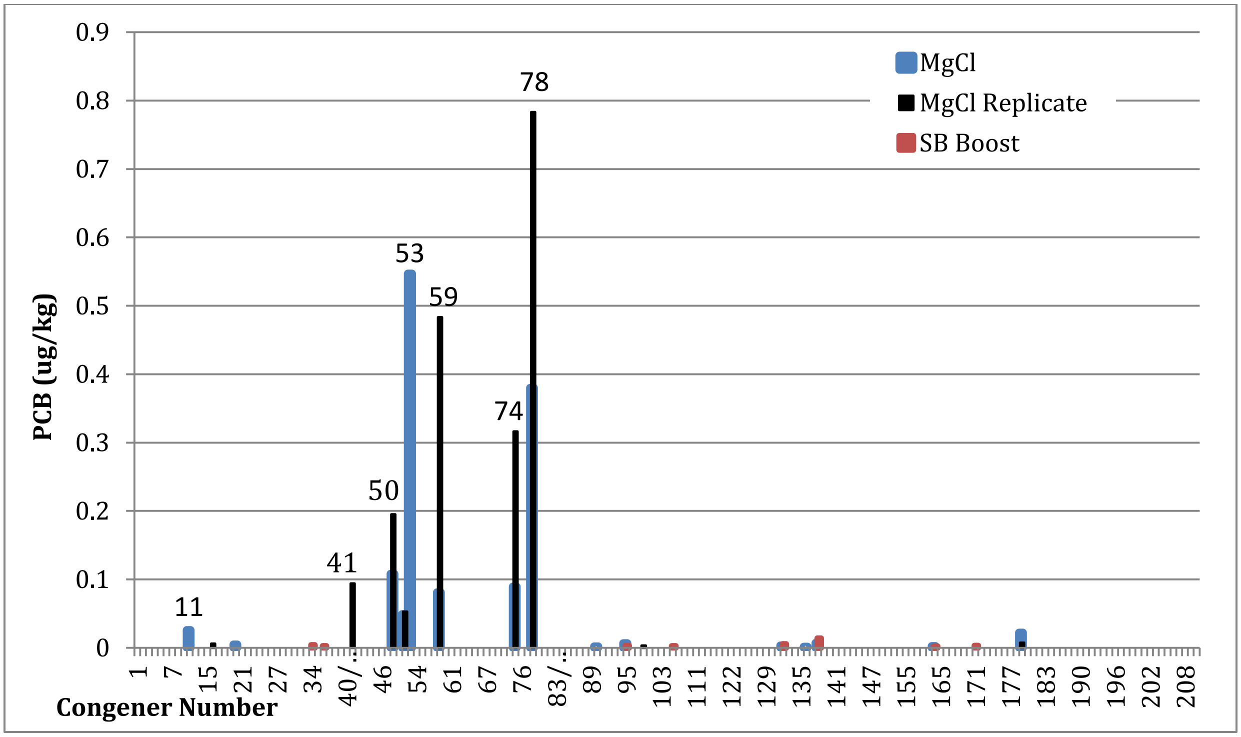


Figure 9. Deicer PCB Congeners

Antifreeze

Antifreeze mixtures may contain inadvertently generated PCBs, particularly those made with glycerol (also known as glycerin) synthesized from epichlorohydrine (Munoz, 2007). Kool Green Extended Life antifreeze was sampled, which contains a yellow color. The MSDS indicates that it contains ethylene glycol, diethylene glycol, and proprietary additives, inhibitors, and dye. The ethylene and diethylene glycols and glycerol have a similar chemical structure, but are not the same compound. Total PCB detected in the sample was **0.018 ug/kg**. Despite its yellow color, PCB-11 was not detected in the sample.

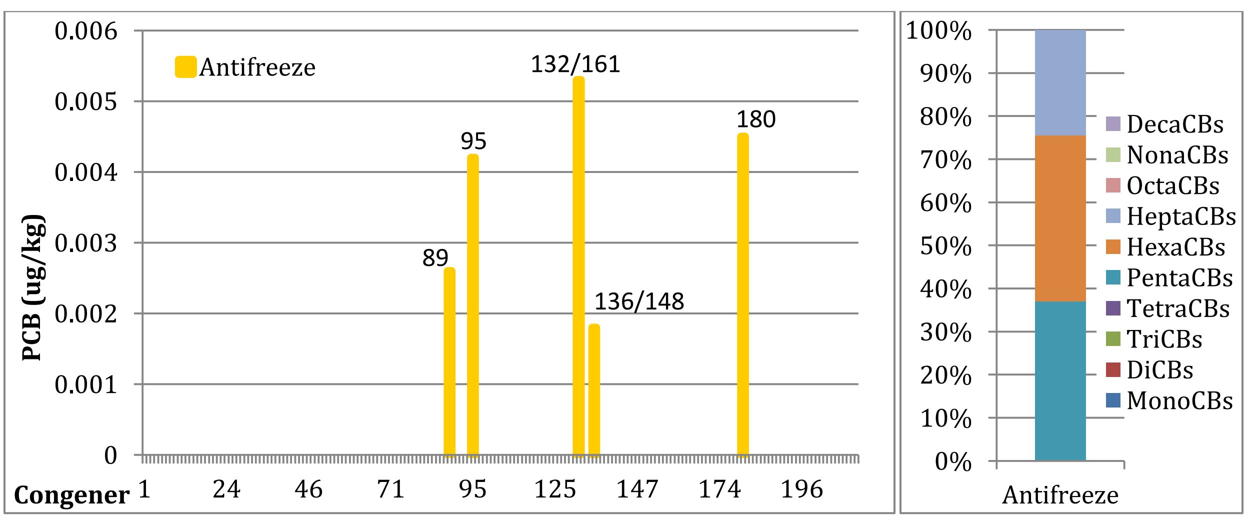


Figure 10. Antifreeze PCB Congeners and Homologue Patterns

Pesticides

Three types of pesticide and one adjuvant were sampled, including Weedar 64 (2,4-D formula), Portfolio 4F, Roundup Pro Max, and the adjuvant Crosshair. The chemical processes that make up chlorinated pesticides have been broadly determined by EPA to have a high potential for inadvertent PCB generation (Munoz, 2007).

PCBs were **non-detect** in the Weedar 64 sample and laboratory duplicate. None of the congeners were flagged for blank contamination. The main ingredients listed on the MSDS are 2,4-dichlorophenoxy acetic acid (2,4-D), dimethylamine salt, and trade secret inert ingredients. Interestingly, chemicals with similar structures to 2,4-D, including trichlorophenoxy acetic acid and dichlorophenyl acetic acid are listed as having the potential for inadvertent PCB generation, but 2,4-D is not (Munoz, 2007).

The total PCBs detected in the Portfolio 4F sample were **6.89 ug/kg**. The majority of this sample was composed of the coeluting congeners PCB-64 and 72. Sulfentrazone is the active ingredient in Portfolio 4F, making up about 40% of the product. Its chemical name is N-[2,4-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]phenyl]methanesulfonamide. Other ingredients include toluene and propylene glycol.

Total PCBs detected in the Roundup Pro Max sample were **0.012 ug/kg**. The active ingredient, making up about 49% of the product, is potassium salt of N-(phosphonomethyl) glycine (potassium salt of glyphosate). Glycine is listed as a chemical product having the potential to contain inadvertently generated PCBs (Munoz, 2007).

The sample of the adjuvant Crosshair contained **0.316 ug/kg** total PCBs. It is composed of methyl ester, modified soybean oil. Soybean oil can be modified through a number of different processes. One option is to synthesize it from epoxidised soybean oil using methylene chloride (Xu et al., 2011). If this process was used, it could possibly be the pathway for inadvertent PCB generation because chlorine is introduced in the process. Glycerine is also a byproduct of this process, which is also listed as a potential inadvertent PCB generating substance when a chlorinated compound is used (Munoz, 2007). Figure 11 shows the congeners detected in the pesticide and adjuvant samples.

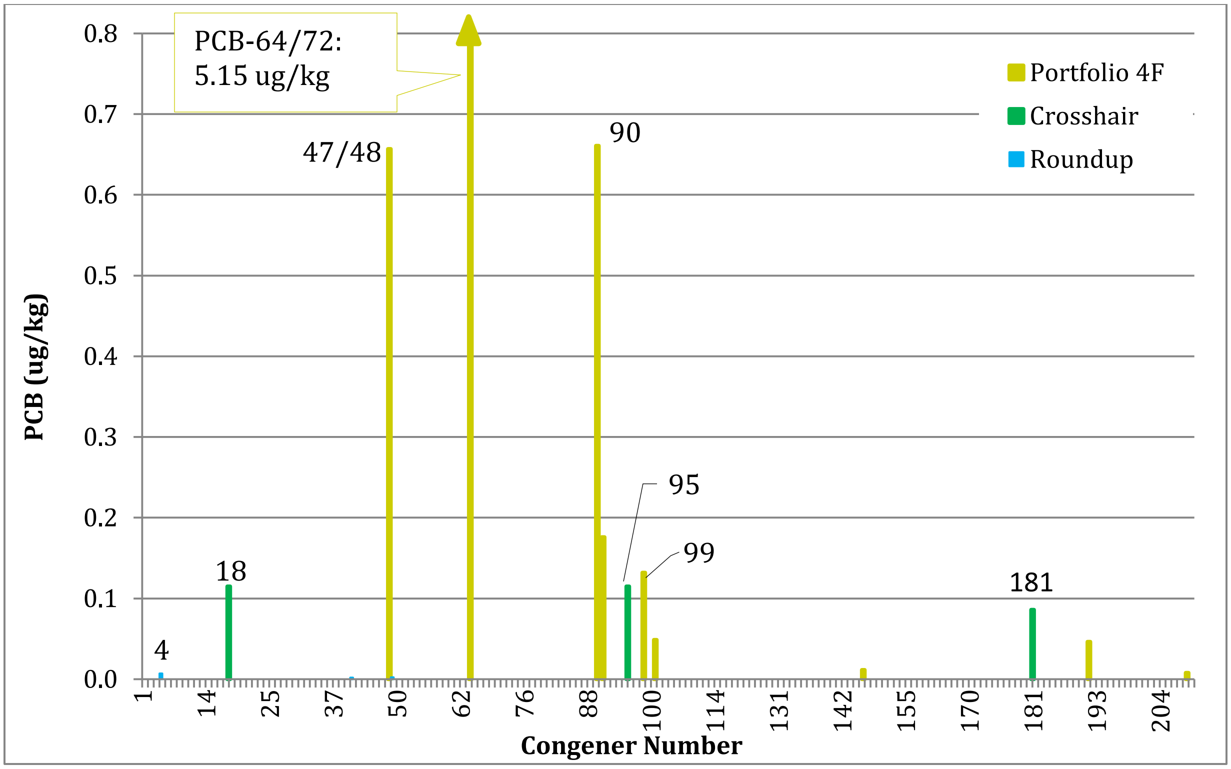


Figure 11. Pesticide and Adjuvant Congeners

Motor Oil and Lubricant

The Fleet Maintenance department primarily uses ConocoPhillips Firebird SAE 15W-40 Heavy Duty EC oil to maintain the City's vehicle fleets. This oil is made from greater than 50% re-refined base stocks. Because this same oil is used in many vehicles and serviced at the same shop, there was an opportunity to sample the same type of oil both before use and after an oil change for comparison. Additionally, Valvoline Full Synthetic SAE 5W-30 was sampled off-the-shelf from a local automotive store. This oil was sampled by the City in 2011 and contained the greatest concentration of PCBs of the oils sampled (see Table 2). A lubricant, MP Gear Lube SAE 85W-140 by Phillips 66 was also sampled. Total motor oil and lubricant PCB concentrations sampled in 2014 are shown in Table 6.

Table 6. Motor Oil and Lubricant Total PCBs

Sample	Total PCB (ug/kg)
Firebird 15-40 Bulk	0.856
Used Firebird 15-40 Bulk	0.502
Used Firebird 15-40 Bulk Replicate	2.375
Valvoline Full Synthetic 5-30	0.969
Gear Lube	0.623

There was a wide range of PCB congener distribution for the various oil and lubricant samples. Most of the congeners were in the low to mid chlorinated range. The used Firebird motor oil sample and its duplicate were not similar to each other in total PCB concentration or congener distribution as a result of its heterogeneity.

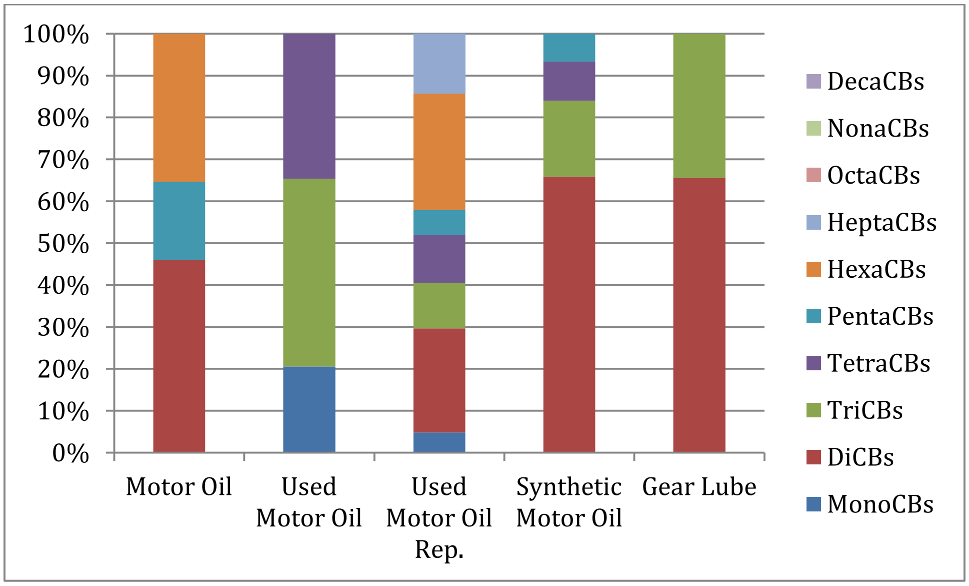


Figure 12. Motor Oil and Lubricant PCB Homologue Patterns

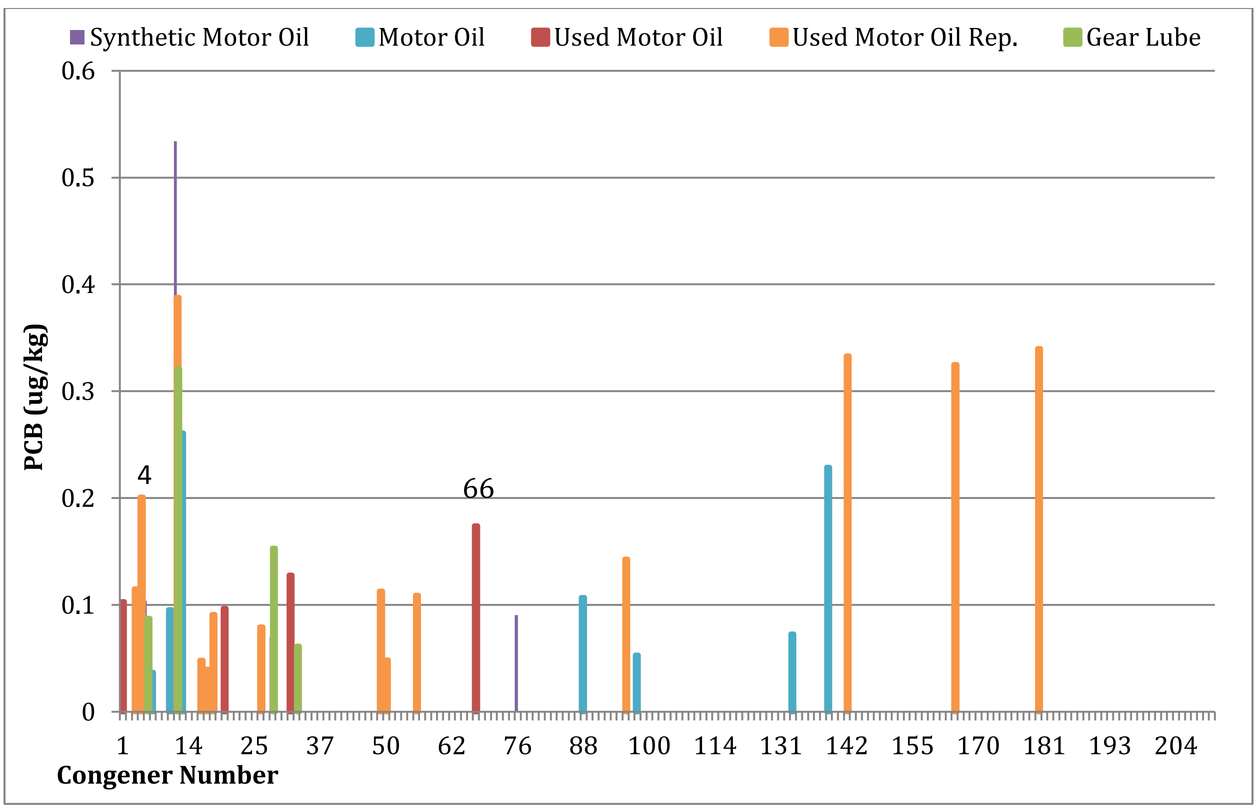


Figure 13. Motor Oil and Lubricant PCB Congeners

Gasoline and Diesel

Regular unleaded gasoline and #2 dyed diesel were sampled from the fuel tanks at the City's Riverside Park Water Reclamation Facility. The diesel sample was non-detect. During laboratory analysis, coextracting interferences resulted in the detection limits being raised to 2 ug/kg for each of the monoCB, diCB, and triCB congeners. Therefore, PCBs may still be present in diesel at less than 2 ug/kg per congener, but were unable to be detected due to interferences.

The total PCBs for the gasoline sample was **0.935 ug/kg**. Nearly all of the sample was composed of PCB-2 (0.93 ug/kg). The remainder was the coeluting congeners PCB-138 and 160.

Dust Suppressant

The City of Spokane has some unimproved roads that have not been paved and require dust control. Three forms of dust control approved for use in the City are magnesium chloride (at a different concentration than the deicer), emulsified asphalt dust abatement (EADA), and lignosulfonate. Samples were collected from each of these three dust suppressants.

The magnesium chloride dust suppressant brand is DustGard, made from naturally occurring minerals from the Great Salt Lake. EADA is a petroleum-based product, containing primarily petroleum asphalt and petroleum bitumen with water and a proprietary mix of petroleum distillates, polymer modifier, surfactants, emulsifier, and other additives. Ligno Road Binder lignosulfonate is derived from natural polymers in wood, and contains sucrose, plant fiber, and an aquatic solution according to its MSDS.

Table 7. Dust Suppressant Total PCBs

Sample	Total PCB (ug/kg)
EADA	0.091
Lignosulfonate	0.086
Magnesium Chloride	3.574

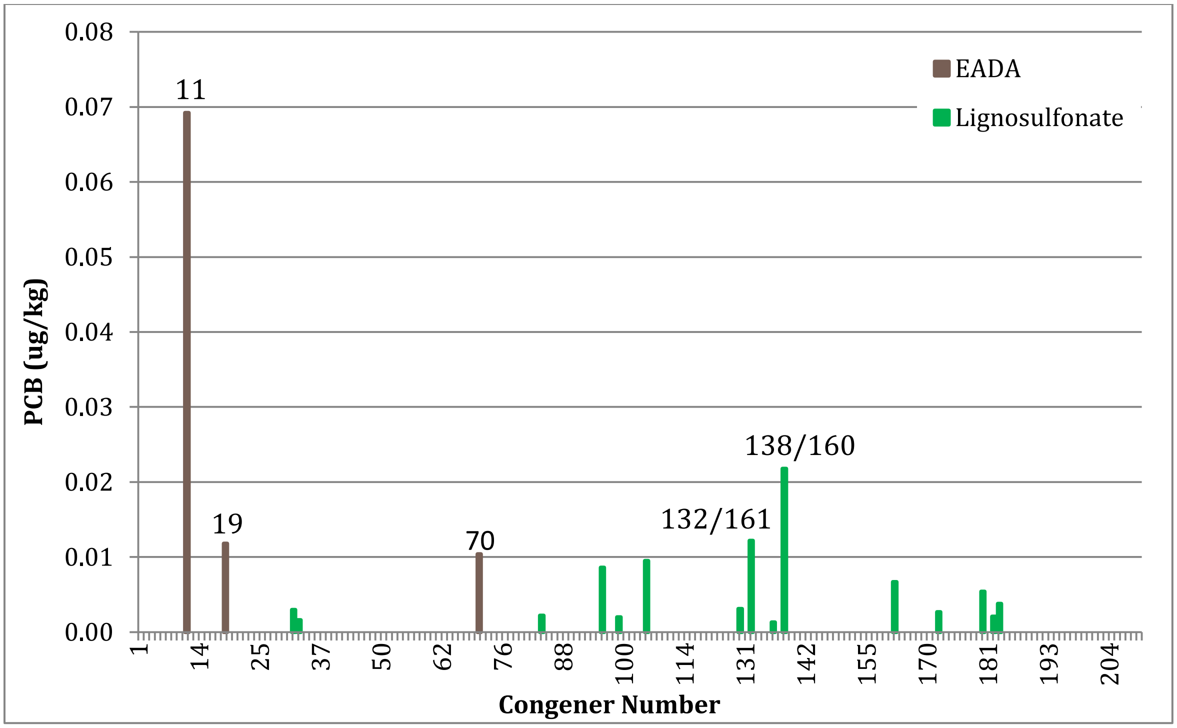


Figure 14. EADA and Lignosulfonate Congeners

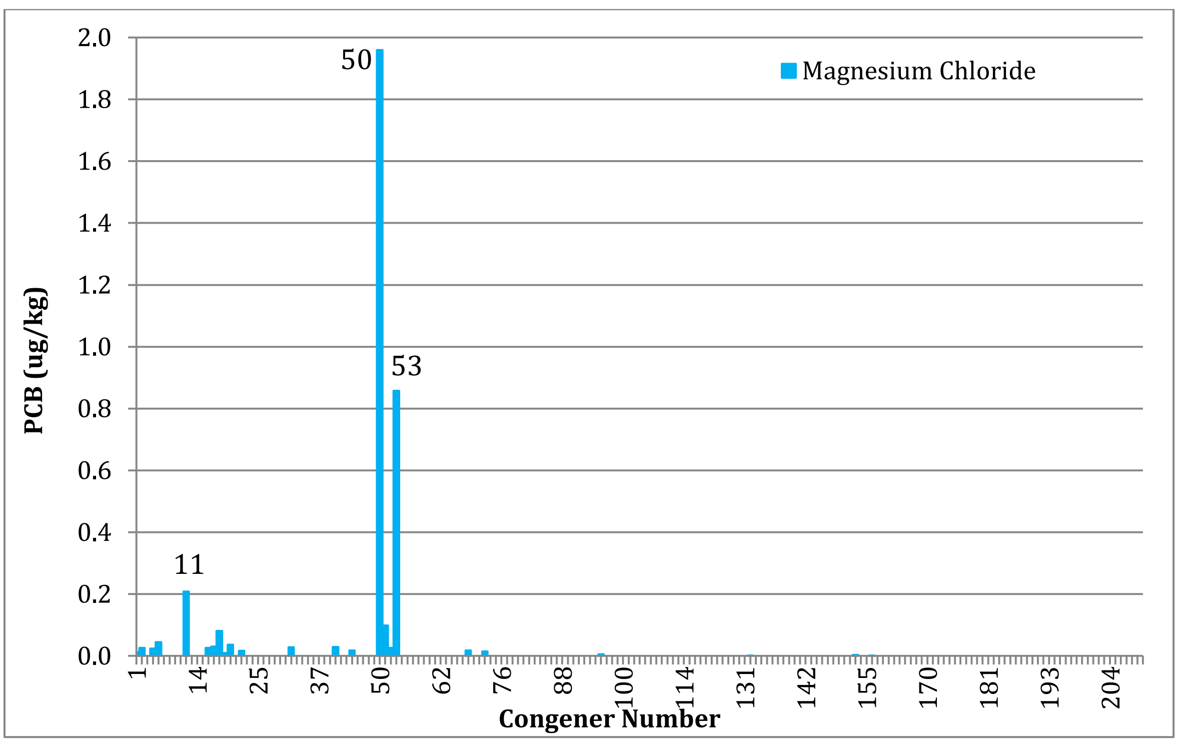


Figure 15. DustGard Magnesium Chloride Congeners

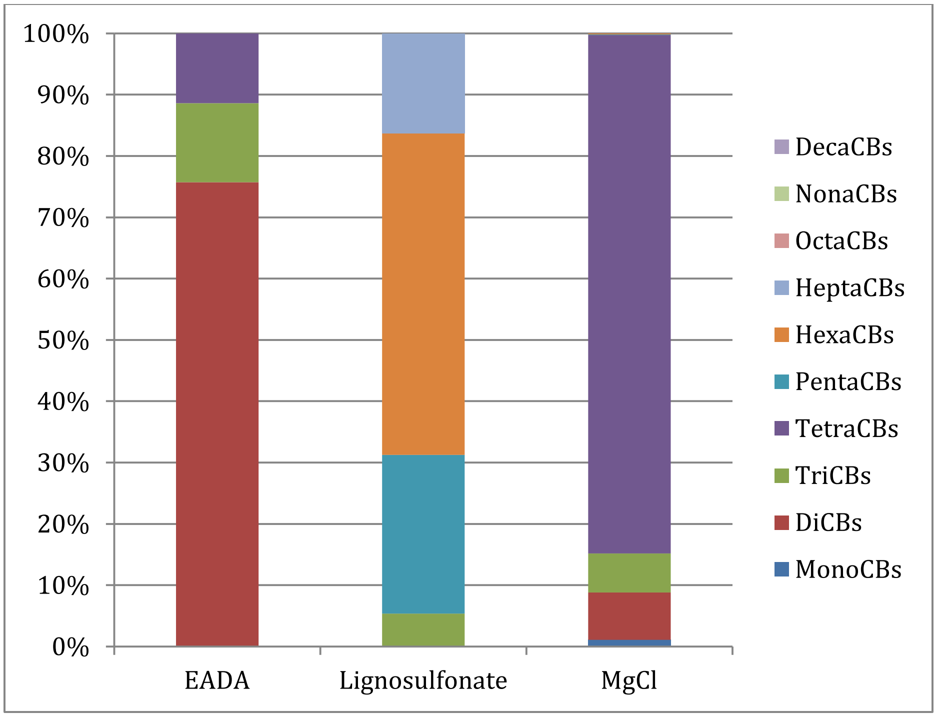


Figure 16. Dust Suppressant Homologue Patterns

The homololgue pattern for EADA is similar to synthetic oil (Figure 12), dominated by diCBs with lesser percentages of triCBs and tetraCBs. Lignosulfonate has a somewhat similar homologue pattern to Aroclor 1260, but the individual congener patterns don't match up well (see Appendix A).

Asphalt Related Products

The asphalt products that were sampled include asphalt tack, crack sealer, and an asphalt release agent. Asphalt tack is made of an asphalt emulsion, and is placed between old and new asphalt layers to adhere them to one another. The crack sealer, SA Premier, is made of asphalt, vacuum distillate, petroleum distillate, styrene-butadiene block copolymer, vulcanized rubber compound, mineral filler, methyl methacrylate, and linear low density polyethylene. The asphalt release agent brand is Soy What by TechniChem, and is "crafted from a by-product that is extracted from soybeans," according to the technichemcorp.com website. Total PCBs and congener and homologue patterns are shown in the following table and figures.

Table 8. Asphalt Related Product Total PCBs

Sample	Total PCB (ug/kg)
Asphalt Tack	0.085
Crack Sealer	7.975
Asphalt Release Agent	0.558

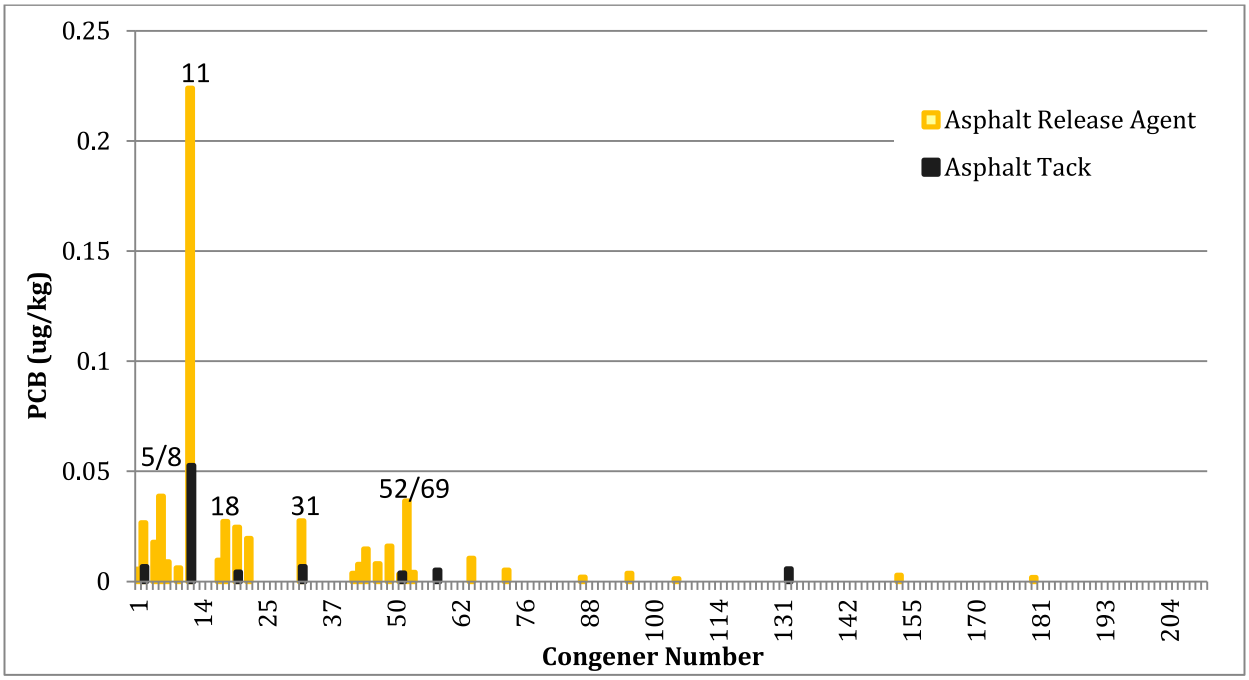


Figure 17. Asphalt Release Agent and Tack Congener Patterns

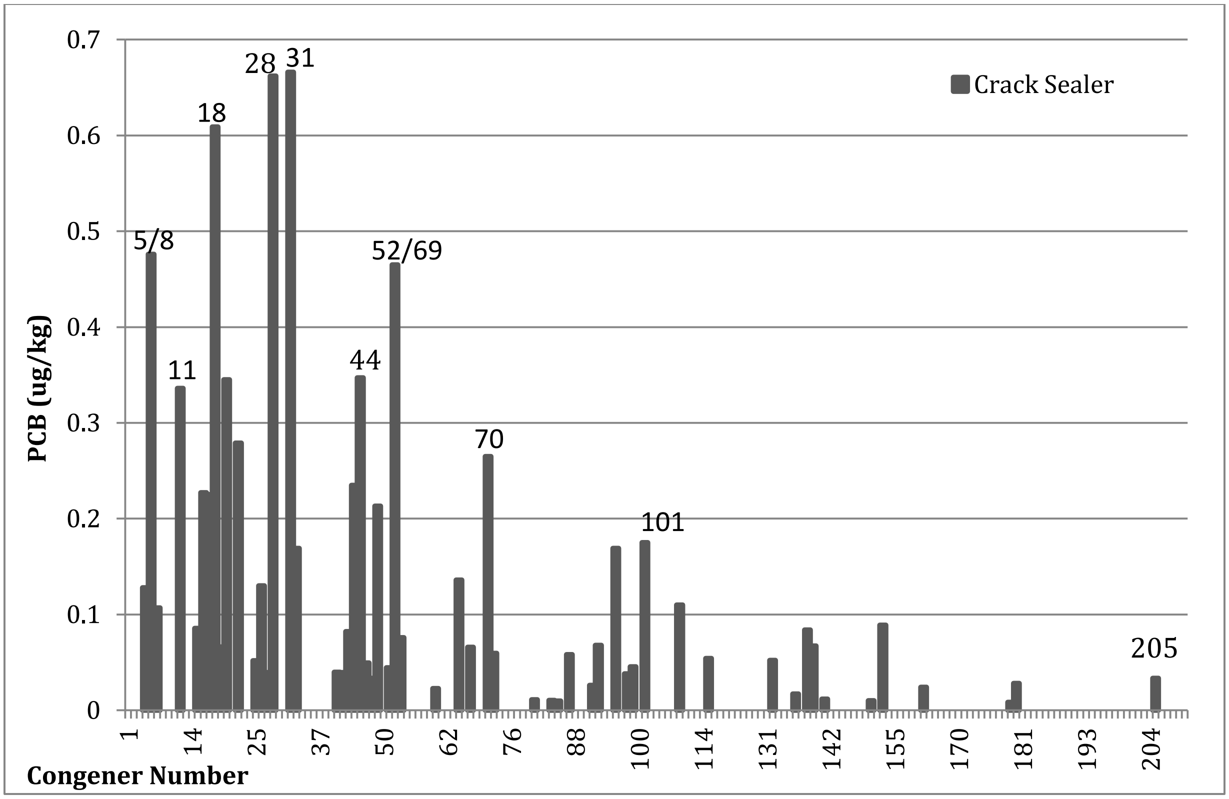


Figure 18. Crack Sealer Congener Pattern

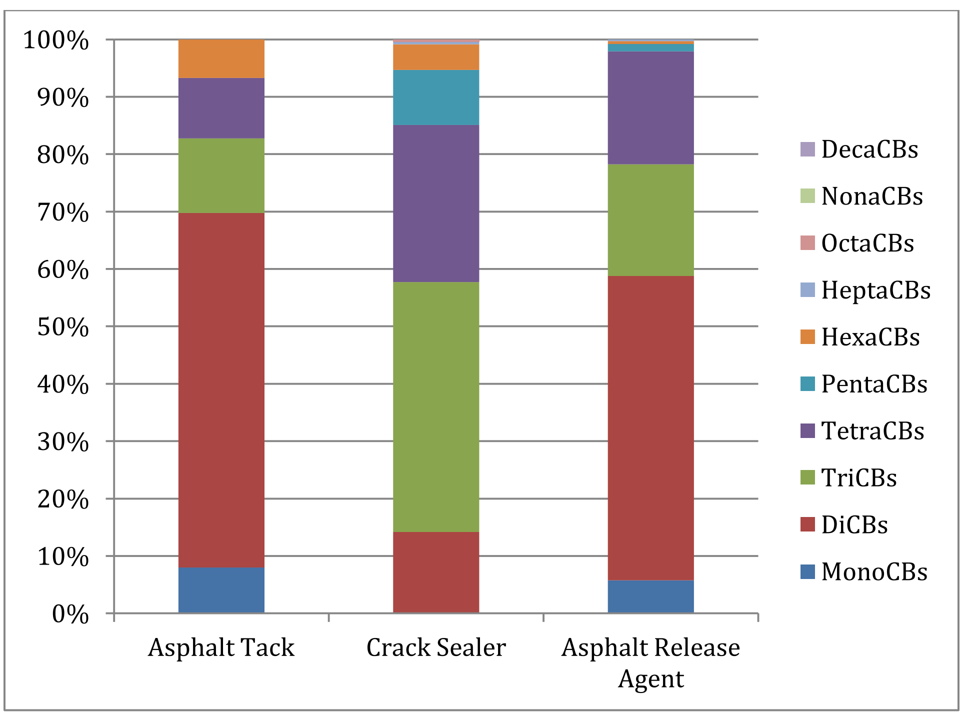


Figure 19. Asphalt Product Homologue Patterns

The crack sealer has a similar congener and homologue pattern to Aroclor 1242. The congeners from the crack sealer sample were converted to percent of total PCB by weight and are plotted against Aroclor 1242 in the same units in Figure 20. Aroclor 1242 had a wide variety of end uses, one of them being in rubbers. One of the ingredients in the crack sealer is vulcanized rubber compound. PCB-11 was detected at over 4% of the crack sealer PCB composition, but is not present in most Aroclor mixes.

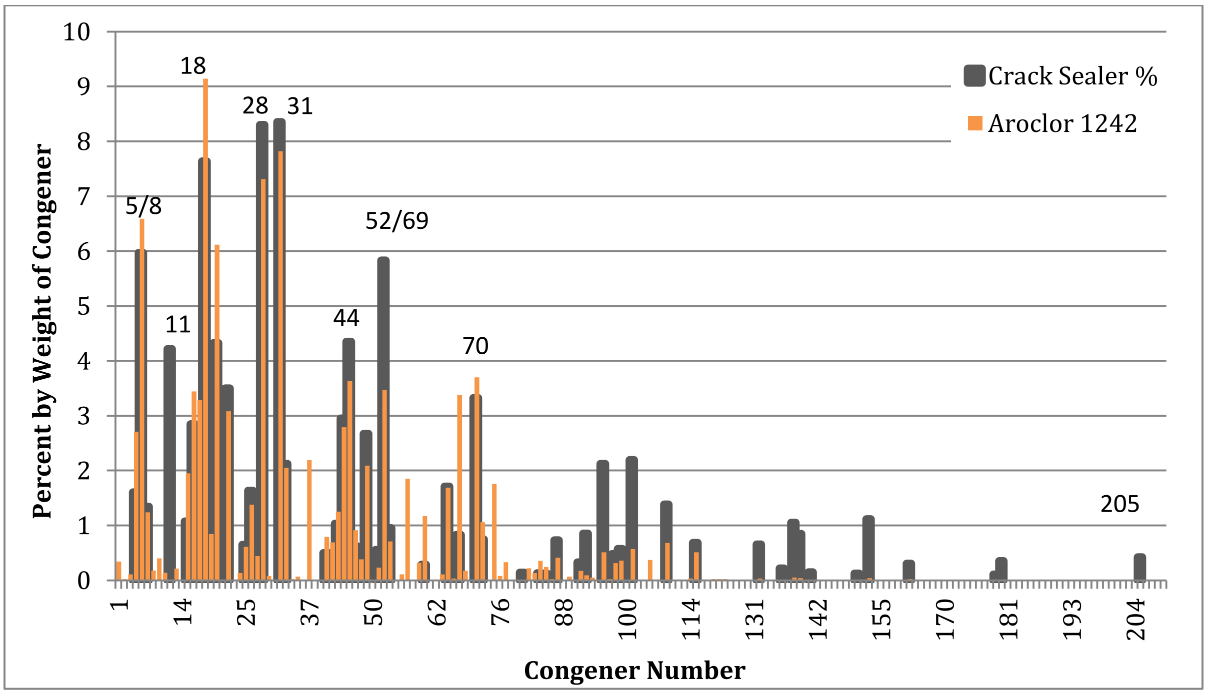


Figure 20. Crack Sealer and Aroclor 1242 Congener Distributions

Hydroseed

A hydroseed mix was sampled due to the prevalent use of hydroseed in roadside projects and its typical green coloring. The sample was collected from a new 50 pound bag of Nature's Own Hydromulch, which was not yet mixed with seed, fertilizer, or other additive. The Nature's Own Hydromulch MSDS indicates that it is composed of primarily wood fiber material with green liquid and a surfactant. The sample contained shredded colored newspaper cellulose. Total PCBs detected in the sample was **2,509 ug/kg**. The following figures show the congeners detected and homologue patterns for the sample.

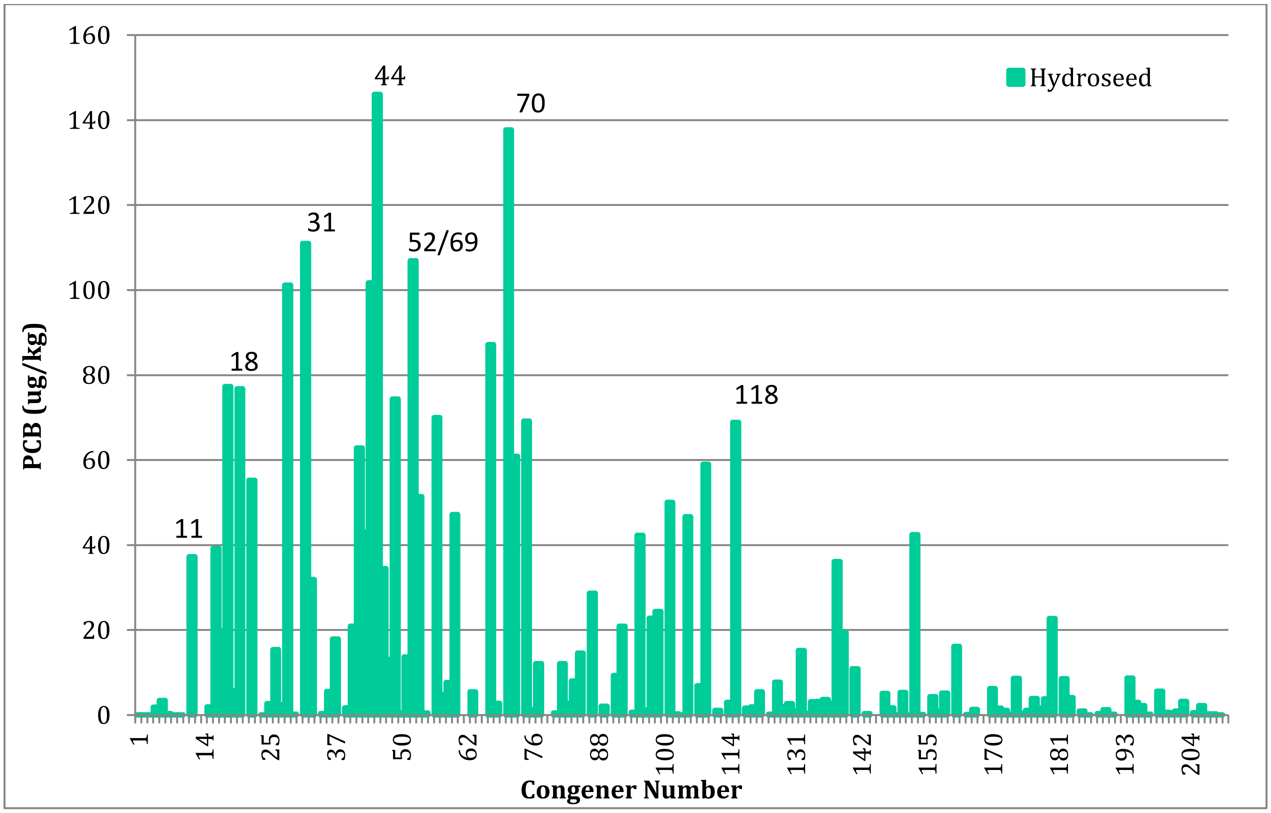


Figure 21. Hydroseed Congeners

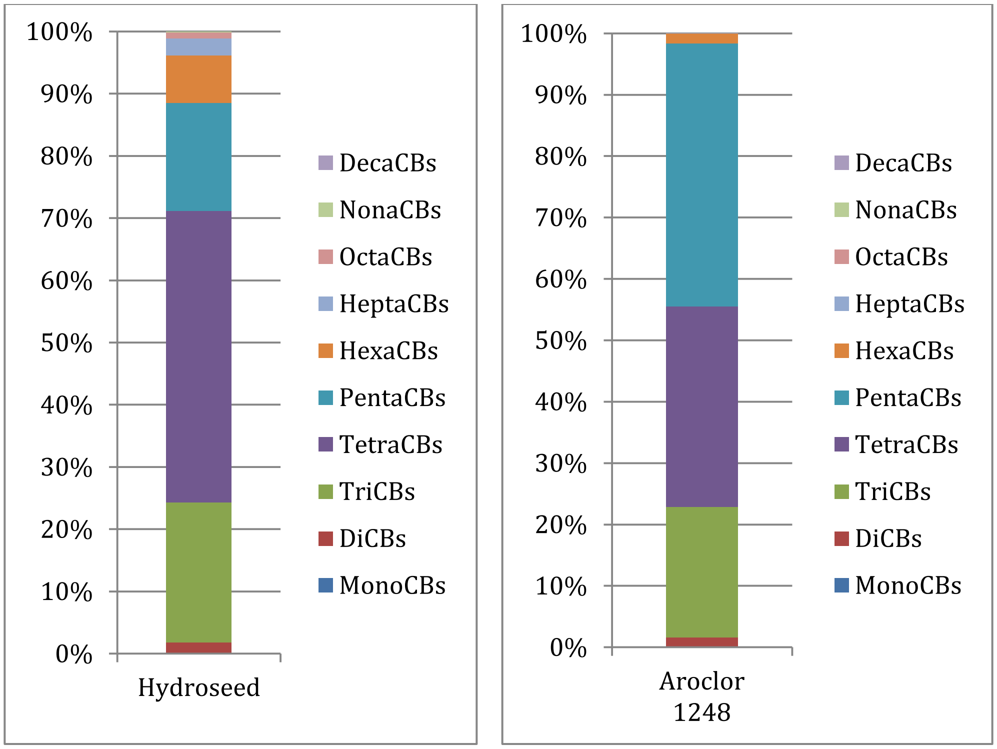


Figure 22. Hydroseed and Aroclor 1248 Homologue Patterns

In an unrelated incident, a landscape contractor received a penalty from the State of Iowa for illegally discharging a hydroseed mixture on the bank of a creek (Scriven-Young, 2010). The hydroseed contained 320 parts per billion of Aroclor 1248 as well as the pesticides DDT and DDE. Interestingly, the sample collected by the City of Spokane has a homologue pattern very similar to that of Aroclor 1248.

The hydroseed congeners from the City's sample were converted to percent of total PCB by weight and are plotted against Aroclor 1248 in the same units in Figure 23 below. The two congener patterns are quite similar. Note that PCB-11 is present in the hydroseed, but not the Aroclor. This indicates a secondary source of PCBs from pigment that is relatively minor compared to the Aroclor.

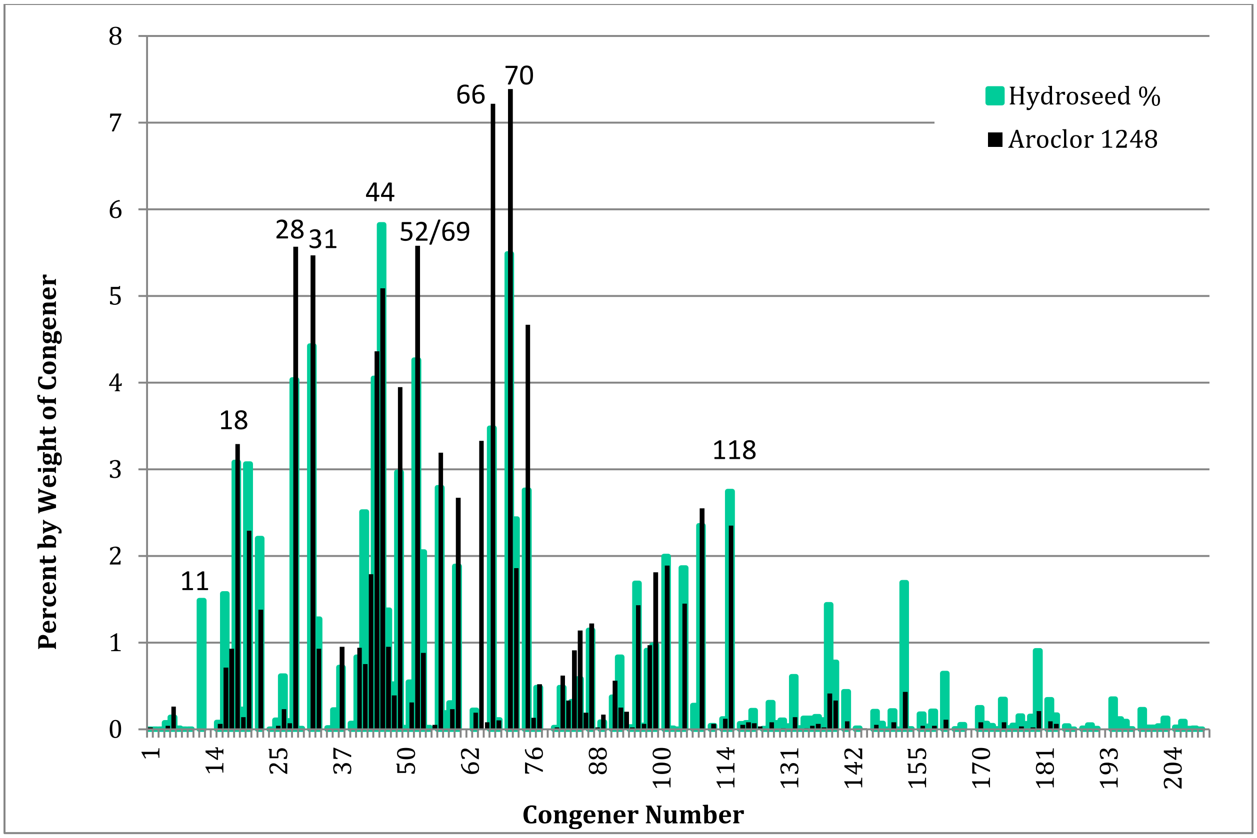


Figure 23. Hydroseed and Aroclor 1248 Congener Distributions

Pipe Material

There are hundreds of miles of PVC pipe used in the City's sanitary and storm sewer systems. Dischargers in the Spokane region have been collecting sanitary and stormwater samples for ultra low-detection PCB analysis, and many of these samples have traveled through miles of PVC pipe prior to collection. In an effort to screen the potential for PCB contribution from pipe material, PVC pipe, cast in place pipe (CIPP) liner and shortliner pipe repair materials were sampled.

The type of PVC sampled was ASTM 3034 collected from a new, unused eight-inch diameter pipe. CIPP is constructed from a felt tube saturated with resin and coated with polyurethane, and is cured inside an existing pipe. The section of CIPP liner sent in for analysis was originally collected from a construction project in northeast Spokane in April, 2013. It was kept in an office environment and not exposed to the elements after that time. Shortliner pipe repair is constructed in the same way, and made of a polyester-fiberglass liner impregnated with thermosetting epoxy resin. A test section of shortliner was cured in a new pipe on the ground surface at the City's Sewer Maintenance Department in October, 2014 for use in this sampling study.

Pieces of pipe were sent to the laboratory for analysis to help determine the PCB content in the material itself. The potential for PCBs to leach from the pipe material to stormwater and sanitary sewage is outside the scope of this project, but future analysis is warranted based on the results shown in Table 9.

Table 9. Pipe and Pipe Repair Material Total PCBs

Material	Total PCB (ug/kg)
PVC (ASTM 3034) Pipe	1.999
CIPP Liner	1.110
Shortliner	17.780

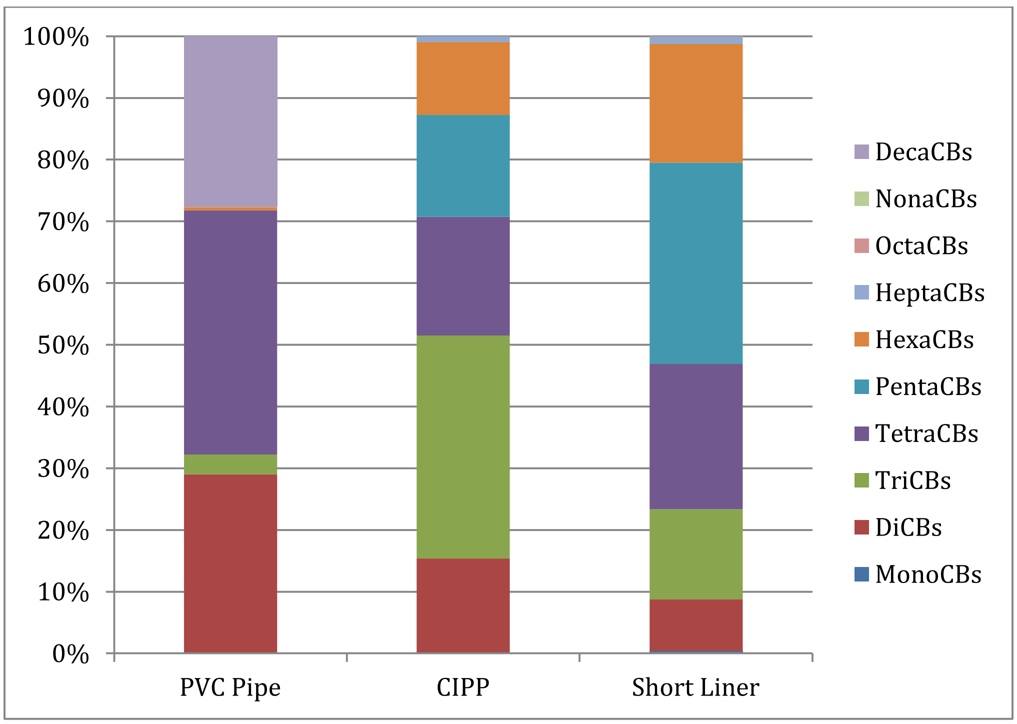


Figure 24. Pipe Material Homologue Patterns

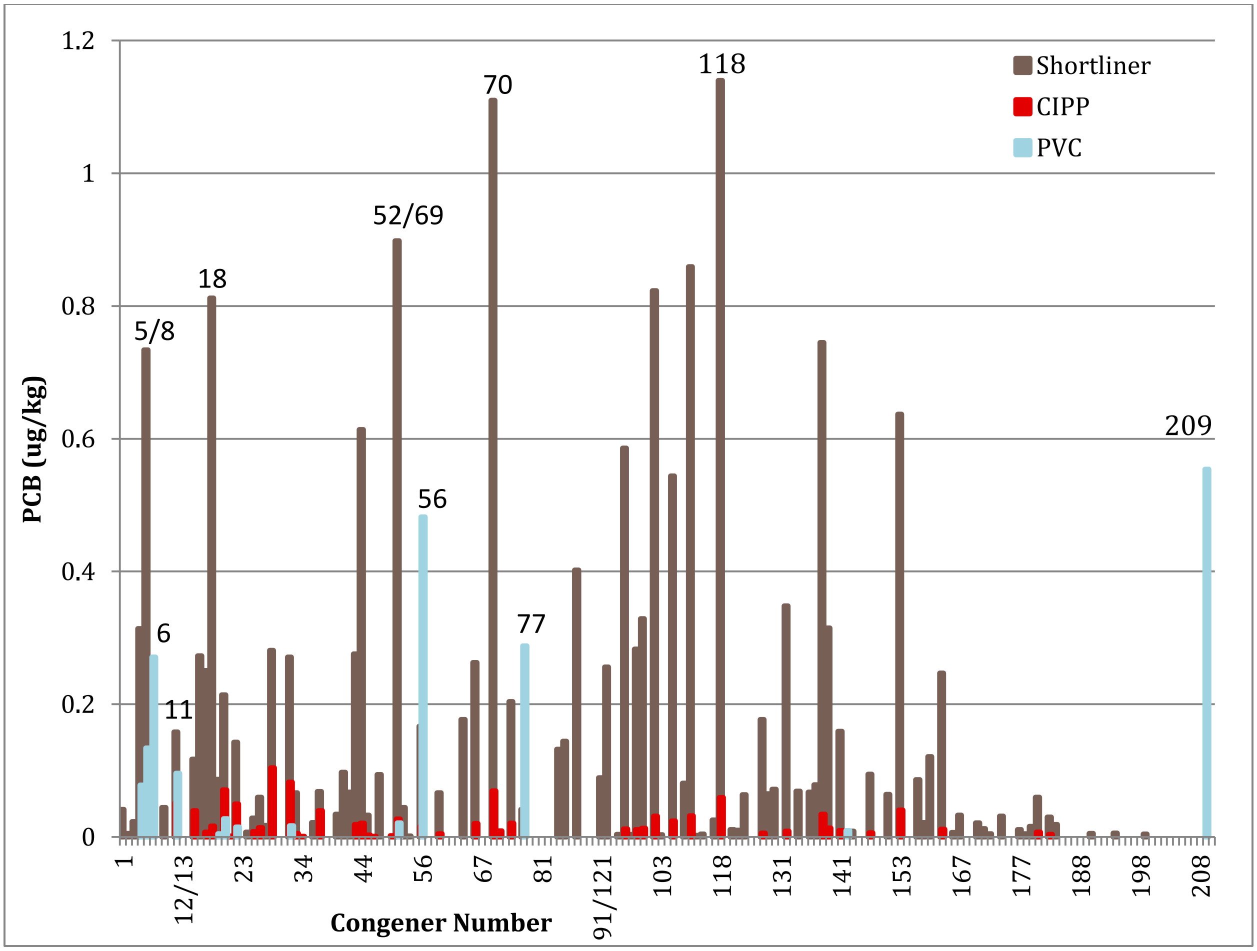


Figure 25. Pipe Material PCB Congeners

Figure 25 shows congener patterns for the sampled pipe materials. Congener distributions (percent of total PCB) for the pipe materials were then compared to congener patterns for Aroclors. The PVC and CIPP samples did not appear to correlate with Aroclor patterns. The Shortliner sample appears to correlate somewhat with a combination of two or more Aroclors. Specifically, a combination of both Aroclors 1242 and 1248 matches the shortliner sample the most closely (Figure 26).

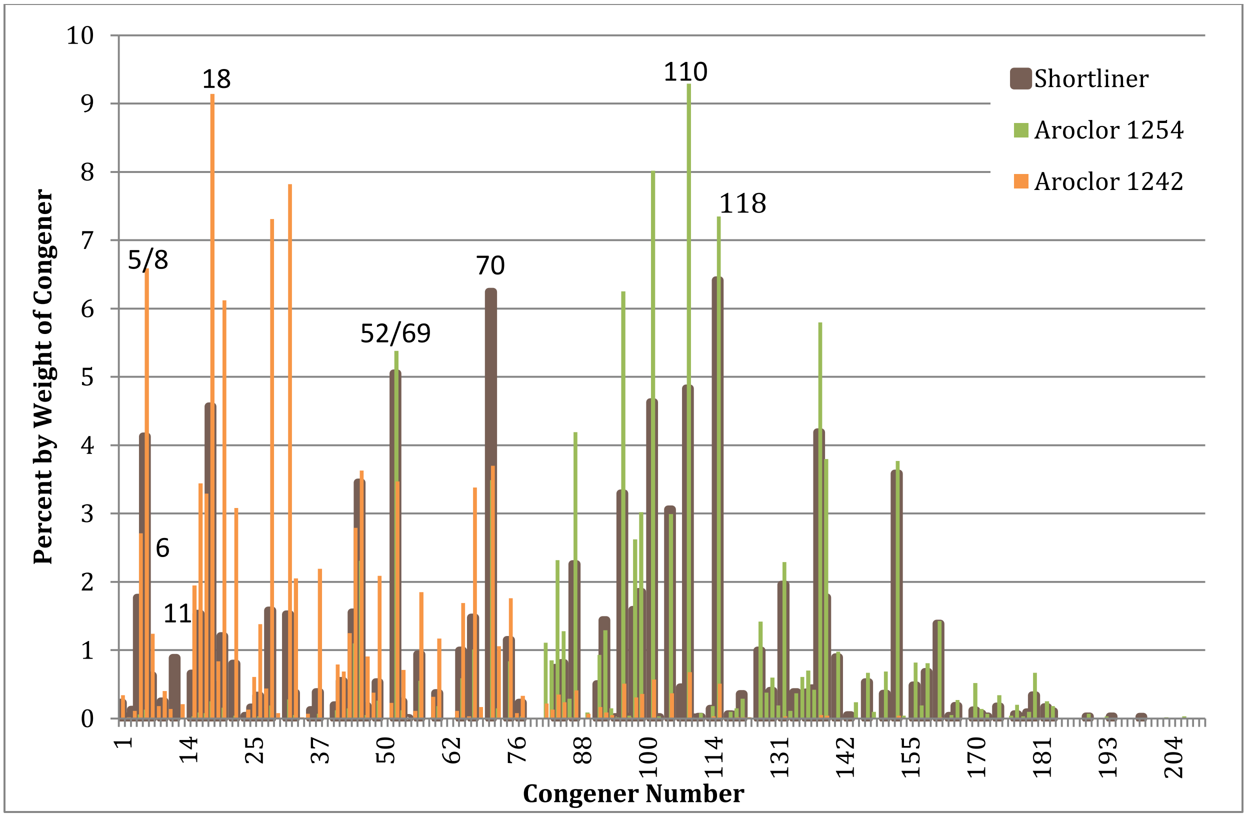


Figure 26. Shortliner Congener Distribution Compared to Aroclors 1242 and 1254

Firefighting Foam

Discharges from emergency firefighting activities are an exempt activity under the Phase II Eastern Washington Municipal Stormwater Permit. However, these discharges can easily enter a storm sewer system without proper containment and contribute contaminants to the environment. Alcoseal 3-3 Class B firefighting foam was sampled. Ingredients listed on the MSDS sheet include hydrolyzed protein, fluorosurfactants, 1,2 benzoisothiazelin, and hexylene glycol. The total PCB concentration was **0.029 ug/kg**. The associated congener and homologue patterns are shown in Figure 27.

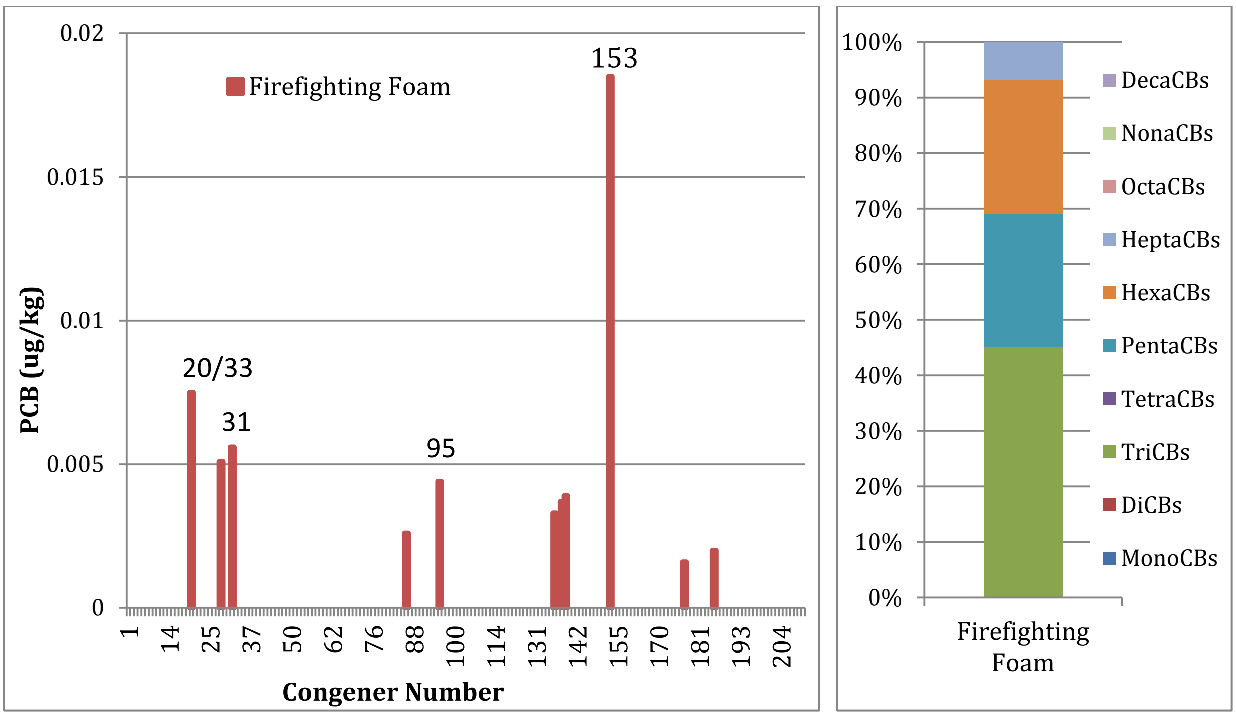


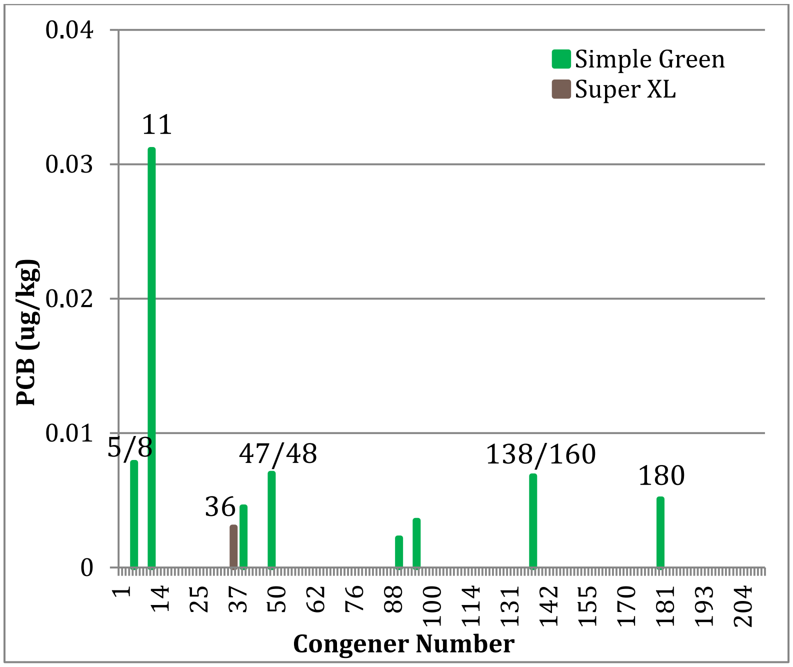
Figure 27. Firefighting Foam PCB Congeners and Homologue Pattern

Cleaners and Degreasers

Inadvertent PCB generation is possible with the manufacture of soaps, detergents, surfactants, and degreasers (Munoz, 2007). A detergent made by Hotsy was sampled as well as Simple Green degreaser.

The Hotsy Super XL detergent contained **0.003 ug/kg** total PCBs. A laboratory duplicate was analyzed, containing 0.068 ug/kg total PCBs. This product contains trisodium phosphates, alkaline builders, and surfactants. Congener distributions from the primary sample are shown in the figure below, containing only PCB-36.

The Simple Green degreaser contained **0.068 ug/kg** total PCBs, with nearly half of this total from PCB-11. The ingredients consist of primarily water with 2-butoxyethanol, ethoxylated alcohol, tetrapotassium pyrophosphate, sodium citrate, and a proprietary mix of fragrance and polymeric colorant.



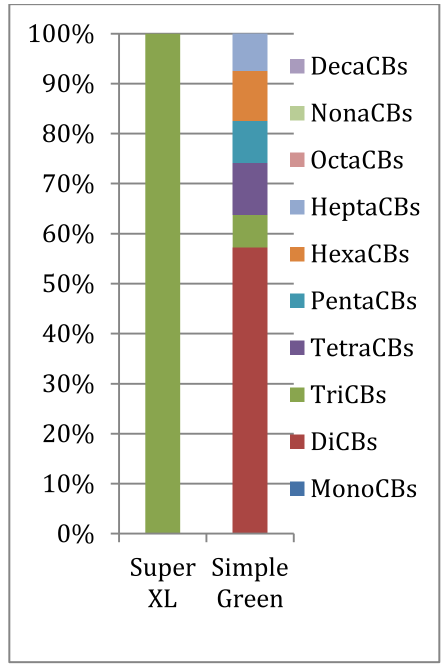


Figure 28. Simple Green and Super XL PCB Congeners and Homologue Pattern

Personal Care Products

Sampling in the storm and sanitary sewer systems over the past several years has indicated that total PCB concentrations in the sanitary sewer collection system are slightly greater than average concentrations in stormwater. So, in addition to products that can contribute PCBs to stormwater, five personal care products that may contribute PCBs to the sanitary sewer collection system were sampled. The products sampled were liquid and contained pigments. Table 10 shows the product brands sampled, total PCBs, pigments listed in the ingredients, and the so-noted 'ingredients of interest.' Many of these products have a long list of ingredients. Those ingredients that are chlorinated, contain benzene rings, or are suspected to be associated with inadvertent PCB production based on the literature search are included in Table 10 as ingredients of interest.

Table 10. Personal Care Products

Brand	Total PCB (ug/kg)	Ingredients of Interest	Pigments
Dial Antibacterial hand soap (pomegranate and tangerine)	0.037	Triclosan, tetrasodium EDTA, sodium chloride, polyquaternium-7	Yellow 6, Red 33, Red 40

Brand	Total PCB (ug/kg)	Ingredients of Interest	Pigments
Tide Original laundry detergent	0.174	Ethanolamine, Benzene sulfonic acid (sodium salt and monoethanolamine salt), disodium diaminostilbene disulfonate, dimethicone (type of silicone)	Liquitint® Blue HP (Polymeric colorant)
Dawn Ultra antibacterial dish soap	0.083	Chloroxylenol, sodium chloride	Yellow 5, Blue 1
Suave Naturals shampoo	0.058	Tetrasodium EDTA, ammonium chloride, methylchloroisothiazolinone	Blue 1, Red 33
Aquafresh Extreme Clean Whitening toothpaste	0.032	Glycerin, titanium dioxide, sodium saccharin	Red 30

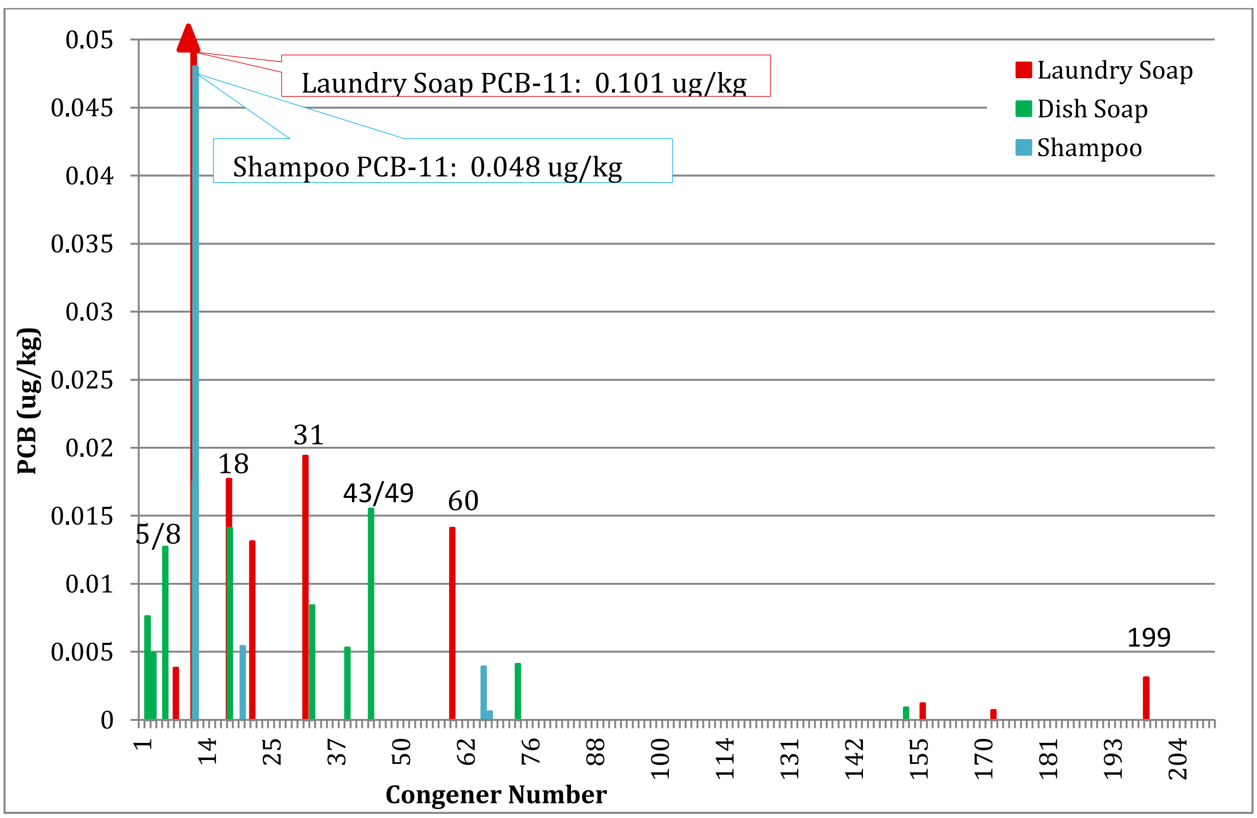


Figure 29. Laundry Soap, Dish Soap, and Shampoo Congeners

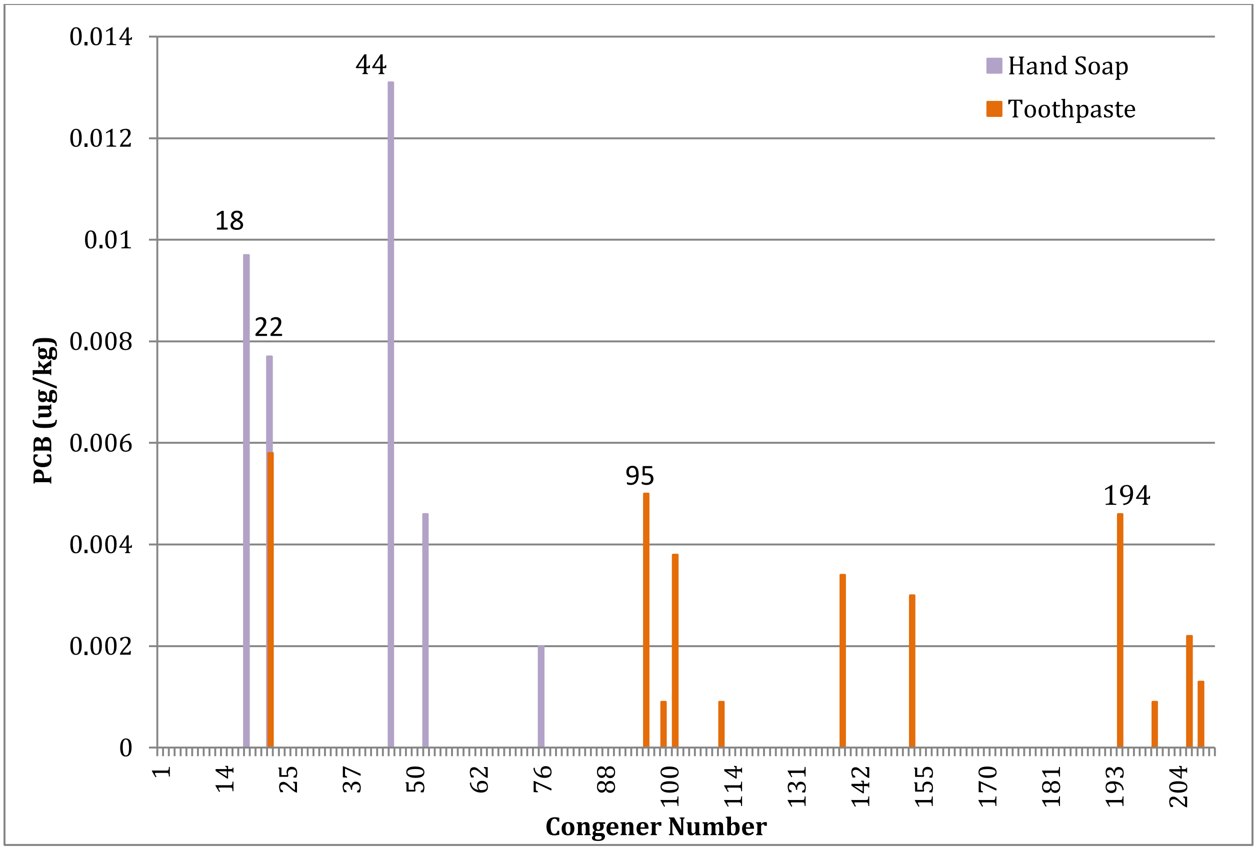


Figure 30. Hand Soap and Toothpaste Congeners

Figure 31. Personal Care Product Homologue Patterns

CONCLUSIONS

PCBs were detected in 39 of the 41 product samples, with a wide range of congener patterns. Figure 32 shows the frequency of detection of each congener in this study. The congeners most frequently detected are the coeluting congeners PCB-52/69 (detected in 30 of the samples) followed by PCB-11 and PCB-28 (detected in 25 of the samples). PCB-52 is one of the most abundant congeners found in the environment, and is found in Aroclor mixtures from 0.1% to 5.6% of the mixture by weight (Frame et. al, 1996). PCB-28 is also commonly found in Aroclor mixtures at up to 8.5% of the total mixture by weight (Frame et. al, 1996). Because PCB-11 was one of the most frequently detected congeners, and it is generally not found in Aroclor mixes, pigments are likely a common source of inadvertently produced PCBs in the products sampled.

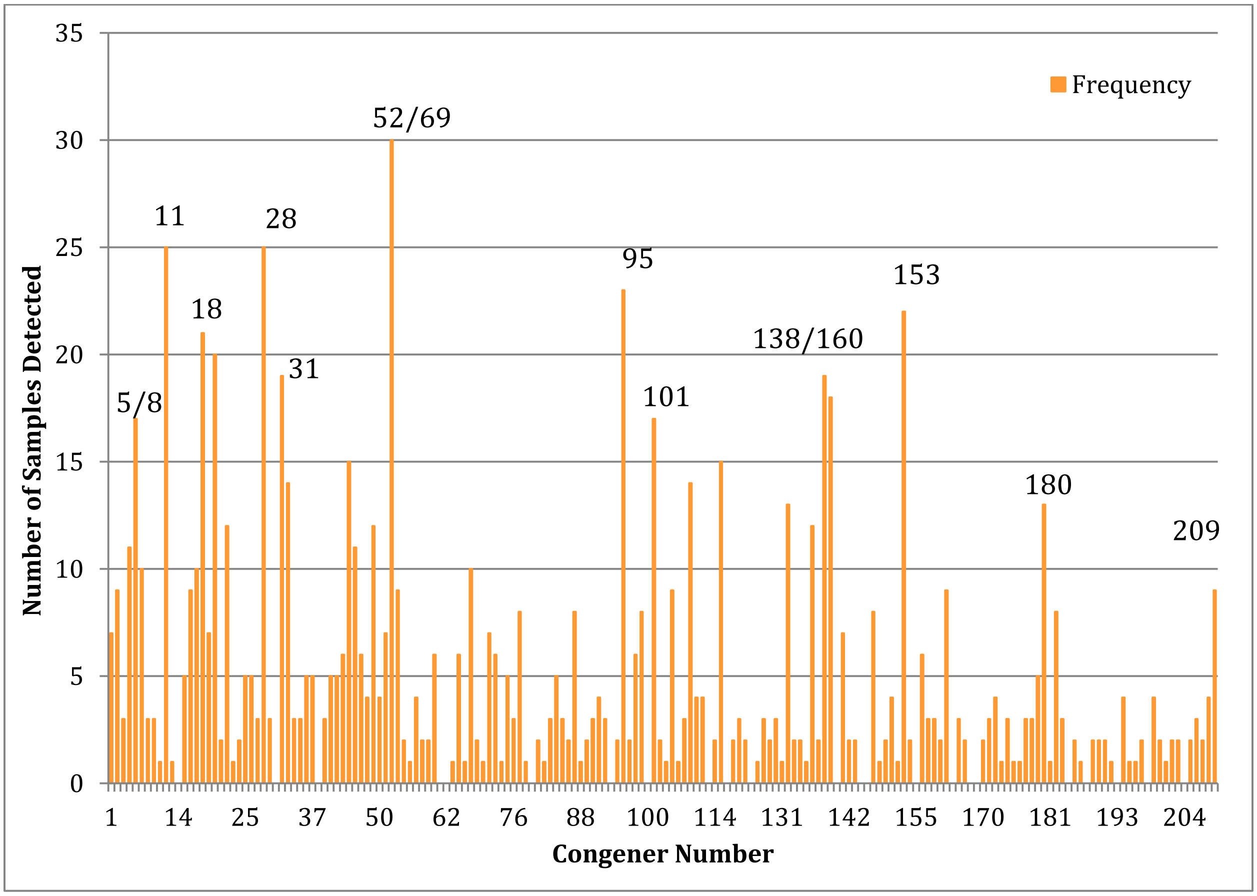


Figure 32. Frequency of Detections per Congener

The results from this report may be used for a number of PCB tracking and reduction activities. Additional research may be needed to determine potential pathways between some of the sampled products and stormwater. For PCB reduction activities, total PCB loading (volume of product used) should be assessed to aid in prioritization. Manufacturers may also be interested in exploring PCB-free alternatives where feasible.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). (2000). *Toxicological Profile for Polychlorinated Biphenyls (PCBs)*. US Department of Health and Human Services, Public Health Service.

Christie, R. M. (2014). *Alternatives for elimination of polychlorinated biphenyls (PCBs) in pigments used for printing inks and architectural paints.* (Ecology Publication No. 14-07-005).

Ecology. (2014). *Polychlorinated Biphenyls (PCBs) in General Consumer Products*. (Ecology Publication No. 14-04-035).

EPA. (2010)a. *Method 1668, Revision C-Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS*. (EPA Publication No. EPA-820-R-10-005). U.S. Environmental Protection Agency, Office of Water. Washington, DC.

EPA. (2010)b. *PCBs and Chemistry, Hudson River PCBs*. Retrieved from http://www.epa.gov/hudson/pcbs101.htm.

EPA. (2015). *US Magnesium*. U.S. Environmental Protection Agency, Region 8. http://www2.epa.gov/region8/us-magnesium

Erickson, M. D. (1986). *Analytical Chemistry of PCBs*. Lewis Publishers.

Frame, G. M., Cochran, J. W., and Bowadt, S. S. (1996). *Complete PCB Congener Distributions for 17 Aroclor Mixtures Determined by 3 HRGC Systems Optimized for Comprehensive, Quantitative, Congener-Specific Analysis.* J. High Resol. Chromtogr. Vol. 19. pp. 657-668.

Hu, D. and Hornbuckle, K. C. (2010). Inadvertent Polychlorinated Biphenyls in Commercial Paint Pigments. *Environ. Sci. Technol., 44*. pp. 2822-2827.

LimnoTech. (2014). *Quality Assurance Project Plan, Polychlorinated Biphenyls in Municipal Products*. Prepared for the City of Spokane.

Munoz, G. (2007). Processes that Inadvertently Produce PCBs. *Optimizing Contaminant Trackdown: Focusing on Wastewater Treatment Plants and Related Systems*. The New York Academy of Sciences. Retrieved from http://www.nyas.org/asset.axd?id=0f0f0d12-2d2a-4449-93a0-383d9d4e61ec

Rodenburg, L. A. (2012). *Inadvertent PCB production and its impact on water quality*. Panel discussion presentation. ECOS Annual Meeting. Colorado Springs, CO.

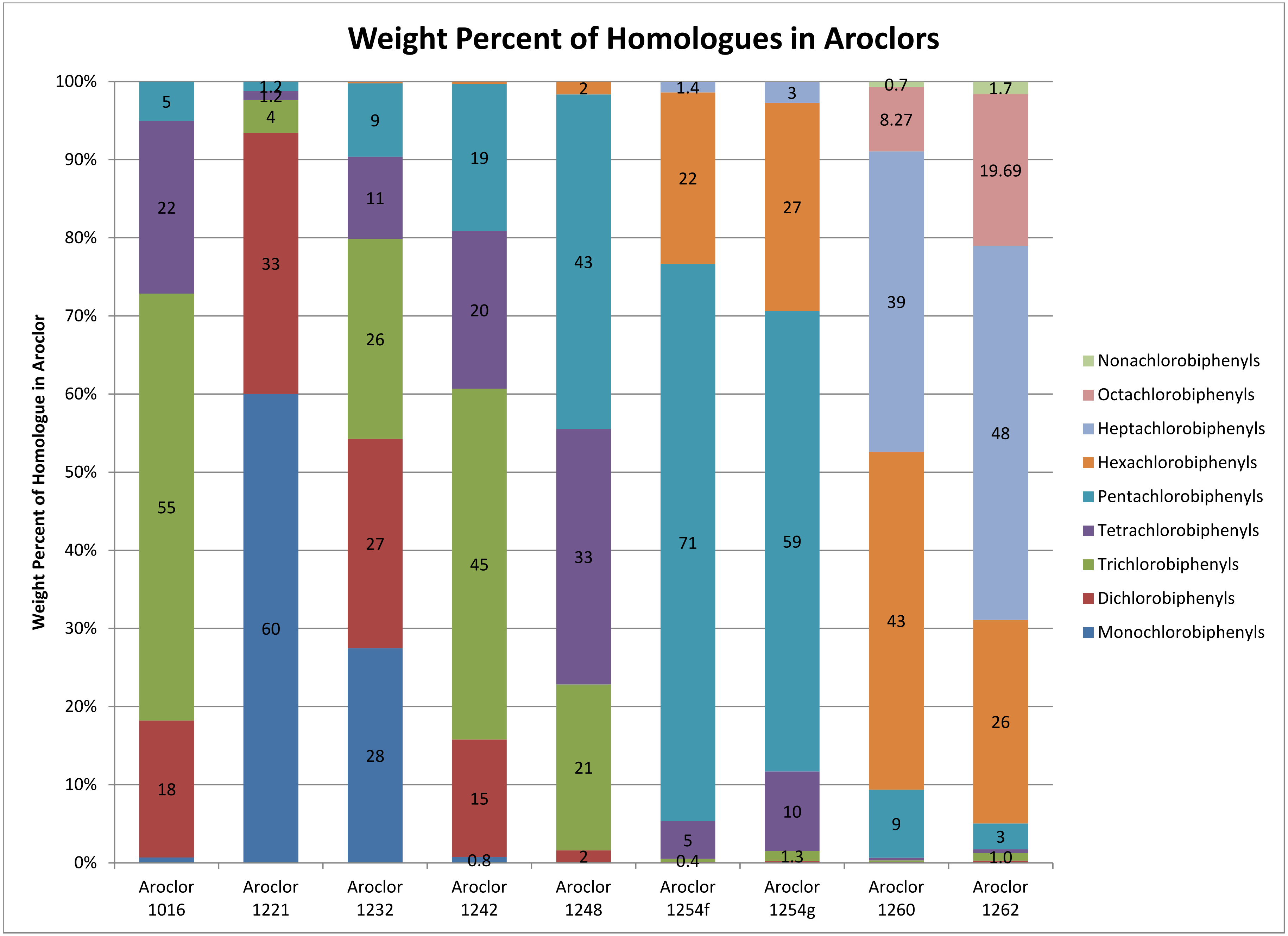
Scriven-Young, Dave. (2010). *$14,300 Settlement of State Enforcement Action Alleging Dumping of Pesticides*. Illinois Environmental Law Blog. Retrieved from http://illinoisenvironmentallaw.blogspot.com/2010/03/14300-settlement-of-state-enforcement.html.

Thomsen, M. N., and Illerup, J. B. (2009). *Unintentional formation and emission of the persistent organic pollutants HDB and PCBs in the Nordic Countries*. Nordic Council of Ministries, Copenhagen. TemaNord 2009:518.

Xu, Q., Nakajima, M. Liu, Z., and Shiina, T. (2011). *Soybean-based Surfactants and Their Applications*. Soybean – Applications and Technology. InTech. Pp. 341-364.

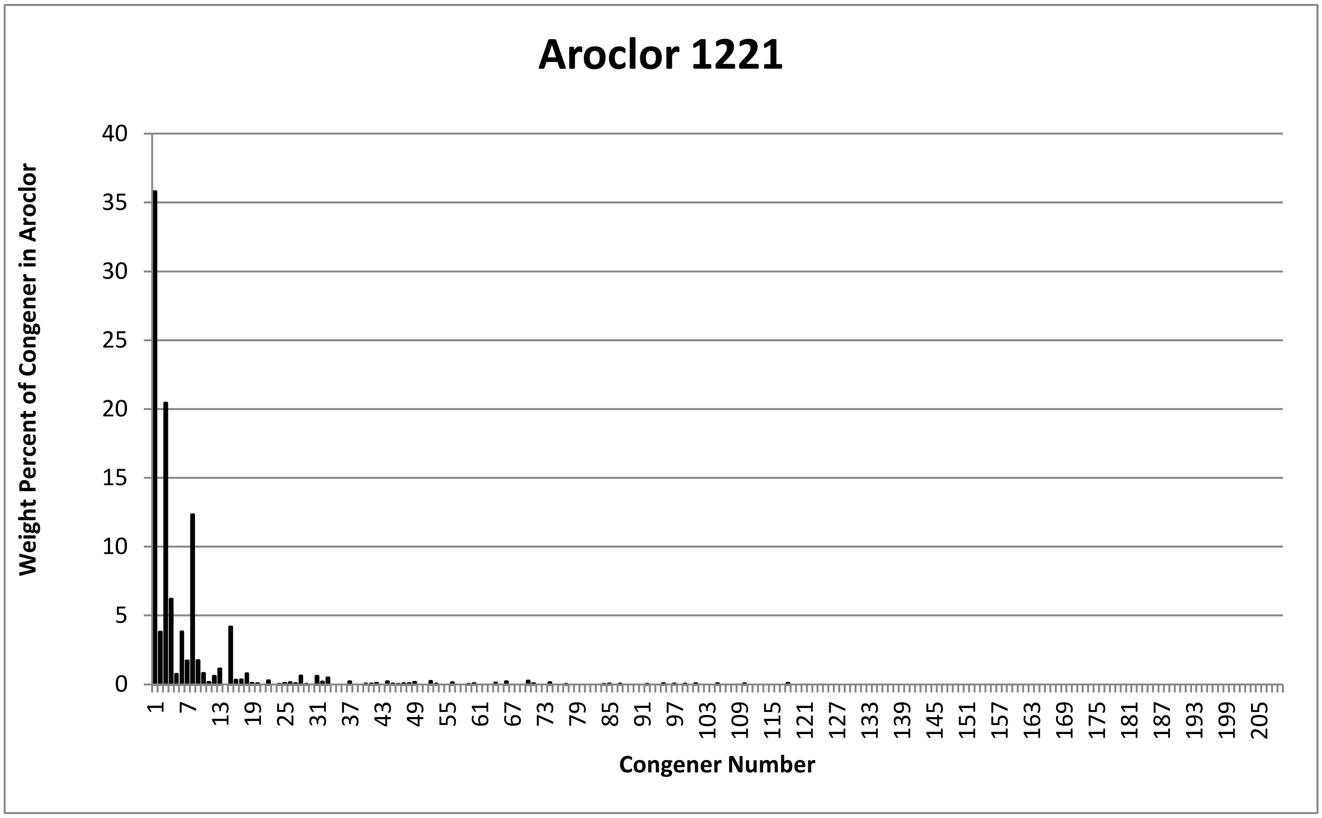
Appendix A

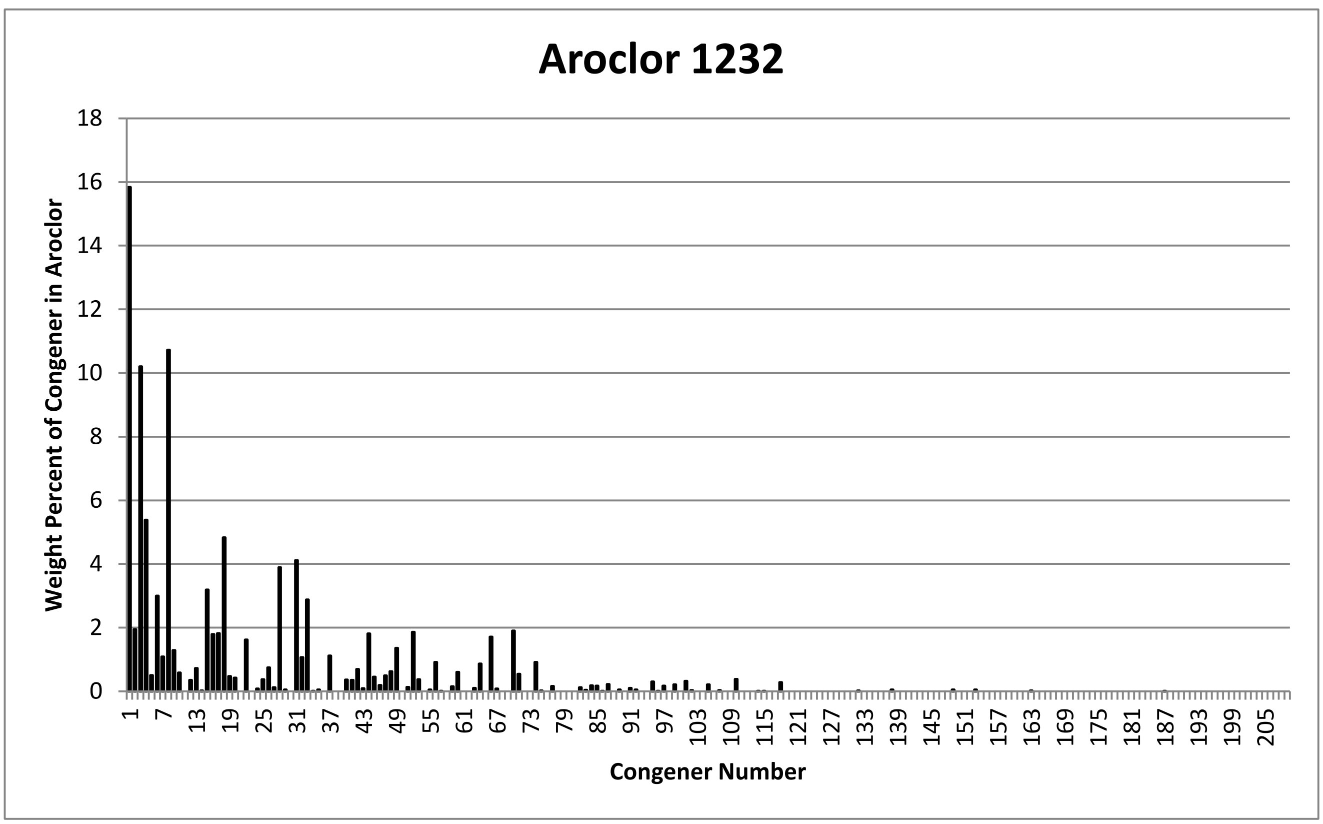
AROCLOR HOMOLOGUES AND CONGENERS



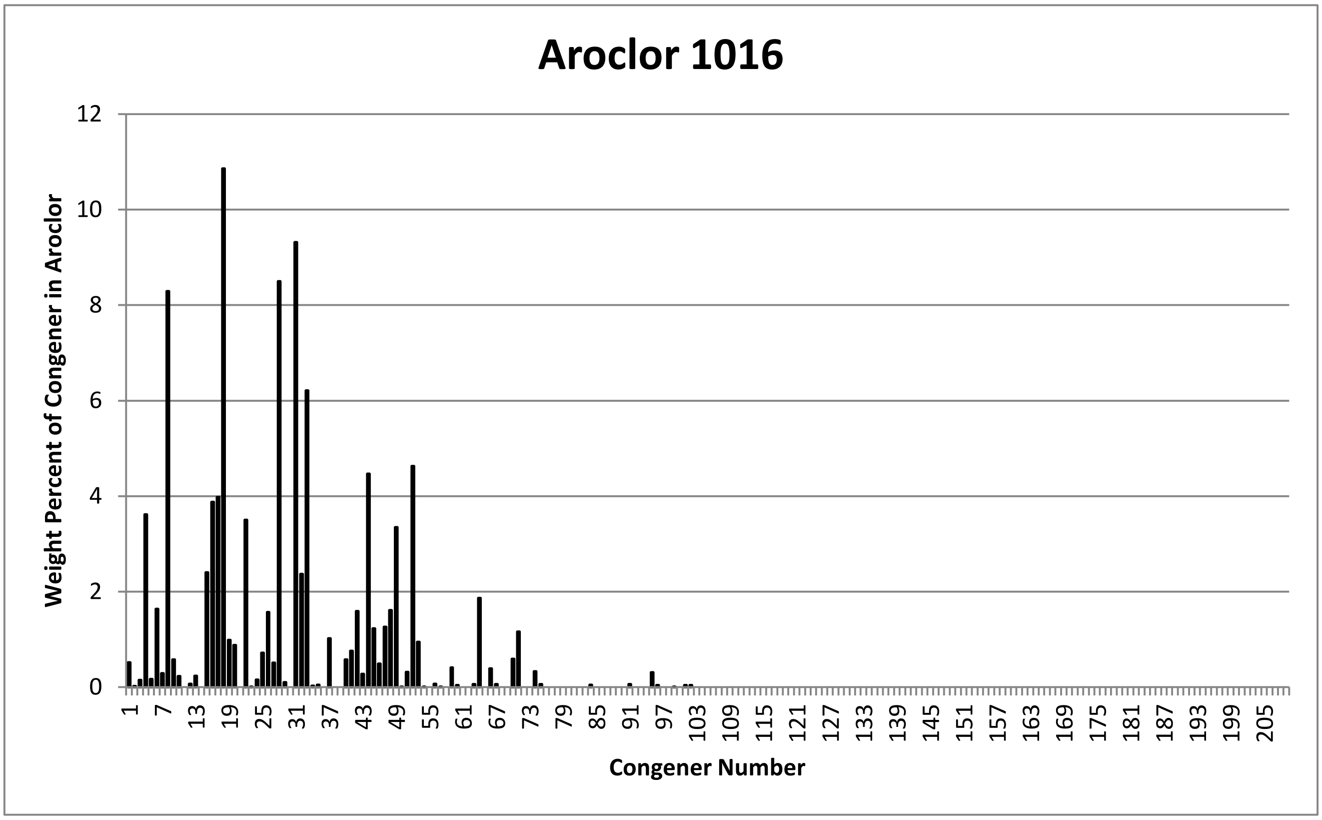
Adapted from ASTDR, 2000.

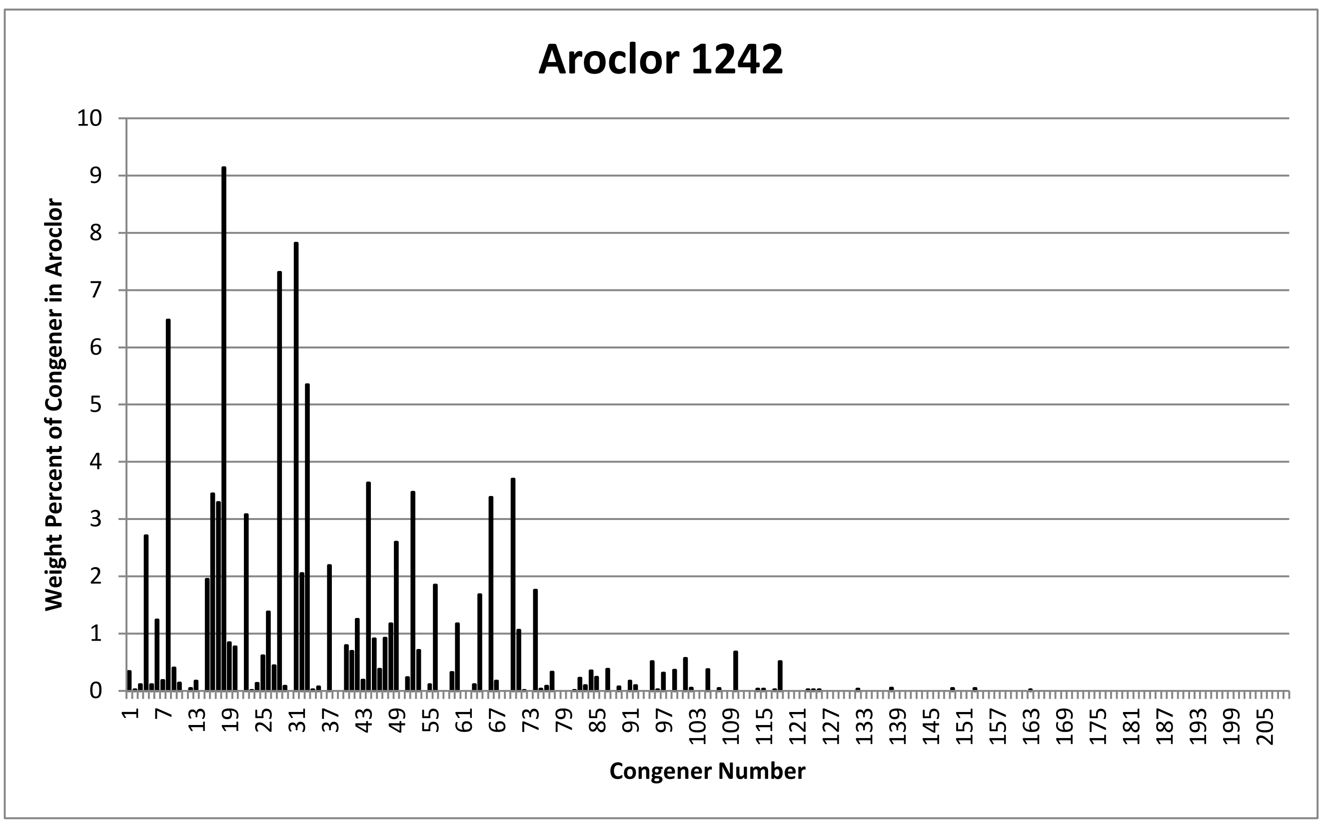
Weight Percent of Congeners in Aroclors





(Adapted from Frame et. al, 1996)





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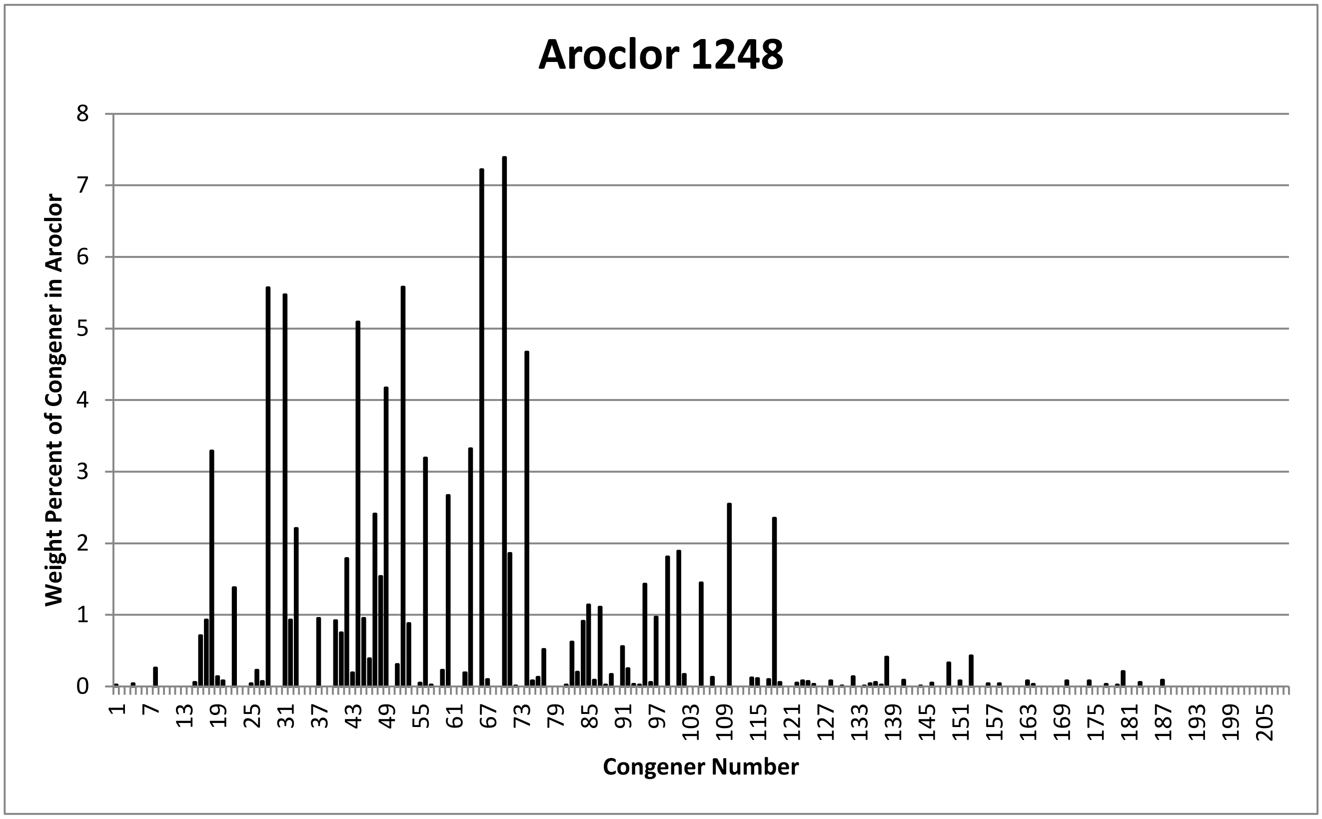

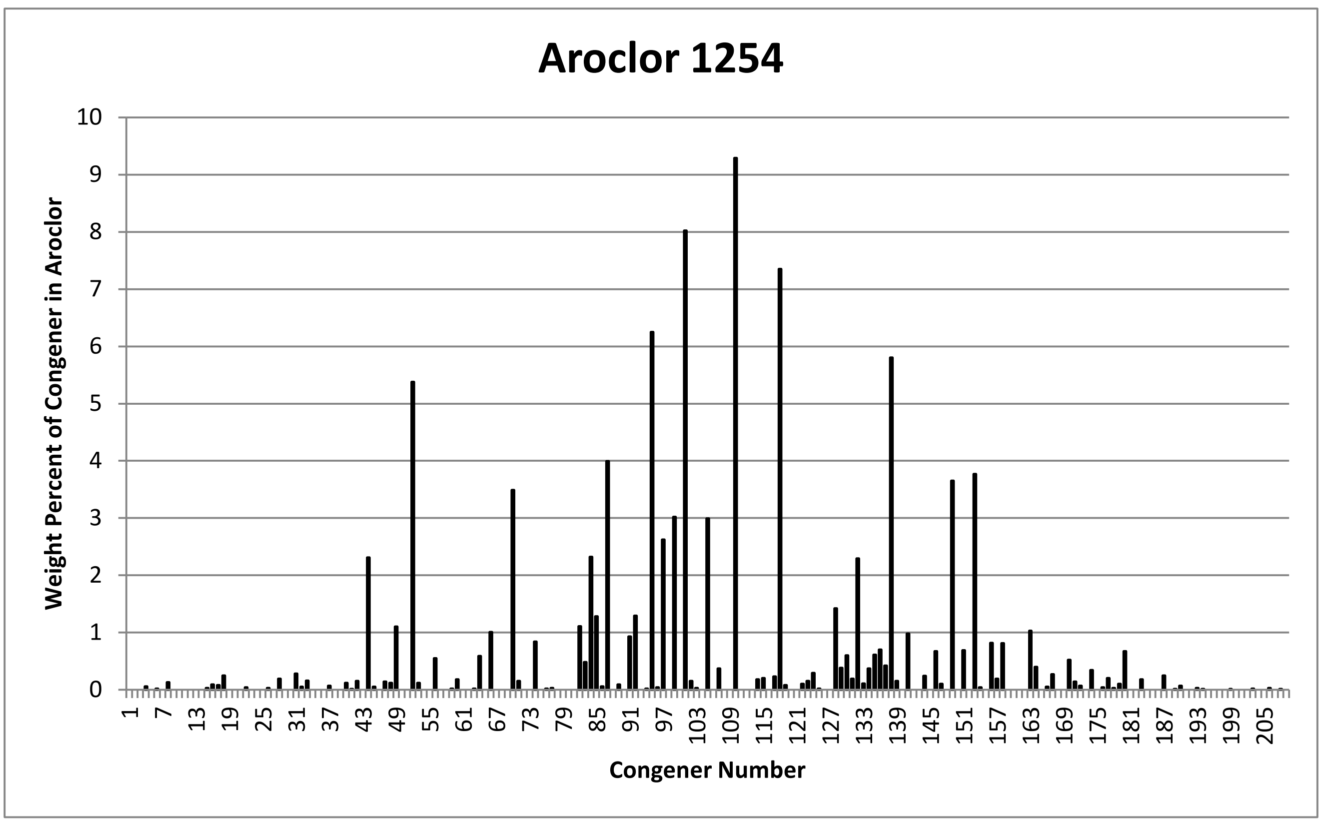

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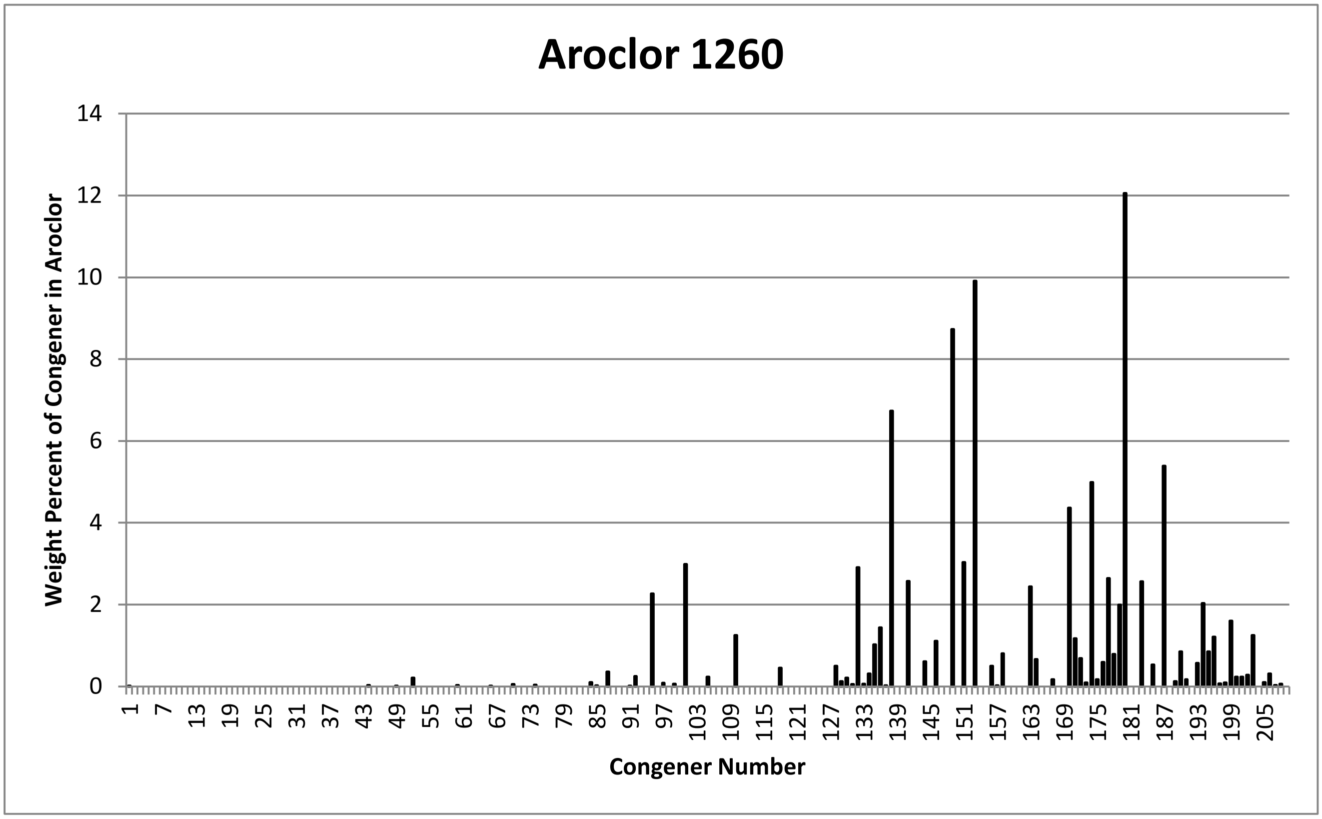

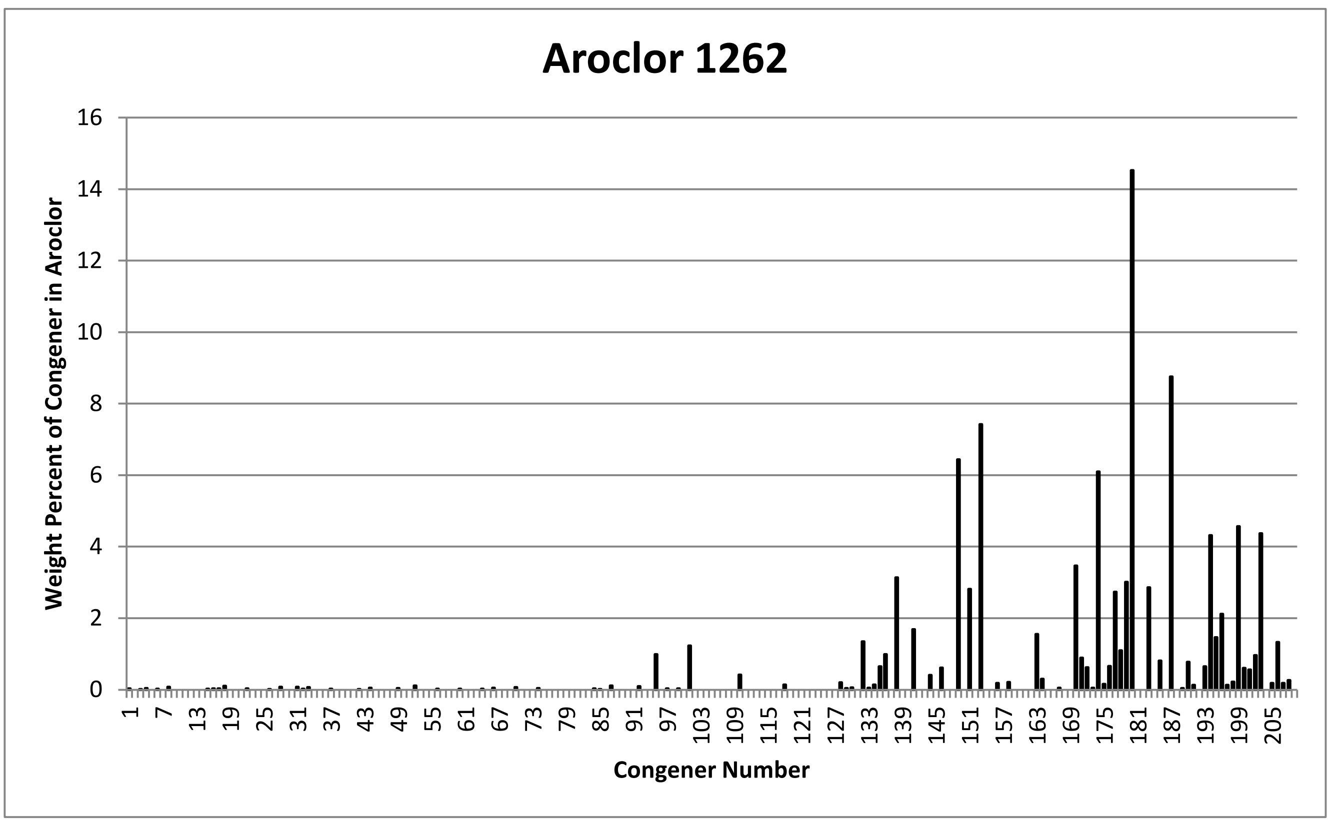

(Adapted from Frame et. al, 1996)

Appendix B

SUMMARY OF RESULTS

Table B-1

Summary of PCB Product Sampling Results

Product Type	Media	Product ID	Total PCB (ug/kg or ppb)	Field Replicate (ppb)	Lab Duplicate (ppb)	Brand
Yellow road paint	Liquid	001	0.732	2.686		Ennis standard #2 - Product # 983712
Yellow road paint	Liquid	002	64.880			Sherwin Williams Promar TM 5713
White road paint	Liquid	003	0.414	0.396		Ennis standard #2 - Product # 983711
White road paint	Liquid	004	0.281		0.220	Sherwin Williams Promar TM 5712
Hydrant Paint	Liquid/Spray	005	0.003		0.010	Rustoleum Pro HP Enamel - Aluminum
Utility Locate Paint	Liquid/Spray	006	21.527			Rustoleum Industrial Choice, Solvent-based - green
Class B Firefighting Foam	Liquid	007	0.029			Alcoseal 3-3 (AR-FFFP)
Deicer	Liquid	008	1.332	1.952		MgCl Freezegard
Deicer	Liquid	009	0.038			Enhanced salt brine with SB Boost
Vehicle wash soap	Liquid	010	0.003		0.068	SuperXL, Hotsy
Vehicle wash soap	Liquid	011	0.068			Simple Green
Pesticide/Herbicide	Liquid	012	<0.0001		<0.0001	2-4D: Nufarm Weedar 64
Pesticide/Herbicide	Liquid	013	6.890			Portfolio 4F, Wilbur-Ellis
Pesticide/Herbicide	Liquid	014	0.012			Roundup Pro Max, Monsanto
Pesticide/Herbicide	Liquid	015	0.316			Crosshair, Wilbur-Ellis
Motor oil	Liquid	016	0.856		0.826	SAE 15W-40 Firebird Heavy Duty EC (bulk), Connell Oil
Motor oil	Liquid	017	0.969			Valvoline Full Synthetic 5W-30
Used motor oil	Liquid	018	0.502	2.375		SAE 15W-40 Firebird Heavy Duty EC, Connell Oil
Diesel	Liquid	019	<0.019			#2 Diesel, dyed
Gasoline	Liquid	020	0.935		0.811	Regular unleaded
Dirt road dust suppressant	Liquid	021	0.091			Asphalt emulsions- EADA
Dirt road dust suppressant	Liquid	022	0.086			Lignosulfonate- Ligno Road Binder (natural polymer in wood)
Dirt road dust suppressant	Liquid	023	3.574			Dustguard Liquid MgCl (different concentration than deicer)
Lubricant	Liquid	024	0.623			MP Gear Lube SAE 85W-140, Phillips 66 Company
Asphalt tack	Liquid	025	0.085			SSR1 asphalt tack
Crack sealer	Solid	026	7.975			Special Asphalt SA Premier (3405- midrange crack sealer)
Asphalt release agent	Liquid	027	0.558		0.443	Soy What, TechniChem Corp.
Hydroseed	Solid	028	2,509.088			Natures Own Hydroseeding Mulch, Hamilton Mfg Inc
PVC pipe	Solid	029	1.999			ASTM 3034 8", Diamond PVC
CIPP liner	Solid	030	1.110			Cast in place pipe liner, installed by SAK
Shortliner	Solid	031	17.780			Infrastructure Repair Systems Inc
Yellow road paint, dried	Solid	032	0.565			Ennis standard #2 - Product # 983712
White road paint, dried	Solid	033	0.379		0.335	Ennis standard #2 - Product # 983711

Product Type	Media	Product ID	Total PCB (ug/kg or ppb)	Field Replicate (ppb)	Lab Duplicate (ppb)	Brand
Thermoplastic tape road striping	Solid	034	10.776			Ennis-Flint Pre-Mark
Antifreeze	Liquid	035	0.018			Kool Green Extended Life (recycled)
Thermoplastic tape road striping	Solid	036	3.325			Ennis-Flint Pre-Mark

Personal Care Products

Product Type	Media	Product ID	Total PCB (ug/kg or ppb)	Field Replicate (ppb)	Lab Duplicate (ppb)	Brand
Hand soap	Liquid	101	0.037			Dial Antibacterial, pomegranate and tangerine
Laundry soap	Liquid	102	0.174			Tide original liquid
Dish soap	Liquid	103	0.083			Dawn Ultra antibacterial
Shampoo	Liquid	104	0.058			Suave naturals
Toothpaste	Liquid	105	0.032			Aquafresh Extreme Clean Whitening

Notes:

Total PCB values have been blank corrected: congeners < 3 times the associated blank value not included in total.

ug/kg = micrograms per kilogram

ppb = parts per billion

EXHIBIT 8

Environ. Sci. Technol. **2010,** *44,* 2822–2827

Inadvertent Polychlorinated Biphenyls in Commercial Paint Pigments†

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Received August 7, 2009. Revised manuscript received September 17, 2009. Accepted November 16, 2009.

A polychlorinated biphenyl (PCB) that was not produced as part of the Aroclor mixtures banned in the 1980s was recently reported in air samples collected in Chicago, Philadelphia, the Arctic, and several sites around the Great Lakes. In Chicago, the congener 3,3′-dichlorobiphenyl or PCB11 was found to be the fifth most concentrated congener and ubiquitous throughout the city. The congener exhibited strong seasonal concentration trends that suggest volatilization of this compound from common outdoor surfaces. Due to these findings and also the compound's presence in waters that received waste from paint manufacturing facilities, we hypothesized that PCB11 may be present in current commercial paint. In this study we measured PCBs in paint sold on the current retail market. We tested 33 commercial paint pigments purchased from three local paint stores. The pigment samples were analyzed for all 209 PCB congeners using gas chromatography with tandem mass spectrometry (GC-MS/MS). More than 50 PCB congeners including several dioxin-like PCBs were detected, and the PCB profiles varied due to different types of pigments and different manufacturing processes. PCB congeners were detected in azo and phthalocyanine pigments which are commonly used in paint but also in inks, textiles, paper, cosmetics, leather, plastics, food and other materials. Our findings suggest several possible mechanisms for the inadvertent production of specific PCB congeners during the manufacturing of paint pigments.

Introduction

Polychlorinated biphenyls (PCBs) are a family of 209 compounds, called congeners, produced commercially as Aroclors by chlorination of biphenyl. The Aroclor mixtures were marketed for use in electrical transformers, capacitors, heat transfer systems, and hydraulic systems (*1, 2*). Lower quantities were used in voltage regulators, adhesives, caulking compounds, inks, lubricants, paints, sealants, carbonless copy paper, coatings, electrical switches, plasticizers, circuit breakers, dust control agents, and older fluorescent lighting fixtures (*2*). Aroclors were used in paint formulations as drying oils (resins) and plasticizer or softening agents (liquids). Data provided to EPA indicate that PCBs have been found in dried paint at concentrations that range from less than 1 ppm to 97,000 ppm (*3*).

Some PCB congeners, usually called non-Aroclor PCBs, are not present or are very low in concentration due to unfavored or improbable formation during the Aroclor manufacturing process (*2*). PCB11 is one of such non-Aroclor PCB congeners. In air samples from Chicago collected in 2007, we found PCB11 widely distributed throughout the city (*4*). The compound was almost simultaneously reported in air of polar regions (*5*). Since then, its presence was also reported in air of Philadelphia (*6*) and five sites around the Great Lakes (*7*). It appears that PCB11 is a global pollutant. In addition, PCB11 was measured in the wastewater effluent from paint production. Possible production of PCB11 from dechlorination is not likely because its possible precursors are in very low concentration in Aroclors (*8, 9*). The widespread distribution of PCB11 throughout Chicago and elsewhere suggests volatilization of this compound from surfaces. Litten et al. reported that PCB11 was in surface waters and effluent waste streams from a pigment manufacturing plant around New York Harbor (*10*). Recently, Rodenburg et al. detected it in consumer goods including newspapers, magazines, and cardboard boxes, which usually contain color pigments (*11*). Therefore, we hypothesize that PCB11 and other PCB congeners are present as byproduct in current commercial pigments.

Paint is composed of pigments, solvents, resins, and various additives (*12*). Two major groups of paints are latex (water-based) and alkyd (oil-based) paints (*13*). The major difference between latex and alkyd paints is that the major liquid portion of latex paints is water while the liquid in oil-based paints consists of petroleum distillates and other organic solvents such as toluene and xylene. Latex paints are the most common type for house use from exterior paint and trim, to interior walls and woodwork. Generally, a paint store has about 10 different colors of base pigments, and paints are sold by mixing pigments with other components. To test our hypothesis, we purchased and analyzed paint pigments from three paint stores. According to IBISWorld Inc., in 2007 these companies account for about 70% of the market share in the United States.

Materials and Methods

Reagents. Paint pigments were purchased from three different paint retailers: Sherwin Williams, PPG Pittsburgh, and Vogel, in Iowa City, Iowa in 2009. A calibration standard solution with a full suite of 209 PCB congeners was prepared from five PCB congener solutions purchased from AccuStandard (New Haven, CT). Acetone and hexane (pesticide grade) were purchased from Fisher Scientific (Fair Lawn, NJ).

Sample Analysis. The extraction method was modified from U.S. EPA method 3545 (*14*). In brief, approximately 5.0 g of the fresh pigment sample was accurately weighed and mixed with combusted diatomaceous earth, then spiked with 50 μL of 500 ng/mL surrogate standards containing PCB14 (3,5-dichlorobiphenyl), PCB65 (2,3,5,6-tetrachlorobiphenyl) and PCB166 (2,3,4,4′,5,6-hexachlorobiphenyl) (Cambridge Isotope Laboratories, Inc.). The samples were extracted utilizing a pressurized fluid extraction (Accelerated Solvent Extractor, Dionex ASE-300) with a mixture of acetone and hexane (1:1, v/v). The extract was concentrated to ~2 mL from ~200 mL, and the concentrated extract was transferred to a glass test tube; ~2 mL of concentrated sulfuric acid was slowly added and mixed. Hexane (8 mL) was used to extract the acidified mixture 3 times after a 10-min mechanical shaking and centrifugation at 3000 rpm/min for 5 min. The pooled extract was concentrated down to ~2 mL and passed

† Part of the special section "Sources, Exposures, and Toxicities of PCBs in Humans and the Environment".

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10.1021/es902413k
Published on Web 12/03/2009

through a silica gel column prepared with 0.1 g of combusted silica gel at the bottom and 1 g of acidified silica gel (2:1silica gel:concentrated sulfuric acid by weight). Hexane (10 mL) was used to elute PCBs from the column and the eluate was concentrated down to ~0.5 mL for PCB analysis. All samples were analyzed in duplicate, and the average is reported.

The final extract was spiked with 20 ng of PCB204 (2,2′,3,4,4′,5,6,6′-octachlorobiphenyl) as internal standard (Cambridge Isotope Laboratories, Inc.). All 209 PCB congeners, in about 170 chromatographic peaks, were analyzed using a gas chromatograph with mass selective detection (GC-MS/MS) modified from the EPA method 1668A (*15*). The quantification of PCB congeners was performed by an Agilent 6890N gas chromatograph with an Agilent 7683 series autosampler coupled to a Waters Micromass Quattro micro GC mass spectrometer (Milford, MA) operating under electron impact (EI) positive mode at 70 eV and multiple reaction monitoring (MRM), and the trap current was 200 μA. The retention windows were defined by PCB parent/daughter ion pairs from mono- to deca- homologues which were 188/152, 222/152.10, 255.96/186, 291.92/222, 325.88/255.90, 359.84/289.90, 393.80/323.90, 427.76/357.80, 461.72/391.83, 497.68/427.70, respectively.

Quality Assurance/Quality Control. During extraction of paint pigments using ASE, samples and blanks (combusted diatomaceous earth) were alternated on the instrument to avoid, and detect, any cross contamination between pigment samples. The average recoveries of PCB 14, PCB 65, and PCB 166 surrogate standards injected in every sample were 56 ± 15%, 85 ± 25%, and 86 ± 20%, respectively. Di- to tri- PCB concentrations in samples were corrected for PCB14 recovery and tetra- to deca-PCBs for PCB166 based on our analytical method validation using Standard Reference Material 1944.

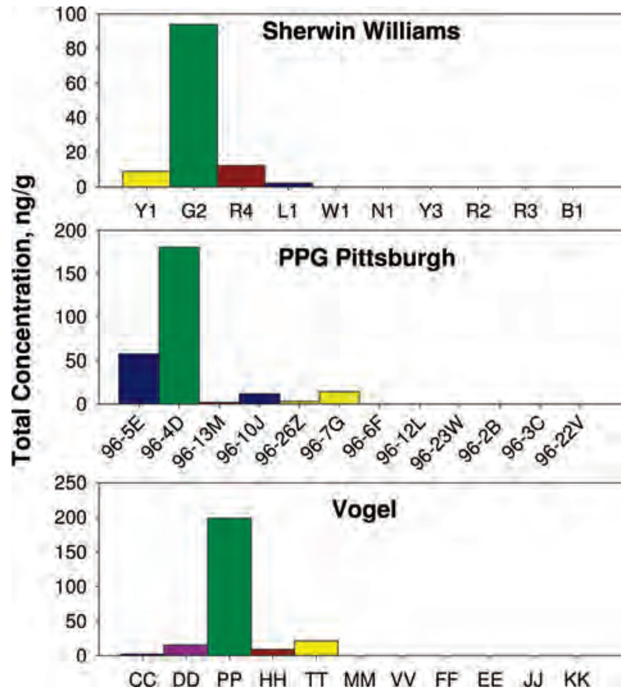

FIGURE 1. ∑PCB concentrations in 33 commercial paint pigments purchased from Sherwin Williams, PPG Pittsburgh, and Vogel paint stores.

Results and Discussion

Inorganic and Organic Pigments. Inorganic pigments are produced from either naturally mined pigments (sienna, umber, ochre) or synthetically manufactured pigments (iron oxide, carbon black, etc). Titanium dioxide is the most important white pigment in the industry because of its high refractive index, reflectance, ease of dispersion, brightness, and opacity (*16, 17*). Titanium dioxides and iron oxides account for approximately 70% and 15% of world consumption of inorganic pigments (*18, 19*). No PCBs were found in inorganic pigments which primarily contain titanium dioxide, iron oxide, raw umber, or carbon black (Figure 1 and Table 1). PCB formation is expected to be associated with chlorinated solvent or intermediates used in the manufacturing process of pigments.

PCBs were primarily found in organic paint pigments with a concentration range from 2 to 200 ng/g fresh weight (f.w.) in 15 of 33 analyzed paint pigments (Figure 1 and Table 1) in this study. Pigment chemical structures were provided by Sherwin Williams. PPG Pittsburgh and Vogel did not provide this information, although we were able to determine several pigment types based on their material safety data sheets. Most orange, red, and yellow pigments are made from azo pigments, and PCBs are only found in two groups of organic pigments: azo pigments and phthalocyanine pigments. For pigment samples from Sherwin Williams, we clearly see PCBs are only present in these two types of pigment. Chlorinated solvents or intermediates are usually involved to produce these two types of organic pigments, and side-reactions of these chlorinated compounds result in formation of PCBs during the manufacturing process. The EPA is aware of the presence of PCBs in diarylide pigments and phthalocyanine pigments. Diarylide pigments belong to the azo category of pigments (*20*). However, we observed the presence of PCBs not only in diarylide pigments but also in other azo pigments such as Hansa yellow, quinacridone, isoindolinone, and maybe more, since some pigment types are unknown.

Azo and phthalocyanine pigments and chemically identical dyes are the most important groups of synthetic colorants with a great variety of industrial applications. They are used for coloring paints, inks, textiles, paper, cosmetics, leather, plastics, food and other materials (*21, 29*). The widespread use of these pigments explains the presence of PCB11 in commercial goods common throughout modern society, such as newspapers, magazines, and cardboard boxes (*11*). Although we do not know if inadvertent PCBs have adverse effects on human health, there are many potential routes for human exposure to these PCBs through inhalation, dermal exposure, and ingestion due to their physicochemical characteristics of semivolatility, hydrophobicity, and persistence.

Congener Profiles. The detailed PCB distribution profile in each pigment is provided in Tables S1–S3, and two examples are presented in Figure 2. The pigments, Y1 of Sherwin Williams and 96-26Z of PPG Pittsburgh, are both yellow and made from monoazo yellow pigments. The synthesis of monoazo yellow pigments involves the coupling of a diazotized substituted aniline with a coupling component containing an active methylene moiety in a linear structure (*18*). There are different PCB distribution profiles in different pigments due to various manufacturing processes for different pigments or even the same pigments. The same type pigment might have different starting materials, intermediates, or manufacturing conditions. For a particular manufacturing process, only very limited numbers of chlorinated compounds are involved; however, up to 22 congeners were detected in one pigment. Among these detected congeners, PCBs 77, 114, and 123 are dioxin-like congeners which have distinct toxic properties. A variety of PCB profiles in paint pigments were observed in this study (Tables S1–S3), although the reason for their presence is not completely understood. PCB11 was most often detected: it was found in 13 of 15 pigment samples for which any PCBs were detected, followed by PCBs 8, 6, 4, 1, 12/13, 2, 3, and 209—each with more than 40% detection frequency (Figure 2). PCB congeners of all chlorination levels were found in the pigments.

TABLE 1. Colors and Types of Commercial Paint Pigments Purchased from Three Paint Stores[a]

paint store	code	color	pigment type
Sherwin Williams	Y1	yellow	hansa yellow
	G2	green	phthalocyanine green
	R4	red	isoindolinone
	L1	blue	phthalocyanine blue
	W1	white	titanium dioxide
	N1	raw umber	raw umber titanium dioxide
	Y3	deep gold	iron oxide
	R2	maroon	iron oxide
	R3	magenta	quinacridone
	B1	black	carbon black
PPG	96-5E	blue	phthalocyanine blue
	96-4D	green	phthalocyanine green
	96-13M	durable red	/
	96-10J	carbazole violet	/
	96-26Z	medium yellow	monoazo yellow
	96-7G	durable yellow	/
	96-6F	red	iron oxide
	96-12 L	raw umber	/
	96-23W	white	titanium dioxide
	96-2B	lamp black	/
	96-3C	yellow oxide	iron oxide
	96-22 V	violet	quinacridone
Vogel	CC	blue	phthalocyanine blue
	DD	magenta	/
	PP	green	phthalocyanine green
	HH	exterior red	/
	TT	medium yellow	/
	MM	red oxide	/
	VV	white	/
	FF	raw umber	/
	EE	black	/
	JJ	yellow oxide	/
	KK	brown oxide	/

[a] "/": proprietary.

However, lower chlorinated PCB congeners dominated in most pigment samples except in phthalocyanine green pigments which contain very high levels of PCB209 relative to other detected congeners. PCB209 accounts for approximately 66%, 33%, and 50% of total PCBs in phthalocyanine green pigments of G2, 86-4D, and PP, respectively, from three different paint stores. It is interesting that although dissimilar in structure, both PCB 11 and PCB 209 are non-Aroclors that could be used as signatures of pigment use or discharge.

Formation Mechanism. *Phthalocyanine Pigments.* Copper phthalocyanine pigments are the most widely used blue and green pigments for various applications (*16, 21*). Two different general processes are used for commercial production of phthalocyanine pigments: one is from phthalic anhydride, urea, and copper or a copper salt, and the second is from phthalonitrile and copper or a copper salt (*22*). The first route is less expensive and is usually used to produce phthalocyanine pigments for high-volume and low-cost applications such as paint pigments and dyes for textiles and paper; the second route is more expensive but produces high-quality and high-purity phthalocyanine pigments such as charge generation materials for electrophotography (*21*). The first urea process usually involves organochlorine solvent such as di- or trichlorobenzene as the reaction medium. Uyeta et al. showed that starting materials (urea, phthalic anhydride, copper chloride, ammonium molybdate) and the initial reaction medium (di- or trichlorobenzene) did not contain PCB congeners (*22*), so they are not a direct source of PCBs in pigments.

PCB formation mechanisms (Figure 3) are proposed for the urea manufacturing process. Phthalocyanine blue is produced from starting materials without chlorines, and phthalocyanine green is derived from phthalocyanine blue by chlorination (*21*). Lower chlorinated PCB congeners are produced as by-products during the manufacturing process of phthalocyanine blue pigments from the reaction medium chlorobenzene (*23*). The reaction medium, dichlorobenzene or trichlorobenzene, can form tetra-, penta-, and/or hexa-PCB congeners by a reaction with each other under heat through a free radical mechanism (the dashed arrow pathway in Figure 3) (*24, 25*). The resulting PCB congeners may thermally degrade further into lower chlorinated congeners by the same mechanism (*26*). Mono- through tetra-chlorobiphenyls have been created through a free radical mechanism from pyrolysis and combustion of other chlorinated organics at temperatures ranging from 300 to 700 °C (*27*). The free radical mechanism to form PCBs from chlorobenzenes has been experimentally demonstrated (*25*). The temperature is usually below 300 °C during the pigment manufacturing process; however, the presence of copper chloride and ammonium molybdate as a catalyst might promote this mechanism at a lower temperature range (*25, 28*). To gain proper brightness, shade, strength, and flow properties of synthetic pigments, various factors including the reaction temperature and the drying temperature might be altered to meet these purposes (*20*). With increase of the reaction temperature, the total PCB formation increases independent of reaction time after the initial 2 h (*25*). Lower chlorinated benzenes might produce more PCB congeners than higher ones.

During the process of perchlorination from phthalocyanine blue to phthalocyanine green, decachlorobiphenyl (PCB 209) is formed along with some other highly chlorinated

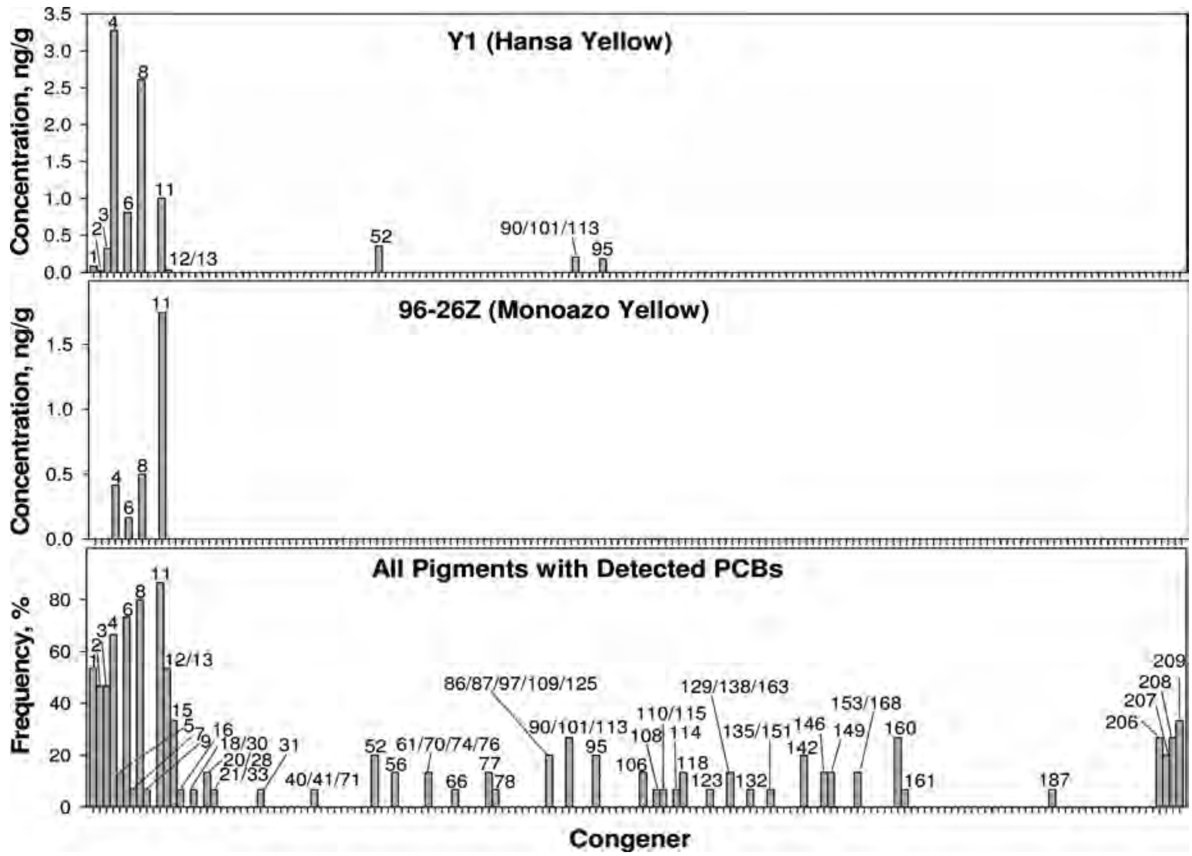

FIGURE 2. Examples of PCB profiles in paint pigments (top two plots) and the frequency of congener detection in the 15 pigments with detected PCBs (bottom plot).

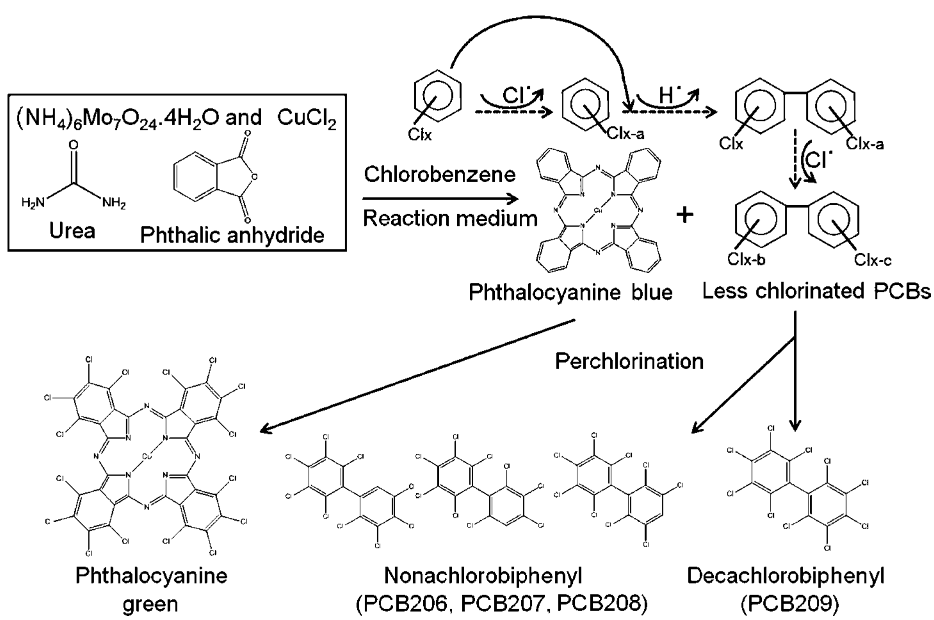

FIGURE 3. PCB formation mechanisms in the manufacture process of phthalocyanine blue and phthalocyanine green. The subscripts x, a, b, and c refer to the number of chlorine atoms.

congeners such as nonachlorobiphenyls (PCBs 206, 207, and 208) from less chlorinated congeners (Figure 3). This explains the presence of much more nona- and deca-PCB congeners in phthalocyanine green than in phthalocyanine blue, which can be observed by comparison of PCB distribution profiles in L1 and G2 from Sherwin Williams, 96-5E and 96-4D from PPG Pittsburgh, and CC and PP from Vogel.

Azo Pigments. Azo pigments are the most important group of synthetic colorants with the largest fraction (more than 50%) of organic pigments on the market (*29*). Azo pigments have a wide range of colors covering almost the entire visible spectrum although blue and green colors are mostly provided by phthalocyanine and two other pigments (*18*). Some vivid colors of azo pigments are commercially dominant, especially reds, oranges, and yellows.

Azo pigments are almost exclusively produced through a reaction sequence of diazotization and coupling to afford the azo group (—N=N—) which is the chromophore respon-

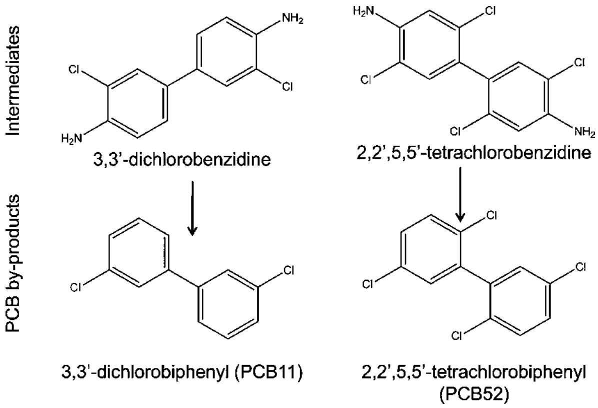

FIGURE 4. Possible formation pathways of PCB11 and PCB52 in pigments.

sible for its vivid colors (*18*). The reaction involves a primary aromatic amine as a diazo component and a nucleophilic aromatic or aliphatic compound with active methylene groups as a coupling component. An aromatic amine such as a mono-, di, or trichlorinated aniline is typically involved in the diazotization reaction as a diazo component, and frequently they are also used as coupling components. Another important group of diazo components for azo pigment formation include 3,3′-dichlorobenzidine, and to a lesser extent 2,2′5,5′-tetrachlorobenzidine, 3,3′-dimethoxybenzidine, and 3,3′-dimethylbenzidine (*18*). The last two compounds do not contain chlorines which are required elements for formation of PCB congeners.

For synthesis of azo pigments, there are more than 10 common intermediates and starting materials such as chlorinated aniline and chlorinated benzidines that can potentially have side-reactions to produce PCBs. PCBs are probably formed by coupling of bis-diazotized dichlorobenzidines or tetrachlorobenzidines under basic conditions as a result of the decomposition of the diazo moiety. Polychlorinated anilines can be also used to form PCBs through the free radical mechanism, and the free radical rearrangement of chlorine positions might play a significant role in varieties of PCB congeners with limited chlorinated intermediates. Lower PCB congeners may be formed by carrying out the coupling process at lower pH or in the presence of unsaturated aliphatic compounds such as acylamides (*20*). For example, 3,3′-dichlorobenzidine and 2,2′,5,5′-tetrachlorobenzidine are probably the diazo components for TT and HH pigments that contain high PCB11 and PCB52 (Table S3), respectively. Unfortunately, we cannot verify the pathways for pigments considered proprietary by manufacturers; however, the links of intermediates and PCB by-products can be illustrated structurally (Figure 4). The azo pigments based on 3,3′-dichlorobenzidine appear preponderant (*30*), which might explain partially the consistency of PCB11 detection.

Environmental Emission. A wide variety of organic pigments are commercially available; however, in terms of chemical structure, almost all currently produced organic pigments belong to four different groups: azo pigments and lakes (salt type), phthalocyanine pigments, polycyclic pigments, and heterocyclic pigments (*20*). In spite of accelerated progress in the synthesis of organic pigments, commercially available pigments at present are chemically identical to those produced historically since the use of synthetic pigments. PCB congeners are primarily detected in azo pigments and phthalocyanine pigments. PCB11 is consistently detected in almost all azo and phthalocyanine pigments, and it is absent or in very low relative concentrations in commercial Aroclor mixtures. Therefore, PCB11 can be regarded as a key indicator of PCB emission from de novo synthesis as by-products of industrial synthetic process of paint pigments. PCB11 is the fifth highest congener and ubiquitous in Chicago air (*4*). Although we do not know the contribution of PCB congeners from paint pigments to the airborne PCBs in the environment, these congeners, especially low chlorinated congeners, might contribute a significant portion as PCB11 because of their high volatility.

Based on 40 CFR 761.80, PCBs are allowed at less than 25 mg/kg with a 50 mg/kg maximum in commerce of diarylide pigments or phthalocyanine pigments when leaving a manufacturing site or imported to the United States. PCB levels in the examined paint pigments are all below the regulatory standard; however, paints are being extensively and constantly used especially in urban areas. PCBs might accumulate due to their resistance to degradation in the environment. It has been reported that PCB11 and total PCB levels in air are directly proportional to human population density (*7, 31, 32*). To our knowledge, pigments or dyes are the only significant source of PCB11. The elevation of PCB11 in air must be associated with human activity utilizing pigments or dyes. The presence of PCB11 indicates paint should be an important source of airborne PCBs although the link of PCBs in paint pigments and PCBs in air is still not clear.

Acknowledgments

We thank our analytical core coleader, Craig Just, and our laboratory director, Collin Just. We also thank Kristin Isley and Timothy Schulz for assisting with sample preparation in the laboratory. Funding for this work was provided by the National Institute for Environmental Health Sciences (NIEHS/NIH) Superfund Basic Research Program (ES013661).

Supporting Information Available

Three tables. This information is available free of charge via the Internet at http://pubs.acs.org.

Literature Cited

(1) Aroclor advertisement by Monsanto Chemical Company. *Chem. Eng.* June 1956, p 386.
(2) De Voogt, P.; Brinkman, U. A. T. Production, properties and usage of polychlorinated biphenyls. In *Halogenated Biphenyls, Terphenyls, Naphthalenes, Dibenzodioxins, and Related Products*, 2nd ed.; Kimbrough, R. D., Jensen, A. A., Eds.; Elsevier Science Ltd: New York, 1989; pp 3−45.
(3) EPA. Use Authorization for and Distribution in Commerce of Non-Liquid Polychlorinated Biphenyls. *Fed. Regist.*, Vol. 64, No. 237, 1999.
(4) Hu, D.; Martinez, A.; Hornbuckle, K. C. Discovery of non-Aroclor PCB (3, 3′-dichlorobiphenyl) in Chicago air. *Environ. Sci. Technol.* **2008**, *42*, 7873–7877.
(5) Choi, S. D.; Baek, S. Y.; Chang, Y. S.; Wania, F.; Ikonomou, M. G.; Yoon, Y. J.; Park, B. K.; Hong, S. Passive air sampling of polychlorinated biphenyls and organochlorine pesticides at the Korean Arctic and Antarctic research stations: Implications for long-range transport and local pollution. *Environ. Sci. Technol.* **2008**, *42*, 7125–7131.
(6) Du, S.; Wall, S. J.; Cacia, D.; Rodenburg, L. A. Passive Air Sampling for Polychlorinated Biphenyls in the Philadelphia Metropolitan Area. *Environ. Sci. Technol.* **2009**, *43*, 1287–1292.
(7) Basu, I.; Arnold, K. A.; Venier, M.; Hites, R. A. Partial Pressures of PCB-11 in Air from Several Great Lakes Sites. *Environ. Sci. Technol.* **2009**, *43*, 6488–6492.
(8) Zanaroli, G.; Perez-Jimenez, J. R.; Young, L. Y.; Marchetti, L.; Fava, F. Microbial reductive dechlorination of weathered and exogenous co-planar polychlorinated biphenyls (PCBs) in an anaerobic sediment of Venice Lagoon. *Biodegradation* **2006**, *17*, 19–27.
(9) Rhee, G. Y.; Sokol, R. C.; Bethoney, C. M.; Bush, B. Dechlorination of Polychlorinated-Biphenyls by Hudson River Sediment Organisms - Specificity to the Chlorination Pattern of Congeners. *Environ. Sci. Technol.* **1993**, *27*, 1190–1192.
(10) Litten, S.; Fowler, B. I.; Luszniak, D. Identification of a novel PCB source through analysis of 209 PCB congeners by US EPA modified method 1668. *Chemosphere* **2002**, *46*, 1457–1459.

(11) Rodenburg, L. A.; Guo, J.; Du, S.; Cavallo, G. J. Evidence for Unique and Ubiquitous Environmental Sources of 3,3-Dichlorobiphenyl (PCB 11). *Environ. Sci. Technol.* **2009**, *44*, DOI: 10.1021/es901155h.

(12) Peterson, J. E. Toxic Pyrolysis Products of Solvents, Paints, and Polymer-Films. *Occup. Med.* **1993**, *8*, 533–548.

(13) Scelo, G.; Metayer, C.; Zhang, L. P.; Wiemels, J. L.; Aldrich, M. C.; Selvin, S.; Month, S.; Smith, M. T.; Buffler, P. A. Household Exposure to Paint and Petroleum Solvents, Chromosomal Translocations, and the Risk of Childhood Leukemia. *Environ. Health Perspect.* **2009**, *117*, 133–139.

(14) Test Methods for Evaluating Solid Waste, Method 3545. *USEPA SW-846*, 3rd ed.; U.S. Government Printing Office: Washington, DC, July 1995.

(15) U.S. EPA. Method 1668, Revision A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS; EPA No. EPA-821-R-00-002; U.S. Environmental Protection Agency, Office of Water: Washington, DC, 1999.

(16) Doroszkowski, A. Paints. In *Technological Applications of Dispersions*; McKay, R. B., Ed.; Marcel Dekker: New York, 1994; pp 1−66.

(17) Hext, P. M.; Tomenson, J. A.; Thompson, P. Titanium dioxide: Inhalation toxicology and epidemiology. *Ann. Occup. Hyg.* **2005**, *49*, 461–472.

(18) Herbst, W.; Hunger, K. *Industrial organic pigments:production, properties, applications 2*; VCH: Weinheim, Germany, 1997.

(19) In *Industrial Inorganic Pigments*; Buxbaum, G., Pfaff, G., Eds.; Wiley-VCH: New York, 2005.

(20) Czajkowski, W. S. Organic pigments. In *Modern Colorants: Synthesis and Structure*; Peters, A. T., Freeman, H. S., Eds.; Chapman & Hall: New York, 1995; pp 63−86.

(21) Gregory, P. Industrial applications of phthalocyanines. *J Porphyr. Phthalocya.* **2000**, *4*, 432–437.

(22) Uyeta, M.; Taue, S.; Chikazawa, K. Polychlorinated Biphenyls in Phthalocyanine Pigments. *Bull. Environ. Contam. Toxicol.* **1976**, *16*, 417–421.

(23) Buchta, R. C.; Wyles, H. F.; Hensler, C. J.; Vanlenten, F. J.; Westerberg, R. B.; Williams, L. A. Determination of Polychlorinated-Biphenyls in Copper Phthalocyanine Pigments. *J. Chromatogr.* **1985**, *325*, 456–461.

(24) Liu, W. B.; Zheng, M. H.; Wang, D. S.; Xing, Y.; Zhao, X. R.; Ma, X. D.; Qian, Y. Formation of PCDD/Fs and PCBs in the process of production of 1,4-dichlorobenzene. *Chemosphere* **2004**, *57*, 1317–1323.

(25) Liu, P. Y.; Zheng, M. H.; Zhang, B.; Xu, X. B. Mechanism of PCBs formation from the pyrolysis of chlorobenzenes. *Chemosphere* **2001**, *43*, 783–785.

(26) Bleise, A.; Kleist, E.; Gunther, K.; Schwuger, M. J. Formation of octachloroacenaphthylene in the pyrolysis of decachlorobiphenyl. *Chemosphere* **1997**, *35*, 655–666.

(27) Erickson, M. D. *Analytical Chemistry of PCBs 2*; CRC Press: Boca Raton, FL, 1997.

(28) Zheng, M. H.; Bao, Z. C.; Wang, K. O.; Xu, X. B. Formation of polychlorinated biphenyls from the pyrolysis of hexachlorocyclohexane in the presence of Fe_2O_3. *Bull. Environ. Contam. Toxicol.* **1997**, *59*, 83–89.

(29) Stolz, A. Basic and applied aspects in the microbial degradation of azo dyes. *Appl. Microbiol. Biotechnol.* **2001**, *56*, 69–80.

(30) Golka, K.; Kopps, S.; Myslak, Z. W. Carcinogenicity of azo colorants: influence of solubility and bioavailability. *Toxicol. Lett.* **2004**, *151*, 203–210.

(31) Sun, P.; Basu, I.; Hites, R. A. Temporal trends of polychlorinated biphenyls in precipitation and air at Chicago. *Environ. Sci. Technol.* **2006**, *40*, 1178–1183.

(32) Breivik, K.; Sweetman, A.; Pacyna, J. M.; Jones, K. C. Towards a global historical emission inventory for selected PCB congeners - a mass balance approach. 2. Emissions. *Sci. Total Environ.* **2002**, *290*, 199–224.

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EXHIBIT 9

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and)
WESTPORT COMMUNITY)
SCHOOLS,)
)
Plaintiffs,)
)
v.) Civil Action No.
) 1:14-cv-12041
MONSANTO COMPANY,)
SOLUTIA INC., and)
PHARMACIA)
CORPORATION,)
)
Defendants.)

WEDNESDAY, APRIL 6, 2016

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Videotaped deposition of Robert G. Kaley, II, Ph.D., Volume II, held at the offices of HUSCH BLACKWELL, L.L.C., 190 Carondelet Plaza, Suite 600, St. Louis, Missouri, commencing at 9:00 a.m., on the above date, before Carrie A. Campbell, Registered Merit Reporter, Certified Realtime Reporter, Illinois, California & Texas Certified Shorthand Reporter, and Missouri Certified Court Reporter.

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to give their customers a chance to find substitutes. They would have shut down those customers' businesses had they just done it without warning and giving them some time.

QUESTIONS BY MS. EVANGELISTI:

Q. And there were alternative plasticizers available in that time frame even earlier than 1970.

In 1968, was there alternative plasticizers available that could have been utilized by Monsanto's customers in their -- to meet their plasticizer needs?

MR. GOUTMAN: Objection. Overly broad as to all plasticizers. All plastics.

Go ahead. You can answer.

THE WITNESS: Well, there were other plasticizers available, but these manufacturers had chosen PCBs for a particular reason for their particular product.

So was there a one-for-one for each application for PCB plasticizers?

I don't know. I doubt it.

QUESTIONS BY MS. EVANGELISTI:

Q. Moving back to Exhibit 56. This is a --

MS. EVANGELISTI: I'm going to to ask counsel, were you able to find the Bates numbers of the documents?

MR. GOUTMAN: Which documents?

MS. EVANGELISTI: Oh, the handwritten one from Cumming Paton, the handwritten documents from the PCB meeting of August 25th, and the letter discussing the presentation to field sales. I gave you the Bates numbers earlier.

MR. CAMPBELL: Are they still looking?

MS. SAVINELLI: We're looking.

MS. EVANGELISTI: So you're unable to find them at this point in the production?

MR. GOUTMAN: I'm still looking. I'm not saying we're unable to find them. We're still looking.

objected to every single one of my questions?

MS. EVANGELISTI: Because they're all objectionable.

MR. GOUTMAN: And she will continue to do so even though I've given her a stipulation that she will have -- she has every objection as to form for this deposition.

QUESTIONS BY MR. GOUTMAN:

Q. Now, sir, with respect to PCBs, those, in your view, reliable sources of estimates of PCBs around the world, what is the percentage of PCBs that were manufactured abroad versus domestically?

MS. EVANGELISTI: Objection. Lacks foundation. Compound.

THE WITNESS: Approximately 60 percent.

QUESTIONS BY MR. GOUTMAN:

Q. Were manufactured abroad?

A. Yes.

Q. With respect to Monsanto's production of PCBs, what percentage of PCB production by Monsanto related to PCBs used as plasticizers?

A. I believe it's about 7 percent.

Q. And what were the other applications for which PCBs were used?

A. Well, by far the largest application was for electrical equipment. I believe around 77 percent or so. They were also used as hydraulic fluids or in hydraulic fluids and heat transfer fluids.

Q. With respect those applications, what, if anything, was there about PCBs that made producers of electrical equipment put PCBs in them?

MS. EVANGELISTI: Objection. Lacks foundation. Calls for speculation.

THE WITNESS: Primarily they were -- I mean, the biggest reason for their use in electrical equipment was their fire resistance. Their nonflammability. But they were also very good electrical fluids. They have high dielectric constants.

QUESTIONS BY MR. GOUTMAN:
Q. To this day, has anyone ever discovered a nonflammable dielectric fluid like PCBs?
MS. EVANGELISTI: Objection. Calls for speculation. Lacks foundation. And calls for speculation.
THE WITNESS: No, they have not.
QUESTIONS BY MR. GOUTMAN:
Q. Now, were nonflammable dielectric fluids required by building codes and fire safety codes and electrical codes around the country?
MS. EVANGELISTI: Objection. Calls for expert testimony. Lacks foundation. Calls for speculation. Calls for legal conclusion.
THE WITNESS: Yes, they were.
QUESTIONS BY MR. GOUTMAN:
Q. Who owned the patent for dielectric uses of PCBs in the 1930s, or who took out of the original patent?

MS. EVANGELISTI: Objection. Argumentative.

QUESTIONS BY MR. GOUTMAN:

Q. The question -- go ahead.
Do you understand the question?

A. Yes.
Those specifications were determined by the electrical equipment manufacturers.

Q. Now, with respect to PCBs used for plasticizers, could you tell us what physical properties were present in plasticizers -- excuse me, in PCBs that would warrant their use in plasticizers?

A. Well, in many cases --

Q. As plasticizers?

A. In many cases, they were nonflammable. That was one of the application -- or one of the reasons that someone would use them.
They also had good flowability characteristics, good adhesion characteristics. They were, for all practical purposes, nonvolatile, and they

stuck around. They were in the product and stayed in the product for years.

Q. What happens to a plasticizer -- what happens to the plastic, the matrix, if the plasticizer volatilizes?

MS. EVANGELISTI: Objection. Lacks foundation. Calls for expert testimony.

THE WITNESS: It cracks and dries up.

QUESTIONS BY MR. GOUTMAN:

Q. Would -- based upon your review of documents and literature, who were Monsanto's customers generically for PCBs used in plasticizer applications?

A. Well, they were -- generically they were large chemical companies or manufacturer entities.

Q. And did those entities, did they have their own teams of scientists and engineers?

MS. EVANGELISTI: Objection. Lack of foundation. Calls for speculation.

THE WITNESS: Yes, they did. I think some of the documents we've examined talk about your research department needs to investigate these other applications -- or other these other possibilities. So clearly they have research departments.

QUESTIONS BY MR. GOUTMAN:

Q. And how is it that their research departments would go about choosing a plasticizer, a particular plasticizer, as one of the many ingredients that might go into a plastic product, be it adhesive caulk, paint, and so forth?

MS. EVANGELISTI: Lacks foundation. Calls for speculation. Compound.

THE WITNESS: Well, they would need -- I mean, they would -- they would know what their target audience was and what their target product was, and they would have a suite of options to choose from and would make those choices based on the specific application.

QUESTIONS BY MR. GOUTMAN:

Q. Did Monsanto provide those -- would you call them sophisticated manufacturers of products?

MS. EVANGELISTI: Objection. Leading.

THE WITNESS: Yes, I believe they were. They had their own research departments.

QUESTIONS BY MR. GOUTMAN:

Q. Well, how would you characterize them, those companies, that made paint, plastics and caulk and the like?

MS. EVANGELISTI: Objection. Compound and vague.

THE WITNESS: Well, they knew their business, and they knew what properties they needed for their various components, including plasticizers. So surely they were, you know, advanced, sophisticated as they needed to be for their product line.

MS. EVANGELISTI: Objection.
Nonresponsive. Move to strike.
QUESTIONS BY MR. GOUTMAN:
Q. Are -- this is unreal.
Are -- were PCB -- excuse me, did Monsanto ever manufacture the finished products, that is to say the adhesive, the paint, the caulk, that would contain PCBs?
MS. EVANGELISTI: Objection.
Compound.
THE WITNESS: No, they did not.
QUESTIONS BY MR. GOUTMAN:
Q. Did -- how is it that PCBs then got into those products?
MS. EVANGELISTI: Objection.
Oh, sorry, withdrawn.
MR. GOUTMAN: No, just keep on objecting.
Go ahead.
THE WITNESS: Well, as we were -- as we discussed, the PCBs would get into those products because the formulator, the company making the particular product, would choose PCBs

as -- among other options, and either order them from Monsanto or from a distributor.

QUESTIONS BY MR. GOUTMAN:

Q. Now, with respect to their volatility or lack of volatility, as you said, what is it about PCBs that would make PCBs attractive to a formulator?

MS. EVANGELISTI: Objection. Calls for speculation. Lacks foundation. Calls for expert testimony.

THE WITNESS: They -- I think it goes back to the -- once they're integrated into the plastic formulation, they stay in there for all practical purposes. They're really kind of locked into a matrix and do not evaporate.

QUESTIONS BY MR. GOUTMAN:

Q. Now, going forward in time, was that Monsanto's understanding as to the fate, if you will, of PCBs once they were put into a plastic matrix?

how low PCB volatility is?

MS. EVANGELISTI: Vague.

THE WITNESS: Well -- sorry.

MS. EVANGELISTI: It's also leading.

Sorry, go ahead.

THE WITNESS: Well, the example I like to use is if you had a dish of water on a table, let it sit to the open atmosphere for several days, when you came back, it would be gone. It would have evaporated. But if you put, for instance, the same amount of Aroclor 1254 in that dish and came back months or even years later, you wouldn't be able to tell that the volume had changed.

QUESTIONS BY MR. GOUTMAN:

Q. And what if you had put that pure PCBs in the matrix of a plastic, how would that affect its volatility?

MS. EVANGELISTI: Incomplete hypothetical and calls for expert testimony. Lacks foundation.

THE WITNESS: It would even have less volatility because of its interaction with the plastic matrix.

QUESTIONS BY MR. GOUTMAN:

Q. In Exhibit 6 that you were asked about, you were shown a chart at Bates 5604, approximate vapor pressures calculated, 100 Fahrenheit for various Aroclor mixtures; is that right?

A. Yes, I was.

Q. Following up on my earlier question, what would be the effect -- and is that for pure Aroclors or Aroclors incorporated into a plastic matrix?

A. Oh, no, that's pure Aroclors.

Q. What effect would that -- would incorporating PCBs in a plastic matrix such as caulk have on that?

MS. EVANGELISTI: Calls for expert testimony. Lacks foundation. Incomplete hypothetical.

THE WITNESS: It would significantly reduce those vapor pressures.

Q. What did -- by the way, up -- did Dr. Jensen or anyone else discover -- which Aroclors were discovered by Dr. Jensen and others up to, say, 1970?

A. The ones that were being reported were Aroclor 1254 and Aroclor 1260.

Q. Okay. So the executive committee of -- or whatever the corporate management committee was called, what did they decide in late 1960 -- excuse me, 1969 after they had received the ad hoc committee's report?

A. They decided they should quit making those two Aroclors.

Q. Now, in January of 1970, could you tell us whether Monsanto met with representatives of General Electric?

MS. EVANGELISTI: Leading and irrelevant.

THE WITNESS: Yes, they did.

QUESTIONS BY MR. GOUTMAN:

Q. And what, if anything, was Monsanto advised about Monsanto's decision to get out of the PCB market for the Aroclors that had been detected in the environment?

A. General Electric told them that they couldn't do that, that it would lead to a complete shutdown of the American electrical system grid.

Q. Two years after that, was there something called the Interdepartmental Task Force?

A. Yes, it was an agency put together by the federal government -- or not an agency, but a task force.

Q. And how many departments of the federal government were represented?

A. Seven or so, I believe. Give or take one or two.

Q. And what, if any, conclusions did they reach concerning PCBs?

MS. EVANGELISTI: Objection. Beyond the scope because it goes beyond just plasticizer use.

QUESTIONS BY MR. GOUTMAN:

Q. Go ahead.

A. That they said that PCBs for electrical equipment had to keep being frame, at least.

Q. Were PCBs continued to be manufactured and sold throughout the world after Monsanto got out of the market?

A. Long after.

Q. With respect to Monsanto's -- when did Monsanto announce that it was finally getting out of the electrical use PCB market, the only market it still had?

MS. EVANGELISTI: Objection. Beyond the scope because it doesn't deal with plasticizers.

QUESTIONS BY MR. GOUTMAN:

Q. Go ahead.

A. I believe the formal announcement was in January of '76.

Q. And what, if any, communications had it received from the producers of electrical equipment as to whether any substitutes had been found?

MS. EVANGELISTI: Objection. Beyond the scope because it doesn't deal with plasticizers.

THE WITNESS: They were -- they

had told Monsanto that they had what
they thought were acceptable
substitutes.

QUESTIONS BY MR. GOUTMAN:

Q. At the time Monsanto got out of the PCB market, was it legal to manufacture and sell PCBs in the United States?

MS. EVANGELISTI: Objection. Calls for a legal conclusion. Lacks foundation.

THE WITNESS: Yes, it was.

QUESTIONS BY MR. GOUTMAN:

Q. Are you -- with respect to Exhibit 50, which is the presentation to field sales document, are you familiar with any testimony from Cumming Paton as to whether that document was ever actually used in the sales force?

MS. EVANGELISTI: I am sorry, can you read that question back before you answer?

(Court Reporter read back question.)

THE WITNESS: Yes, I've seen --

<u>EXHIBIT 10</u>

Environ Sci Pollut Res (2011) 18:135–151
DOI 10.1007/s11356-010-0392-1

REVIEW ARTICLE

Applications of polychlorinated biphenyls

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Received: 18 May 2010 / Accepted: 23 August 2010 / Published online: 17 September 2010

Abstract
Background, aim, and scope In the 50 years or so that polychlorinated biphenyls (PCBs) were manufactured in the USA and elsewhere, they were widely used in numerous applications because of their desirable properties. The purpose of this paper is to review and summarize in one place the factual information about the uses of PCBs, as well as to correct some misconceptions that have arisen over the years. The focus is on applications in the USA for which there is ample documentation. However, use patterns were probably similar worldwide.
Materials and methods Review.
Results PCBs were used primarily as electrical insulating fluids in capacitors and transformers and also as hydraulic, heat transfer, and lubricating fluids. PCBs were blended with other chemicals as plasticizers and fire retardants and used in a range of products including caulks, adhesives, plastics, and carbonless copy paper. In the USA, PCBs were manufactured from 1929 through mid-1977, although many products remained in service for decades after the manufacture of PCBs was terminated. This article reviews the historic uses of PCBs in the USA and discusses, where possible, the relative sales volumes. Especially with smaller volume, military, and third-party uses, documenting a use and/or differentiating between a commercial use and an experimental test batch is not possible.
Discussion A major contribution of this paper is to differentiate reported commercial applications of PCBs that can be documented from those which cannot. Undocumented uses may include actual minor uses as well as reported applications that are unlikely ever to have been commercialized.

Keywords PCBs · Polychlorinated biphenyls · Aroclor · Capacitor · Transformer

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1 Introduction

In July of 1977, the sole US manufacturer of commercial polychlorinated biphenyls (PCBs), the former Monsanto Company[1] voluntarily ceased manufacturing the products at their plant in Sauget, IL (production at the Anniston, AL, plant had ceased in 1971). Starting about a decade previously and continuing for the succeeding three-plus decades, PCBs have been among the most studied groups of chemicals. Publications number in the tens of thousands and the publication rate shows no sign of slowing. PCBs remain an economic force over 30 years after the last products were made. Issues relating to PCBs provide professional opportunities, funding, and income to numerous regulators, academic, and government research scientists, consultants, remediation firms, and attorneys.

In the 40 years or so that PCBs have been in the eyes of all these various parties, as well as those of the public itself, much has been learned. However, some of what has been "learned" is based on misunderstandings, apocrypha, and careless repetition of undocumented "facts" that just were

[1] All succeeding mentions of Monsanto Company refer to the "old" Monsanto Company, now known as Pharmacia. The company now known as Monsanto was chartered in 2000 and is a manufacturer of agricultural products.

not so. Some of these "myths" are merely amusing, for example, the myth that the "12" in the names of Aroclor products stood for the 12 carbon atoms in the biphenyl molecule. Others have had more serious implications as discussed below.

Here, we review a range of factual information about the uses of PCBs, as well as to correct some of the misconceptions that have continued to be expounded over the years. PCB nomenclature, manufacturing, and properties are discussed for perspective. The focus is on applications in the USA for which there is ample documentation. However, used patterns were probably similar worldwide. PCBs synthesized incidentally to other chemistries and incorporated into products as inadvertent constituents are not addressed here. Also, the manufacture and use of single congeners for research and as analytical standards are outside the scope of this article. Finally, issues related to the presence of PCBs in the environment and associated potential exposures are not dealt with here.

2 A brief history

PCBs were first described in the German chemical literature in the 1880s (Schmidt and Schultz 1881). PCBs were first manufactured commercially in 1929 by the Swann Chemical Company in Anniston, AL. Theodore Swann had developed a commercially viable process to manufacture biphenyl from benzene by bubbling benzene through molten lead. Chlorination of the biphenyl was one of many routes explored to develop commercial uses for the biphenyl (Penning 1930). General Electric was among the companies which tested this new product. They were looking for a flame-retardant transformer fluid to use in locations where mineral oil fires put persons or property at risk. General Electric recognized that PCBs were ideal fluids for this application and patented various PCB-containing products in the early 1930s.

In 1935, the Swann Chemical Company, including Swann's Anniston, AL, plant was purchased by the Monsanto Company, based in St. Louis, MO. Swann's line of polychlorinated polyphenyl products, known as Aroclor® products, was among the product lines now manufactured by Monsanto at Anniston.

In the late 1930s, a second manufacturing facility was constructed in Sauget, IL. During World War II, the manufacture of PCBs was taken over by the US Government, because of their essential uses in support of the war effort. After the war, the uses of PCBs expanded into a number of functional areas, including flame retardant heat transfer fluids, hydraulic fluids, and plasticizers. These uses are described in detail below.

The discovery and subsequent investigations of the presence of PCBs in the environment is a tale oft-told and will only be quickly summarized here. The first mention of PCBs in the environment was in the British science news magazine *New Scientist* in December of 1966 (Anonymous 1966), reporting the findings of Sören Jensen and colleagues in Stockholm. The first mention of the Swedish work in the USA was in January 1967 (Anonymous 1967). Over the next several years, additional studies were published, including the December 1968 publication in *Nature* first reporting PCBs in US birds (Risebrough et al. 1968). In 1972, Jensen (1972) published *The PCB Story*, doubtless thinking it important to commemorate this historic tale before we all moved on to other scientific challenges. As we know, the PCB story was far from over in 1972.

By early 1970, Monsanto had undertaken a program to address the presence of PCBs in the environment. Customers were notified of the developing information about PCBs in the environment, and Monsanto introduced a label warning users to prevent environmental discharges. Monsanto also voluntarily withdrew PCBs from all markets which were considered likely to lead to environmental discharges. Sales were restricted to a limited number of manufacturers of electrical equipment for uses in nominally closed systems, such as capacitors and transformers. Consideration was given to early cessation of manufacture, but a US Government inter-departmental task force noted in May of 1972 that the continued use of PCBs in electrical equipment was essential to the safe delivery of electrical power in the USA (ITF 1972).

In 1968, the Yusho incident occurred in Western Japan, mainly in the Fukuoka and Nagasaki prefectures. "Yusho" is a Japanese word meaning "oil disease"; it is not the name of a geographical location in Japan, as is often stated. The incident did not occur "in Yusho." Thermally degraded Japanese PCB-containing heat transfer oil had leaked into rice oil during processing. The rice oil was subsequently consumed by residents in Western Japan. The details of this incident have been thoroughly covered in the scientific literature (Kunita et al. 1984) and in books (Erickson 1997 and citations therein). The thermal degradation of the fluid had resulted in elevated levels of polychlorinated dibenzofurans and other chemicals in the fluid and subsequently in the rice oil. Although investigations continue to this day, it is widely acknowledged that the primary causative factor of Yusho was the polychlorinated dibenzofurans, since Japanese electrical workers with comparable levels of PCBs in their bodies did not exhibit the symptoms of Yusho.

After Monsanto was notified by its customers that acceptable substitute fluids for PCBs in electrical equipment were available, Monsanto ceased production of PCBs in 1977, 2 years before the EPA's ban on the manufacture of

PCBs was published in May of 1979. However, PCB manufacturing in several European and Asian countries continued well into the 1980s and probably later. Today, the intentional manufacture of PCBs is not known to be occurring anywhere in the world, except for the synthesis of small amounts for research purposes.

2.1 PCB manufacturing process

Monsanto manufactured PCBs by the direct chlorination of biphenyl (Hubbard 1964). Ferric chloride was used as a catalyst. When the desired degree of chlorination was attained, as determined by the specific gravity, the crude liquid Aroclor product was pumped to a tank where residual hydrochloric acid (HCl), which was a byproduct of the chlorination reaction, was blown out with air. Following treatment with lime to neutralize any residual acid, the crude mixtures were refined by vacuum distillation. To prepare electrical grade Aroclor 1200 series products, the distilled material was treated with attapulgus earth (fuller's earth) to remove electrically conductive impurities such as traces of water and HCl and thereafter filtered.

The complex congener composition of the various Aroclor PCB products was determined by the chemistry and physics of the chlorination process. There is a frequent misunderstanding that Monsanto and the other manufacturers somehow manufactured and blended the individual congeners to produce the various products. This is simply not the case. While it is not possible to delineate all of the reaction kinetics, a couple fairly simple considerations may help to illustrate the considerations that determined the congener mixes. Readers who either enjoyed or suffered through college organic chemistry may recall that substituents on benzene rings "direct" further substitutions to either the *ortho*/*para* or the *meta* positions on the rings. The second benzene ring in the biphenyl molecule is an *ortho*/*para* director, so substitution is much more common in those positions than in *meta* positions. Also, the chlorines tend to be distributed somewhat equally between the two rings, so that congeners with three or more chlorines on one ring and none on the other are not present in actual product mixtures, even though such congeners frequently serve as research curiosities. Although there is a consensus on the general homologous compositions of the major Aroclor products (see Table 1), characterization of the composition of the commercial mixtures at the congener-specific level is much more complex and remains a subject of continuing research.

The manufacturing process also helps explain why PCB products of the same chlorination level are remarkably similar among different manufacturers and among batches from the same manufacturer. As long as the processes are well-controlled, the reactions will occur in the same way in every batch for every manufacturer. Of course, there will be minor variations, but the major components will always be major components, and the trace components will always be trace components.

Table 1 Comparison of commercial PCB mixtures

Aroclor	Average No. Cl/Molecule	Approximate Weight% Cl
1221	1.15	21
1232	2	32–33
1242, 1016	3	40–42
1248	4	48
1254	5	52–54
1260	6–6.3	60
1262	6.8	62
1268	8.7	68
1270	10	71

Source: (Brinkman and De Kok 1980)

2.2 The naming of cats: PCBs

As we were reminded in the musical *Cats*, every cat has three names. The same is true of PCBs, although some have even more names. For example, 3,3′,4,4′-tetrachlorobiphenyl is also known as PCB 77, is a non-*ortho* PCB or coplanar PCB, and has CAS Registry Number 32598-13-3. Of course, it is also a congener and an isomer, and it may be a component of a commercial mixture, such as one of the Aroclor products. We sort out this confusing nomenclature here.

The term "congener" has come to be applied to any single member of a class of related compounds, such as PCBs, which are the class of compounds comprising molecules with 1–10 chlorine atoms attached to the two rings of biphenyl. Despite the linguistic inconsistency, monochlorobiphenyls are included in all PCB discussions. Unchlorinated biphenyl is never included as a PCB. There are 209 PCB congeners. These congeners can be further classified according to the number of chlorines attached to the rings. Thus, there are 10 "congener classes," ranging from monochlorobiphenyls (three class members) through pentachlorobiphenyl (46 class members) to decachlorobiphenyl (one class member). When grouped by degrees of chlorination, the congener classes are often referred to as "homologs," although that term is strictly applicable only to groups of chemicals with increasing carbon chain lengths. However, the application of the term to PCBs and other groups of chlorinated compounds is widespread in formal and informal writing and must be considered an accepted use.

The term "isomer" refers to one of a group of chemicals that have the same molecular formula, i.e., they comprise the same elements and the same numbers of those elements. Thus, the 42 members of the congener class of tetrachlorobiphenyls are isomers of one another. They all have the molecular formula $C_{12}H_6Cl_4$. (N.B., there are not 209 *isomers* of PCBs, because PCBs as a group have 10 possible molecular formulae.)

Of course, like every chemical, each PCB congener has a precise chemical name in accordance with the system established by IUPAC. In our example above, that name is 3,3′,4,4′-tetrachlorobiphenyl. That name can only apply to that specific congener, and it uniquely specifies the number and location of the chlorine atoms on the biphenyl rings. That naming system is precise and works well for congeners with only a few chlorine atoms, but it quickly becomes cumbersome as the number of chlorines increases. Accordingly Ballschmiter and Zell (1980; corrected in Ballschmiter et al. 1992) proposed a numbering system in which each congener was arranged in ascending IUPAC hierarchical order from mono- to decachlorobiphenyl and given a number from 1–209 (the BZ number) to facilitate communication of information about individual congeners. Thus, in the BZ system, 2-chlorobiphenyl is PCB 1; 3,3′,4,4′-tetrachlorobiphenyl is PCB 77; and 2,2′,3,3′,4,4′,5,5′,6,6′-decachlorobiphenyl is PCB 209.

All 209 congeners, "PCB," the ten homologs, Aroclor products, and other PCB-related mixture terms have a unique number assigned by the Chemical Abstracts Service, which has assigned numbers to over 50 million organic and inorganic substances. 3,3′,4,4′-Tetrachlorobiphenyl has CAS Registry Number 32598-13-3. Numbers are assigned when the chemical is reported in the literature, so the CAS numbering system is not sequential. For example, the next congener on the BZ list, 3,3′,4,5-tetrachlorobiphenyl, has a CAS RN of 70362-49-1. A comprehensive list of all congeners with IUPAC, BZ, and CAS numbers can be found in Appendix A in Erickson (1997).

Primarily to facilitate discussions of the toxicological properties of certain PCB congeners, the *ortho*, *meta*, and *para* designations are used to classify PCBs according to their potential ability to bind to the aryl hydrocarbon (Ah) receptor in animal cells. The Ah receptor is a cellular receptor that binds planar organic compounds such as polychlorinated dibenzo-*p*-dioxins and dibenzo-*p*-furans with high affinity, leading to various toxic effects. The most potent ligand is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin or TCDD. In this classification scheme, *ortho*-chlorines are those in the 2, 2′, 6, or 6′ positions, i.e., those adjacent to the carbon–carbon bond in biphenyl. Likewise, *meta*-chlorines are those in the 3, 3′, 5, or 5′ positions, and *para*-chlorines are those in the 4 or 4′ positions. The significance of this scheme is that PCB congeners with at least four chlorines and with no chlorines in the *ortho* positions can assume the planar conformation necessary for binding to the Ah receptor. These congeners (BZ numbers 77, 81, 126, and 169) are thus frequently called coplanar, non-*ortho*, or dioxin-like PCBs (note that these PCBs are not "locked" into the planar conformation, but they can assume that conformation during rotation around the carbon–carbon bond.) PCBs with at least four chlorines in the 3, 3′, 4, 4′, 5, or 5′ positions and a single chlorine in an *ortho* position are denoted mono-*ortho*-PCBs. These eight congeners bind weakly to the Ah receptor. Lastly, the remaining congeners are designated as either di-*ortho*-PCBs and, more generally, as *ortho*-PCBs.

It should be noted that the four non-*ortho* and eight mono-*ortho* PCBs have been assigned TCDD toxicity equivalency factors by the World Health Organization (WHO) and other organizations to reflect the potential relative potencies associated with binding to the Ah receptor, compared to that of TCDD (Van den Berg et al. 2006).

2.3 The naming of cats: Aroclor products[2]

As noted earlier, Monsanto's trade name for its line of polychlorinated polyphenyl products was Aroclor®. Readers will please note that there is no "h" in Aroclor (the trademark designation is generally omitted throughout this article to be consistent with common usage). Of course, the most widely known of these products were the polychlorinated biphenyls, but the product line also included polychlorinated terphenyls (PCTs), as well as mixtures and blends of PCBs and PCTs. In the broadest of terms, most PCBs were known as liquid Aroclors, while the term solid Aroclors encompassed PCTs and the most highly chlorinated PCBs.

In general, the naming system for Aroclor PCB products is well known. The trade name Aroclor was followed by a four-digit number (Table 1), in which the first two digits were "12," designating the product as a refined PCB. The second two digits specified the average percentage of chlorine, by weight, in the particular product. Thus, Aroclor 1242 was a polychlorinated biphenyl product containing 42% chlorine by weight. While 42% chlorine by weight is also the approximate composition of trichlorobiphenyls, the product is a complex mixture of congener classes containing from one to six or seven chlorines. It is not "trichlorobiphenyl," per se (this frequent misconception is compounded by the naming systems of some non-US PCB products, as will be discussed below).

[2] Unreferenced Aroclor and other Monsanto product information (Section 2.4) is derived from personal knowledge, RGK.

One frequently reads the myth[3] that the "12" in the product name refers to the fact that there are 12 carbon atoms in the biphenyl molecule, which is decidedly not true. In fact, for every product in the Aroclor 1200 series (refined PCBs), there was a corresponding product in a less well-known 1100 series, the crude PCBs. As noted elsewhere, the final step in the manufacture of the 1200-series PCBs was the distillation of the corresponding crude 1100-series material. Thus, Aroclor 1142 was distilled to produce Aroclor 1242. Further, like PCBs, the PCTs were marketed with a four digit specification, in which the last two digits indicated the percentage of chlorine by weight in the product. However, the first two digits were "54." Thus Aroclor 5460 was chlorinated terphenyl with an average chlorine content of 60%. If the "12=12 carbon atoms" myth were true, the first two digits of the PCT line would have been "18," since there are 18 carbon atoms in the terphenyl molecule (the crude PCT products had designations in the Aroclor 5000 series).

The one oft-noted exception to the naming system for PCBs is Aroclor 1016. This product was developed and introduced after 1971, when it became clear that PCB congeners containing three to four chlorines or fewer were fairly rapidly biodegradable, while those with five or more were less so. Aroclor 1016 was produced by distilling Aroclor 1242 to remove the more highly chlorinated congeners to make a more biodegradable product. Further, since it was introduced after Monsanto limited sales of PCBs to manufacturers of electrical equipment for use in closed systems, Aroclor 1016 was predominantly used in capacitors, with some limited use in transformers.

The "1016" designation was an outgrowth of Monsanto's system for keeping track of materials in the research stage of development. Each new research chemical, whether PCB-containing or not, was given a sequential Monsanto Chemical Substance or Sample number (MCS). Thus, MCS 1016 was the designation of the Aroclor 1242 distillation product that was undergoing research to see if it would be a suitable replacement for Aroclor 1242 in electrical equipment. During the product development stage, both Monsanto personnel and customers began to refer to the research material as simply "1016," just as they referred to the other PCB products simply by their four-digit name. When MCS 1016 was commercialized, it was called Aroclor 1016, because that is what practitioners were already calling it. The name was not an attempt to disguise the fact that it was a PCB product or to suggest that it had only 16% chlorine. Claims to that effect fail to recognize the developmental history of the product.

[3] For example, http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/aroclor.htm and http://en.wikipedia.org/wiki/Polychlorinated_biphenyls. Accessed April 2010.

Finally, there were also a few products containing both PCBs and PCTs, namely Aroclor 2565 and Aroclor 4465 (which was refined from Aroclor 4065). The Aroclor 6000 series of plasticizers was formulated as blends of Aroclor 5460 and Aroclor 1221. These products served as transitional plasticizers between PCB-containing and non-PCB-containing products. In this series, the final two digits indicated the amount of Aroclor 5460 in the product. For example, Aroclor 6050 contained 50% Aroclor 5460 and 50% Aroclor 1221.

2.4 The naming of cats: other Monsanto PCB products

Aroclor was the dominant trade name for Monsanto's PCB and PCT products. However, other trade names were used for specific applications, sometimes because the Aroclor product was blended with other chemicals.

Therminol® was the trade name for Monsanto's line of heat transfer fluids. The original fluids were all in the FR series, where the "FR" referred to the flame retardant properties of the fluids. Only the Therminol FR series fluids contained PCBs (EPRI 1999; Therminol 66 was erroneously noted to be a PCB-containing product at p. 3–12). In fact, with the exception of Therminol FR-0 and Therminol FR-1 Lo-Temp, the Therminol FR products were 100% PCBs: FR-1 (Aroclor 1242), FR-2 (Aroclor 1248), and FR-3 (Aroclor 1254). After Monsanto ceased selling PCBs for open application in the early 1970s, they continued to sell heat transfer fluids and continued to use the Therminol trade name. The Therminol trade name is currently used by Solutia Inc. to which the business was spun off in 1997. Of course, no Solutia-manufactured Therminol fluids ever contained PCBs.

The situation with regard to Monsanto's former line of Pydraul® hydraulic fluids is not so straightforward. Monsanto's early line of PCB-containing Pydraul fluids were blends of PCBs along with, variously, hydrocarbon oils, phosphate esters, and other chemicals, as well as additives such as rust inhibitors, viscosity modifiers, and colorants. In most cases, each particular Pydraul product was developed for a specific application, often in association with customers. For example, Pydraul AC was developed specifically for use in air compressors. Accordingly, there is no simple way to know or predict the composition of any particular Pydraul fluid.

As was the case with other "open" uses, Monsanto stopped making and marketing PCB-containing Pydraul fluids in the early 1970s. In many cases, however, the company introduced non-PCB-containing fluids with the same name with a suffix indicating that the fluids no longer contained PCBs. In general, Pydraul fluid names with the suffix "B" indicated the fluid was a transitional fluid, often containing PCTs. Fluids with "C" or higher designations contained neither PCBs nor PCTs. As with the Therminol name, Monsanto continued to develop and market new, non-PCB containing hydraulic fluids under the Pydraul trade name. Monsanto's hydraulic fluid business was sold in 1986. However, the Pydraul trade name continued to be used by subsequent manufacturers.

Monsanto also marketed a line of aircraft hydraulic fluids with the trade name Skydrol(R). Those fluids were based on phosphate esters and never contained PCBs (Hatton 1964). Phosphate ester-based Skydrol fluids continue to be manufactured and marketed by Solutia Inc. (www.skydrol.com)

2.5 The naming of cats: other manufacturers and products

PCBs were manufactured worldwide through at least the 1980s. Monsanto's Aroclor products accounted for nearly all of the US production. Foreign manufacturers sold similar products under trade names such as Kanechlor® (Japan), Clophen® (Germany), Phenoclor® and Pyralene® (France), Fenchlor® (Italy), Sovol (Russia), Chlorfen (Poland), and Delor® (the former Czechoslovakia). In addition, many use-specific PCB-containing products had identifying trade names. Manufacturers other than Monsanto also added numerical "suffixes" to their trade names to specify the average composition of their product (Erickson 1997 Table 2-V). As noted above, Aroclor 1242 was a complex mixture of PCB congeners from many congener classes, but the average percentage of chlorine closely corresponded to that of trichlorobiphenyl. Comparable products from other manufacturers were Clophen A30, Phenoclor DP-3, and Kanechlor 300; in each case, the "3" referred to trichlorobiphenyl, the average number of chlorines on the biphenyl rings in the particular product. Each manufacturer had similar product names for products with average percentage chlorine compositions close to those of tetrachlorobiphenyl, pentachlorobiphenyl and hexachlorobiphenyl. In some cases, these naming schemes have led to the incorrect inference that the products were composed of "purely" the congener class suggested by the number. However, all of these products were complex mixtures of PCB congeners from many congener classes, just like the Monsanto products.

As noted above, Monsanto used the Pydraul® trade name for PCB-containing hydraulic fluids and Therminol FR® for PCB-containing heat transfer fluids. Further, many users had their own trade names for PCB-containing fluids used in their own products. For example, General Electric's trade name for their PCB-containing dielectric fluids was Pyranol®; that of Westinghouse was Inerteen®; and that of Kuhlman was Saf-T-Kuhl®. Many authors have tabulated and further described those products (Erickson 1997, Table 2-VI; USEPA 2010).

3 Physical properties

The physical properties of the various PCB mixtures have been discussed extensively in other publications, so they will only be briefly mentioned here. Table 2 shows the physical properties adapted from the Monsanto (2004) Material Data Safety Sheet.

Table 2 Properties of selected Aroclor products

PROPERTY	1016	1221	1232	1242	1248	1254	1260	1268
Color (APHA)	40	100	100	100	100	100	150	1.5(NPA) molten
Physical state	Mobile oil	Mobile oil	Mobile oil	Mobile oil	Mobile oil	Viscous liquid	Sticky resin	Off-white powder
Stability	Inert	Inert	Inert	Inert	Inert	Inert	Inert	Inert
Density (lb/gal 25°C)	11.40	9.85	10.55	11.50	12.04	12.82	13.50	15.09
Specific gravity at ºC	1.36–1.37 25°	1.18–1.19 25°	1.27–1.28 25°	1.30–1.39 25°	1.40–1.41 65°	1.49–1.50 65°	1.55–1.56 90°	1.80–1.81 25º
Distillation range (°C)	323–356	275–320	290–325	325–366	340–375	365–390	385–420	435–450
Acidity mg KOH/g, maximum	.010	.014	.014	.015	.010	.010	.014	0.05
Fire point (°C)	None to boiling point	176	238	None to boiling point	None to boiling point	None to boiling point	None to boiling point	None to boiling point
Flash point (°C)	170	141–150	152–154	176–180	193–196	None	None	None
Vapor pressure (mm Hg @ 100°F)	NA	NA	0.005	0.001	0.00037	0.00006	NA	NA
Viscosity (Saybolt Univ. Sec. at 100°F) (centistokes)	71–81	38–41	44–51	82–92	185–240	1800–2500	–	–
	13–16	3.6–4.6	5.5–7.7	16–19	42–52	390–540	–	–

NA not available

Individual PCB congeners are white, crystalline materials. However, as shown in Table 2, the various mixtures are liquids (less chlorinated) or resinous (more chlorinated) because of the mutual melting point depression effects of the congeners. As expected, the physical properties among the mixtures vary according to the amount of chlorine in the products. Specific gravity, boiling point, and viscosity increase as the chlorine content increases, while the water solubility and vapor pressure decrease.

As has been often noted, the very properties that made PCBs desirable for numerous industrial applications were those that contributed to the environmental persistence of the more highly chlorinated congeners. PCBs were resistant to chemical and thermal degradation, as well as to biodegradation.

Of course, the most important property of PCBs was their fire resistance or, alternatively, their flame retardant properties. When PCBs were involved in fires, the primary product of combustion was hydrochloric acid, which is not flammable, so the products of combustion served to quench the fire. Thus, PCBs were highly desirable for applications where fire was a threat to life and property, such as in electrical equipment in commercial buildings and hospitals, in hydraulic systems in foundries, and in heat transfer systems.

4 Uses

4.1 General use categories

Commercial PCB mixtures were used in a wide variety of applications, including dielectric fluids in capacitors and transformers, heat transfer fluids, hydraulic fluids, lubricating oils, and as additives in paints, carbonless copy ("NCR") paper, adhesives, sealants, and plastics. By far, the preponderance of the PCBs was used in capacitors and transformers. Their commercial utility was based largely on their chemical stability, including low flammability, and desirable physical properties, including electrical insulating properties. PCB production and use has been thoroughly reviewed (Durfee et al. 1976; EPRI 1999; Erickson 1997, 2001; Johnson et al. 2006; WHO 1993).

As reviewed by the WHO (1993), PCB use can be divided into three categories:

- *Completely closed systems* (electrical equipment such as capacitors and transformers)
- *Nominally closed systems* (hydraulic and heat transfer systems, vacuum pumps)
- *Open-ended applications* (Major: plasticizer in PVC, neoprene, and other chlorinated rubbers. Other: surface coatings, paints, inks, adhesives, pesticide extenders, and microencapsulation of dyes for carbonless copy paper. Also: immersion oils for microscopes, catalysts in the chemical industry, casting waxes (decaCB), cutting oils, and lubricating oils)

These use categories had different implications for the introduction of PCBs into the environment. Some uses, like carbonless copy paper, resulted in environmental discharges through the recycling of the paper. Other uses, such as caulks, were intended to remain in place for extended periods. The majority of the PCBs were sealed in electrical equipment, where the only environmental impact would have been from accidents, maintenance, or disposal after the original PCB-containing materials had remained in service for years or even decades.

With increased interest in the environmental impact of PCBs, the sale of PCBs for so-called "open" uses, which could lead to near-term release into the environment if not managed properly, were voluntarily curtailed by Monsanto. By 1972, Monsanto had restricted PCB sales to electrical equipment applications.

Durfee et al. (1976) prepared a 489-page report, "PCBs in the United States—Industrial Use and Environmental Distributions," that was published by EPA. This report is cited frequently in this article and a famous table on the "End-Uses of PCTs and PCBs by Type" has been extensively referenced (ATSDR 2000; Johnson et al. 2006; WHO 1978). Durfee's end-use table summarized the report's text and provided a good synopsis of mid-1970s public information on PCB use. Since that time, additional documentation and additional perspectives allow us to improve upon Durfee's classic work, as discussed in this paper.

A Subpanel on PCBs under an Ad Hoc Committee on Environmental Health Research under the apparent auspices of the National Institute of Environmental Health Sciences reviewed the environmental impact of PCBs in 1972 (Hammond et al. 1972). This list of uses was important, given the 1972 publication date and the communications with Monsanto officials for other use data.

Durfee et al. (1976) also tabulated the US PCB production and sales as adapted in Table 3 and Fig. 1. Other publications documented similar use patterns in Japan (Hammond et al. 1972), six European countries (Brinkman and De Kok 1980), and in 23 Organization for Economic Cooperation and Development countries as well as the USA (WHO 1978). In aggregate, the foreign manufacturers accounted for nearly 50% of worldwide production (Bletchly 1983). In all cases, capacitor use dominated, followed by transformers, and then the other applications.

Clearly capacitor and transformer fluids dominated the sales with a combined 75% of US sales. We discuss these acknowledged and major uses of PCBs in this article, but we also delve into other uses that may have comprised smaller amounts, unknown to Monsanto or EPA at the time

Table 3 Estimates of cumulative US production and usage over the period 1930–1975 in metric tons (g×10E6)

	Commercial production	Commercial sales	Industrial purchases	% of Production	% of Domestic sales
US PCB Production	635,000				
US Imports	1,360			0.2	
US Domestic Usage		538,000			
Total US Exports		68,000		11	
Use Category					
Petroleum Additive			450	0.07	0.08
Heat Transfer			9,100	1	2
Misc Industrial			12,000	2	2
Carbonless Copy Paper			20,000	3	4
Hydraulics and Lubricants			36,000	6	6
Other Plasticizer Uses			52,000	8	9
Capacitor			286,000	45	50
Transformers			152,000	24	27
Total	636,000	636,000			

Adapted from Table 1.2-1, p. 7 in Durfee et al. (1976) by conversion from pounds to metric tons and calculation of percentages

of Durfee's tabulation. We also discuss undocumented uses. Table 4 presents an overview of commercial uses; Table 5 lists published PCB applications with no known commercial use; the sections that follow provide additional detail.

4.2 Electrical equipment

The vast majority of PCBs were used in capacitors and transformers and other electrical equipment as dielectric fluids. PCBs were used in electrical equipment because of performance and safety attributes. For example, one of the most important factors was their fire resistance or flame retardancy. The Underwriters Laboratories flammability rating for Aroclor 1242 was 2–3, while that for mineral oil was 10–20, compared to gasoline, with a flammability rating of 90–100 (ITF 1972).

4.2.1 Capacitors

The properties of the dielectric liquid impregnating the cellulosic paper are: non-flammability, dielectric constant matching that of paper, low dissipation factor, high dielectric strength, high chemical stability, low vapor pressure, inert decomposition products in an electric arc, low toxicity of the material, and its decomposition products and low cost (ITF 1972).

PCBs fit those criteria. The industry term for this PCB dielectric fluid was capacitor askarel.[4] The capacitor askarels include neat Aroclors 1221, 1242, 1254, and 1016, as well as a mixture of 75% Aroclor 1254 and 25% trichlorobenzene. The ASTM (1991a) has published standard specifications for capacitor askarels. As with transformers, General Electric used the trade name Pyranol and Westinghouse used the trade name Inerteen; both had code numbers to designate the specific type of askarel (Erickson 1997).

Small capacitors contained as little as 2 mL and large capacitors contained up to 27 L PCB (ITF 1972). From 1957–1971, capacitors accounted for most of the PCB use in the USA (Durfee et al. 1976). The start date of 1957 is based on availability of Monsanto records and the statement may apply to earlier years as well. In 1968, 95% of all US production of capacitor liquids was PCBs (ITF 1972). In 1976, 90–95% of all impregnated capacitors manufactured in the USA were of the PCB type (Durfee et al. 1976). In 1979, EPA estimated that "9.56 million pieces of equipment...contain PCB capacitors" (Westin and Woodcock 1979). Unlike transformer askarels, capacitor askarels were generally pure PCB.

Two important types of capacitors were phase-correcting capacitors for power lines and fluorescent light ballasts. In capacitor manufacture, the PCBs were used to impregnate the paper dielectric and fill air voids. Other applications included a wide variety of uses of small capacitors in appliances and other products, such as air conditioner pump motors, submersible water pumps, automobiles, televisions, light fixtures, clothes washers, clothes driers, refrigerators, freezers, and microwave ovens (EPRI 1999). The fluorescent light ballasts contained a PCB capacitor and/or petroleum-asphalt insulating material ("potting") contaminated with PCBs (USCFR 1999).

4.2.2 Transformers

Most power transformers use a liquid to electrically insulate and remove heat from the core and windings. The desired

[4] Note that "askarel" is not a trade name and is *not* capitalized.

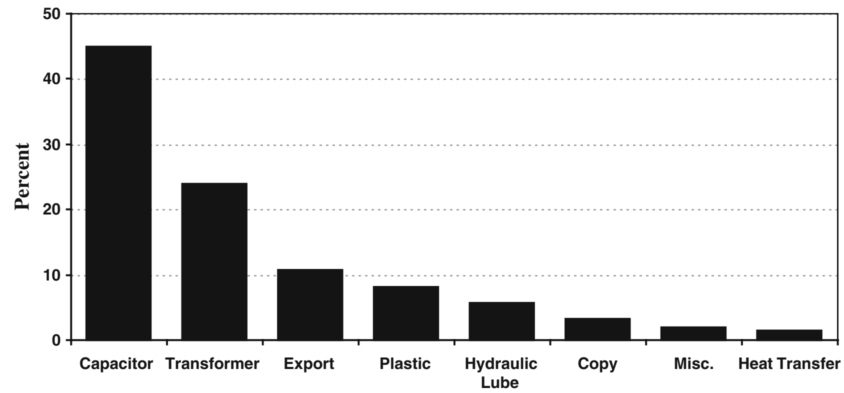

Fig. 1 Applications in the USA based on sales records 1930–1975 (Erickson 2001)

properties are: non-flammability, high dielectric strength, low viscosity, high chemical stability, compatibility with other materials, inert decomposition products, low toxicity of the liquid and its decomposition products and low cost (ITF 1972). PCBs fit those criteria, except that if the appropriate Aroclor fluid was too viscous, it was blended with trichlorobenzene[5] to achieve the desired viscosity. The industry term for this PCB-containing dielectric fluid was transformer askarel. The most common transformer askarels were 60% Aroclor 1260/40% trichlorobenzene (Type A) and 70% Aroclor 1254/30% trichlorobenzene (Type D). The transformer askarels contain other minor components used as free radical scavengers. The ASTM (1991b) has published standard specifications for transformer askarels. General Electric used the trade name Pyranol and Westinghouse used the trade name Inerteen, both with code numbers to designate the type of askarel (Erickson 1997).

Only about 5–10% of transformers were ever manufactured with PCBs during the period when PCBs were used in this application (Durfee et al. 1976; ITF 1972). The vast majority (96% in 1968) used mineral oil for the dielectric fluid, because an askarel transformer cost 1.3 times as much as a mineral oil transformer. The cost of askarel was cited as $1.80/gal and the cost of mineral oil was $0.25/gal, a 7-fold premium for the fluid. (ITF 1972). Fire underwriters required the use of non-flammable dielectric fluids in indoor transformers unless the transformers were in a fireproof concrete vault (ITF 1972).

Askarel dielectric fluids were used in network, pad-mounted, pole-mounted, and precipitator power supply transformers containing 200–2,000 kg in each unit with an average of about 1,400 kg (ITF 1972). Specifically (Durfee et al. 1976):

- "Furnace transformers used in the hot, dirty atmosphere in proximity to glass-melting and induction furnaces... contain 900–1800 kg of askarel each..."
- "Rectifier transformers used for large rolling mills and DC [direct current] industrial power supplies... contain about 8600 kg of askarel..."
- "Railroad transformers used on-board in electric locomotives or multiple unit electric railroad cars...contain 300–1100 kg of askarel in each unit... since a tunnel fire in 1940 caused by an oil filled locomotive transformer, Penn Central will not allow any oil containing transformer equipped locomotive into New York City."
- Reactors: "During power surges they choke the voltage and deliver the normal output."
- Grounding Transformers

In large transformers, hundreds of liters of PCB fluid provided insulation between the high voltage core and the tank, which would be grounded.

4.3 Air and gas compressor lubricants

The use of PCBs in air compressor lubricants was driven primarily by two considerations; reduced fire and explosion hazard and lower maintenance costs due to the reduction of carbon deposits on air compressor valves. The first consideration was particularly attractive to customers operating natural gas pipelines and in other operations where high ambient temperatures made the introduction of mineral oil-based lubricants especially dangerous. PCB uses included "gas-transmission turbines, Aroclors 1221 and 1242" (Hammond et al. 1972).

EPA published a synopsis of the use of PCBs in natural gas pipelines, quoted in part here (USEPA 2004).

> Major interstate natural gas pipelines transport natural gas from production areas on the Gulf Coast and western US to local distribution companies that distribute the natural gas to industrial and urban customers. PCBs were used in turbine and air compressors as a hydraulic/lubricant and a plug valve sealant. As part of the normal operation of large turbine compressors, PCB compressor lubricants could leak or blow by pressure seals and enter the

[5] The term "trichlorobenzene" is used generically herein for various combinations of tri- and tetrachlorobenzenes used in askarel fluids.

Table 4 Commercial PCB uses

Application	Aroclor(s)	Metric Tons ($g \times 10^6$)	Reference[a]
Electrical equipment			
Capacitors (large, small, fluorescent light ballasts)	1242, 1016, (1254)[b]	286,000	Durfee et al. 1976
Transformers	1254, 1260 (1242, 1016)	152,000	Durfee et al. 1976
Transformer equipment			EPRI 1999
- slip gears			EPRI 1999
- phase converters			EPRI 1999
Slip motors			EPRI 1999
Electromagnets			EPRI 1999
Hydraulics/Lubricants/Heat Transfer Fluids			
Air Compressor/Gas Transmission Turbine Lubricants	Pydraul	G, A	Hammond et al. 1972; USEPA 2004
	Turbinol		
	Santovac		
	1221, 1242		
Heat Transfer	1242, 1248, 1254	9100	Durfee et al. 1976
Hydraulic Fluids (and other lubricants)	1232–1260	36,000	Durfee et al. 1976; Hammond et al. 1972
Vacuum Pumps			EPRI 1999
Motor coolants (mining equipment)	French import		Durfee et al. 1976
Heat transfer systems	1242	9,100	Durfee et al. 1976; Hammond et al. 1972
Vacuum pumps	1248, 1254	A	Hammond et al. 1972
Vapor diffusion pumps			EPRI 1999
Immersion oils for microscopes	1260 & PCT		McCrone 1985
Optical oils in telescopes			EPRI 1999
Cutting oils	1254	A	Hammond et al. 1972
PCBs Incorporated into Products and Materials			
Miscellaneous Industrial		12,000	Durfee et al. 1976
Plasticizers		52,000	Durfee et al. 1976
Carbonless Copy Paper (microencapsulation of ink)	1242	20,000	Durfee et al. 1976; Hammond et al. 1972
Inks	1254		Hammond et al. 1972
Thermographic and xerographic copying		P	ITF 1972
Paints, varnishes, lacquers, and other surface coatings	Many	No info	ITF 1972
Flooring and floor wax/sealants		G,A	USCFR 1999
Coal-tar enamel coatings			USCFR 1999
Pipeline Valve Grease	1268	G	USEPA 2004
Adhesives	1221–1254	P	Hammond et al. 1972; EPRI 1999
Adhesive Tape			USCFR 1999
Caulk and Joint sealants	1254 & other		Multiple (see text)
Gasket sealers			Power Res Inst 1999
Insulation and other building materials	1254, 1268		Multiple (see text)
Rubber products	1232–1254, 1268	A	Hammond et al. 1972; EPRI 1999
Wire and cable coatings	1254, 1260	A, G	Cleghorn et al. 1990; EPRI 1999; USCFR 1999
Die or investment castings	DecaCB (Imported)	13–22/year	Durfee et al. 1976
Petroleum Additive		450	Durfee et al. 1976

[a] In general, we have cited the oldest primary reference for uses, assuming that newer references generally used the first as a source

[b] Aroclors in parentheses are known minor uses

P patent literature, *A* article in published journal, *G* US Government Publication, *M* Monsanto Marketing Literature

Table 5 Published PCB applications with no known commercial use

Application	Aroclor(s)	Metric Tons ($g \times 10^6$)	Reference
Insecticide & bactericide		P, G	ITF 1972
Pesticide extenders	1254	P, A	Hammond et al. 1972
Wax extenders	1242, 1254, 1268	M, A	Hammond et al. 1972; EPRI 1999; Hubbard 1964
Textiles and textile coatings		P	EPRI 1999
Synthetic Resins		A	EPRI 1999
Vinyl chloride polymer films		A	EPRI 1999
Dedusting agents	1254, 1268	A	Hammond et al. 1972
Catalyst carrier		P	ITF 1972

P patent literature, *A* article in published journal, *G* US Government Publication, *M* Monsanto Marketing Literature

> transmission pipeline. These PCBs would generally mix with the "pipeline liquids" already in the transmission lines. The main components of pipeline liquids are water and heavier hydrocarbons that condense-out ("condensate") of the natural gas as pressure drops along the pipeline...
> Between 1950 and the early 1970s, Monsanto manufactured and sold several brands of hydraulic/lubricant oils containing PCBs. These included Turbinol 153 that contained 6.4% Aroclor 1221 and 81.5% Aroclor 1242...

4.4 Heat transfer systems

Heat transfer fluids absorb thermal energy from a hot source to provide cooling or to deliver heat. PCBs were used in high-temperature heat transfer systems where their thermal stability, chemical stability and low flammability were needed (ITF 1972). "Flammable heat transfer fluids present a fire hazard if they leak onto a furnace or onto hot surfaces. The use of PCBs prevents this danger" (ITF 1972). Heat transfer systems in petroleum refineries and chemical plants used PCB fluids such as Monsanto's Therminol FR-series heat transfer fluids prior to Monsanto's conversion to non-PCB-containing Therminol fluids.

4.5 Hydraulic fluids

Hydraulic fluids are used as force transmitters. Requirements for such fluids include high lubricity, stability, appropriate viscosity, and compatibility with rubber seals, good fire resistance, and other attributes (ITF 1972). Hydraulic systems are considered nominally closed systems.

In harsh environments in which fire retardancy was particularly valued, PCBs were used as hydraulic fluids (EPRI 1999). Subsurface mining, automobile manufacture, metal finishing, and aluminum industries are examples in which PCB-containing fluids were used. PCBs also served as lubricating additives to hydraulic fluids in extreme pressure applications and as pour-point depressants in hydraulic fluids (ITF 1972). The use of PCBs in hydraulic systems peaked in 1970 when it constituted 15% of the domestic Monsanto sales of Aroclor fluids (Durfee et al. 1976). A US Government panel (Hammond et al. 1972) cited Aroclors 1242, 1248, 1254, and 1260 as having been used in hydraulic fluids and lubricants.

4.6 Vacuum pumps

PCBs were used as diffusion pump oil because of their differential vapor pressure, chemical inertness and other attributes (ITF 1972). Monsanto marketed Santovac 1 and 2 containing 100% Aroclor 1248 and 1254, respectively, for vacuum pump applications.

4.7 Coolants

PCBs were used as engine coolants in mining machinery where fire retardancy was particularly valued. Joy Manufacturing (Pittsburgh, PA) manufactured mining equipment containing motors using PCBs imported from France. Note that this use as a "motor oil" should never be interpreted to include automotive motor oils; there is no evidence of automotive use.

4.8 Microscopy

Aroclors 5442 (a polychlorinated terphenyl) and 1260 were favored by microscopists as mounting media, as components of refractive index liquids, and as immersion oils (McCrone 1985). As recently as 2007, EPA has granted exemptions to "process and distribute in commerce PCBs for use as a mounting medium in microscopy, an immersion oil in low fluorescence microscopy and an optical liquid" (USCFR 2007).

4.9 PCBs incorporated into products and materials

Although PCBs were primarily used as fire-resistant safety fluids for electrical equipment and other applications, over the years they were used as ingredients in products for a variety of additional applications, including the general category of applications known as "plasticizer" applications. As environmental concerns over PCBs began to emerge in the late 1960s and early 1970s, Monsanto voluntarily terminated sales of PCBs for plasticizer applications effective August 31, 1970. Although plasticizer manufacturers could have legally manufactured PCB-containing products until July of 1979, when the Toxic Substances Control Act (TSCA) regulations restricting the use of PCBs became effective, it is not likely that PCB-containing plasticized products were manufactured in the USA after the early 1970s.

4.9.1 Plasticizers

PCBs fell in a broad class of additives called plasticizers that increase flexibility and durability of polymers, plastics, and coatings (Cadogan and Howick 2004; Broadhurst 1972; Hubbard 1964). PCBs mixed well with other components to form a homogeneous composition and had other desirable plasticizer properties (ITF 1972). They were used as plasticizers in paints and coatings where chemical resistance was required (Martens 1968). Other coating performance considerations—air permeability, water permeability, surface hardness—all contributed to the choice of plasticizer.

The PCBs were added in a useful range—too low and they were ineffectual, too high and they imparted undesirable properties to the paint. "If underplasticized, the film will be harder but more brittle and its adhesion may be low. If overplasticized, the film will be softer and more thermoplastic, and consequently will suffer more dirt retention. The permeability of the film is also affected" (Davies 1968). "Aroclor 1221 greatly improves flexibility [to epoxy resins]...Aroclors are especially effective as secondary plasticizers or extenders for polyvinyl chloride. Aroclor 1262, used 1:3 with dioctylphthalate, sharply reduces migration to nitrocellulose lacquers. All Aroclor compounds can be used to improve the chemical resistance of vinyl chloride-vinyl acetate coating formulations" (Monsanto advertisement, *Plastics Technology*, December, 1960).

4.9.2 Carbonless copy paper

Carbonless copy paper was commonly known as NCR paper, variously spelled out as "no carbon required" or "National Cash Register" (a major vendor). "...Aroclor 1242 was used as a solvent for dyes which were micro-encapsulated into microspheres 10–20 microns in diameter and applied to one side of the paper during the coating process" (Durfee et al. 1976). Durfee calculated the average weight percent of Aroclor 1242 in carbonless paper was 3.4%. The US Food and Drug Administration noted that carbonless copy paper contains 3–5% PCBs (38 Fed. Reg. 18101).

Paper recycling or secondary fiber recovery converts waste paper into pulp for new paper products. Because of PCB use in NCR paper and possibly other uses, the recycling processes in numerous paper mills diluted the ~3% PCB content in small volumes of NCR paper through much larger volumes of paper to yield trace concentrations in a variety of media. "Past usage of PCBs in paper coatings and adhesives appears likely, although the quantities used could not have been near the magnitude of PCB in the carbonless copy paper" (Durfee et al. 1976).

4.9.3 Printing

PCBs were added to formulations for several applications in printing:

- Pressure sensitive record paper
- Colored copying paper
- Thermographic duplication paper
- Xerographic transfer process paper

PCBs were added to solvent-free printing mixtures for polyolefin surfaces and in plastic printing plates (ITF 1972).

4.9.4 Paints and surface coatings

The use of PCBs in paints was a plasticizer application. PCBs were a component of specialty paints and coatings to improve performance of the paint in industrial and/or military applications, but they were not for residential or interior decorative use. This application fell within the "open-ended applications" discussed above. The PCBs used for plasticizer applications, including those used in paints, were often sold to independent distributors who resold them to the manufacturers of the ultimate product, for which adhesion, chemical resistance, and/or flame resistance were deemed important. Therefore, product names and PCB composition are largely undocumented. Fabulon floor finish contained PCBs in 1957 (Rudel et al. 2008).

PCBs and other plasticizers were added to coatings in prescribed amounts—generally in the 5–20% range (Chittick and Kirkpatrick 1941; Davies 1968; Parker 1967). EPA has noted (USCFR 1999) that during the 1950–1960 time frame, PCBs were added to paint formulations as drying oils (resins) and plasticizers or softening agents (liquids) in concentrations that range from 10–30% PCBs.

PCBs were a component of an epoxy lacquer used to coat polyethylene and other plastic bottles to make them pliant, impervious, and resistant to aromas, acids, and alkalis. PCBs were used as plasticizers in polyorganosiloxanes that were employed in electrical coatings, insulating tapes, and protective lacquers. PCB-plasticized epoxy resin coatings were used in electrical capacitors, ferrite computer magnet cores, resistors, pipes, blocks, and other surfaces (ITF 1972).

Military and other government uses are not well documented; for example, one source noted PCBs in "wiring insulation, paint, gaskets, caulking, plastic and other non-metallic materials in nearly all of over 100 naval vessels sampled and in service prior to 1977" (Lukens and Selberg 2004). The PCB surface and air concentrations were measured on US Navy surface and submarine vessels to estimate possible exposure of crew members and shipyard workers. Aroclors 1242, 1248, 1254, 1260, and 1268 were found. PCB maximum concentrations of 1–7% were measured in felt insulation, paint, rigid foam, cork, rubber, Armaflex, and Arobol (Still et al. 2003). Military, marine and other applications included waterproofing compounds, anti-fouling compounds, and fire-retardant coatings (USCFR 1999).

"Some older Army, municipal and other water supply systems" used PCB-containing "coal-tar enamel coatings for steel water pipe and underground storage tanks (i.e., AWWA C203 coal tar enamel)" (USCFR 1999). Chlorinated rubber coatings with up to 40% Aroclor 1254 were used as metal coatings where resistance to acids, alkalis, oxidation, electrical conductivity, and properties were important. (Davies 1968; Parker 1967).

"Cumar,[6]" a coating used from 1941–70 to ensure proper curing of concrete used in building 5000–6000 grain silos on farms in the Eastern half of the US, contained ~19% Aroclor 1254 and ~5.4% Aroclor 5460 (PCTs). Upon application and evaporation of the carrier solvents, the PCB content rose to ~32.6%. In some cases, the coatings were eroded by the organic acids produced in the fermentation of the silage, leading to contamination of the silage (Willett and Hess 1975; Willett et al. 1985).

4.9.5 Valve grease and sealant

Aroclor 1268 was used in high-pressure gas pipeline valve grease as a ~10% constituent of the grease. "Rockwell made a plug valve sealant (No 860 and 991) that contained PCB Aroclor 1268 sometime prior to the mid-1970s (Woodyard et al. 1993). The PCB sealant or grease was apparently dissolved by transmission pipeline condensate and spread to other downstream locations" (USEPA 2004, Appendix G).

4.9.6 Adhesives

Because there are myriad surfaces to be bonded with a broad range of functions from temporary to permanent, the world of adhesives is quite large. "Almost every thermoplastic resin is used individually or in resin blends as a hot-melt adhesive. This necessitates a wide range of plasticizers [including] the more resinous chlorinated polyphenyls (higher PCB Aroclors and PCT Aroclors)..." (ITF 1972) Patents were issued for the use of PCBs in:

- Laminating adhesive formulations involving polyurethanes and polycarbonates to prepare safety and acoustical glasses.
- Polyarylene sulfides to laminate ceramics and metals
- Ethylene-propylene copolymer blended with PCB has been used in a hot melt adhesive having improved toughness and resistance to oxidative and thermal degradation...
- Washable Wall Coverings and upholstering materials, made from films of polyvinyl chloride, are claimed to be improved by the addition of PCB to the adhesive formulation.
- PCBs can also be applied in the preparation of polyvinyl alcohol adhesive compositions which are used in the manufacture of envelopes, in self-adhering films, and in the preparation of coatings of pressure-rupturable capsules for adhesive tape. (ITF 1972; The text contains citations to patent literature which were removed for clarity).

Cambric tape containing up to 11% Aroclor 1254 or up to 6% Aroclor 1260 was used as a component of high-voltage electrical cables (Cleghorn et al. 1990).

The bulk of the references to the use of PCBs as adhesives are from patents; there is no evidence how many products were ever in commerce or what PCB volumes they represented.

4.9.7 Caulk and joint sealants

PCBs were used in caulks and joint sealants to plasticize the sealant to maintain a flexible seal between two materials to keep out water, moisture, dust, air, sound, and heat/cold. In some cases, PCBs were incorporated into sealants explicitly to improve fire retardancy (ITF 1972). Polymeric putties were plasticized with PCBs and found to be non-hardening, resistant to moisture and frost and show good

[6] Cumar is a trade name for "Coumarone-indene resin. Can be used in adhesives. Exhibits good resistance to alkalis, dilute acids, and moisture." http://www.specialchem4adhesives.com/tds/Cumar-LX-509/Neville/529/index.aspx; http://www.nevchem.com/index.asp?pid=02_00_01&pcat=70&prodID=4050 (websites accessed April 2010). There appear to be multiple formulations and there is no implication here that current Cumar formulations contain PCBs.

weather ability. “Elastic pavement or concrete sealing compositions, used for traffic markings, were prepared from coal-tar-polysulfide mixtures which are plasticized with PCB” (ITF 1972). PCB sealants were used in American (Herrick et al. 2004) and European buildings (Andersson et al. 2004; Balfanz et al. 1993; Benthe et al. 1992; Corner et al. 2002; Coghlan et al. 2002; Fengler 1993; Mengon and Schlatter 1993; Priha et al. 2005) and concrete joints and liners in water reservoirs in the USA (Sykes and Coate 1995).

4.9.8 Insulation and other building materials

PCBs were used in fireproof fiberboards and also panels made from starch which can be used for doors, floors, ceilings, and partitions. However, rigid polyurethane foams and hardboard compositions did not show significant increase in flame retardance upon addition of PCBs (ITF 1972). Armstrong manufactured and sold Travertone Sanserra, Santaglio, and Embossed Design ceiling tiles with 4–12% Aroclor 1254 in the coating in 1969–1970 (MMWR 1987). “Wool felt and foam rubber insulation as well as sound-dampening materials have been discovered in naval vessels and may include ships of all types, as well as nuclear submarine reactor compartments” at concentrations up to 70% (USCFR 1999).

Aroclor 1268 was used in various building materials as a fire retardant, including roofing and siding material known as Galbestos. “The main PCB compound used in Galbestos was Aroclor 1268. This construction material was... manufactured from the 1950s to the 1970s by the H. H. Robertson Company” (Panero et al. 2005; USCFR 1999).

PCBs have been found in electric cable components up to 28%, including plastics, foam rubber, rubber, adhesive tape and insulation. These cables were used in marine and industrial applications (USCFR 1999).

4.9.9 Investment casting

“The investment casting [also termed ‘lost-wax casting’] industry produces precision-cast metal parts and shapes for the aircraft and other machinery manufacturing industries. Approximately 25 of the 135 investment casting foundries in the USA currently use PCB-filled waxes in the manufacture of metal castings. The PCB incorporated in the waxes was decachlorobipheny1 (Fenclor DK or ‘deka’), which was imported from Caffaro S.P.A., Italy. The remaining foundries use either PCT-filled waxes or unfilled waxes” (Durfee et al. 1976).

4.10 PCB applications with no known commercial use

Monsanto manufactured PCBs from 1935–1977, while foreign manufacturers continued for years after. Aroclor fluids and other trade-named products were industrial products. Although some applications were mandated by industrial codes, building codes, military specifications, and other requirements, most were subject to free-market rules: PCBs were sold and used where the perceived cost-benefit ratio outweighed that of competing chemicals. Prior to the discovery of their environmental persistence, PCBs were specialty chemicals offered for sale, and the manufacturers and customers assertively investigated new applications and marketing.

4.10.1 Examples of patented applications

In 1972, ITF (1972) cited these interesting and non-conventional uses:

1. Catalyst carrier for polymerization of olefins.
2. Conversion of water-permeable soil to a non-permeable state. Soil is made non-permeable by applying to the soil a composition consisting of an ethoxylene-based resin, polyamide, camphor, and PCB as plasticizer. The composition has a density greater than water, and it hardens under water. It can be applied to river banks, where it flows down the bank, and after hardening, prevents penetration of water (soil erosion-retardant).
3. Combined insecticide and bactericide formulations. The composition contains aldrin or dieldrin, naphthalene hydrocarbons, malathion, methoxychlor, lindane, chlordane, terpineol, and chlorinated biphenyl as active agents.
4. Inhibitors of microbial growth in enamel clay formulations.
5. Plastic sound insulating materials for railway cars.
6. Plastic (PVC) decorative articles which give the impression of internal scintillation.
7. Increasing the density of carbon plates by impregnation with PCB.
8. Graphite electrodes with low thermal expansion coefficients and high bending strengths.
9. Increasing the coke yield from coal pitch. The coke is very hard, dark, and brilliant.
10. As a metal quencher or tempering agent for steel, alloys, and glass.
11. As an aid to fusion cutting of stacked metallic plates without adherence. The cutting is done with an electric arc or oxy-gas torch (ITF 1972; the text contains citations to patent literature which were removed for clarity).

The original citations in this government report are drawn from international patent literature. There is no indication that any of these “uses” ever saw commercial application.

4.10.2 Pesticide extenders

Some chlorobiphenyls were shown to have insecticidal and fungistatic activity; however, they were apparently never used as pesticides although recommended for incorporation into pesticide formulations.

"PCBs are also reported to increase the insecticidal properties of DDT, lindane, organophosphorous compounds, and carbaryl" (Hutzinger et al. 1974).

Although such uses may have occurred in limited situations, at least one attempt to determine whether that was the case was unsuccessful (Reynolds 1971). In an abundance of caution, however, the USDA canceled all registrations of pesticides containing PCBs in 1970 (USDA 1970).

4.10.3 Textiles

PCBs were reportedly used in various textile coatings. Most of the cited uses are in patents and there is no evidence that any products were ever in commercial applications:

- Ironing board covers—PCBs, cellulose acetobutyrate, and aluminum metal particles mixed.
- Delustering rayon
- Coating polypropylene films with mixture of PCBs, UV light absorbers, and antioxidants stabilize against oxidation by sunlight and weathering.
- Polyimide (nylon-type) yarns were flame proofed when treated with PCBs.
- PCBs were a component of a sealing formulation to waterproof canvas.
- PCB additives retarded flame in polyolefin yarns (ITF 1972; The text contains citations to patent literature which were removed for clarity).

4.10.4 Wax extenders

Aroclors 1242, 1254, and 1268 were used as wax extenders (Durfee et al. 1976; Hutzinger et al. 1974). "Carnauba wax may be extended by blending with chlorinated biphenyl in combination with ceresin and paraffin" (Hubbard 1964). No information is available on amounts used.

4.10.5 Discussion of PCB applications with no known commercial use

The possible incorporation of PCBs in various products is virtually endless. Two major factors prevent documenting other uses: time and quantity.

1. Time. The further back, the fewer records have been retained and are available for recreating the history. In the mid-1970s, when Durfee's report was published, Monsanto had made available production and use records. Monsanto's sales records for different applications only go back to 1957 (Durfee et al. 1976).
2. Quantity. Historic low-volume uses often went unrecorded. Small quantities were often sold through intermediate suppliers and the end-uses were never recorded outside the formulator's records. Some "applications" may have been nothing more than a laboratory batch prepared for test and evaluation.

Over the past four decades, a number of PCB uses have been reported that fall in the category of folklore: there is no evidence of their use and no basis for the assertions, although the applications may have been contemplated by lab scientists or salesmen. In an effort not to propagate unsubstantiated rumors, we do not include folklore here.

5 Conclusions

PCBs were used primarily as electrical insulating fluids in capacitors and transformers and also as hydraulic, heat transfer, and lubricating fluids. PCBs were blended with other chemicals as plasticizers and fire retardants and used in a range of products including caulks, adhesives, plastics, coatings, and carbonless copy paper. In the USA, PCBs were manufactured from 1929–1977, although many products remained in service for decades after their manufacture was terminated.

Capacitors (~50%) and transformers (~25%) were the dominant uses of PCBs. Hydraulic and lubrication fluids made up about 6%. The applications where PCBs were incorporated in other products were all minor: NCR Paper was <4% and the numerous plasticizer applications were about 9%.

This article reviews the historic uses of PCBs and discusses, where possible, the relative sales volumes. Especially with smaller volume, military, and third-party uses, documenting a use and/or differentiating between a legitimate commercial use and an experimental test batch is not possible. A major contribution here is to sort out those reported uses which can be documented from those which cannot. Undocumented uses may include actual minor uses as well as reported applications that are unlikely ever to have been commercialized.

Acknowledgment We wish to thank our wives, Colleen Erickson and Julie Kaley, for giving us the space to pursue this interest. Barbara McKenzie has provided endless research. John H. Craddock has provided extensive insight over the years. We also acknowledge the contributions of the myriad people involved in PCB regulation, research, consulting, remediation, and litigation who make this article timely.

Both authors have consulted for and/or have testified on behalf of various parties in regulatory or litigation matters in which PCBs were at issue. The views expressed in this publication are those of the authors and do not represent the views of, nor endorsement by, our current or former employers. No funding was provided from any source.

References

Anonymous (1966) Report of a New Chemical Hazard. New Sci, 612, December 15

Anonymous (1967) Conservationists have another chemical to worry about. Chem Eng:52, Jan 30

ASTM (1991a) Standard Specifications for Chlorinated Aromatic Hydrocarbons (Askarels) for Capacitors, ANSI/ASTM D 2233–86. In: Annual Book ASTM Standards, Vol.10.03. Amer Soc Test Mater (ASTM), Philadelphia, PA

ASTM (1991b) Standard Specifications for Chlorinated Aromatic Hydrocarbons (Askarels) for Transformers, ANSI/ASTM D 2283–86. In: Annual Book ASTM Standards, Vol.10.03. Amer Soc Test Mater (ASTM), Philadelphia, PA

Andersson M, Ottesen RT, Volden T (2004) Building materials as a source of PCB pollution in Bergen, Norway. Sci Total Environ 325:139–144

ATSDR (2000) Toxicological Profile for PCBs (Update). Agency for Toxic Substances Disease Registry (ATSDR), Washington, DC, November

Balfanz E, Fuchs J, Kieper H (1993) Sampling and analysis of polychlorinated biphenyls (PCB) in indoor air due to permanently elastic sealants. Chemosphere 2:871–880

Ballschmiter K, Zell M (1980) Analysis of polychlorinated biphenyls (PCB) by glass capillary gas chromatography composition of technical Aroclor- and Clophen-PCB mixtures. Fresenius Z Anal Chem 302:20–31, see Erickson (1997) p. 21 for details on errata and refinements to the Ballschmiter numbering system

Ballschmiter K, Bacher R, Mennel A, Fischer R, Riehle U, Swerev M (1992) The determination of chlorinated biphenyls, chlorinated dibenzodioxins, and chlorinated dibenzofurans by GC-MS. J High Resolut Chromatogr 15:260–270

Benthe C, Heinzow B, Jessen H, Mohr S, Rotard W (1992) Polychlorinated biphenyls. Indoor air contamination due to thiokol-rubber sealants in an office building. Chemosphere 25:1481–1486

Bletchly JD (1983) Proceedings of PCB Seminar, The Hague. Neth Org Econ Coop Devel, Paris

Brinkman UATh, De Kok A (1980) Production, properties and usage. In: Kimbrough RD (ed) Halogenated biphenyls, terphenyls, naphthalenes, dibenzodioxins and related products. Elsevier, New York, pp 1–40

Broadhurst MG (1972) Use and replaceability of PCBs. In: PCBs and the Environment, Report No. ITF-PCB-72-1; Accession No. COM-72-10419. Interdep Task Force PCBs, Washington, DC

Cadogan DF, Howick CJ (2004) Plasticizers. In: Kirk-Othmer Encycl Chem Tech. Wiley, New York 30 pp

Chittick MB, Kirkpatrick A (1941) Synthetic hydrocarbon resins—petropols and chlorinated diphenyls, Chapter 30. In: Mattiello JJ (ed) Protective and decorative coatings, vol 1. Raw materials for varnishes and vehicles. Wiley, New York

Cleghorn HP, Caton RB, Groskopf NW (1990) Production of dibenzofuran fumes during splicing of PCB contaminated electrical cable. Chemosphere 20:1517–1524

Coghlan KM, Chang MP, Jessup DS, Fragala MA, McCrillis K, Lockhart TM (2002) Characterization of polychlorinated biphenyls in building materials and exposures in the indoor environment. In: Levin H (ed) Indoor Air 2002:147–152

Corner M, Sundahl M, Rosen L, Ek-Olausson B, Tysklind M (2002) PCB in indoor air and dust in buildings in Stockholm. In: Levin H (ed) Indoor Air, pp141–146

Davies DL (1968) Chlorinated rubber. In: Martens CR (ed) Technology of paints, varnishes and lacquers. Reinhold, New York

Durfee, R L, Contos G, Whitmore FC, Barden JD, Hackman EE III, Westin RA (1976) PCBs in the United States - industrial use and environmental distributions, Report No. EPA 560/6-76-005 (NTIS No. PB-252 012). US Environ Prot Agency, Washington, DC

EPRI (Electr Power Res Inst) (1999) The PCB information manual: production, uses, characteristics, and toxicity of PCBs. TR-114091-Vl. Electr Power Res Inst, Palo Alto, CA

Erickson MD (1997) Analytical chemistry of PCBs, 2nd edn. CRC, Boca Raton

Erickson MD (2001) PCB properties, uses, occurrence, and regulatory history. In: Robertson LW, Hansen LG (eds) PCBs-recent advances in the environmental toxicology and health effects of PCBs. University Press of Kentucky, Lexington, pp xi–xxx

Fengler K (1993) Remediation of PCB contaminated buildings. Tech Mitt 86(3):142–147

Hammond PB, Nisbet ICT, Sarofim AF, Drury WH, Nelson N (1972) PCBs-environmental impact. Environ Res 5:249–362

Hatton RE (1964) Phosphate Esters. In: Gunderson RC, Hart AW (eds) Synthetic Lubricants. Reinhold, New York, pp 103–150

Herrick RF, McClean MD, Meeker JD, Baxter LK, Weymouth GA (2004) An Unrecognized source of PCB contamination in schools and other buildings. Environ Health Perspect 112:1051–1053

Hubbard HL (1964) Chlorinated biphenyl and related compounds. In: Kirk-Othmer Encycl Chem Tech 5:289–297

Hutzinger O, Safe S, Zitko V (1974) The chemistry of PCB's. CRC, Cleveland

ITF (1972) PCBs and the environment, Report No. ITF-PCB-72-1; Accession No. COM-72-10419. Interdep Task Force PCBs (ITF), Washington, DC

Jensen S (1972) The PCB story. Ambio 1(4):123–131

Johnson GW, Quensen JF III, Chiarenzelli JR, Hamilton MC (2006) Polychlorinated biphenyls. In: Morrison RD, Murphy BL (eds) Environ forensics contaminant specific guide. Elsevier, New York, pp 187–225

Kunita N, Kashimoto T, Miyata H, Fukushima S, Hori S, Obana H (1984) Causal agents of Yusho. Ame J Ind Med 5:45–58

Lukens R, Selberg C (2004) Guidelines for marine artificial reef materials, 2nd ed. Artificial reef subcommittees of the Atlantic and gulf states marine fisheries commissions, a joint publication of the gulf and Atlantic states marine fisheries commissions, Number 121

Martens CR (ed) (1968) Technology of paints, varnishes, and lacquers. Reinhold, New York

McCrone WC (1985) Use of Aroclors in microscopy. Amer Lab, 16–31, Dec

Mengon W, Schlatter C (1993) Polychlorinated biphenyl (PCB) from elastic sealing compounds in Swiss indoor air. Mitt Geb Lebensmunters Hyg 84:250–263

MMWR (1987) Epidemiologic notes and reports PCB contamination of ceiling tiles in public buildings-NJ. Morb Mortal Wkly Rep (MMWR) 36(6):89–91

Monsanto (2004) Material safety data: Polychlorinated Biphenyls (PCBs). St. Louis, MO

Panero M, Boehme S, Muñoz G (2005) Pollution prevention and management strategies for polychlorinated biphenyls in the NY/NJ harbor. NY Acad Sci, New York

Parker HE (1967) Chlorinated rubber, Chapter 5. In: Myers RR, Long JS (eds) Film-forming compositions, vol. 1, part 1. Dekker, New York

Penning C (1930) Physical characteristics and commercial possibilities of chlorinated diphenyl. Ind Eng Chem 22:1180–1182

Priha E, Hellman S, Sorvari J (2005) PCB contamination from polysulphide sealants in residential areas—exposure and risk assessment. Chemosphere 59:537–543

Reynolds LM (1971) Pesticide Residue Analysis in the presence of polychlorinated biphenyls (PCB'S). Residue Rev 34:27–57

Risebrough RW, Reiche P, Peakall DB, Herman SG, Kirven MN (1968) Polychlorinated biphenyls in the global ecosystem. Nature 220:1098–1102

Rudel RA, Seryak LM, Brody JG (2008) PCB-containing wood floor finish is a likely source of elevated PCBs in residents' blood, household air and dust: a case study of exposure. Environ Health 7:2. doi:10.1186/1476-069X-7-2

Schmidt H, Schultz G (1881) Uber Benzidin (alpha-Diamidodiphenyl) p. 338, in Schultz G, uber Diphenylbasen. Ann Chemie 207:311–368

Still KR, Arfsten DP, Jederberg WW, Kane LV, Larcom BJ (2003) Estimation of the health risks associated with polychlorinated biphenyl (PCB) concentrations found onboard older US Navy vessels. Appl Occup Environ Hyg 18:737–758

Sykes RG, Coate AR (1995) PCBs in sealants in water distribution reservoirs. J Am Water Works Assoc 87(4):96–100

USCFR US Code of Federal Regulations (1999) 40 CFR Part 761 Use authorization for, and distribution in commerce of non-liquid polychlorinated biphenyls; notice of availability; partial reopening of comment period; proposed rule. Federal Register: (Volume 64, Number 237) Page 69358 et seq Citation at p. 69360, December 10

USCFR US Code of Federal Regulations (2007) 40 CFR Ch. I (7–1–07 Edition) § 761.80 p. 712

USDA (1970) PR Notice 70–25 Elimination of polychlorinated biphenyls and polychlorinated terphenyls from economic poisons, October 29, 1979. US Dep Agric, Washington, DC

USEPA (2004) Polychlorinated biphenyl inspection manual, EPA-305-X-04-002. US Environ Prot Agency (USEPA), Washington, DC http://www.epa.gov/compliance/resources/publications/monitoring/manuals.html. Accessed April 2010

USEPA (2010) Aroclor and other PCB mixtures. US Environ Prot Agency (USEPA), Washington, DC http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/aroclor.htm. Accessed April 2010

Van den Berg M et al (2006) The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Tox Sci 93(2):223–241

Westin R, Woodcock B (1979) PCB manufacturing, processing, distribution in commerce, and use ban regulations: economic impact analysis, Report No. EPA 230-03/79-001. US Environ Prot Agency, Washington, DC

WHO (1978) IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: polychlorinated biphenyls and polybrominated biphenyls, vol 18. Int Agency Res Cancer, Lyon

WHO (1993) Polychlorinated biphenyls and terphenyls. In: Dobson S, van Esch GJ (eds) Environ Heal Criteria 140, 2nd edn. World Health Organization (WHO), Geneva

Willett LB, Hess JF Jr (1975) Polychlorinated biphenyl residues in silos in the United States. Residue Rev 55:135–147

Willett LB, Liu T-TY, Durst HI, Cardwell BD, Renkie ED (1985) Quantification and distribution of polychlorinated biphenyls in farm silos. Bull Environ Contam Toxicol 35:51–60

Woodyard J, Linz DG, Geer EC (1993) Prediction and control of PCB migration. In: Proceedings: PCB Forum, 5th International Conference for the Remediation of PCB Contamination, Houston, TX

EXHIBIT 11

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

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TOWN OF WESTPORT, and        )
WESTPORT COMMUNITY SCHOOLS,  )
                             )
              Plaintiffs,    ) Civil Action No.
                             ) 1:14-CV-12041-DJC
         vs.                 )
                             )
MONSANTO COMPANY,            )
SOLUTIA INC., and            )
PHARMACIA CORPORATION,       )
                             )
              Defendants.    )
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VIDEOTAPED DEPOSITION OF
JACK VINCENT MATSON, P.E.
State College, Pennsylvania
Friday, September 9, 2016

Reported by:
Stacey L. Daywalt
JOB NO. 111873

J. MATSON, P.E.

Q. Why do you say "hopefully not"?
A. I may have been contaminated.
Q. Oh. Or you may have some special knowledge about the manufacture of polymers. Right?
A. Possibly.
Q. That sort of knowledge you don't have now, do you?
MR. LAND: Objection, vague, ambiguous.
Q. Well, let me rephrase the question.
A. Okay.
Q. Sir, were you ever a formulator?
A. No.
Q. A formulator is somebody who comes up with the recipe for a plastic. Right?
A. Yes.
Q. And that formulator is usually a fairly sophisticated chemist, engineer or scientist of some kind. Right?
A. Depends on the company.
Q. Well, if we're talking about, say, Thiokol, Thiokol is a pretty -- or was a pretty sophisticated company, was it not?

J. MATSON, P.E.

I gave them back their feedback.

Q. What feedback did you give them?

A. I'm under nondisclosure on that.

Q. Oh. Well, did you change their formula?

I'm not asking for the formula.

Companies, by the way, don't like their formulas disclosed, do they, in public? They're proprietary. Right?

A. Well, this company had a new one and it was in the process of being patented.

And no, they did not want me to disclose it.

Q. And that's not unusual for fabricators of plastic products.

They don't want their formulas out in the public, do they?

A. You know, it's -- whether they want their formulas in public or not, other companies can find out. It's not -- it's --

Q. That wasn't my question, and you know that wasn't my question.

My question is: Generally speaking, companies that have proprietary formulas don't want that to become public information. Right?

MR. LAND: Objection --

Q. Yes or no?

MR. LAND: -- misleading, calls for speculation.

THE WITNESS: If you're saying public information, third person on the street, no.

Q. They don't want their competitors to get that information. Correct?

A. In my experience, they don't.

But competitors could reverse engineer and find out what it is.

Q. Manufacturers of plastic products often take years to develop products that they think distinguish their products from their competitors. Correct?

A. Yes.

Q. And it could be the slightest alteration of a chemical formula. Correct?

A. Well, hypothetically it could be.

Q. And those companies zealously guard their formulas from their competitors. Correct?

J. MATSON, P.E.

MR. LAND: Objection, vague, misleading, calls for speculation.

THE WITNESS: Well, what -- yes and no.

Yes, they would like to zealously guard, but the reality is that other companies can find out what they're doing.

Q. Tell me all of your experience in working the plastics industry, that is to say, my name is Jack Matson, and I am employed in the plastics industry.

What are we talking about? What years? For whom?

MR. LAND: Objection, vague, compound.

THE WITNESS: You want me just to repeat what I've already said or add more to it?

Q. No, I want an answer to my question.

MR. LAND: Objection, vague, compound, unclear.

THE WITNESS: Okay. Let's go back to the period 1968 to 1970.

Q. Okay.

J. MATSON, P.E.

A. Well, I need to hear that question again.

Q. Can you name one scientific article that documented injury to people due to exposure to environmental, as opposed to occupational, environmental levels of PCBs?

MR. LAND: Same objections.

THE WITNESS: Well, there's a multitude of ways to address your question.

Q. I'm looking for the name of a scientific article, lead author. Then we can go from there.

A. The science wasn't at that point at that time.

Q. Can you name a scientific article that documented injury to human beings due to exposure to environmental levels of PCBs prior to 1970? Yes or no?

A. No, because the science wasn't there yet.

Q. Can you name --

A. It was getting there.

Q. Can you name -- let me ask you this: What is the first scientific article that

J. MATSON, P.E.

of it, it doesn't necessarily mean that the dose is sufficient to cross a threshold such that it will be an adverse effect. Correct?

A. Yes.

Q. Now, PCBs were industrial chemicals, were they not?

A. Well, they were used for more than just industrial chemicals.

Q. Well, they were manufactured by Monsanto and sold to companies that incorporated them into other products. Right?

A. Yes.

Q. And those products were primarily electrical equipment, were they not?

MR. LAND: Objection, lacks foundation, calls for speculation.

THE WITNESS: Yes.

Q. And closed or semiclosed system like heat transfer and hydraulic systems. Correct?

MR. LAND: Objection, calls for speculation, lacks foundation.

THE WITNESS: Yes.

Q. And the primary attribute for those applications of PCBs was that they were not

J. MATSON, P.E.

nonflammable. Correct?

MR. LAND: Objection, lacks foundation, calls for speculation.

THE WITNESS: That was one element.

Q. It was a major element, wasn't it?

A. It was a major element, yes.

Q. In fact, fire codes around the country required PCBs to be used in electrical equipment under certain circumstances. Correct?

MR. LAND: Objection, lacks foundation, calls for speculation.

THE WITNESS: Yes.

Q. And of the PCBs manufactured by Monsanto, about 80 or over 85 percent of those PCBs were devoted to those fire safety fluids. Correct?

MR. LAND: Objection, lacks foundation, calls for speculation.

THE WITNESS: Well, there's data.

I don't know the truthfulness of that statement. I thought it's more like 60 percent.

Q. Well, if the United States

J. MATSON, P.E.

Q. Was it --

A. The EPA had no independent way to know.

Q. Was it an EPA document, the document you're referring to?

A. My recollection is that it was Nesbit in '72.

Q. Nesbit is not EPA, is it?

A. No, but he was involved in the interdepartmental task force report, and I believe that it's around the same time.

Q. Sir, am I correct that with respect to the electrical uses, Monsanto's primary customers were large corporations like General Electric and Westinghouse?

A. And Kuhlman and others, yes.

Q. And you would agree with me that those companies had large and sophisticated staffs of scientists and engineers themselves. Correct?

MR. LAND: Objection, lacks foundation, calls for speculation.

THE WITNESS: Yes.

Q. Another aspect of Monsanto's PCB

second. No, those went by another name.

Q. Sir, am I correct that with respect to the companies who purchased PCBs as plasticizers -- those companies include Thiokol, among others -- those companies had large and sophisticated staffs of scientists and engineers, did they not?

MR. LAND: Objection, compound, misleading.

THE WITNESS: Well, I think we've covered that ground.

Yes, on Thiokol.

Q. And it is the formulator who purchases the PCBs who decides what's in that formula, what the recipe is. Correct?

MR. LAND: Objection, lacks foundation, calls for speculation, misleading.

THE WITNESS: They ultimately decide.

Q. And many of these plastic products -- let's take caulk, for example -- can include over a dozen ingredients. Right?

MR. LAND: Objection, lacks foundation, calls for speculation.

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have been weeks, months, years to get the concentrations of PCBs in the test chambers that he wanted?

MR. LAND: Same objections.

THE WITNESS: I can't give you a number because it depends on the facilities he would have had to be made available to do it.

Q. Sir, would you agree with me that PCBs that are contained in some matrix such as caulk or paint will not -- will more slowly volatilize than PCBs that are existing in pure form?

A. Yes.

Q. When was the first time somebody tested a caulk containing PCBs to determine whether PCBs volatilized?

MR. LAND: Objection, calls for speculation, lacks foundation.

THE WITNESS: Well, in terms of the literature from my look at it, it was in the early 2000s.

Q. Early 2000s? And who did that?

A. Could have been earlier, but I saw some papers.

J. MATSON, P.E.

scientific literature that measured PCB levels in PCB plants, aren't you?

A. Yes.

Q. And those levels were very high, weren't they?

A. Yes.

Q. Do you know of any building, such as a schoolroom, any building that has ever had PCBs measured at levels found in PCB plants?

A. I have not seen any, no.

Q. Are you aware of any scientific literature that purports to demonstrate adverse health effects from PCBs volatilizing from building products containing PCBs?

MR. LAND: Misleading.

THE WITNESS: Not scientific literature.

But it was an issue with Monsanto in the mid-1950s because paints they were using exceeded the hygiene limits, and they had to decide basically to discontinue for public use those paints.

Q. That wasn't my question.

Are you aware of any scientific

and secondly, the vapor pressure.
Q. Are there any other factors that a formulator would evaluate in its selection of a plasticizer other than vapor pressure and compatibility?
A. Cost.
Q. Anything else?
A. Whether it was harmful for its workers.
Q. Toxicity?
A. Yeah.
Q. Anything else?
A. I think those are the major factors.
Q. Now, the volatility of the plasticizer would be important for what reason?
A. Longevity of the plasticizer.
Q. The durability of the product, you mean?
A. Yes. It's -- yeah.
Q. If the plasticizer were to volatilize, the product may lose its functionality. Correct?
A. If too much of it did, yes.
Q. Yeah. Was there anything about

J. MATSON, P.E.

PCBs' volatility that was, or would have been, attractive to a formulator?

A. Yes, a very low or insignificant volatility.

Q. And why would that have been important?

A. Because in general the less that escapes, the longer the life.

Q. In your report, in the body of your report and then in a completely different appendix, C, I think it was, you go on at some length about some discrepancy in calculations -- extrapolations of Aroclor 1254 vapor pressure as between a single study done by SRI and other published data. Correct?

A. Yes.

Q. And are you aware of any caulk or paint manufacturer who selected PCBs as a plasticizer for its products -- let me start again.

Are you aware of any caulk or paint manufacturer who would not have chosen to use Aroclor 1254 if they were apprised of SRI's extrapolation as opposed to the data in

Monsanto's technical bulletins?

MR. LAND: Objection, lacks foundation, calls for speculation, incomplete hypothetical and misleading.

THE WITNESS: Well, we have a section on that in terms when these manufacturers were dealing with double-paned windows, and they were getting fogging and other problems associated with it and seeing that it had a significant vapor pressure that surprised them.

Q. Sir, are you aware of any manufacturer in the 1950s who would have not used Aroclor 1254 as a plasticizer had they been made aware of SRI's extrapolation as opposed to the data presented in Monsanto's technical bulletins?

MR. LAND: Same objections and asked and answered.

THE WITNESS: I think that's an unanswerable question; that certainly the fact that they had the wrong number and it was off by an order of magnitude may have. It's --

Q. You just don't know, do you?

MR. LAND: Objection, misleading.

THE WITNESS: Well, since vapor pressure was important and Monsanto had a table and a chart and basically inaccurately used the incorrect vapor pressure for 1254, which was the major product, PCB product, that went into plasticizers, that that may have had an influence.

Q. You just don't know though, do you?

MR. LAND: Misleading.

THE WITNESS: Well, we can't reconstruct what was in the minds of plasticizer purchasers back in 1950s.

Q. How about 1960s? Same answer?

A. 1960?

Q. 60s.

Same answer?

MR. LAND: Same objection.

THE WITNESS: Well, I told you in the 1960s there -- in '67/'68, there was a concern for the high vapor pressure of PCBs, and companies were asking for alternatives to 1254.

You want me to locate that in the

pressure of substances?

MR. LAND: Objection, mischaracterization of prior testimony and misleading.

THE WITNESS: Not that I can recall at this time.

MR. LAND: It's been about an hour.

Is this a good time for a break, final break?

MR. GOUTMAN: Sure.

THE VIDEOGRAPHER: Time is 4:44. We're off the record.

(Recess was taken from 4:44 p.m. to 4:55 p.m.)

THE VIDEOGRAPHER: Time is 4:55. We're on the record.

BY MR. GOUTMAN:

Q. Doctor, it has been common knowledge in science and industry for most of the 20th century, correct, that plasticizers used in plastics will volatilize? Correct?

A. To some degree they all do, yes.

Q. And certainly the PRCs and Thiokols of the world were aware of that. Correct?

J. MATSON, P.E.

MR. LAND: Objection, speculation.

THE WITNESS: I assume that they were.

Q. In 1969, Monsanto convened an ad hoc committee, correct, on Aroclor?

A. Yes, they did.

Q. And this followed the publication by a scientist by the name of Riseborough in late 1968 raising the question of whether PCBs were hurting wildlife. Correct?

A. Yes.

Q. And you were not aware of anything published in the peer reviewed literature that suggested that PCBs might be hurting wildlife until Dr. Riseborough's publication. Right?

MR. LAND: Objection, misleading.

THE WITNESS: Yes.

Q. And Dr. Riseborough in particular raised concerns about whether PCBs were hurting peregrine falcons. Right?

A. Yes.

Q. Am I not correct that subsequent literature on that issue has attributed the damage to peregrine falcons, eggshell thinning profitable -- that stopped selling a profitable product because of its potential environmental impact --

MR. LAND: Objection, asked and answered.

Q. -- before 1970. Correct?

MR. LAND: And misleading.

THE WITNESS: Well, I think the radium business was terminated because of environmental impact.

Q. Anything else?

A. Well, that's all I can think of right now.

Q. Going back to plasticizers -- I have to find it here -- would you agree with me that there are a number of factors that would affect the volatilization of plasticizers from the matrix that it's in?

MR. LAND: Objection, vague, ambiguous.

THE WITNESS: Yes.

Q. One of them would be what the matrix is, that is, paint versus caulk. Right?

A. Yes.

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Q. One of them would be the other ingredients within the matrix. Is that correct?

A. Yes.

Q. One of them would be the thickness of the product. Right?

A. Yes.

Q. One of them would be the amount of the plasticizer in the product?

A. Yes.

Q. One of them would be the air temperature in which the product is sitting. Correct?

A. Yes.

Q. One of them would be the surface temperature on which the product is sitting?

A. Yes.

Q. One of them would be, in terms of the extent of collection of the volatilized molecules, the air exchanger ventilation?

A. Yes.

Q. Another factor would be the manner in which the product is applied, that is to say whether it's aerosolized or brushed on or shot

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through a caulk gun. Right?

A. It can be, yes.

Q. One of them would be whether the product has cured or dried. Right?

A. Yes.

Q. Once it's cured or dried, one would expect volatilization to decrease. Correct?

A. Well, depending --

MR. LAND: Objection, misleading.

THE WITNESS: -- depending on how much curing occurred or drying, yes.

But that's not the -- the purpose of a plasticizer is to have a consistency such that it's -- it doesn't dry much over time.

Q. I'm sorry? What did you say?

A. A value of a good plasticizer is it doesn't dry much over time because it's got to maintain its elasticity.

Q. It has to stay put basically?

A. Well, it -- not just stay put, which is true. But in the expansion and contraction of the joints, it has to be able to maintain its integrity.

Q. Monsanto -- well, I think we've

you're not aware of any scientific studies that have demonstrated or purported to demonstrate that PCBs in building air cause adverse human health effects. Right?

MR. LAND: Objection, asked and answered, misleading.

THE WITNESS: Well, I previously answered that EPA has set guidelines based on scientific work. And that's an area that Olson is expert in.

Q. Could you answer my question?

You can't name for me any scientific studies in the peer reviewed literature that purport to demonstrate that PCBs in ambient air cause human health problems?

A. That wasn't --

MR. LAND: Objection, asked and answered.

THE WITNESS: That wasn't the area that I was to opine on. So no.

Q. I'd like to go back to some of the alternative plasticizers that you mentioned.

Have you evaluated those plasticizers in terms of -- I think we've

J. MATSON, P.E.

Thermal stability was not an important factor in caulk, and so I don't think that's a question that was, you know, important in that respect.

Q. Am I correct, sir, that there were in fact numerous other factors that formulators would consider other than the ones that you mentioned?

Specifically, would they consider ease of coding and whether it would promote ease of coding?

A. Sure.

Q. Would they consider its drying characteristics?

A. That would be another consideration, yes.

Q. Would they consider whether it increased adhesion?

A. Yes.

Q. Would they consider whether it protected against corrosion?

A. If that was the application that involved corrosive materials, yes.

Q. Would they also consider, depending

upon whether it was an electrical application and whether -- its electrical insulation characteristics?

A. Certainly.

Q. Would they consider resistance to heat and flame?

A. Heat and what?

Q. Flame.

A. Flame. Resistance to heat and flame.

Well, in those circumstances where that's important, they would.

Q. Certainly in industrial settings it may well be important. Correct?

A. Well, it depends on the industrial settings. But if there was a risk, certainly they would consider it.

Q. Would they consider resistance to chemicals?

MR. LAND: Objection, vague.

THE WITNESS: Again, depends on the situation, whether there's the kind of chemicals that would affect caulk.

Q. Would they consider resistance to

water, depending upon whether the application involved exposure to moisture?

A. Certainly.

Q. Would they consider resistance to sunlight?

A. Yes, for sure.

Q. Would they consider resistance to mold?

A. Yes.

Q. Would they consider resistance to mildew?

A. If that's the application, yes.

Q. Would they consider resistance to fungus?

A. If that's the application, yes.

Q. Would you agree with me that the selection of plasticizers can be an enormously complex wing of all of these various factors?

MR. LAND: Objection, vague, ambiguous, misleading.

Q. Again, depending upon the application.

A. Depending on the application and the market, it can be complex or simple.

EXHIBIT 12

Monsanto

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

Feb 1970
(Feb 27, '70 MAILING)

Dear Customer

Dear Customer:

Recently several newspaper and magazine articles have been published indicating that Polychlorinated Biphenyls (PCBs) have been discovered at some points in some marine, aquatic and wildlife environments. The quantities detected are said to be in the parts per million and parts per billion categories.

It is claimed that the PCBs found strongly resemble chlorinated biphenyls containing 54% and 60% chlorine by weight. Products which are sold by Monsanto under the tradenames of Aroclor® 1254 and 1260 contain chlorinated biphenyls.

As your supplier of Aroclor® 1254 and 1260, we wish to alert you to the potential problem of environmental contamination as referred to in the newspaper and magazine articles.

We would like to point out the following additional facts.

1. Certain Monsanto products which are sold under the Aroclor® trademark, namely Aroclor® 5060, 5442 and 5460, are not polychlorinated biphenyls.

2. PCBs with a chlorine content of less than 54% have not been found in the environment and appear to present no potential problem to the environment.

EXHIBIT 54
WIT: Kaley
DATE: 4-4-14
C. Campbell, RPR CRR CSR #13921

We feel that all possible care should be taken in the application, processing and effluent disposal of these products to prevent them becoming environmental contaminants. Of interest to you may be an article in Chemical Week, October 29, 1969 regarding water pollution standards set by each state in the Union. It is attached. This article reflects the view that good manufacturing practice in the future may require that no products used by any company be lost or discharged in such a manner as to ultimately be found in waterways.

Very truly yours,

W. E. Schalk

W. E. Schalk
Director of Sales
Plasticizers

ek

CHEMICAL WEEK / OCTOBER 29, 1969

Environment

The huge water requirements of the chemical industry—now the nation's third largest user—make water quality and availability increasingly important factors for site selectors. Legislation enacted in recent years has forced planners to pay close attention to pollution control standards.

All 50 states have had their water quality standards approved entirely or in part by the Federal Water Pollution Control Administration (FWPCA). Recently a state-by-state summary of key standards was put together for the first time. Surprisingly, it was not the FWPCA that did the job. Instead it was handled by an American Public Health Assn. (APHA) subcommittee headed by TVA Health Director F. E. Gartrell, assisted by the APHA Engineering and Sanitation Section. A portion of the study, covering standards for surface industrial water, is summarized in the tables starting on p. 80.

Contrary to widely held opinions, there is considerable variation in state standards. Take the dissolved oxygen (DO) standard, for example. Minimum allowable DO (as milligrams per liter or percent saturation) is the single most important standard to chemical site evaluators. As a rough rule of thumb, a 2-mg./l. standard is considered to be one industry can live with comfortably, while a 6.0 mg./l. value is pegged "extremely tough."

California, Wyoming and Washington have set the standard at 6 mg./l. or higher. But a few states such as Connecticut, Maine, Illinois, Indiana, Massachusetts, Virginia and Wisconsin require 2 mg./l. or lower.

Other standards—notably turbidity, taste, odor, color and solids—may also be important, depending upon the nature of the chemical plant's waste effluents. These standards also exhibit state-by-state differences. Moreover, they are generally less specific than the straight numerical DO standards.

Although chemical plant site experts see little point in "running from tough standards," the criteria do make a difference: Plans for two nonferrous metals plants in Puerto Rico are now on the shelf, because of standards that call for a 4.5 mg./l. DO, no wastes that interfere with the esthetics of the waters and other specifications.

No compilation of ground water standards has yet been published. Ground water standards may prove important in the future as companies are forced to use costly deep-well disposal for wastes. Availability of ocean waste disposal services is also looming more important.

Waste Cost.: The price tag for pollution control is high. A recent FWPCA study on the organic chemicals industry estimated that water waste-treatment facilities can increase installed capital equipment costs 40% or more. Between '69-'73, the organic chemical industry would have to shell out $182.5 million to remove 10% of its biological and chemical oxygen demand waste and 65% of its suspended solids. Removal levels of 83%, 13% and 71%, respectively, for biologic oxygen demand, chemical oxygen demand and suspended solids would require $242.6 million, while 98%, 30% and 89%, respectively, would up the ante to $608 million.

Cleaner Air: Establishment of air quality standards is not nearly as far advanced as are water standards. The National Air Pollution Control Administration (NAPCA) is still designating regional air control regions. At last count, 16 regions had been formally designated and another 41 had been proposed. NAPCA has issued air quality criteria and control technology data for sulfur oxides and particulate matter, will follow with similar studies for other pollutants.

Once criteria and control data have been issued for a pollutant and control regions have been designated, a comp[illegible] process involving standards, hearings and implementation and enforcement plans will be initiated that can take over a year to produce standards.

So far, no firm sulfur oxide or particulate standards have emerged. But NAPCA's criteria for setting the standards suggest they'll be tough. The oxide criteria report, for example, emphasizes that there are deleterious effects to man at concentrations as low as 0.04 ppm.

NAPCA's control data reports present detailed appraisals of various methods and equipment, along with estimated costs. As in the case of water, the costs will be high, although some pollutants—mainly sulfur dioxide—will have recovery values. NAPCA is sponsoring a number of research projects to improve technology. Pollution control is being spurred by financial assistance programs (mandated by state law) now operative in the following 28 states:

Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Maine, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington, Wisconsin and West Virginia.

In addition, Pennsylvania offers financial aid sanctioned by administrative regulation. Several states, including Utah and Maryland have legislative studies under way.

The incentives take a variety of forms. Most common are exemption from personal property taxes (e.g., Arkansas), fast depreciation (Arizona), exemption from ad valorem equipment and structures taxes (Connecticut), exemption from local taxes for stated period of time (New Hampshire), operating loss deductions (New York); credit against state income tax (Oregon).

Quantity: The large chemical complexes now in vogue make water—and lots of it—a major site criterion. The cooler the water is, the better, for it can reduce the investment in heat-exchange equipment. Occasionally, plants can manage on ground water, but usually surface water is required. That means location on or near the big, drought-resistant rivers. There are less than 200 rivers in the U.S. with minimum flows over 50 cu. ft. per second *(CW Oct. 5, '68, pp. 94-95)*. For companies whose plant needs at least 100 cu. ft/second, the list numbers only 150 (excluding Alaska). Sea water is generally avoided because of high equipment corrosion costs.

Piping water in is expensive. Duval, now opening a 1.5 million tons/year sulfur mine in the arid Northwest area, was forced to install a 36-in., 38-mile-long water line and a 40-million-gal. reservoir. Cost of the water supply system hasn't been disclosed, but it is estimated that the tab was at least several million dollars.

The adequacy of domestic water resources in the year 2000 has recently been evaluated by the Geological Survey. Nationally, projected demand will be 173% of potentially assured supply. Only in three regions, New England, Ohio, and the South Atlantic Eastern Gulf, will future water requirements be easily met. Economic growth may be handicapped in nine regions: Eastern Great Lakes, Lower Mississippi, Upper Missouri-Hudson Bay, Lower Missouri, Western Gulf–Rio Grande, Pecos, Colorado, Great Basin, and Central and South Pacific.

For the first time, a summary of water quality standards set by all 50 states.

State	pH Range	pH Allowable Deviation	Temperature (°F) allowable: Maximum	Temperature (°F) allowable: Increase above ambient	Dissolved oxygen (minimum, mg./l. or %)	Other Requirements
Alabama	6.0–8.5	1.0	90° (24 hrs.) 93° (any 8 hrs.) 93° (cooling water)	10% — 10°	2.0 at 5 ft. or middepth if less than 10 ft.	Radioactivity, Color, Taste and Odor, Toxic Substances: Only in amounts that would not render waters unsuitable for industrial-cooling and process-water supply purposes. Solids: Free from waste materials that cause unsightly or putrescent conditions or interfere directly or indirectly with industrial use.
Alaska	7.0–8.0	0.5	70°	—	5.0	Radioactivity: Not to exceed limits of PHS Drinking Water Standards. Turbidity: No imposed values that would interfere with established levels of treatment. Color: True color less than 50 color units. Taste and Odor: Shall not unreasonably impair esthetic considerations. Solids: No dissolved solids above natural conditions causing corrosion or scaling problems. No visible evidence of other floating solids or sludge deposits. No imposed sediment loads that would interfere with established treatment levels.* Toxic Substances: Chemical constituents should be below concentrations found to be of public health significance.*
Arizona	6.5–8.6	0.5	93°	5°	—	Radioactivity: Not to exceed 1/30 of the MPC_w value given for continuous occupational exposure in NBS Handbook 69. Turbidity: 50 JCU (streams); 25 JCU (lakes). Color: Free from waste materials in amounts sufficient to change existing color enough to interfere with industrial use or to create a nuisance. Taste and Odor: Free from wastes in amounts sufficient to produce enough taste and odor to create a nuisance or interfere with industrial use. Solids: Free from wastes that would be unsightly, putrescent, odorous or in amounts that would interfere with industrial use. Toxic Substances: Free from wastes toxic to human, animal, plant or aquatic life or in amounts that would interfere with industrial use.
Arkansas	6.0–9.0	1.0 (24 hrs.)	95°	5°	4.0 (average for any cross section)	Radioactivity: "Rules and Regulations for the Control of Ionizing Radiation," Arkansas Board of Health, apply. Turbidity: No distinctly visible increases due to wastes. Color: Shall not be increased to the extent that it interferes with industrial use, present or future. Taste and Odor: Must not cause offensive odors or otherwise interfere with industrial use. Solids: No distinctly visible persistent solids, bottom deposits or sludge banks due to wastes. Toxic Substances: Must not be present in amounts toxic to human, animal, plant or aquatic life.
California	6.5–8.6 7.0–8.6 (Coastal waters)	—	71.6°* (fresh water)	None that would cause ecological change or harm aquatic life (coastal waters)*	6.0 Coastal water: 5.0 (unless naturally lower)	Radioactivity: Shall not exceed 1/10 of the MPC_w values given for continuous occupational exposure in NBS Handbook 69. Turbidity: Free from wastes that could alter water's existing turbidity. Color: Free from substances attributable to wastes that produce detrimental color. Taste and Odor: No substances that impart foreign taste or odor. Solids: Dissolved solids in fresh water must not exceed 300 mg./1. at any time; annual mean: 175 mg./1. Settleable solids must not be able to change nature of stream bottom or harm aquatic environment. Toxic Substances: At all times free from concentrations harmful to humans, aquatic life or wild or domestic animals.
Colorado	5.0–9.0	—	93°	—	3.0	Radioactivity: Not to exceed 1/30 of the 168-hr.-week values in NBS Handbook 69. Turbidity: Must not interfere with established levels of treatment. Color: Wastes present must not cause appreciable change in color or interfere with industrial use. Taste and Odor: Free from wastes that cause odor or appreciable change in taste. Solids: Free from wastes that are unsightly, putrescent or odorous or would interfere with use. Toxic Substances: Free from wastes in concentrations or combinations sufficient to harm human or animal life.
Connecticut	6.0–9.0	—	—	None unless it does not exceed recommended limits for industrial use	2.0	Radioactivity: Limits to be approved by appropriate state agency. Turbidity, Color, Taste and Odor: None in such quantities that would impair industrial use. Solids: Limited to small amounts that may result from discharge of appropriately treated wastes. Toxic Substances: Free from chemical constituents in concentrations or combinations harmful to human, animal or aquatic life.
Delaware	6.5–8.5	—	—	5°	50%* or 4.0	Radioactivity: Alpha emitters limited to 3 pc/1.; beta emitters, to 1,000 pc/1. Color, Taste and Odor: None in concentrations that cause color, taste or odor. Solids: Free from unsightly and malodorous nuisances due to floating solids or sludge deposits. Toxic Substances: None in concentrations harmful (synergistically or otherwise) to humans, fish, shellfish, wildlife or aquatic life.
Florida	6.0–8.5	1.0	—	—	4.0	Radiation: Gross beta—1,000 pc/1. (in absence of Sr-90 and alpha emitters). Turbidity: 50 JCU. Color: Must not render water unfit for industrial-cooling or process-water supply purposes. Taste: Must not render water unfit for industrial use; phenols 0.001 maximum. Solids: Dissolved solids must not exceed 1,000 mg./1.; monthly average: 500 mg./1. Must be free from floating wastes that are unsightly or deleterious or other wastes that settle to form putrescent or objectionable sludge deposits. Toxic Substances: Free from wastes harmful to human, animal or aquatic life. Cu, 0.5 mg./1.; Zn, 1.0; Cr, 0.05; Pb, 0.05; Fe, 0.3; As, 0.05; F, 10.0; Cn, none detectable.

	pH Allowable Range	pH Allowable Deviation	Temperature (°F) allowable Maximum	Temperature (°F) allowable Increase above ambient	Dissolved oxygen (minimum mg./l. or %)	Other Requirements
Georgia	6.0–8.5	—	93.2°	10° (above intake)	2.5 3.0 (daily average)	**Radioactivity:** Must conform to state statutes. **Turbidity, Color, Taste and Odor:** Free from wastes that cause objectionable conditions or interfere with industrial use. **Solids:** Free from wastes that are unsightly, putrescent or otherwise objectionable or would interfere with industrial use. **Toxic Substances:** No wastes in concentrations that would prevent fish survival or interfere with industrial use.
Hawaii	6.5–8.5	—	—	—	4.5	**Radioactivity:** Not to exceed 1/30 of the values given by NBS Handbook 69. **Turbidity:** Free from soil particles from erosion caused by land development or agricultural use. **Taste and Odor:** Wastes, after dilution and mixture, must not interfere with industrial use. **Toxic Substances:** Free from substances in concentrations harmful to human, animal, or marine life or that make waters unsuitable for industrial use.
Idaho	6.5–9.0	0.5	—	2° Only if water 68° or less	75% (at seasonal low)	**Radioactivity:** Not to exceed limits of '62 PHS Drinking Water Standards. **Turbidity:** No objectionable turbidity that can be traced to a point source. **Solids:** No floating or submerged matter; no sludge deposits that could adversely affect industrial use. **Toxic Substances:** No wastes of other than natural origin in concentrations of public health significance or that could adversely affect industrial use.
Illinois	5.0–9.0	—	95°	—	2.0 3.0 (for 16 hrs. in any 24-hr. period)	**Color, Taste and Odor:** Free from wastes that produce color, odor or taste in such a degree as to create a nuisance. **Solids:** Free from floating wastes that settle and form unsightly, deleterious or putrescent deposits. **Toxic Substances:** Free from wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Indiana	5.0–9.0	—	95°	—	1.0 2.0 (daily average)	**Color, Taste and Odor:** Free from wastes that produce color, taste or odor in such a degree as to create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; monthly average, 750 mg./l. Must be free from unsightly, putrescent, deleterious or otherwise objectionable wastes. **Toxic Substances:** Free from wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Iowa	—	—	—	—	—	**Color, Taste and Odor:** Free from wastes that produce color, taste or odor in such a degree as to be detrimental to industrial use. **Solids:** Free from floating wastes in amounts that would be unsightly or deleterious or other wastes that settle to form putrescent or objectionable sludge deposits. **Toxic Substances:** No wastes in concentrations or combinations detrimental to human, animal or aquatic life or to industrial use.
Kansas	6.5–9.0	—	90°*	—	4.0*	**Turbidity:** No increase that causes substantial visible contrast with natural appearance or that is detrimental to industrial use. **Color:** Discharges of color-producing substances limited to concentrations not detrimental to industrial use. **Taste and Odor:** Concentrations limited to those that would not result in noticeable offensive odors or otherwise interfere with industrial use. **Solids:** Free from floating debris or material in amounts that would be unsightly or detrimental to industrial use. **Toxic Substances:** Pollutional substances must be maintained below concentrations detrimental for industrial use.
Kentucky	5.0–9.0	—	95° 73° (Dec.-Feb.)	2°/hr 10°/day	—	**Color, Taste and Odor:** Wastes must not create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; monthly average: 750 mg./l. No floating wastes in unsightly or deleterious amounts; no other wastes that settle to form putrescent or objectionable sludges. **Toxic Substances:** No wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Louisiana	6.0–9.0	—	96.8°	5.4°	50%	**Radioactivity:** Specific limits set for all radioactive isotopes released as waste. **Solids:** None that would produce floating masses, sludge banks or beds on bottom, either organic or inorganic. **Toxic Substances:** No wastes in concentrations or combinations harmful to animal or plant life.
Maine	6.0–9.0*	0.5*	90°*	—	2.0*	**Radioactivity:** Not to exceed '62 PHS Drinking Water Standards. **Turbidity, Color, Taste and Odor:** Free from wastes that impart turbidity, color, taste or odor or impair industrial use. **Solids:** Free from sludge deposits, solid refuse and floating solids. **Toxic Substances:** No chemical constituents from waste sources harmful to humans or that adversely affect industrial use.
Maryland	5.0–9.0 (unless natural)	—	100°	—	4.0 (unless naturally lower)	**Color, Taste and Odor:** Free from waste materials that change existing color or produce taste and odor to such a degree as to create a nuisance or interfere with industrial use. **Solids:** Free from wastes that float, settle to form deposits, create a nuisance or interfere with industrial use and are unsightly, putrescent or odorous. **Toxic Substances:** Free from toxic wastes that interfere with industrial use or that are harmful to human, plant, animal or aquatic life.
Massachusetts	6.0–9.0	—	90°	—	2.0	**Radioactivity:** None in concentrations harmful to human, animal or aquatic life. **Turbidity, Color, Taste and Odor:** None in concentrations that would impair industrial use. **Solids:** None allowed except that which may result from the discharge from waste-treatment facilities providing appropriate treatment. **Toxic Substances:** None in concentrations or combinations harmful to human, animal or aquatic life.

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Water quality standards

	pH Range	Allowable Deviation	Temperature (°F) Maximum	Temperature (°F) allowable Increase above ambient	Dissolved oxygen (minimum mg./1. or %)	Other Requirements
Michigan	6.5–8.8	0.5	—	10°	Enough to prevent nuisance	**Radioactivity:** Standards to be established when information is available on deleterious effects. **Turbidity, Color:** No objectionable unnatural turbidity or color in quantities sufficient to interfere with industrial use. **Taste and Odor:** Below levels that are or may become injurious to industrial use. **Solids:** Dissolved solids must not exceed 750 mg./1.; monthly average: 500 mg./1. No floating solids or objectionable deposits in quantities that would interfere with industrial use. **Toxic Substances:** Limited to concentrations less than those that are or may become injurious to this use.
Minnesota	6.0–9.0	—	86°	—	—	**Color, Taste and Odor, Solids:** Free from wastes that cause nuisance conditions, such as material discoloration, obnoxious odors, significant floating solids, excessive suspended solids or sludge deposits.
Mississippi	6.0–8.5	1.0	93°	10°	3.0	**Color, Taste and Odor:** Free from wastes that produce color or odor in such degree as to create a nuisance. **Solids:** Dissolved solids must not exceed 1,500 mg./1.; monthly average 750 mg./1. Must be free from floating wastes that settle to form unsightly, deleterious, objectionable or putrescent deposits. **Toxic Substances:** No wastes in concentrations or combinations harmful to human, animal or aquatic life.
Missouri	6.5–9.0	—	90°	9° (average of cross section)	4.0*	**Radioactivity:** Gross beta: 1,000 pc/1. (in absence of Sr-90 and alpha emitters). Sr-90: 10 pc/1. Dissolved Ra-226: 3 pc/1. **Color:** Wastes must not cause substantial visible contrast with natural appearance of stream or interfere with industrial use. **Taste and Odor:** Limited to concentrations that would not result in noticeable offensive odors or otherwise interfere with industrial use. **Solids:** No noticeable organic or inorganic deposits or floating materials in unsightly or deleterious amounts. **Toxic Substances:** Concentrations not detrimental to industrial use or toxic to humans, fish, wildlife. F:1.2.
Montana	6.5–9.5	0.5	—	No adverse change	—	**Radioactivity:** Not to exceed '62 PHS Drinking Water Standards. **Turbidity:** Must not interfere with established levels of treatment. **Color, Taste and Odor:** Water shall be maintained in condition not offensive to sense of sight or smell. **Solids:** No floating solids and sludge deposits in amounts deleterious to industrial use; no sediments or settleable solids that affect treatment levels. **Toxic Substances:** Amounts present must not adversely affect industrial use.
Nebraska	6.5–9.0	1.0	90°	5° (May-Oct.) 10° (Nov.-Apr.) Rate: 2°/hr.	5.0	**Radioactivity:** Must conform with Radiological Health Regulations (1st. ed.), State of Nebraska, '66. **Turbidity:** No more than 10% increase above normal level. **Color:** No evidence of matter that creates nuisance conditions. **Taste and Odor:** Less than amounts that would degrade water quality for industrial use; phenol: 0.001 mg./1. **Solids:** Dissolved solids must not exceed 1,500 mg./1. No more than 20% increase (limit 100 mg./1.) from any point source. No waste solids that permit deposition or are deleterious to industrial use. **Toxic Substances:** None in concentrations or combinations that would render water unsuitable for industrial use.
Nevada	6.5–8.5 Annual median: 7.4–8.3	—	77.0° (summer) 57.2° (winter)	—	5.0 6.0 (average, June–Sept.)	**Radioactivity:** Limited to 1/10 of the 168-hr.-week values in NBS Handbook 69. **Turbidity, Color, Taste and Odor:** Free from wastes in amounts sufficient to change existing turbidity or color enough to create a nuisance or interfere with industrial use, or to produce taste or odor in the water. **Solids:** Free from floating or other wastes that settle to form sludge banks or deposits in amounts that would be unsightly or odorous or interfere with industrial use. **Toxic Substances:** Free from wastes in concentrations or combinations toxic to human, animal, plant or aquatic life or that interfere with industrial use.
New Hampshire	6.0–8.5 (unless natural)	—	90°*	No increase that would interfere with this use*	5.0	**Turbidity, Color, Taste and Odor:** None in objectionable amounts. **Solids:** No floating solids or sludge deposits in objectionable amounts. **Toxic Substances:** None in toxic concentrations or combinations.
New Jersey	6.5–8.5 (unless natural)	—	87° (unless natural)	5° (up to 87°)	4.0*	**Turbidity, Solids:** None noticeable in water or deposited along shore. **Color, Taste and Odor:** None that are offensive to humans or detrimental to aquatic biota. **Toxic Substances:** None that would affect humans or be detrimental to aquatic biota.
New Mexico	6.6–8.6	—	—	Must not pollute or make water unfit for this use	No oxygen demand that would cause pollution	**Radioactivity:** Not greater than 1/10 of the 48-hr. value in NBS Handbook 69. **Turbidity:** Shall not cause substantial visible contrast with natural appearance. **Color:** Should not create an esthetically undesirable condition. **Taste and Odor:** No odors, other than of natural origin, that are esthetically objectionable or obnoxious. **Solids:** No objectionable floating solids or debris and sediment that significantly alter properties of bottom. **Toxic Substances:** No amounts toxic to humans, plants, fish, animals.
New York	6.0–9.5	—	86°	5° (average 7 days) Rate: 2°/hr. 9°/24 hrs.	3.0	**Color:** No colored wastes that alone or in combinations make water unsuitable for industrial use. **Solids:** No floating or settleable solids or sludge deposits that are readily visible and attributable to wastes. **Toxic Substances:** None alone or in combinations that would impair industrial use.

Water quality standards

	pH Allowable		Temperature (°F) allowable		Dissolved oxygen	
	Range	Deviation	Maximum	Increase above ambient	(minimum) mg./1. or %)	Other Requirements
North Carolina	Normal for area, usually 6.0–8.5; as low as 4.3 in swamps	—	95°•	7°	3.0	**Color:** Must not render water unfit for industrial cooling. **Solids:** Must not, after dilution and mixture, make water unfit for industrial cooling. **Toxic Substances:** Must not make water unfit for industrial cooling.
North Dakota	6.0–9.0	0.5	93°	10°	3.0 5.0 (for 16 hrs./day)	**Radioactivity:** No discharge allowed unless materials are readily soluble or dispersible and of quantities acceptable to state health department. **Color, Taste and Odor:** No wastes that color water or result in objectionable odors to a degree that impairs industrial use. **Solids:** No unsightly floating wastes that would adversely affect industrial use or wastes that settle to form putrescent or objectionable deposits. **Toxic Substances:** No concentrations or combinations harmful to human, animal or aquatic life.
Ohio	5.0–9.0	—	95°	—	1.0 2.0 (daily average)	**Color, Taste and Odor:** Free from wastes that produce color or odor to a degree that creates a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./1.; monthly average: 750 mg./1. Must be free from floating or other wastes that settle to form putrescent or objectionable deposits or that are unsightly or deleterious. **Toxic Substances:** No wastes in concentrations or combinations harmful to human, animal or aquatic life.
Oklahoma	6.5–8.5	—	93°	5°	4.0	**Radioactivity:** Average concentration at points of controlled release shall not exceed State Board of Health Radiation Protection Regulations. **Turbidity:** None that causes visible contrast with natural conditions. **Color:** None that is persistent in concentrations detrimental to industrial use. **Taste and Odor:** No concentrations that would cause offensive odors in vicinity of water or otherwise interfere with industrial use. **Solids:** Free from floating debris, bottom deposits or other materials. **Toxic Substances:** None in quantities that make water toxic to human, animal, plant or aquatic life.
Oregon	6.5–9.0	—	—	2° (only if water 70° or less)	5.0	**Radiation:** Shall not pose external hazard. **Turbidity:** 5 JCU above natural. **Color, Taste and Odor:** No objectionable discoloration or conditions esthetically offensive to human senses of taste or smell. **Solids:** No floating solids, organic or inorganic deposits injurious to industry. **Toxic Substances:** No conditions injurious to public health.
Pennsylvania	6.0–9.0	—	93°	2°/hr.	4.0 5.0 (daily average)	**Color, Taste and Odor:** No wastes that produce colors, tastes or odors in amounts harmful to industrial use. **Solids:** Dissolved solids must not exceed 750 mg./1.; monthly average: 500 mg./1. No floating wastes or substances that settle to form sludge in amounts harmful to industrial use. **Toxic Substances:** None in amounts harmful to industrial use.
Rhode Island	6.0–8.5	—	—	4°	3.0* 5.0* (16 hrs./day)	**Radioactivity, Toxic Substances:** No concentrations or combinations harmful to human, animal or aquatic life. **Turbidity, Taste and Odor:** None in concentrations that would impair industrial use. **Solids:** No solid refuse, floating solids or sludge deposits.
South Carolina	6.0–8.5 5.0–8.5 (swamps)	—	93.2°•	10°•	3.0• 2.5• (swamps)	**Turbidity, Color, Taste and Odor:** Free from wastes that change the existing turbidity or color or that produce taste or odor to such a degree as to cause a nuisance or interfere with industrial use. **Solids:** None from waste sources in amounts that are unsightly, putrescent, odorous or that cause a nuisance or interfere with industrial use. **Toxic Substances:** Free from wastes harmful to human, animal, plant or aquatic life or that interfere directly or indirectly with industrial use.
South Dakota	6.0–9.5	1.0	—	—	—	**Radioactivity:** None permitted in water unless readily soluble or dispersible and in quantities allowed by federal or state agencies. **Color, Taste and Odor:** No wastes that produce material discoloration or undesirable odors. **Solids:** Dissolved solids must not exceed 2,000 mg./1. No wastes producing floating solids, sludge deposits or other offensive effects. **Toxic Substances:** None in concentrations toxic to human, animal or aquatic life.
Tennessee	6.0–9.0	1.0 (24 hrs.)	93°	10° Rate: 3°/hr.	Enough to prevent offensive conditions	**Radioactivity:** None that could adversely affect industrial use. **Turbidity, Color:** None in amounts or concentrations that could not be reduced to acceptable levels by conventional treatment. **Taste and Odor:** None that would result in taste or odor that would prevent use for industrial processing. **Solids:** Dissolved solids must not exceed 500 mg./1. No distinctly visible solids, bottom deposits or sludge banks that could be detrimental to industrial use. **Toxic Substances:** None that produces toxic conditions that would adversely affect water for industrial use.
Texas	5.0–8.5 5.0–9.0 (cooling water)	—	—	—	4.0	**Radioactivity:** Regulated by Texas Radiation Control Act and Texas Regulations for Control of Radiation. **Turbidity:** No substantial increase due to wastes. **Color:** No substantial visible contrast with natural appearance of receiving waters after wastes receive best practical treatment. **Taste and Odor:** No concentrations that produce offensive odors. **Solids:** Dissolved solids must not exceed 1,000 mg./1., unless water used only for cooling. Must be essentially free from floating or settleable suspended solids that would adversely affect industrial use. **Toxic Substances:** Shall not show acute or chronic toxicity to humans, animals or aquatic life to such an extent as to interfere with industrial use.

Water quality standards

	pH Allowable Range	pH Allowable Deviation	Temperature (°F) allowable Maximum	Temperature (°F) allowable Increase above ambient	Dissolved oxygen (minimum mg./l. or %)	Other Requirements
Utah	6.5-9.0	—	—	—	—	**Radioactivity:** Shall not exceed 1/30 of MPC_w values for continuous occupational exposure in NBS Handbook 69. **Turbidity, Color:** No wastes in amounts that would change existing turbidity or color enough to create public nuisance or interfere with industrial use. **Taste and Odor:** No wastes in amounts that would produce taste or odor. **Solids:** No floating wastes that are unsightly or that interfere with industrial use; no wastes that settle to form unsightly or odorous sludge or bottom deposits. **Toxic Substances:** No wastes in concentrations or combinations toxic to human, animal, plant or aquatic life or that would interfere with industrial use.
Vermont	6.0-8.5	—	—	4*	3.0* 5.0* (16 hrs./day)	**Radioactivity:** To be approved by appropriate state agency. **Turbidity, Color, Taste and Odor:** None in concentrations that would impair industrial use. **Solids:** No floating solids, sludge deposits or solid refuse. **Toxic Substances:** No chemical constituents in concentrations or combinations harmful to human, animal or aquatic life.
Virginia	5.0-9.0 (swamps as low as 4.3)	—	95** (unless naturally higher)	No sudden changes that could harm aquatic life	1.0* 2.0* (daily average)	**Color, Taste and Odor:** No wastes that change existing color or produce odor to such a degree as to create a nuisance or interfere with industrial use. **Solids:** No floating wastes that are unsightly or create a nuisance or other wastes that settle to form unsightly, putrescent or odorous deposits. **Toxic Substances:** No wastes in concentrations or combinations that would interfere directly or indirectly with industrial use.
Washington	6.5-8.5	0.5	70*	t = 110/(T-15)†	6.5 or 70%	**Radioactivity, Toxic Substances:** Below concentrations that could adversely affect industrial use. **Turbidity:** Less than 10 JCU over natural conditions. **Color, Taste and Odor, Solids:** Dissolved, suspended, floating or submerged matter shall not reduce esthetic values so as to affect industrial use.
West Virginia	Process water: 5.5-9.0 Cooling water: 5.0-9.0	—	Cooling water: 93* (May-Nov.) 73* (Dec.-Apr.) Process water must permit fish passage	5* Rate: 2°/hr. (Dec.-Apr.)	— 1.0 2.0 (daily average)	**Color:** None that is objectionable. **Taste and Odor:** No objectionable odors in vicinity of the water. **Solids:** No distinctly visible floating, settleable or suspended solids of unreasonable kind or quantity. No objectionable bottom deposits or sludge banks. **Toxic Substances:** No concentrations of materials poisonous to human, animal or fish life.
Wisconsin	6.0-9.0	0.5	89*	—	1.0 2.0 (daily average)	**Color, Taste and Odor:** No materials producing color, taste or odor in amounts that would create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; daily average: 750 mg./l. No floating or submerged debris or waste substances that would cause objectionable deposits in amounts to create a nuisance. **Toxic Substances:** None in concentrations or combinations toxic to humans or of public health significance.
Wyoming	6.5-8.5	...	—	4* 2* (for streams where temp. not over 70°)	6.0	**Radioactivity:** Not to exceed 1/30 of NBS Handbook 69 values. **Turbidity:** No more than 15 JCU above natural (when turbidity is 150 JCU or less); otherwise, no more than 10% above natural. **Color:** Essentially free of wastes that visibly alter natural color of water or impart color to vessels or structures. **Taste and Odor:** Essentially free from substances that would produce detectable odor at site of use. **Solids:** Essentially free from floating or settleable solids that are unsightly or settle to form sludge, bank or bottom deposits. **Toxic Substances:** Free from toxic substances in concentrations or combinations toxic to human, animal or aquatic life.

* Standard reserved from Federal Water Pollution Control Administration approval.
† t = total cumulative heat addition allowed from unnatural waste sources, at any point throughout the given stream reach. T = highest occurring temperature for a given period, in a specific stream reach.
Abbreviations: PHS—Public Health Service; NBS—National Bureau of Standards; JCU—Jackson Candle Units; pc/l.—picocuries per liter.
Source: Water Quality Standards of the United States, Territories, and the District of Columbia. American Public Health Assn., Subcommittee on Water Quality Control, and Engineering and Sanitation Section.
Note: Specific limits for coliforms, biologic oxygen demand, plant nutrients, oil, grease, scum, bottom deposits, pesticides, specific conductance, carbon chloroform extract, synthetic detergents not included. Some states set standards for each stream reach or river basin; in such cases, table shows least stringent requirement.

This reprint is an excerpt from the "Plant Sites, '69" report
that appeared in the October 29, 1969 issue of CHEMICAL WEEK

MEMORANDUM

FROM (NAME & LOCATION) Cumming Paton - General Offices

MAR 3 1970

DATE : March 2, 1970

SUBJECT : CUSTOMER NOTIFICATION LETTER ON PCBs

REFERENCE :

TO : P. C. Park
W. B. Papageorge

CC: M. W. Farrar
D. A. Olson
W. E. Schalk
J. E. Springgate
W. F. Waychoff

CONFIDENTIAL

The Plasticizer Group mailed a PCB notification letter to our direct Aroclor customers. 660 were mailed on February 27, 1970 and one (Nelson Oil) was mailed on March 2, 1970.

The Presidents of our distributors, namely:

Central Solvents and Chemicals
Great Western Chemical
Tab Chemicals
American Mineral Spirits Company

were notified on February 24, 1970.

Cumming Paton

/dbw

This list was used through the June 1, 1970 mailings - per W. Clark.
May 2, 1973

IM-10 REV 11-65

NAME	ADDRESS	DATE MAILED	PER
1. AAA Capacitors	P. O. Box F Cherry Tree, Pa. 15724	2-27-70	DK
2. Abco, Inc.	P. O. Box J Irwin, Pa. 15642	2-27-70	DK
3. Acme Adhesives	207 West Central Ave. Maywood, N. J. 07607	2-27-70	DK
4. Action Products	Nitro, W. Va. 25143	2-27-70	DK
5. Adams Carbide Corp.	141 Market St. Kenilworth, N. J. 07033	2-27-70	DK
6. Adchem Corp.	625 Main St. Westbury, L.I., N. Y. 11590	2-27-70	DK
7. Adelphi Paint & Color Works, Inc.	8600 DuMont Avenue Ozone Park, L.I., N.Y.11817	2-27-70	DK
8. Adhesives Mfg. Ind.	724-26 N. First St. St. Louis, Mo. 63102	2-27-70	DK
9. Adhesives Research	100 Eight Ave. York, Pa. 17404	2-27-70	DK
10. Advanced Chem. Corp.	Route 547 Box 355 Farmingdale, N. J. 07727	2-27-70	DK
11. Airco Chemicals & Plastics Div. Air Reduction Co.	150 East 42nd St. New York, N. Y. 10017	2-27-70	DK
12. Airco Speer Electrodes	Packard Rd. at 47th St. Niagara Falls, N. Y. 14302	2-27-70	DK
13. Airco Speer Electronic	Bolivar Drive Bradford, Pa. 16701	2-27-70	DK
14. Airco Speer Carbon	Theresia St. St. Marys, Pa. 15857	2-27-70	DK
15. Airex Rubber Prods.	Portland, Conn. 06480	2-27-70	DK
16. Akron Rubber Corp.	29 West Market St. Akron, Ohio 44308	2-27-70	DK
17. Masury Columbia Co.	2525 W. Armitage Ave. Melrose Park, Ill. 60160	2-27-70	DK
18. Albion Industries, Inc.	P. O. Box 411 Albion, Mich. 49224	2-27-70	DK
19. Alcan Metal & Powder Div.	P. O. Box 290 Elizabeth, N. J. 07207	2-27-70	DK

NAME	ADDRESS	DATE MAILED	PER
20. Alfa Ink & Chem. Corp.	214½ Washington Ave. Carlstadt, N. J. 07072	2-27-70	DX
21. All Tronics, Inc.	45 Bond St. Westbury, L.I., N.Y. 11590	2-27-70	DX
22. All Rite Pen Co., Inc.	241 Hudson St. Hackensack, N. J. 07602	2-27-70	DX
23. Allentown Paint	East Allen & Graham Sts. Allentown, Pa. 18103	2-27-70	DX
24. Allied Chemical	40 Rector St. New York, N. Y. 10006	2-27-70	DX
25. Allied Material Corp.	Stroud, Okla. 74079	2-27-70	DX
26. Alpha Metals	56 Water St. Jersey City, N. J. 07305	2-27-70	DX
27. Aluminum Co.	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	2-27-70	DX
28. Amax Specialty Metals	Box 1748 Parkersburg, W. Va. 26101	2-27-70	DX
29. American Cyanamid Co.	1937 W. Main St. Stamford, Conn. 06902	2-27-70	DX
30. American Cyanamid Co.	Organic Chemicals Div. Boundbrook, N. J. 08805	2-27-70	DX
31. Amercoat Corp.	201 North Berry St. Brea, California 92621	2-27-70	DX
32. Western Elec. Mfg. Dept.	Hawthorne Station Chicago, Illinois 60623	2-27-70	DX
33. Western Elec.	Box 14000 W. Omaha Sta. Omaha, Nebraska 68114	2-27-70	DX
34. American Adhesive Mfg. Co., Inc.	30 Waverly Ave. Brooklyn, N. Y. 11205	2-27-70	DX
35. American Aerosols	182 East 12th St. Holland, Michigan 49423	2-27-70	DX
36. M. & T. Chemicals, Inc.	P. O. Box 1104 Rahway, N. J. 07065	2-27-70	DX
37. American Can Co.	Highway 22 Union, N. J. 07083	2-27-70	DX
38. Amer. Finish & Chem. Co.	10 - 12 Broadway Chelsea, Mass. 02150	2-27-70	DX

NAME	ADDRESS	DATE MAILED	PER
39. American Lacquer Solvents Co.	Valley Forge, Pa. 19481	2-27-70	DH
40. American Motor Corp.	14250 Plymouth Road Detroit, Mich. 48227	2-27-70	DH
41. American Optical Corp. AO Instrument Co. Div.	Buffalo, N. Y. 14215	2-27-70	DH
42. American Stencil	4290 Holly St. Denver, Colo. 80216	2-27-70	DH
43. American Lacquer Solvents Co.	Factory Office Tampa, Fla. 33601	2-27-70	DH
44. Amer. Mach. & Foundry	689 Hope St. Stamford, Conn. 06907	2-27-70	DH
45. Amer. Metal Seal Corp.	509 Washington Ave. Carlstadt, N. J. 07072	2-27-70	DH
46. Amer. Paint Corp.	3001 W. Superior St. Duluth, Minn. 55806	2-27-70	DH
47. American Petro Chem.	Spruce St. Ext. P. O. Box 382 Wooster, Ohio 44691	2-27-70	DH
48. Amer. Petro Chem.	3134 California St., N.E. Minneapolis, Minn. 55418	2-27-70	DH
49. Ames Rubber Co.	Hamburg, N. J. 07419	2-27-70	DH
50. Amity Lacquer Pt. & Mfg. Co.	Amity, Ark. 71921	2-27-70	DH
51. AMP, Inc.	Eisenhower Blvd. Harrisburg, Pa. 17111	2-27-70	DH
52. Amsterdam Color Works	1546 Stillwell Ave. Bronx, N. Y. 10461	2-27-70	DH
53. Anaconda Wire & Cable Co.	Hastings-On-Hudson, N.Y. 10706	2-27-70	DH
54. Anderson & Ruzzin, Inc.	37030 Green St. New Baltimore, Mich. 48047	2-27-70	DH
55. Andrews Paper & Chem. Co.	P. O. Box 509 75 Shore Road Port Washington, N.Y. 11050	2-27-70	DH
56. Apex Alkali Prod. Co.	Main & Rector Sts. Philadelphia, Pa. 19127	2-27-70	DH

NAME	ADDRESS	DATE MAILED	PER
57. Archem Corp.	1514 11th St. Portsmouth, Ohio 45662	2-27-70	DH
58. Argonne Nat'l. Lab.	P. O. Box 299 Lemont, Ill. 60439	2-27-70	DH
59. Armour-Dial, Inc.	P. O. Box 4309 Chicago, Ill. 60680	2-27-70	DH
60. Armour Indust. Pro.	Box 1805 401 N. Wabash Chicago, Ill. 60690	2-27-70	DH
61. Armstrong Cork	2500 Columbia Ave. Lancaster, Pa. 17603	2-27-70	DH
62. Armstrong Pt. & Varnish Works	1330 S. Kilbourne Ave. Chicago, Ill. 60623	2-27-70	DH
63. Arwood Corp.	Rockleigh Industrial Park Rockleigh, N. J. 07647	2-27-70	DH
64. Ashland Chem. Co. Div. Resins & Plast.	32 Henry St. Bethel, Conn. 06801	2-27-70	DH
65. Ashland Chem. Co.	142nd St. Paxton Ave. Calumet City, Ill. 60409	2-27-70	DH
66. Assoc. Rubber	Quakertown, Pa. 18951	2-27-70	DH
67. Astro Chem.	2063 Baker Ave. Schenectady, N. Y. 12309	2-27-70	DH
68. Atlan Gummed PPR	1 Main St. Brooklyn, N. Y. 11201	2-27-70	DH
69. Atlantic Paint	5901 W. Beaver St. Jacksonville, Fla. 32205	2-27-70	DH
70. Aviation Fluids Serv. Co.	2617 Poe Ave. Overland, Mo. 63114	2-27-70	DH
71. Babcock & Wilcox	Harrisburg & Sawburg Rd. Alliance, Ohio 44601	2-27-70	DH
72. Barker Chem. Co.	700 East 138th St. Chicago, Ill. 60627	2-27-70	DH
73. Barrstalfort Co. Div. of Pitway Corp.	6100 W. Howard St. Niles, Ill. 60648	2-27-70	DH
74. Bartlett Chem.	1460 South Peters St. New Orleans, La. 70130	2-27-70	DH

NAME	ADDRESS	DATE MAILED	PER
75. Basf Corp.	50 Central Ave. South Kearny, N.J. 07032	2-27-70	DK
76. J. H. Baxter	P. O. Box 2809 Eugene, Oregon 97402	2-27-70	DK
77. Mobay Chem.	Penn Lincoln Parkway West Pittsburgh, Pa. 15215	2-27-70	DK
78. Frye Mfg. Co.	2531 Dean Ave. Des Moines, Iowa 50317	2-27-70	DK
79. Belray Co., Inc.	Farmingdale, N. J. 07727	2-27-70	DK
80. Adhesive Eng.	1411 Industrial Road San Carlos, Calif. 94070	2-27-70	DK
81. Benjamin Foster	5841 W. 66th St. Chicago, Ill. 60638	2-27-70	DK
82. Benjamin Moore	134 Lister Newark, N. J. 07105	2-27-70	DK
83. Benson Chemical	2250 First Ave. So. Seattle, Wash. 98134	2-27-70	DK
84. Berco Ind. Corp.	1250 Shames Drives Westbury, L.I., N.Y. 11590	2-27-70	DK
85. Betosia Corp.	185 Foundry St., Bldg. 4 Newark, N. J. 07105	2-27-70	DK
86. Bixby Box Toe Co.	179 Washington St. Haverhill, Mass. 01830	2-27-70	DK
87. Blair Process	363 N. E. Ave. Tallmadge, Ohio 44278	2-27-70	DK
88. Bond Chemical Prod.	2100 N. Fulton Chicago, Ill. 60612	2-27-70	DK
89. Bond Stazon Co.	255 Factory Road Addison, Ill. 60101	2-27-70	DK
90. Borden, Inc.	350 Madison Ave. New York, New York 10017	2-27-70	DK
91. Marbon Chem. Div. Borg Warner Corp.	P. O. Box 68 Washington, W. Va. 26181	2-27-70	DK
92. Borne Chem. Co.	632 S. Front St. Elizabeth, N. J. 07202	2-27-70	DK
93. Bradley & Vrooman	2629 Dearborn St. Chicago, Ill. 60616	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
94.	W. H. Brady Co.	727 W. Glendale Ave. Milwaukee, Wisc. 53209	2-27-70	DH
95.	Brandt Assoc.	2018 Naamans Road Wilmington, Del. 19803	2-27-70	DH
96.	Bridgeport Chem.	1 Willow Park Center Farmingdale, L.I., N.Y. 11735	2-27-70	DH
97.	Briner Paint Mfg. Co.	3713 Agnes St. Corpus Christi, Texas 78405	2-27-70	DH
98.	Brod Dugan Paint Co.	2145 Schuetz St. Louis, Mo. 63141	2-27-70	DH
99.	Brookline Wall Decor	1105 Coney Island Ave. Brooklyn, N. Y. 11230	2-27-70	DH
100.	Brooklyn Paint & Varnish	50 Jay St. Brooklyn, N. Y. 11201	2-27-70	DH
101.	Bruning Paint Co.	Fleet & Haven Sts. Baltimore, Md. 21224	2-27-70	DH
102.	George N. Brunt, Inc.	Industrial Blvd. Calhoun, Ga. 30701	2-27-70	DH
103.	Brush Beryllium Co.	17876 St. Clair Ave. Cleveland, Ohio 44110	2-27-70	DH
104.	William L. Buckwald, Jr. c/o H.C. Oswald Supply Co.	120 East 124th St. New York, N. Y. 10035	2-27-70	DH
105.	Budd Co.	2450 Hunting Park Ave. Philadelphia, Pa. 19132	2-27-70	DH
106.	Buhl Chem.	Weirsdale, Fla. 32695	2-27-70	DH
107.	Burroughs Corp.	Box 299 Detroit, Mich. 48221	2-27-70	DH
108.	Butler Mfg. Co.	135 and Bates Rd. Grandview, Mo. 64030	2-27-70	DH
109.	Butterfield Barry	800 Huyler St. Teterboro, N. J. 07608	2-27-70	DH
110.	Ultramar Chem. Co.	P. O. Box 48 Honolulu, Hawaii 96810	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
111.	C. D. Sparling Plastics Industries, Inc.	9229 General Court Plymouth, Mich. 48170	2-27-70	ok X
112.	C. J. Webb, Inc.	Dresher, Pa. 19025	2-27-70	DK
113.	Capitol Prtg. Ink Co., Inc.	806 Channing Place, N.E. Washington, D.C. 20018	2-27-70	DK
114.	Caprock Paint Mfg. Co.	P. O. Drawer 5427 Lubbock, Texas 79417	2-27-70	DK
115.	Cardinal Paint Corp.	2533 Sullivan Ave. St. Louis, Mo. 63107	2-27-70	DK
116.	R. P. Cargille Lab, Inc.	33 Factory St. Cedar Grove, N.J. 07009	2-27-70	DK
117.	Castrol Oils, Inc.	254 Doremus Ave. Newark, N. J. 07105	2-27-70	DK
118.	CBS Laboratories	227 High Ridge Road Stamford, Conn. 06905	2-27-70	DK
119.	Celanese Ctgs. Co.	Station E Box 8248 Louisville, Ky. 40208	2-27-70	DK
120.	Cellular Products Corp.	18656 Fitzpatrick Detroit, Mich. 48228	2-27-70	DK
121.	Century Laboratories	4936 Veterans Mem. Hwy. Metairie, La. 70002	2-27-70	DK
122.	Certain-Teed-Saint Gobain	P. O. Box 15080 Kansas City, Kansas 66115	2-27-70	DK
123.	Champion Foils	36 High St. Amesbury, Mass. 01913	2-27-70	DK
124.	Champion Papers	Hamilton Mill Hamilton, Ohio 45013	2-27-70	DK
125.	U. S. Plywood Champion Papers	130 N. Franklin St. Chicago, Illinois 60606	2-27-70	DK
126.	Chapman Chemical Co.	416 Brooks Road Memphis, Tenn. 38109	2-27-70	DK
127.	Chemical Prods. Co.	King Philip Road E. Providence, R.I. 02916	2-27-70	DK
128.	Chemagro Corp.	P. O. Box 4913 Station F Kansas City, Mo. 64120	2-27-70	DK
129.	Chemical Components	20 DeForest Ave. Hanover, N. J. 07936	2-27-70	DK
130.	Chemetron Corp.	P. O. Box 2166 Huntington, W. Va. 25722	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
131.	Chem-Fast Chemical Fastners, Inc.	127 N. Summit St. Akron, Ohio 44304	2-27-70	DH
132.	Chemical Eng. Assoc.	603 E. Pulaski Hwy. Elkton, Md. 21921	2-27-70	DH
133.	Chem. Research	83 Eastwater St. Rockland, Mass. 02370	2-27-70	DH
134.	Chemical Sealing Corp.	5401 Banks Ave. Kansas City, Mo. 64130	2-27-70	DH
135.	Chem. Service, Inc.	P. O. Box 15 Media, Pa. 19063	2-27-70	DH
136.	Chemtech Corp.	7882 Folk Ave. St. Louis, Mo. 63143	2-27-70	DH
137.	Chem-Trend, Inc.	Howell, Mich. 48843	2-27-70	DH
138.	Ciba Pharmaceuticals	556 Morris Ave. Summit, N. J. 07901	2-27-70	DH
139.	Cincinnati Milling Machine Co. Prods. Div.	Marburg & South Sts. Cincinnati, Ohio 45209	2-27-70	DH
140.	Cities Serv. Oil Co.	P. O. Box 245 Tulsa, Okla. 74102	2-27-70	DH
141.	Clearprint Mfg. Co.	1482 67th St. Emeryville, Calif. 94608	2-27-70	DH
142.	Clearview Textile Corp.	1414 Clearview St. Scranton, Pa. 18508	2-27-70	DH
143.	Coburn Coating Corp.	256 East Third St. Mount Vernon, N. Y. 10550	2-27-70	DH
144.	Colonial Chem. Corp.	P. O. Box 865 Dalton, Ga. 30720	2-27-70	DH
145.	Colonial Press	1 Green St. Clinton, Mass. 01510	2-27-70	DH
146.	Colonial Rubber Works, Inc.	Dyersburg, Tenn. 38024	2-27-70	DH
147.	Columbia River & Carbon Mfg.	Glen Cove, N. Y. 11542	2-27-70	DH
148.	Columbia Paint & Varnish	452 Communipaw Ave. Jersey City, N. J. 07304	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
149.	Columbia Technical	26-60 Brooklyn-Queens Exp. Woodside, N. Y. 11377	2-27-70	DK
150.	Commercial Steel Co.	Forest Hill Industrial Pk. Jarrettsville Road Forest Hills, Md. 21050	2-27-70	DK
151.	Commerical Ink Corp.	627 Broadway New York, N. Y. 10012	2-27-70	DK
152.	Conap, Inc.	184 East Union St. Allegany, N. Y. 14706	2-27-70	DK
153.	Conchemo, Inc.	1401 Severn St. at Bush St. Baltimore, Md. 21230	2-27-70	DK
154.	Concrete Cure Chem.	9260 N. Hooker St. Westminister, Colo. 80030	2-27-70	DK
155.	Congoleum Ind.	195 Belgrove Drive Kearny, N. J. 07032	2-27-70	DK
156.	Conley Corp.	91st & Delaware Ave. Tulsa, Okla. 74105	2-27-70	DK
157.	Construction Spec.	8301 Landsowne Ave. Upper Darby, Pa. 19082	2-27-70	DK
158.	Continental Aviation & Aircraft Co.	1510 Laskey Road Toledo, Ohio 43612	2-27-70	DK
159.	Continental Can Co., Inc.	135 S. LaSalle St. Chicago, Ill. 60603	2-27-70	DK
160.	Continental Prods. Co.	East 222nd & Nickel Pl. Cleveland, Ohio 44123	2-27-70	DK
161.	Cook Paint & Varnish Co.	P. O. Box 389 Kansas City, Mo. 64141	2-27-70	DK
162.	Corning Glass Works	Corning, N. Y. 14830	2-27-70	DK
163.	Coronado Paint Co.	P. O. Box 308 Edgewater, Fla. 32032	2-27-70	DK
164.	Curd Enterprises	211 Iroquois Ave. N. Charleston, S.C. 29406	2-27-70	DK
165.	Curtis-Young Corp.	2550 Haddonfield Road Pennsauken, N. J. 08110	2-27-70	DK
166.	Custom Chemicals	30 Paul Kohner Place E. Patterson, N. J. 07407	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
167.	Cutlers Paint Stores	3500 Cottman St. Philadelphia, Pa. 19149	2-27-70	DH
168.	Dave Loes	2014 Norfolk St. Paul, Minn. 55116	2-27-70	DH
169.	Don V. Davis Co.	4200 North Second St. St. Louis, Mo. 63107	2-27-70	DH
170.	DCA Food Industries	31-01 Washington Blvd. Catonsville, Md. 21228	2-27-70	DH
171.	Defender Industries	384 Broadway New York, N. Y. 10013	2-27-70	DH
172.	Del Paint & Mfg. Co.	3105 East Reno Oklahoma City, Okla. 73117	2-27-70	DH
173.	Dennis Chemical Co.	2701 Papin Street St. Louis, Mo. 63103	2-27-70	DH
174.	Dennison Mfg. Co.	300 Howard St. Framingham, Mass. 01701	2-27-70	DH
175.	Dergen Oil & Chem. Co.	200 Kellogg St. Jersey City, N. J. 07305	2-27-70	DH
176.	Design & Development Pkg. Co.	2156 Flintstone Drive Tucker, Ga. 30084	2-27-70	DH
177.	Diamond Shamrock	P. O. Box 430 Painesville, Ohio 44077	2-27-70	DH
178.	Hydro-Dredge Accessory Co.	P. O. Box 11 Smithton, Ill. 62285	2-27-70	DH
179.	Doubleday & Co., Inc.	Berryville, Va. 22611	2-27-70	DH
180.	Dow Chemical Co.	P. O. Box 1724 Midland, Mich. 48640	2-27-70	DH
181.	Dow Corning Corp.	P. O. Box 592 Midland, Mich. 48640	2-27-70	DH
182.	L. A. Dreyfus	3775 Park Ave. Edison, N. J. 08818	2-27-70	DH
183.	Dumont Chemical	2126 E. 33rd St. Erie, Pa. 16510	2-27-70	DH
184.	E. I. Dupont Denemours & Co.	Room 6074 Dupont Bldg. Wilmington, Del. 19801	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
185.	Durkee Atwood Co.	215 7th St. N. E. Minneapolis, Minn. 55413	2-27-70	DK
186.	Dynasurf Chemical Corp.	1411-13 Fleet St. Baltimore, Md. 21231	2-27-70	DK
187.	Eagle-Picher Co.	Couples Plant Joplin, Mo. 64801	2-27-70	DK
188.	Distillation Prods. Ind.	755 Ridge Road West Rochester, N. Y. 14613	2-27-70	DK
189.	Eastman Kodak Co.	543 State St. Rochester, N. Y. 14604	2-27-70	DK
190.	Eaton-Allen Corp.	67 Kent Ave. Brooklyn, N. Y. 11222	2-27-70	DK
191.	Economics Lab, Inc.	914 Guardian Bldg. St. Paul, Minn. 55101	2-27-70	DK
192.	EDP Supply	50 Ledgewood Drive Norwalk, Conn. 06850	2-27-70	DK
193.	Egyptian Lacquer Mfg. Co.	P. O. Box 444 Newark, N. J. 07101	2-27-70	DK
194.	Elan Chemical Co.	671 Hope St. Springdale, Conn. 06907	2-27-70	DK
195.	Elan Chemical Co.	268 Doremus Ave. Newark, N. J. 07105	2-27-70	DK
196.	Electrical Ind.	691 Central Ave. Murray Hill, N. J. 07974	2-27-70	DK
197.	Electromold Corp.	140 Enterprise Ave. Trenton, N. J. 08638	2-27-70	DK
198.	Electro Chemical Eng. & Mfg.	750 Broad St. Emmaus, Pa. 18049	2-27-70	DK
199.	Elliot Paint & Varnish Co.	4525 Fifth Ave. Chicago, Ill. 60624	2-27-70	DK
200.	Endicott Johnson Corp.	Endicott, N. Y. 13760	2-27-70	DK
201.	Engineered Yarns, Inc.	372 Main St. Coventry, R. I. 02816	2-27-70	DK
202.	Enmar, Inc.	25th & New York Wichita, Kansas 67201	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
203.	Wallace Erickson	842 North Wells Chicago, Ill. 60610	2-27-70	DH
204.	Essex Chem. Corp.	1401 Broad St. Clifton, N. J. 07013	2-27-70	DH
205.	Ethyl Corp.	P. O. Box 341 Baton Rouge, La. 70821	2-27-70	DH
206.	Exotic Rubber & Plastics	26302 W. Seven Mile Road Detroit, Mich. 48240	2-27-70	DH
207.	Farac Oil & Chem.	13601 S. Ashland Riverdale, Ill. 60627	2-27-70	DH
208.	Fasson Prod. Div. Avery Adhesives	250 Chester St. Painesville, Ohio 44077	2-27-70	DH
209.	Fiber Resin Corp.	23395 Hoover Warren, Mich. 48089	2-27-70	DH
210.	Fiber Industries, Inc.	P. O. Box 10038 Charlotte, N. C. 28201	2-27-70	DH
211.	Fiberite Corp.	516 West Fourth St. Winona, Minn. 55987	2-27-70	DH
212.	Fibreglas Masonry PR	1400 Marietta Way Sparks, Nevada 89431	2-27-70	DH
213.	Field Rubber Co.	State Rd. 32 East Noblesville, Ind. 46060	2-27-70	DH
214.	Findley Adhesives, Inc.	3033 West Pemberton Ave. Milwaukee, Wisc. 53210	2-27-70	DH
215.	Firestone Tire & Rubber Co.	South Main St. Akron, Ohio 44311	2-27-70	DH
216.	Flex-O-Glass, Inc.	4647 W. Augusta Blvd. Chicago, Ill. 60651	2-27-70	DH
217.	Flexon Chemical Corp.	8 Jane St. Trenton, N. J. 08638	2-27-70	DH
218.	Flintkote Co.	Oak St. & Central Ave. E. Rutherford, N. J. 07073	2-27-70	DH
219.	Florasynth Labs, Inc.	P. O. Box 12 900 Van Ness Ave. New York, N. Y. 10062	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
220.	Flouramrics, Inc.	P. O. Box 438 Westwood, N. J. 07675	2-27-70	DH
221.	FMC Corp.	P. O. Box 1616 Baltimore, Md. 21203	2-27-70	DH
222.	FMC Corp., Div. Am. Vi.	1617 Pennsylvania Blvd. Philadelphia, Pa. 19130	2-27-70	DH
223.	Focal Paint, Inc.	3710 S. Roswell Rd., Rt. 3 Marietta, Ga. 30060	2-27-70	DH
224.	Foeseco, Inc.	20200 Sheldon Road Cleveland, Ohio 44142	2-27-70	DH
225.	Foote Mineral Co.	Route 100 Exton, Pa. 19341	2-27-70	DH
226.	Ford Paint & Varnish Co.	601 Crosby St., N. W. Grand Rapids, Mich. 49504	2-27-70	DH
227.	Formax Mfg. Corp.	3171 Bellevue Ave. Detroit, Mich. 48207	2-27-70	DH
228.	Fort Pitt Chem. Co.	26th & Smallman Sts. Pittsburgh, Pa. 15222	2-27-70	DH
229.	Franklin Glue Co.	2020 Bruck St. Columbus, Ohio 43207	2-27-70	DH
230.	Frekote	4300 N. Emmeran Ave. Indianapolis, Ind. 46218	2-27-70	DH
231.	Franklin Paint Co.	Franklin, Mass. 02038	2-27-70	DH
232.	Tenn. Eastman	Div. of Eastman Kodak Kingsport, Tenn. 37662	2-27-70	DH
233.	Texas Eastman Co.	Div. of Eastman Kodak Longview, Texas 75601	2-27-70	DH
234.	Endurall Coatings	3333 10th Avenue North Birmingham, Ala. 35205	2-27-70	DH
235.	Pabco Paint	P. O. Box 8502 Emmryville, Calif. 94608	2-27-70	DH
236.	H. B. Fuller Co.	2400 Kasota Ave. St. Paul, Minn. 55108	2-27-70	DH
237.	Gard Industries	1970 Estes Blvd. Elk Grove Village, Ill. 60007	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
238.	Gates Engr. Co.	200 W. 9th St. P. O. Box 1711 Wilmington, Del. 19899	2-27-70	DK
239.	Geigy Chemical Corp.	Saw Mill River Road Ardsley, N. Y. 10702	2-27-70	DK
240.	Gemini Products	P. O. Box 82607 Oklahoma City, Okla. 73108	2-27-70	DK
241.	Sylvania Elec. Prod., Inc.	Emporium, Pa. 15834	2-27-70	DK
242.	General Foam	109 Kero Rd. Carlstadt, N. J. 07072	2-27-70	DK
243.	General Motors Corp. Ternstedt Div.	30007 Van Dyke Ave. Warren, Mich. 48090	2-27-70	DK
244.	General Motor Corp.	Inland Division Dayton, Ohio	2-27-70	DK
245.	Genesco, Inc.	61st & Centennial Blvd. Nashville, Tenn. 37209	2-27-70	DK
246.	General Latex & Chem. Corp.	666 Main St. Cambridge, Mass. 02139	2-27-70	DK
247.	General Motors Corp. Research Lab	Box 388 Warren, Mich. 48090	2-27-70	DK
248.	General Electric	Coshocton, Ohio 43812	2-27-70	DK
249.	General Electric	1430 E. Fairchild St. Danville, Ill. 61832	2-27-70	DK
250.	General Electric	1 Plastic Avenue Pittsfield, Mass. 01201	2-27-70	DK
251.	General Tire & Rubber Co.	1708 Englewood Ave. at Holmes St. Akron, Ohio 44305	2-27-70	DK
252.	Gentex Corp.	Maine & Simpson Sts. Carbondale, Pa. 18407	2-27-70	DK
253.	P. D. George Co.	5200 North Second St. St. Louis, Mo. 63107	2-27-70	DK
254.	Gerin Mfg. Co.	683 N. 5th St. Newark, N. J. 07107	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
255.	Germain C. Crossmen	23 Esternay Lane Pittsford, N. Y. 14534	2-27-70	DH
256.	Giles Varnish Co.	109-09 15th Ave. College Point, N. Y. 11356	2-27-70	DH
257.	Girdler Thermex Div.	P. O. Box 96 Carlton Hill, N. J.	2-27-70	DH
258.	Given Paint Mfg. Co.	111 North Piedras El Paso, Texas 79905	2-27-70	DH
259.	Gleam Chem. Prod., Inc.	Box 448 Austin, Texas 78767	2-27-70	DH
260.	Glenco Corp.	200 Durham Avenue Metuchen, N. J. 08840	2-27-70	DH
261.	Globe Woven Belting	1400 Clinton St. Buffalo, N. Y. 14206	2-27-70	DH
262.	Glue Specialties	East Ontario & Bath Sts. Philadelphia, Pa. 19134	2-27-70	DH
263.	B. F. Goodrich Co. Sponge Rubber Prods. Div.	P. O. Box 433 Derby, Conn. 06485	2-27-70	DH
264.	Goodyear Tire & Rubber Co.	1144 East Market St. Akron, Ohio 44316	2-27-70	DH
265.	W. R. Grace & Co. Const. Prods. Div.	6051 W. 6th St. Chicago, Ill. 60638	2-27-70	DH
266.	Marco Chem. Div. W. R. Grace Co.	1711 W. Elizabeth Linden, N. J. 07036	2-27-70	DH
267.	W. R. Grace & Co. A. C. Horn Div.	2133 85th St. N. Bergen, N. J. 07047	2-27-70	DH
268.	Hampshire Mfg. Co.	Factory Street Nashua, N. H. 03060	2-27-70	DH
269.	Grand Trunk WRR Co.	c/o Gen. Supt. MP & Car Equipment Battle Creek, Mich. 49015	2-27-70	DH
270.	Graniteville Co.	Graniteville, S. C. 29829	2-27-70	DH
271.	Grignard Chem. Co.	23 S. Front St. Elizabeth, N. J. 07202	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
272.	Gr. Lakes Dental Lab.	17138 W. McNichols Detroit, Mich. 48235	2-27-70	DX
273.	Gulton Industries	312 Durham Ave. Metuchan, N. J. 08840	2-27-70	DX
274.	Jaime C. Guttman	Wagner Circle Clark Shores Palm Beach, Fla. 33406	2-27-70	DX
275.	Guyan Mach. Co.	P. O. Box 156 Logan, W. Va. 25601	2-27-70	DX
276.	H. E. Wisdom	10270-T Pacific Ave. Franklin Park, Ill. 60131	2-27-70	DX
277.	H. H. Robertson Co.	1107 Two Gateway Center Pittsburgh, Pa. 15222	2-27-70	DX
278.	Hadley Adhesives & Chem. Co.	514 Calvery Ave. St. Louis, Mo. 63147	2-27-70	DX
279.	Hallett Construction	P. O. Box 13 Boone, Ia. 50036	2-27-70	DX
280.	Hallmark Cards	P. O. Box 437 Kansas City, Mo. 64141	2-27-70	DX
281.	Hardman, Inc.	600 Cortlandt St. Belleville, N. J. 07109	2-27-70	DX
282.	Lake Chemical Co.	P. O. Box 112 Chicago, Ill. 60690	2-27-70	DX
283.	Harshaw Chemical Co.	19200 Villaview Road N.E. Cleveland, Ohio 44119	2-27-70	DX
284.	Hartin Paints & Filler	590 Belleville Turnpike Kearny, N. J. 07032	2-27-70	DX
285.	Hart Manufacturing	Malvern Ave. Hot Springs, Ark. 71901	2-27-70	DX
286.	Haskell Chemical	6101 Staples Mills Rd. Richmond, Va. 94806	2-27-70	DX
287.	Hastings & Co.	2314 Market Philadelphia, Pa. 19103	2-27-70	DX
288.	Hawley Products Co.	333-39 North 6th St. St. Charles, Ill. 60174	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
289.	Heat Tapes, Inc.	1812 S. Halstedt. St. Chicago Heights, Ill. 60411	2-27-70	DK
290.	Helene Curtis Ind. Protective Treatment	4401 N. North Avenue Chicago, Ill. 60639	2-27-70	DK
291.	Hempels Marine Paint, Inc.	25 Broadway New York, N. Y. 10004	2-27-70	DK
292.	Hercules, Inc.	900 Market St. Wilmington, Del. 19801	2-27-70	DK
293.	Haveg Corp.	900 Greenbank Road Wilmington, Del. 19808	2-27-70	DK
294.	Hercules Packaging Corp.	11061 Walden Road Alden, N. Y. 14004	2-27-70	DK
295.	Hexagon Laboratories	3536 Peartree Ave. Bronx, N. Y. 10469	2-27-70	DK
296.	Hi-Strand Chemicals	P. O. Box 368 Lenoir, N. C. 28645	2-27-70	DK
297.	Hickory Adchem	P. O. Box 1451 Hickory, N. C. 28601	2-27-70	DK
298.	High Strength Plastics	1407 W. Jackson Chicago, Ill. 60607	2-27-70	DK
299.	Hilton-Davis Chem. Co., Div. Sterling Drug, Inc.	2235 Langdon Garm Road Cincinnati, Ohio 45237	2-27-70	DK
300.	H. & M. Plastics	129 South Second St. Philadelphia, Pa. 19106	2-27-70	DK
301.	Hoboken Paints, Inc.	40 Industrial Road Lodi, N. J. 04674	2-27-70	DK
302.	Hollingsworth & Vose Co.	112 Washington St. East Walpole, Mass. 02032	2-27-70	DK
303.	Holliston Mills of Tenn., Inc.	Kingsport, Tenn. 37662	2-27-70	DK
304.	Holz Rubber Mfg. Co.	1129 So. Sacramento St. Lodi, California 95240	2-27-70	DK
305.	Honeywell Test In Div.	P. O. Box 5227 Denver, Colo. 80217	2-27-70	DK
306.	Hooker Chemical Corp.	P. O. Box 344 Niagara Falls, N.Y. 14305	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
307.	Grow Chem. Coatings	1246 West 70th St. Cleveland, Ohio 44102	2-27-70	DX
308.	Howmet Corp. Misco Div.	1713 Seventh St. Muskegon, Mich. 49443	2-27-70	DX
309.	Humphrey Chem.	Devine St. No. Haven, Conn. 06473	2-27-70	DX
310.	Fuller O'Brien Corp.	450 East Grand Ave. So. San Francisco, Calif. 94080	2-27-70	DX
311.	Hysol Div. Dexter Corp.	Olean, N. Y. 14760	2-27-70	DX
312.	Illinois Bronze	300 E. Main Lake Zurich, Ill. 60047	2-27-70	DX
313.	Illinois Adhesive Prod. Co.	3101 S. California Chicago, Ill. 60608	2-27-70	DX
314.	Indurall Coatings	P. O. Box 2371 Birmingham, Ala. 35201	2-27-70	DX
315.	Industrial Chem. Div. Allied Chem.	P. O. Box 218 Riegelwood, N. C. 28456	2-27-70	DX
316.	Industrial Coated Prods. of Am.	P. O. Box 3285 Bristol, Tenn. 37620	2-27-70	DX
317.	Industrial Latex	306 North Pleasant Ave. Wallington, N. J. 07055	2-27-70	DX
318.	Industrial Roll Co.	1613 Guilford Ave. Baltimore, Md. 21202	2-27-70	DX
319.	Industrial Synthetic Adhesives Co.	Rear of 4120 Holly Hills St. Louis, Mo. 63116	2-27-70	DX
320.	Inland Steel Co.	East Chicago, Ill.	2-27-70	DX
321.	Inmont Corp.	707 East 62nd St. Los Angeles, Calif. 90001	2-27-70	DX
322.	Inmont Corp.	4168 Meramec St. Louis, Mo. 63116	2-27-70	DX
323.	Inmont Corp.	475 Division St. Elizabeth, N. J. 07201	2-27-70	DX
324.	Institute Gas Tech.	17 West 34th St. Chicago, Ill. 60616	2-27-70	DX

NAME	ADDRESS	DATE MAILED	PER
325. Intercoastal Corp.	1300 Walnut St. E. St. Louis, Ill. 62201	2-27-70	BX
326. Inter-Coastal Corp.	Dundalk P. O. Baltimore, Md. 21222	2-27-70	BX
327. International Paint Co.	South Linden Ave. So. San Francisco, Calif. 94080	2-27-70	BX
328. International Shoe	P. O. Box 14260 St. Louis, Mo. 63178	2-27-70	BX
329. Int'l. Bus. Machine Corp.	P. O. Box 6 Endicott, N. Y. 13760	2-27-70	BX
330. I-Sis Chemicals, Inc.	P. O. Box 685 Springdale, Conn. 06907	2-27-70	BX
331. J. I. Holcomb Mfg. Co. Premier Indust. Corp.	1601 Barth Ave. Indianapolis, Ind. 46207	2-27-70	BX
332. Jaegle Paint & Varnish Co.	19th & Hayes Ave. Camden, N. J. 08105	2-27-70	BX
333. Jamestown Finishes	125 Blackstone Ave. Jamestown, N. Y. 14701	2-27-70	BX
334. Jewel Paint & Varnish Co.	345 N. Western Ave. Chicago, Ill. 60612	2-27-70	BX
335. Jema American, Inc.	824 South Avenue Middlesex, N. J. 08846	2-27-70	BX
336. John H. Witte & Son	Burlington, Iowa 52601	2-27-70	BX
337. John Lucas & Co., Inc.	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	BX
338. Johns Manville Research Center	Manville, N. J. 08835	2-27-70	BX
339. Chicopee Mfg. Co.	Milltown, N. J. 08850	2-27-70	BX
340. Johnson & Johnson	501 George New Brunswick, N. J. 08901	2-27-70	BX
341. Permacel	U. S. Highway No. 1 New Brunswick, N. J. 08903	2-27-70	BX
342. Johnson Plastic	P. O. Box 100 Chagin Falls, Ohio 44022	2-27-70	BX

NAME		ADDRESS	DATE MAILED	PER
343.	Jones Chem. Co.	1901 W. Commerce Dallas, Texas 75208	2-27-70	DH
344.	Jordon Paint Co.	7250 Franklin Forest Park, Ill. 60130	2-27-70	DH
345.	Joslyn Mfg.	3700 South Morgan Chicago, Ill. 60609	2-27-70	DH
346.	Joslyn Mfg. Co.	Pinco Div. Lima, N. Y. 14485	2-27-70	DH
347.	Kaiser Chemical Research Lab	1945 Davis St. San Leandro, Calif. 94577	2-27-70	DH
348.	Kansas Paint & Color Co.	132 North Mosley Wichita, Kansas 67202	2-27-70	DH
349.	Kare Prod. Co., Inc.	214 South Feltus St. South Amboy, N. J. 08879	2-27-70	DH
350.	Kawecki Berylco Ind., Inc.	P. O. Box 60 Boyertown, Pa. 19512	2-27-70	DH
351.	Kee Lox Mfg.	P. O. Box 137 Rochester, N. Y. 14601	2-27-70	DH
352.	Kendall Company Bauer & Black Div.	2500 S. Dearborn St. Chicago, Ill. 60616	2-27-70	DH
353.	Kenrich Petrochemicals Inc.	Foot of East 22nd St. Bayonne, N. J. 07002	2-27-70	DH
354.	Kentucky Thermo Plastics	St. John Road Elizabethtown, Ky. 42701	2-27-70	DH
355.	Kerns United	824 State St. Calumet City, Ill. 60409	2-27-70	DH
356.	Key Polymer Corp.	275 Lowell St. Lawrence, Mass. 01840	2-27-70	DH
357.	Keystone Lubricating	21st & Clearfield Sts. Philadelphia, Pa. 19134	2-27-70	DH
358.	Keystone Refining Co.	4821 Garden St. Philadelphia, Pa. 19137	2-27-70	DH
359.	Killark Electric	3940 Easton St. Louis, Mo. 63113	2-27-70	DH
360.	Kimberly Clark Corp.	P. O. Box 31 Neenah, Wisc.	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
361.	George Koch & Sons	P. O. Box 385 Evansville, Ind.	2-27-70	DX
362.	Kohler McLister Pt.	P. O. Box 546 Denver, Colo.	2-27-70	DX
363.	Koppers Co.	750 Koppers Bldg. Pittsburgh, Pa.	2-27-70	DX
364.	Lakeside Plastics Corp.	P. O. Box 1007 Oshkosh, Wisc.	2-27-70	DX
365.	Lava Corp.	1650 W. Irving Park Rd. Chicago, Ill. 60613	2-27-70	DX
366.	Leepoxy Plastics	Ferguson Rd. & Baer Rd. Fort Wayne, Ind. 46809	2-27-70	DX
367.	Libby-Owens-Ford Co.	811 Madison Ave. Toledo, Ohio 43624	2-27-70	DX
368.	Lilly Industrial Coatings, Inc.	666 South California Indianapolis, Ind. 46225	2-27-70	DX
369.	Liquid Nitrogen Proc. Corp.	412 King St. Malvern, Pa. 19355	2-27-70	DX
370.	Litho Chem. & Sup.	46 Harriet Place Lynbrook, L.I., N.Y. 11563	2-27-70	DX
371.	Fitchburg Coated Products	P. O. Box 1106 Scranton, Pa. 18501	2-27-70	DX
372.	Litton Industries	336 N. Foothill Road Beverly Hills, Calif. 90213	2-27-70	DX
373.	The Livingston Co. c/o Roisman Prods. Co.	207 S. Compress Oklahoma City, Okla. 73125	2-27-70	DX
374.	Lloyd Studios	419 First Ave. New York, N. Y. 10009	2-27-70	DX
375.	L & M Const. Chemical	404 Pierce Omaha, Nebraska 68108	2-27-70	DX
376.	Lord Corp.	1635 West 12th St. Erie, Pa. 16505	2-27-70	DX
377.	Ludlow Corp.	Fine Papers Div. Ware, Mass. 01082	2-27-70	DX
378.	M. R. Plastics & Coatings	11460 Dorsett Road Maryland Heights, Mo. 63042	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
379.	M. Shiller Corp.	87 North 12th St. Brooklyn, N. Y. 11211	2-27-70	DH
380.	Maas & Waldstein	1221 McCarter Highway Newark, N. J. 07104	2-27-70	DH
381.	Mace Adhesives & Coatings	48 Berlin Road Cromwell, Conn. 06416	2-27-70	DH
382.	Magid Corporation	350 Cantor Ave. Linden, N. J. 07036	2-27-70	DH
383.	Magie Bros.	9101 Fullerton Franklin Park, Ill. 60131	2-27-70	DH
384.	Magnolia Plas.	5547 Peachtree Ind. Blvd. Chamblee, Ga. 30341	2-27-70	DH
385.	Manhattan Adhesives Corp.	425 Greenpoint Ave. Brooklyn, N. Y. 11222	2-27-70	DH
386.	Marbleloid	2046 88th St. North Bergen, N. J. 07047	2-27-70	DH
387.	Marine Industrial Paint Co.	6998 49th St. N. Pinellas Park, Fla. 33565	2-27-70	DH
388.	Marks Polarized Co.	453 16 Tenth Ave. Whitestone, L.I., N.Y. 11357	2-27-70	DH
389.	Martin Cantine Co.	Saugerties, N. Y. 12477	2-27-70	DH
390.	Martin Marietta Corp.	Sand Lake Road Orlando, Fla. 32805	2-27-70	DH
391.	Sinclair & Valentine	201 E. 16th Ave. N. Kansas City, Mo. 64108	2-27-70	DH
392.	Maryland House of Correction	Jessups, Md. 20794	2-27-70	DH
393.	Master Builders	2490 Lee Blvd. Cleveland, Ohio 44118	2-27-70	DH
394.	Matcote Company	P. O. Box 10762 Houston, Texas 77018	2-27-70	DH
395.	Matthews Paint Co.	400 S. Mercantile Court Wheeling, Ill. 60090	2-27-70	DH
396.	Mautz Pt. & Varnish	939 E. Washington Ave. Madison, Wisc. 53703	2-27-70	DH
397.	McCloskey Varn. Co.	7600 State Road Philadelphia, Pa. 19136	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
398.	McCormick Dental Lab.	17006 W. Warren Detroit, Mich. 48228	2-27-70	DH
399.	Medtronic, Inc.	3055 Old Highway Eight Minneapolis, Minn. 55418	2-27-70	DH
400.	Micalline Product	1513 Lyon St. Columbia, S. C. 29204	2-27-70	DH
401.	Michigan Chrome & Chem. Co.	8615 Grinnell Ave. Detroit, Mich. 48213	2-27-70	DH
402.	Michigan Plastic Prod., Inc.	Grand Haven, Mich. 49417	2-27-70	DH
403.	Micro Switch	Freeport, Ill. 61033	2-27-70	DH
404.	Midland Adhesive Chem. Corp.	14100 Stansbury Detroit, Mich. 48227	2-27-70	DH
405.	Midland Div. Dexter Corp.	East Water St. Waukegan, Ill. 60085	2-27-70	DH
406.	Midwest Rubber	Box 744 East St. Louis, Ill. 62202	2-27-70	DH
407.	Mine Safety Appliances	Braddock Thomas & Mead St. Pittsburgh, Pa. 15221	2-27-70	DH
408.	Minnesota Mining	2501 Hudson Road St. Paul, Minn. 55101	2-27-70	DH
409.	Minnesota Paints	1101 Third St. South Minneapolis, Minn. 55415	2-27-70	DH
410.	Miracle Adhesives Corp.	250 Pettit Ave. Bellmore, N. Y. 11710	2-27-70	DH
411.	Mobil Chemical Co.	P. O. Box 1388 Plainfield, N. J.	2-27-70	DH
412.	Monarch Rubber Co.	3500-22 Pulaski Hwy. & Corkling Sts. Baltimore, Md. 21224	2-27-70	DH
413.	Wood Treating Chem. Co.	5137 Southwest Ave. St. Louis, Mo. 63110	2-27-70	DH
414.	Standard T Chem Co.	2600 Richmond Terrace Staten Island, N.Y. 10303	2-27-70	DH
415.	Benj. Moore & Co.	134 Lister St. Newark, N. J. 07105	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
416.	Morris Paint & Varnish	1823 Washington St. Louis, Mo. 63103	2-27-70	DY
417.	J. W. Mortell	144 Grant St. Perth Amboy, N. J. 08861	2-27-70	DY
418.	Morton Chem.	110 N. Wacker Drive Chicago, Ill. 60606	2-27-70	DY
419.	Nashua Corporation	44 Franklin St. Nashua, N. H. 03060	2-27-70	DY
420.	National Chemical & Plastics Co.	1424 Philpot St. Baltimore, Md. 21231	2-27-70	DY
421.	Nat'l. Cash Register	Main & K Streets Dayton, Ohio 45409	2-27-70	DY
422.	Nat'l. Floor Prod. Co.	P. O. Box 354 Florence, Ala. 35630	2-27-70	DY
423.	Baker Castor Oil Co.	35 Avenue A Bayonne, N. J. 07002	2-27-70	DY
424.	Nat'l. Lead Co.	P. O. Box 831 Perth Amboy, N. J. 08862	2-27-70	DY
425.	National Starch & Chem. Corp.	1735 West Front St. Plainfield, N. J. 07063	2-27-70	DY
426.	Nazar Rubber Co.	2727 Avondale Toledo, Ohio 43607	2-27-70	DY
427.	Nelson Oil Co.	P. O. Box 795 Lenoir, N. C.	2-27-70	DY
428.	New York Bronze Powder Co.	519 Dowd Ave. Elizabeth, N. J. 07201	2-27-70	DY
429.	Niagara Rubber Co.	Front St. S. Plainfield, N. J.	2-27-70	DY
430.	Nichols Industries, Inc.	P. O. Box 1191 Jacksonville, Texas	2-27-70	DY
431.	Niles Chem. Paint	Third & Front Niles, Mich.	2-27-70	DY
432.	North American Rockwell	Route 69 By Pass NE McAlster, Okla. 74501	2-27-70	DY
433.	North American Rockwell	P. O. Box 309 Canoga Park, Calif.	2-27-70	DY
434.	North Electric	Portland Way North Galion, Ohio 44833	2-27-70	DY

NAME		ADDRESS	DATE MAILED	PER
435.	Norton Company	1 New Bond St. Worcester 6, Mass.01606	2-27-70	DH
436.	Novagard Corp.	835 New York Ave. Trenton, N. J. 08638	2-27-70	DH
437.	Numec	609 Warren Ave. Apallo, Pa. 15613	2-27-70	DH
438.	Olin Corp.	P. O. Box 547 Brandenburg, Ky. 40108	2-27-70	DH
439.	Olin Mathieson Corp.	Winchester Plant New Haven, Conn. 06517	2-27-70	DH
440.	O'Neil Duro Co.	P. O. Box 1166 Milwaukee, Wisc. 53201	2-27-70	DH
441.	Onyx Chem. Co.	190 Warren St. Jersey City, N. J. 07302	2-27-70	DH
442.	Ore-Lube Corp.	126-06 18th Avenue College Point, N. Y. 11356	2-27-70	DH
443.	Oscar Mayer	910 Mayer Ave. Madison, Wisc. 53701	2-27-70	DH
444.	Owens Illinois	1510 North Westwood Ave. Toledo, Ohio 43607	2-27-70	DH
445.	Owens Corning Fiber-glas Corp.	Granville Technical Center Granville, Ohio 43023	2-27-70	DH
446.	Owens Corning Fiber-glas Corp.	Case Avenue Newark, Ohio 43055	2-27-70	DH
447.	Packaging Corp. of Am.	415 E. Fulton St. Grand Rapids, Mich. 49502	2-27-70	DH
448.	Palm Bros. Decal-comania Co.	Spencer Regent & Lexington Cincinnati, Ohio 45212	2-27-70	DH
449.	Panatlas Corp.	Woolworth Bldg. 233 Broadway New York, N. Y. 10007	2-27-70	DH
450.	Parker Stearns & Co.	300 Sheffield Ave. Brooklyn, N. Y. 11207	2-27-70	DH
451.	Park Name Plate Co.	3410-10 Linden Pl. Flushing, L.I., N.Y. 11354	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
452.	Parr Paint & Sealants Co.	5151 Denison Ave. Cleveland, Ohio 44102	2-27-70	DH
453.	W. M. Parr & Co.	310 State Hwy. No. 10 Hanover, N. J. 07936	2-27-70	DH
454.	Penn-Jersey Paint & Varnish Co.	1256 McCarthy Highway Newark, N. J. 07104	2-27-70	DH
455.	Penwalt Corp.	Lincoln Hwy. East of State St. Chicago Heights, Ill. 60411	2-27-70	DH
456.	Polytech Coatings Corp.	35 High Ridge Rd. Dover, N. J. 07801	2-27-70	DH
457.	Penn Poly Corp.	Route 611 Mount Bethel, Pa. 18343	2-27-70	DH
458.	Penn Refining	2686 Lisbon Road Cleveland, Ohio 44104	2-27-70	DH
459.	Pennzoil Co.	Drake Bldg. Oil City, Pa. 16301	2-27-70	DH
460.	Pentalic Corp.	132 West 22nd St. New York, N. Y. 10011	2-27-70	DH
461.	Permatex Co., Inc.	3255 Harvester Road Kansas City, Kansas 66115	2-27-70	DH
462.	Perry Brothers	6112 32nd Ave. Woodside, L.I., N.Y. 11377	2-27-70	DH
463.	Pettys Exterminating	1515 S. Pulaski Road Chicago, Ill. 60623	2-27-70	DH
464.	Phillips Petroleum	1245 Adams Bldg. Bartlesville, Okla. 74003	2-27-70	DH
465.	Photocircuits Corp.	31 Sea Cliff Ave. Glen Cove, N. Y. 11542	2-27-70	DH
466.	Photolastic, Inc.	67 Lincoln Highway Malvern, Pa. 19355	2-27-70	DH
467.	Pierce & Stevens Chem. Corp.	710 Ohio St. Buffalo, N. Y. 14203	2-27-70	DH
468.	Pigment Dispersions	29 Meridian Rd. Iselin, N. J. 08830	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
469.	PPG Industries, Inc.	One Gateway Center Pittsburgh, Pa. 15222	2-27-70	DK
470.	Plabell Rubber Prod., Inc.	318 So. St. Claire St. Toledo, Ohio 43604	2-27-70	DK
471.	Plastics Research & Dev. Co.	3619 Jenny Lind Fort Smith, Ark. 72901	2-27-70	DK
472.	Plough, Inc.	3022 Jackson Ave. Memphis, Tenn. 38101	2-27-70	DK
473.	DAP, Inc.	5300 Huberville Ave. Dayton, Ohio 45401	2-27-70	DK
474.	Plymouth Rubber Co.	Canton, Mass. 02021	2-27-70	DK
475.	Poly Resins, Inc.	P. O. Box 276 11655 Wicks St. Sun Valley, Calif. 91352	2-27-70	DK
476.	Poly Cast Corp.	69 Southfield Ave. Stamford, Conn. 06902	2-27-70	DK
477.	Polymel Corp.	514 Ensor St. Baltimore, Md. 21202	2-27-70	DK
478.	Polymer Corp.	125-7 Fifth St. Reading, Pa. 19601	2-27-70	DK
479.	Polymers Southern	Plant 4, P. O. Box 2184 Greenville, S. C. 29602	2-27-70	DK
480.	Polymer Ind.	Viaduct Road Springdale, Conn. 06907	2-27-70	DK
481.	Polyplastex United, Inc.	6200 49th St., North Pinellas Park, Fla. 33565	2-27-70	DK
482.	Polyshell Chem. Corp.	209 Pitkin Ave. Brooklyn, N. Y. 11207	2-27-70	DK
483.	H. K. Porter Co.	P. O. Box 1088 2300 North Lewis Tulsa, Okla. 74110	2-27-70	DK
484.	Porter Paint Co. Prod. Finishes Div.	1301 W. Kentucky St. Louisville, Ky. 40210	2-27-70	DK
485.	Premier Thermo Plastics Co.	Middletown Road Jeffersontown, Ky. 40299	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
486.	Premier Vacuum Process Corp.	58-87 55th St. Maspeth, L.I., N.Y. 11378	2-27-70	DH
487.	Prods. Research & Chem. Corp.	2919 Empire Ave. Burbank, Calif. 91504	2-27-70	DH
488.	Purdue Aeronautics	Purdue University Airport West Lafayette, Ind. 47906	2-27-70	DH
489.	Pyrolac Corp.	55 Schoon Ave. Hawthoren, N. J. 07507	2-27-70	DH
490.	Quaker Chem.	Lime Elm & Sandy Sts. Conshohocken, Pa. 19428	2-27-70	DH
491.	Quaker Oil Corp.	801 East Red Bud St. Louis, Mo. 63147	2-27-70	DH
492.	Quelcor, Inc.	Paper Mill Road Media, Pa. 19063	2-27-70	DH
493.	Radiant Color Div. Hercules, Inc.	2800 Radiant Ave. Richmond, Calif. 94804	2-27-70	DH
494.	Radiation Machinery Corp.	1280 Route 46 Parsippany, N. J. 07054	2-27-70	DH
495.	Radio Eng. Labs, Inc.	2901 Borden Avenue Long Island City, N. Y. 11101	2-27-70	DH
496.	Ram Chemicals Div.	P. O. Box 192 Gardena, Calif. 90247	2-27-70	DH
497.	Raritan Plastics	1 Raritan Road Oakland, N. J. 07436	2-27-70	DH
498.	Raybestos Manhattan, Inc.	61 Willett St. Passaic, N. J. 07055	2-27-70	DH
499.	Raychem Corp.	300 Constitution Ave. Menlo Park, Calif. 94025	2-27-70	DH
500.	Rubber Engineering & Mfg. Co.	P. O. Box 15392 Salt Lake City, Utah 84115	2-27-70	DH
501.	Reactive Metal Prods. Div. Howmet Corp.	555 Benstone Road Whitehall, Mich. 49461	2-27-70	DH
502.	Red Spot Paint & Varnish Co.	110-112 Main St. Evansville, Ind. 47708	2-27-70	DH
503.	Regal Finishing Co.	427 N. Hull Ave. Benton Harbor, Mich. 49022	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
504.	Reichhold Chemicals, Inc.	525 N. Broadway White Plains, N. Y. 10601	2-27-70	DH
505.	Reilly Whiteman Walton Co., Inc.	Conshohocken, Pa. 19428	2-27-70	DH
506.	I. Reiss & Co, Inc.	120 Bayway Ave. Elizabeth, N. J. 07202	2-27-70	DH
507.	Reliance Universal, Inc.	1901 Sheridan Road North Chicago, Ill. 60064	2-27-70	DH
508.	Repco Replacement Parts Co.	P. O. Box 40176 Everman, Texas 76140	2-27-70	DH
509.	Republic Dye & Chemical Corp.	60 S. Seiberling St. Akron, Ohio 44305	2-27-70	DH
510.	Republic Powdered Metals	2628 Pearl Road Medina, Ohio 44256	2-27-70	DH
511.	Research Molding & Film Co.	Route 1 Mendon, Mich. 49072	2-27-70	DH
512.	Fiberfil Corp.	Fox Farm Road Evansville, Ind. 47710	2-27-70	DH
513.	R. J. Reynolds Tobacco Co.	Winston-Salem, N.C. 27102	2-27-70	DH
514.	Reynolds Metals Co.	7734 Hall St. St. Louis, Mo. 63147	2-27-70	DH
515.	W. C. Richards Co.	3555 W. 123rd St. Blue Island, Ill. 60406	2-27-70	DH
516.	Richardson Chemical Cleaning Service	68 Liberty St. Metuchen, N. J. 08840	2-27-70	DH
517.	Robertshaw Control Co.	155 Hill St. Milford, Conn. 06460	2-27-70	DH
518.	G. P. Roeser	P. O. Box 92 Lahaska, Pa. 18931	2-27-70	DH
519.	Royal Lubricants Co.	River Road Hanover, N. J. 07936	2-27-70	DH
520.	Royal Typewriter Co., Inc.	1031 New Britain Ave. West Hartford, Conn. 06110	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
521.	Rubatex Corp., Div. Gr. American Ind.	Bedford, Va. 24523	2-27-70	DX
522.	Rubber Industries	Box 6 Shakopee, Minn. 55379	2-27-70	DX
523.	Rubbermaid, Inc.	Route 5 Wooster, Ohio 44691	2-27-70	DX
524.	Rubber Silicone Prods. Co.	Montesano Road Fairfield, N. J. 07006	2-27-70	DX
525.	S. C. Johnson & Son	1525 Howe St. Racine, Wisc. 43403	2-27-70	DX
526.	Glidden-Durkee Div. SMC Corp.	Union Commerce Bldg. Euclid & 9th Sts. Cleveland, Ohio 44115	2-27-70	DX
527.	Samuel Schmidt Chemical Co.	410 Frelinghuysen Ave. Newark, N. J. 07114	2-27-70	DX
528.	Sandoz Pharmaceuticals	P. O. Box 11 Hanover, N. J. 07936	2-27-70	DX
529.	Sandusky Abrasive Wheel Co., Div. Yates Mfg. Co.	441 W. Huron St. Chicago, Ill. 60610	2-27-70	DX
530.	Sapolin Co., Inc.	229 East 42nd St. New York, N. Y. 10017	2-27-70	DX
531.	Schenectady Chemicals Inc.	P. O. Box 1046 Schenectady, N.Y. 12301	2-27-70	DX
532.	Schermerborn Paint Prods.	1521 Hilton Road Ferndale, Mich. 48220	2-27-70	DX
533.	M. Schiller Corp.	87 N. 12th St. Brooklyn, N. Y. 11211	2-27-70	DX See 319
534.	Schramm Fiber Glass Prods.	2849 Montrose Ave. Chicago, Ill. 60618	2-27-70	DX
535.	Seaboard Chem. Corp.	Products Drive Texas, Md. 21030	2-27-70	DX
536.	DeSoto, Inc.	300 State St. Chicago Heights, Ill. 60411	2-27-70	DX
537.	Sem Products Co.	Shoreway Road & Sem Lane Belmont, Calif.	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
538.	Shallcross Co.	48th & Grays Ferry Ave. Philadelphia, Pa. 19131	2-27-70	DH
539.	Shawnee Plastics, Inc.	601 N. Ninth Ave. Evansville, Ind. 47707	2-27-70	DH
540.	Shell Chem. Co.	P. O. Box 500 Geismar, La. 70734	2-27-70	DH
541.	Acme Quality Paints, Inc.	8250 St. Aubin Detroit, Mich. 48211	2-27-70	DH
542.	Lowe Brothers	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	DH
543.	Sherwin Williams	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	DH
544.	Sigma Plastronics, Inc.	10319-21 Grand River Ave. Detroit, Mich. 48204	2-27-70	DH
545.	Simplex Wire & Cable Co.	79 Sidney St. Cambridge, Mass. 02139	2-27-70	DH
546.	Sinnet Lacquer Mfg. Co.	1378 N. Kingsland St. Louis, Mo. 63133	2-27-70	DH
547.	Smith Alsop Paint Co.	North 3rd St. & New York Central Railroad Terre Haute, Ind. 47801	2-27-70	DH
548.	Solar Compounds Corp.	Box 227 Linden, N. J. 07036	2-27-70	DH
549.	Sonneborn Building Prods.	Hancock Ave. Belleville, N. J. 07109	2-27-70	DH
550.	Sonoco Prod. Co.	Hartsville, S. C. 29550	2-27-70	DH
551.	Sou-Tex Chemical Co.	P. O. Box 866 Mt. Holly, N. C. 28120	2-27-70	DH
552.	Sparling Plastics	9229 General Court Plymouth, Mich. 48170	2-27-70	DH
553.	Spartan Electronics	2400 E. Ganson St. Jackson, Mich. 49202	2-27-70	DH
554.	Spencer Kellogg Div. Textron, Inc.	P. O. Box 807 Buffalo, N. Y. 14240	2-27-70	DH
555.	Remington Office Machines	333 Wilson Ave. So. Norwalk, Conn. 06854	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
556.	Sprayon Products, Inc.	26300 Fargo Ave. Bedford Heights, Ohio 44146	2-27-70	DH
557.	St. Clair Rubber Co.	Empire Building 107 Clifford St. Detroit, Mich. 48226	2-27-70	DH
558.	Staley Chem. Co.	320 Schuyler Ave. Kearny, N. J. 07032	2-27-70	DH
559.	UBS Chemical Div.	495 Main St. Cambridge, Mass. 02142	2-27-70	DH
560.	Esso Research & Eng. Co.	P. O. Box 243 Elizabeth, N. J. 07203	2-27-70	DH
561.	American Oil Co.	P. O. Box 401 Texas City, Texas 77590	2-27-70	DH
562.	Standard Packaging Co.	Forsgate Industrial Park Cranbury, N. J. 07821	2-27-70	DH
563.	Standard Drywall Prods.	Box 578 Bristol, Pa. 19007	2-27-70	DH
564.	Amoco Chemicals Corp.	130 East Randolph Chicago, Ill. 60601	2-27-70	DH
565.	Standard Pressed Steel	Jenkintown, Pa. 19046	2-27-70	DH
566.	Stanley Chem. Div.	77 Berlin St. East Berlin, Conn. 06023	2-27-70	DH
567.	Paisley Pro-Div.	1153 Bloomfield Ave. Clifton, N. J. 07012	2-27-70	DH
568.	Star Chemical	9830 Derby Lane Westchester, Ill. 60153	2-27-70	DH
569.	State Chem. Co.	205-207 Polk St. Amarillo, Texas 79107	2-27-70	DH
570.	Sterling Lacquer Mfg. Co.	3150 Brannon St. Louis, Mo. 63139	2-27-70	DH
571.	H. B. Stuck Adhesives, Inc.	3327 Chartres St. New Orleans, La. 70117	2-27-70	DH
572.	Sullivan Co.	212 East Trigg Ave. Memphis, Tenn. 38102	2-27-70	DH
573.	Sun Chem.	631 Central Ave. Carlstadt, N. J. 07072	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
574.	Sun Chem. Corp. Gen. Printing Co.	390 Central Ave. E. Rutherford, N.J. 07073	2-27-70	DK
575.	Sun Oil Co.	1608 Walnut St. Philadelphia, Pa. 19103	2-27-70	DK
576.	Sun Chem. Corp.	750 Third Ave. New York, N. Y. 10017	2-27-70	DK
577.	Sunolin Chem. Co.	North Claymont, Del. 19703	2-27-70	DK
578.	Sunflo Paint	P. O. Box 227 Amsterdam, N. Y. 12010	2-27-70	DK
579.	Super Tire Engineering Co.	7255 Crescent Blvd. Camden, N. J. 08110	2-27-70	DK
580.	Supronics Corp.	100 Dorsa Ave. Livingston, N. J. 07039	2-27-70	DK
581.	W. J. Sutcliffe Co.	P. O. Box 5 E. Rutherford, N.J. 07073	2-27-70	DK
582.	Swift & Co.	115 West Jackson Blvd. Chicago, Ill. 60604	2-27-70	DK
583.	Talon Adhesives	160 Passaic Ave. Kearny, N. J.	2-27-70	DK
584.	Charles S. Tanner Co.	450 Furman Hall Rd. Greenville, S. C. 29608	2-27-70	DK
585.	Technical Tape Corp.	1 LeFevre Lane New Rochelle, N. Y. 10801	2-27-70	DK
586.	Tech. Coatings	1056 Walsh St. Santa Clara, Calif. 95050	2-27-70	DK
587.	Technical Coatings Co., Benj. Moore Co.	134 Lister Ave. Newark, N. J. 07105	2-27-70	DK
588.	Technical Sealants & Adhesives	43 East Water St. St. Paul, Minn. 55107	2-27-70	DK
589.	Technological Lab, Inc.	P. O. Box 395 Ozark, Mo. 65721	2-27-70	DK
590.	Tenneco Chemicals	9001 Randolph Houston, Texas 77017	2-27-70	DK
591.	Tenneco Chemicals, Inc.	P. O. Box 51 Reading, Pa. 19603	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
592.	Texas Rubber & Specialty Corp.	930 Adele St. Houston, Texas 77016	2-27-70	DK
593.	Tex F Tessier	P. O. Box 656 Petaluma, Calif. 94952	2-27-70	DK
594.	Thieile Engdahl, Inc.	1100 Fairchild Winston-Salem, N.C. 27105	2-27-70	DK
595.	Thiem Prod.	9800 W. Rogers St. Milwaukee, Wisc. 53227	2-27-70	DK
596.	Thiokol Chem. Corp.	780 North Clinton Ave. Trenton, N. J. 08607	2-27-70	DK
597.	Tip Top Prods. Co.	1508 Burt St. Omaha, Neb. 68102	2-27-70	DK
598.	Titanine, Inc.	Morris & Elmwood Ave. Union, N. J. 07083	2-27-70	DK
599.	Tri-Wall Containers, Inc.	One DuPont St. Plainview, L.I., N.Y. 11803	2-27-70	DK
600.	Et Trotters Co.	939 Port Washington Port Washington, L.I., N.Y. 11050	2-27-70	DK
601.	Tru-Rite, Inc.	43 Hall St. Brooklyn, N. Y. 11205	2-27-70	DK
602.	Tull Chemical Co.	P. O. Box 246 Oxford, Ala. 36201	2-27-70	DK
603.	Wagner Electric	6400 Plymouth St. Louis, Mo. 63133	2-27-70	DK
604.	UMC Corp. Hermetitie Div.	245 Patterson Plank Rd. Carlstadt, N. J. 07072	2-27-70	DK
605.	U. S. Gypsum Co.	101 S. Wacker Drive Chicago, Ill. 60606	2-27-70	DK
606.	Palmer Products, Inc.	P. O. Box 33 Worcester, Pa. 19490	2-27-70	DK
607.	Ultra Chem., Inc.	1400 N. Walnut St. Wilmington, Del. 19809	2-27-70	DK
608.	Unimar, Inc.	3539 Pinemont Houston, Texas 77040	2-27-70	DK
609.	Union Camp Paper Corp.	793 N. Lathrop Ave. Savannah, Ga. 31401	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
610.	UPACO Adhesives, Inc.	1605 Hyde Park Ave. Hyde Park, Mass. 02136	2-27-70	DX
611.	Union Carbide Corp.	270 Park Ave. New York, N. Y. 10017	2-27-70	DX
612.	Uniroyal	312 N. Hill St. Mishawaka, Ind. 46544	2-27-70	DX
613.	United Resins Prods., Inc.	100 Sutton St. Brooklyn, N. Y. 11222	2-27-70	DX
614.	U. S. Steel	Homestead Steel Works Homestead, Pa. 15120	2-27-70	DX
615.	United Electric Controls Co.	85 School St. Watertown, Mass. 02172	2-27-70	DX
616.	United Lacquer Mfg. Corp.	1001 W. Elizabeth Ave. Linden, N. J. 07036	2-27-70	DX
617.	Universal Oil Prod. Co.	State Highway Route 17 E. Rutherford, N.J. 07073	2-27-70	DX
618.	U. S. Government Office In Charge	Naval Ordnance Laboratory 8050 George Ave. Silver Springs, Md. 20910	2-27-70	DX
619.	U. S. Government Printing Office	Purchasing Div. Washington, D. C. 20402	2-27-70	DX
620.	U. S. Government Dir. Procurement & Prod.	Bldg. 4455 Edgewood Arsenal, Md. 21010	2-27-70	DX
621.	U. S. Catheter & Instr. Corp.	P. O. Box 30 Glens Falls, N. Y. 12801	2-27-70	DX
622.	U. S. Paint Lacquer & Chemical Co.	2115 Singleton St. Louis, Mo. 63103	2-27-70	DX
623.	U. S. Tar Products	Lloyd Road Matawan, N. J. 07747	2-27-70	DX
624.	Vacuum Finishing	15615 W. High St. Middlefield, Ohio 44062	2-27-70	DX
625.	Varcraft Paint Co.	Keim & Cross Sts. Pottstown, Pa. 19464	2-27-70	DX
626.	Vernon Specialties, Inc.	42 River St. North Tarrytown, N.Y. 10591	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
627.	Viking Cooling Co.	15-20 129th St. College Point, N. Y. 11356	2-27-70	DK
628.	Vimasco Corp.	P. O. Box 465 Nitro, W. Va. 25143	2-27-70	DK
629.	Virginia Paint Mfg.	623 West 24th St. Norfolk, Va. 23517	2-27-70	DK
630.	Vulcan Materials Co.	P. O. Box 545 Wichita, Kansas 67201	2-27-70	DK
631.	W & M Mfg., Inc.	Geneva, Ind. 46740	2-27-70	DK
632.	Wallace & Tiernan, Inc.	Harchem Div., Box 178 Newark, N. J. 07101	2-27-70	DK
633.	Wallace Company	P. O. Box 1048 Gonzales, La. 70737	2-27-70	DK
634.	Warwick Chem. Co.	Sun Chem Prods. Div. Wood River Jct., R.I. 02894	2-27-70	DK
635.	Warwick Rubber Molding Corp.	Forester Ave. Warwick, N. Y. 10990	2-27-70	DK
636.	Welborn Paint Mfg. Co.	215 Roosmore Rd., SW Albuquerque, N. M. 87102	2-27-70	DK
637.	West Chester Chem. Co.	Box 39 West Chester, Pa. 19380	2-27-70	DK
638.	West Virginia Pulp & Paper	3400 E. Biddle Baltimore, Md. 21213	2-27-70	DK
639.	Westinghouse Elec. Co.	Industrial Plastics Div. Manor, Pa. 15665	2-27-70	DK
640.	Wetherill Chem.	820 Sherman Ave. Pensauken, N. J. 08110	2-27-70	DK
641.	White Rodgers Co.	9797 Reavis Road St. Louis, Mo. 63123	2-27-70	DK
642.	Wilhold Glues, Inc.	2943 W. Carroll Chicago, Ill. 60612	2-27-70	DK
643.	Willow Grafic, Inc.	2201 S. Wantagh Ave. Wantagh, L.I., N.Y. 11793	2-27-70	DK
644.	Wisconsin Elec. Coop.	1810 St. Part St. P. O. Box 686 Madison, Wisc. 53701	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
645.	Wisc. Rubber Prods., Inc.	P. O. Box 454 Union Grove, Wisc. 53182	2-27-70	DH
646.	Woburn Chem. Corp.	1200 Harrison Ave. Harrison, N. J. 07029	2-27-70	DH
647.	Wolverine Fabricating & Mfg. Co.	Princess St. & McRR Inkster, Mich. 48141	2-27-70	DH
648.	Wooster Finishes	Wooster, Ohio 44691	2-27-70	DH
649.	Walter Wurdack, Inc.	4977 Fyler Ave. St. Louis, Mo. 63139	2-27-70	DH
650.	Wyandotte Chemicals Corp.	Wyandotte, Mich. 48192	2-27-70	DH
651.	Xandadu Corporation	P. O. Box 537 Saddle River, N. J. 07458	2-27-70	DH
652.	Yates Mfg.	1615 W. 15th St. Chicago, Ill. 60608	2-27-70	DH
653.	Yoder Mfg.	1823 E. 17th St. Little Rock, Ark. 72202	2-27-70	DH
654.	Zenith Prods. Co.	9420 W. Byron St. Schiller Park, Ill. 60176	2-27-70	DH
655.	Outside Carpets, Inc.	P. O. Box 692 Rome, Ga. 30161	2-27-70	DH
656.	Raybestos Manhattan, Inc.	P. O. Box 1021 Bridgeport, Conn. 06602	2-27-70	DH
657.	Fiberfill Div. Dart Industries, Inc.	1701 N. Heidelbach Evansville, Ind. 47717	2-27-70	DH
658.	Cosden Chem. Coatings	P. O. Box 230 Norristown, Pa. 19405	2-27-70	DH
659.	Chrysler Corporation Chemical Division	5437 W. Jefferson Trenton, Mich. 48183	2-27-70	DH
660.	North Central Chem.	P. O. Box 3091 Eastside Sta. Madison, Wisc. 53704	2-27-70	DH
661.	Nelson Oil Co.	P. O. Box 795 Lenoir, N. C. 28645	3/2/70	CP

EXHIBIT 13

Monsanto

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

June 1, 1970

Dear Customer:

You have received our letter mailed February 27, 1970 notifying you of the allegations that certain polychlorinated biphenyls (PCBs) had been found in the environment and were contaminants. Since that time other reports concerning PCBs have been published. An examination of the PCB matter has indicated that their use in synthetic resin compositions may be a source of the alleged environmental contamination.

Monsanto has sold PCB-containing materials under the trade name of Aroclor®. These Aroclors® included:

Aroclor® 1232
Aroclor® 1242
Aroclor® 1248
Aroclor® 1254
Aroclor® 1260
Aroclor® 1262
Aroclor® 1268
Aroclor® 4465
Aroclor® 1100 Series
Montar® 1

Toluene or xylene blends of the above products also contained PCB.

EXHIBIT 56
WIT: [illegible]
DATE: 4-4-14
C. Campbell, RPR CRR CSR #13921

In review of the allegations which have been made concerning PCBs, and being a concerned and responsible member of the world community, we have come to a decision to discontinue the sale of PCB-containing products for modifier and plasticizer applications effective August 30, 1970.

Recognizing that this action will result in research effort on your part to ~~find~~ adequate replacements, we have prepared a series of data sheets outlining suggested alternatives for most applications. Copies of the report for your application may be obtained by calling the regional office closest to you as shown on the attached sheet.

We urge that you consider initiating now any necessary work on your part to effect the change to a new material. We stand ready to assist you in any way possible.

Very truly yours,

W. E. Schalk

W. E. Schalk
Director of Sales
Plasticizers

ek

Attachment

MONSANTO COMPANY
REGIONAL SALES OFFICES

Akron Marketing & Research Center
260 Springside Drive
Akron, Ohio
(216) 666-4111

Chicago Sales Office
3158 Des Plaines Avenue
Des Plaines, Illinois 60018
(132) 296-6688

Everett Plant
Everett Station
Boston, Massachusetts 02149
(617) 387-5010

New York Sales Office
277 Park Avenue
New York, New York 10017
(212) 922-4111

St. Louis Sales Office
800 North Lindbergh
St. Louis, Missouri 63166
(314) OX 4-1000

Wilmington Sales Office
2005 Concord Pike
Wilmington, Delaware 19803
(302) OL 8-6531

REPLACEMENT SUGGESTIONS FOR
AROCLORS 1232, 1242, 1248, 1254, 1260, 1262, 1268

The attached charts present the suggestions which Monsanto has put together for replacement of the Aroclors which we are withdrawing from the market. It should be noted that these suggestions are based primarily on their suitability to an application. The cost of using these replacements will range from being more expensive to less expensive.

REPLACEMENT SUGGESTIONS FOR MONSANTO AROCLORS

Resin	Application	Product Presently Used							Suggested Replacements
		1232	1242	1248	1254	1260	1262	1268	
Polysulfide	Automotive - Thermoset Acrylics			X	X				Santicizer 679, Santicizer 213, Aroclor 5442 or Aroclor 5460 with Santicizer 261 in this order. Bentonite may have to be used with Santicizer 679 and Santicizer 213 as a thickener.
	Light Construction			X	X	X	X		Replace Aroclor 1248 and Aroclor 1254 with Santicizer 261. Or use Aroclor 5442/5460 blends with Santicizer 160/261 to replace Aroclors 1248, 1254, 1260, 1262.
Chlorinated Rubber	Coatings			X	X	X			Where resistance to concentrated H_2SO_4 is required, use 2/1 blend of Aroclor 5460/5442. In other applications, use 2/1 blends of Aroclor 5460 and Santicizer 160, Santicizer 261, Santicizer 711.
	Adhesives				X	X			Blends of Aroclor 5460/Santicizer 160 or Santicizer 261.

REPLACEMENT SUGGESTIONS FOR MONSANTO AROCLORS

Resin	Application	Product Presently Used 1232	1242	1248	1254	1260	1262	1268	Suggested Replacements
Styrene Butadiene Rubber	Coatings				X				See chlorinated rubber, coatings for suggested starting points.
	Adhesives	X	X	X	X				DBP, Santicizer 160, Aroclor 1221
Polyvinyl Acetate	Emulsion Adhesives	X	X	X	X				Santicizer 218-A/885, Santicizer 160, Aroclor 1221, Santicizer 148
	Hot Melt Adhesives			X	X				Santicizer 160
								X	This is a flame retardant filler with good heat distortion characteristics. Possible replacements for Aroclor 1268 might be Aroclor 5460, TPP, Phosgard C-22-R, 2XC-20 (Development product)
Other	Miscellaneous	X	X	X	X	X	X		A 62% Aroclor 5460/38% Aroclor 1221 blend gives viscosity equal to Aroclor 1254. Maximum Aroclor 5460 concentration possible is 70%. Higher concentrations do not allow solution of Aroclor 5460 in Aroclor 1221.

EXHIBIT 14

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT, and WESTPORT COMMUNITY SCHOOLS, Plaintiffs, vs. MONSANTO COMPANY, SOLUTIA INC., and PHARMACIA CORPORATION, Defendants. ----------------------------	)))) Civil Action No.) 1:14-CV-12041-DJC))))))))

VIDEOTAPED DEPOSITION OF
FRANKLIN L. DORMAN, PH.D.
State College, Pennsylvania
Thursday, September 8, 2016

Reported by:
Stacey L. Daywalt
JOB NO. 111871

F. DORMAN, PH.D.

A. Well, I didn't say that.

Q. Well, I'm asking you.

There are dozens, perhaps hundreds, of other substances that contain chlorinated hydrocarbons in a room. Correct?

A. Not necessarily.

Q. I didn't say "necessarily."

There can be?

A. I'm saying necessarily.

It depends upon --

Q. That's not my question.

Can there be dozens of other chlorinated hydrocarbons in a room --

MR. LAND: Objection --

Q. -- whether they are from pesticides, solvents, fire retardants and so forth?

MR. LAND: Objection, incomplete hypothetical and misleading.

THE WITNESS: It's totally dependent upon the room. It's totally dependent upon the situation.

Q. My question is: Can there be dozens of other substances containing chlorinated hydrocarbons in the room?

MR. LAND: Same objections.

THE WITNESS: I'm going to just stay with my previous response.

It's totally dependent upon the situation.

Q. Okay. So using this Anniston method, can you tell me how you are going to control for those other substances in an effort to detect PCBs? What would you do?

A. Well, the first thing that I would do is have a proper blank.

Q. Okay.

A. Something that represents a control.

Q. Okay. You have a proper blank.

By the way, the blanks in this experiment showed the presence of chlorinated hydrocarbons, did they not?

A. Don't know.

Q. You didn't check that out?

A. Nope.

Q. That wasn't of interest to you, as a scientist?

A. It wasn't in the document.

Q. It wasn't?

knowledge of the Westport school.

Q. You don't?

A. No.

Q. Okay. Let's use any school. Okay? Any hypothetical school.

You're in the 1950s, you're a Monsanto scientist and you're using the Anniston method. Okay?

A. Mm-hmm.

Q. And you want to know whether there are PCBs in that school. Okay? Right?

A. (Indicating affirmatively.)

Q. So how is it that you are going to, using the Anniston method, determine that what you are seeing using the Anniston method are PCBs as opposed to some other chlorinated hydrocarbon?

A. In the 1950s?

Q. Yes.

MR. LAND: Objection, lacks foundation.

THE WITNESS: In the 1950s, if you were in a school somewhere else, at some other location, and you were using the Anniston method, you would not be able to identify PCBs based upon that singular analysis.

Q. Okay. And the reason is because you?

A. You can't control for background.

Q. Okay. Now, you are giving testimony in this case as an analytical chemist. Is that correct?

A. Yes.

Q. And so you are not here to testify, and you're not an expert in such fields as toxicology?

A. No, I'm not.

Q. Health effects, if any, of PCBs?

A. No.

Q. Fate and transport of PCBs?

A. No.

Q. Polymer sciences?

A. No.

Q. PCB remediation?

A. No.

Q. You mentioned that you don't know anything about the Westport Middle School?

A. No, I have no specific knowledge

F. DORMAN, PH.D.

A. Yeah.

Q. Are you familiar with any, first of all, Monsanto document that suggested that this method, the Anniston method, could be used to detect PCB levels in ambient air at the nanogram level?

A. That it would have that level of sensitivity?

Q. Yes.

A. Not as they actually operated it in the description that they had.

Q. Are you familiar with any scientific literature that suggested -- from the 1950s and 1960s, that suggested that this method was sufficient -- the Anniston method was sufficiently sensitive to detect PCBs in ambient air at the nanogram level?

A. Not as written and not as specified in their operating procedure that they have listed.

Q. When was the first time that somebody conducted an experiment to measure PCBs volatilizing from caulk?

A. From what?

F. DORMAN, PH.D.

reasonable.

Q. Okay. Now, there are some problems with increasing sampling time, are there not? Methodological problems?

A. Practical limitations, yes.

Q. For one thing, interferences will accumulate, these other ambient sources of chlorinated hydrocarbons. Correct?

A. Assuming everything would probably come up.

Q. Conditions in the plant might change. Correct?

A. (Indicating affirmatively.)

Q. Is that yes?

A. Yes.

Q. Am I correct that you might saturate the combustor and the scrubber?

A. You'd have to conduct the experiment to know that.

Q. But that is a possibility. Correct?

A. At some point you probably would, but I'm not sure where that point would be.

Q. You don't know whether it would be after 100 hours or 150 hours or whatever?

F. DORMAN, PH.D.

A. I don't.

But you could always modify the scrubber as well.

Q. You'd also -- by the way, have you done any research on the experimental pumps used in the 1950s to determine whether there were reliability issues with running a pump for upwards to 525 hours?

A. No.

Q. But that would be a concern. Correct?

A. If you were trying to achieve improved detection limits by sampling time only, you'd want to know that the pump was stable or at least be able to monitor what it was doing during that time.

Q. And in any event, you have done no research to determine whether an experimental pump that would be used for these purposes would operate reliably for upwards to 525 hours. Correct?

A. No.

Q. You also mention increasing sampling rates. Is that correct?

F. DORMAN, PH.D.

A. Yes.

Q. Once again, with increasing sampling rates, interferences will accumulate. Correct?

A. You would be sampling more material.

Q. So you agree with me? Yes?

A. You would potentially increase everything, yes.

Q. And once again, you might have problems with saturating the combustor and scrubber?

A. Again, unknown. Depends. You'd have to do the experiment.

Q. Right. But in any event, you have not reviewed any scientific literature to determine when the combustor and scrubber would saturate in terms of the increased sampling rates. Correct?

A. That's correct.

Q. Nor with the increased sampling time. Correct?

A. That's correct.

Q. And of course going back to what was technologically available then, you would have to find a pump, an experimental pump, that

F. DORMAN, PH.D.

Q. Assuming hypothetically that that would be the rate at which you would have to operate the pump to increase the sampling rate to get a detection limit down to 1,000 nanograms per cubic meter, are you -- can you name a laboratory scale pump that was available in the 1950s and 1960s that was capable of doing that?

A. No.

Q. Am I correct that if you do increase the sampling rate to that level, you risk getting blow-through?

A. It would be a concern that you would have to evaluate when you adjusted the parameters of the experiment.

Q. And you're aware of no scientific data where that was quantitatively analyzed, that is to say increasing a pump rate to over 500 liters per minute would result in blow-through?

A. I'm not aware of any data.

Q. Did you do anything, sir, to verify, using the scientific method again, that you could use the Anniston method and increase sampling time and/or increase sampling rate and achieve detection limits down to 1,000 nanograms per cubic meter?

A. No, I've not personally used the Anniston method.

Q. Did you find anything in the scientific literature that would confirm that that would have been possible in the 1950s or 1960s using the Anniston method?

A. No.

Q. Now, I'm almost done with Page 2 of my outline.

You understand this case is about, among other things, volatilization of PCBs from solid matrixes, plastics -- referred to generally as plastics?

A. I understand it's -- that my role is to evaluate PCB analytical methodologies as related to volatilization from various media. I don't know whether I'd use the word "solids."

Q. Okay. Well, I'm talking about caulk and paint.

A. Yeah. I wouldn't necessarily consider caulk a solid.

F. DORMAN, PH.D.

Q. Okay. Whether you consider it a solid or not, caulk and paint, that's what I'm talking about. Okay?

A. Yeah.

Q. And are there a number of factors that would influence the rate and amount of volatilization from caulk or paint?

A. Certainly.

Q. Would one of those be what the matrix is, that is caulk versus paint versus mastic. Correct?

A. Would that affect the -- the what?

Q. The rate and amount of volatilization of PCBs.

A. I would suspect that it could, yes.

Q. Would other ingredients in the matrix affect the rate and amount of volatilization?

A. I would suspect that they could, yes.

Q. Would the amount of PCBs in that matrix affect the rate and amount of volatilization?

A. I would also say yes, once their

concentration in the material became high enough.

Q. Okay. By the way, would the molecular weight of the chemical, such as PCBs, affect the rate and amount of volatilization?

A. Not in and of itself.

So if you change from -- if you increase the molecular weight, let's say from a trichloro to a heptachloro, generally it's going to be less volatile, but it's not as simple as saying that that's universally true.

Q. Well, generally speaking, would the vapor pressure of a chemical affect the amount and rate at which it might volatilize once it's incorporated into a matrix?

A. Yes.

Q. Okay. And obviously, the lower the vapor pressure the less volatilization?

A. Yes, with all other things being constant.

Q. And we're going through what those other things are right now.

A. That's fine.

Q. Do you understand that?

F. DORMAN, PH.D.

A. Yep.

Q. Would the ambient air temperature affect the rate and amount of volatilization?

A. Yes.

Q. And obviously, the higher the temperature, the greater the volatilization?

A. Generally speaking, yes.

Q. Would the surface temperature on which the substance, whether it's caulk or paint, affect the rate and amount of volatilization?

A. I would assume that it would, yes.

Q. Would the surface area affect -- going back to surface temperature, the hotter the surface temperature, the higher the rate and amount of volatilization --

A. Yeah.

Q. -- all other things being equal?

A. That would be reasonable, yes.

Q. And the same with surface area.

The greater the surface area, the higher the rate and amount of volatilization. Is that correct?

A. No. That one's more complex.

F. DORMAN, PH.D.

So that is going to depend upon what the actual molecules are and how they move through the material and whether they're surface bound or have a relatively low depth of penetration versus if they're fully contained.

So it's not as simple as just greater surface area means greater loss. It's going to depend upon --

Q. The thickness of -- is that what you mean, the thickness of the --

A. Yeah, the thickness and also what the material actually is.

Q. The constituent parts of it?

A. The constituent parts and what the analyte are.

Q. How about, again, trying to figure out the extent to which PCBs might volatilize or the rate at which they might volatilize from a substance like caulk or paint?

You'd have to take into account, would you not, air exchange within the room you're measuring? Ventilation issues?

A. Well, that's a complex issue too, because it's going to depend upon whether or probably lead to more rapid volatilization than brushing.

Q. Are you aware of any scientific literature that tested the proposition of whether you could extrapolate volatilization of substances from paint to volatilization of substances from caulk?

A. I'm not aware of any literature that actually shows that correlation.

Q. Would it be fair to say that it's been -- based upon your research, it's been common knowledge in science and industry throughout most of the 20th century that plasticizers would volatilize from plastic products?

A. I think that's probably a fair statement.

Q. And certainly --

A. Actually, let me just pause for one second and say that volatilization is kind of a complex idea.

Like for instance, the phthalate plasticizers of drinking water bottles, I think you could argue whether that's actually

F. DORMAN, PH.D.

volatilization or just migration. But yes.

Q. It might be more leeching, as opposed to volatilization?

A. Yes.

Q. Okay. But generally speaking, scientists and people in the industry have known that plasticizers will volatilize from plastic products. Right?

A. Yeah, I think that's reasonable.

Q. And certainly sophisticated formulators of plastic products like caulk or paint, like Thiokol or Sherwin-Williams, those companies, is it your understanding, have their own teams of scientists and engineers who formulate their products?

MR. LAND: Objection, calls for speculation, lack of foundation.

THE WITNESS: Yeah, I don't have an intimate knowledge of those companies.

Q. But certainly your understanding is that formulators of those products would be aware that the plasticizers they're putting in their products will at some point volatilize?

MR. LAND: Objection, calls for

F. DORMAN, PH.D.

speculation, lacks foundation.

THE WITNESS: I mean, it's -- I would hope that they would.

Q. Okay.

A. But again, I'm aware that a lot of companies are essentially resellers.

So where the formulators actually exist, I mean, I don't know.

Q. What might vary would be the rate of volatilization, correct, depending upon all those factors that we discussed?

A. It could vary, yes.

Q. You're aware, are you not, that Monsanto advised its customers of the chemical properties of PCBs, including molecular weight, vapor pressure?

MR. LAND: Objection, lacks foundation.

THE WITNESS: Molecular weight would have been known because the molecules were specified.

But they were averages, so they weren't -- so they weren't -- it wasn't a detailed isomer knowledge. So they were

F. DORMAN, PH.D.

Do you agree with that?

A. I don't know actually. I don't have numbers for that to agree or disagree.

Q. Can you tell me whether -- or would you agree with me that PCBs do not have significant vapor pressures at temperatures below 200 to 250 degrees Celsius?

A. I can't tell you their exact numbers, but I know that you can elute them through a gas chromatograph at reasonably low temperatures, so...

Q. Well, could you answer my question?

Would you agree with me that PCBs do not have significant vapor pressure at temperatures below about 200 to 250 degrees Celsius?

MR. LAND: Objection, asked and answered.

THE WITNESS: Yeah, I don't know the answer.

Q. Next sentence, "This heated glass inlet was soon supplemented by a solids probe."

We've discussed that. Right?

A. Correct.

F. DORMAN, PH.D.

Q. No. That wasn't my question. Listen to my question.

A. I'm following up to answer your question.

So I'm not familiar with what vapor pressure range they evaluated for petroleum hydrocarbons, as Ron Hites points out.

But I would suspect that they could have gone to molecules with reasonably low vapor pressures, though I do not know.

MR. GOUTMAN: I move to strike as unresponsive.

Q. Can you cite any scientific paper which demonstrated in the 1950s that GC mass spec could successfully analyze substances with vapor pressures on the order of PCB vapor pressures?

MR. LAND: Objection, calls for speculation, lacks foundation.

THE WITNESS: No.

Q. It then goes on. I'm looking at the last two sentences of that paragraph, sir.

"Thus, Gohlke had demonstrated the concept of GC-MS, but it was not sustainable.

EXHIBIT 15

PRC®

1968 Annual Report

Products Research & Chemical Corporation

Polymers For Tomorrow

COMPANY DESCRIPTION

PRODUCTS RESEARCH & CHEMICAL CORPORATION manufactures polymer base chemical products and sells them in a broad range of industrial growth markets. Generally speaking, PRC products may be described as elastomeric compounds, adhesives, and coatings for the sealing and finishing of metals, leather, concrete, and many other surfaces and materials. All products are developed in the company's own research laboratories and are sold by our technically oriented sales force. Particular emphasis is placed on continued technical service to the customer. The company's proprietary polymers are utilized in the formulation of many products specifically developed to meet customer needs.

PRC products are produced and sold in foreign countries through manufacturing licensees and company-owned plants. Market acceptance dates back ten to fifteen years in most countries. In all the growth economies of the free world, PRC products are recognized as the standard of excellence in their field of application.

The outstanding feature of PRC's business is its activity in polymer development. The success of finished compounds for specific industrial purposes is dependent on the quality of the raw material. It is here that PRC's talent and other resources are largely concentrated so that the company may always maintain its technological lead.

CONTENTS

FINANCIAL HIGHLIGHTS

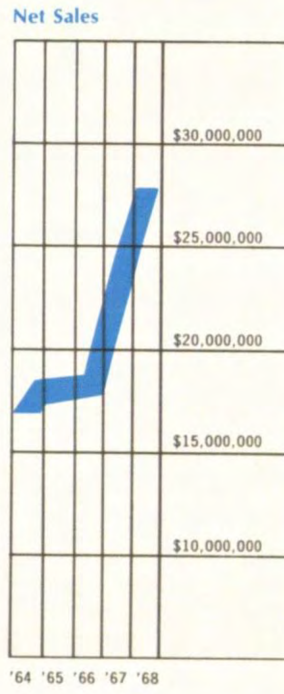
	1968*	1967*	1966*	1965*	1964*
Net Sales	**$27,901,000**	$23,185,000	$18,600,000	$17,086,000	$16,891,000
Net Income	**2,272,000**	1,900,000	1,355,000	1,026,000	1,068,000
**Net Income per share of Common Stock	**$1.53**	$1.28	$ .89	$ .64	$ .66

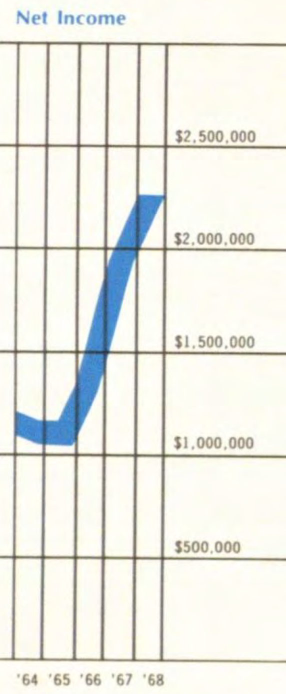
	1968*	1967*
Stockholders' Equity	**$10,525,000**	$ 8,799,000
Number of Stockholders	**3,294**	2,610

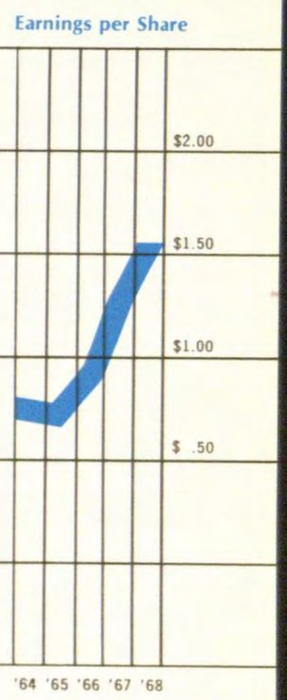
**Figures are consolidated for all years, representing operations of Products Research & Chemical Corporation and all subsidiaries including K. J. Quinn & Co. Inc.*

***Computed on the basis of the average number of common shares outstanding adjusted for the five for four stock splits effected in 1967 and 1968 plus the 401,500 shares of common stocks issued in connection with the pooling of interests with K. J. Quinn & Co. Inc.*

FIVE YEAR SUMMARY







George Gregory, Chairman of the Board and President

President's Message

For Products Research & Chemical Corporation the year 1968 showed the most significant progress in our 23 year history.

On September 11, 1968, PRC acquired K. J. Quinn & Co., Inc., of Malden, Massachusetts, a leading producer of specialty polymeric coatings and finishes for the leather and shoe industry, through a merger; therefore, the sales and earnings for 1968 vs. 1967 are compared on a pooling of interests basis.

For the fiscal year ended September 30, 1968, net sales were $27,901,000, with earnings of $2,272,000 after taxes, or $1.53 per share. These figures compare with net sales of $23,185,000 and earnings of $1,900,000 after taxes, or $1.28 per share for the comparable period of 1967.

These results were achieved in the face of a 9¢ per share charge for the new surtax and added expenses resulting from the bringing on-stream of major new facilities, aggregating total capital investments in excess of $1,000,000. These facilities include a corporate research and development laboratory in Burbank, California; a polymer plant for polyurethane and acrylic polymers in Seabrook, New Hampshire; a sealant manufacturing facility in Toronto, Canada; and a laboratory for our Mexican subsidiary, Qualitas de Mexico, S.A., designed to provide technical service and product development for the Mexican and South American markets. All of these new facilities embody the most up-to-date engineering concepts and efficiencies.

Significant gains in sales and earnings were realized by all divisions and subsidiaries in the year 1968. Major new developments in polymer technology have been the primary reason for the excellent showing.

We see many important benefits from the recent merger with K. J. Quinn & Co., Inc., among them a further strengthening of the company's technological and marketing position in polymer related industries, the acquisition of excellent management and manpower, and therefore the opportunity to expand more effectively in both domestic and international markets.

In 1968, the company has truly become a multi-national corporation, and it is our belief that it has never been in a stronger position to participate in the development of the world's growth areas.

You will be pleased to know that as part of Products Research & Chemical Corporation's new dimension, its common stock is now traded on the New York Stock Exchange under the symbol "PRC".

I want to express sincere gratitude—both personally and on behalf of your management and the Board of Directors—for the continued support of the shareholders and the loyal efforts of PRC employees around the world.

For the Board of Directors

George Gregory
Chairman of the Board & President

Constructing Apollo VII—North American-Rockwell

Aerospace Products & Markets

Aircraft

PRC participates in the growth and prosperity of the commercial and military aircraft transportation industry through its sealants and electrical insulation products. These products are sold to builders and operators of the very latest subsonic and supersonic planes. For example, PRC sealants are an important element of the British-French Concorde supersonic aircraft; and the fuel and cabin pressurization systems of Boeing jet transports and the Lockheed C-5A include the latest products developed through PRC technology. Future projects for PRC in the burgeoning transport aircraft construction field include the forthcoming Lockheed 1011 and the McDonnell-Douglas DC-10.

PRC's record of achievment as a supplier to every free-world, major company in military and civilian aircraft dates back over fifteen years. PRC sealants, electrical insulation compounds, protective coatings, and a myriad of related items custom-designed for individual requirements are responsible for the company's position of leadership in this field. Testing and detailed design are now underway to create a new generation of products, based on proprietary raw materials.

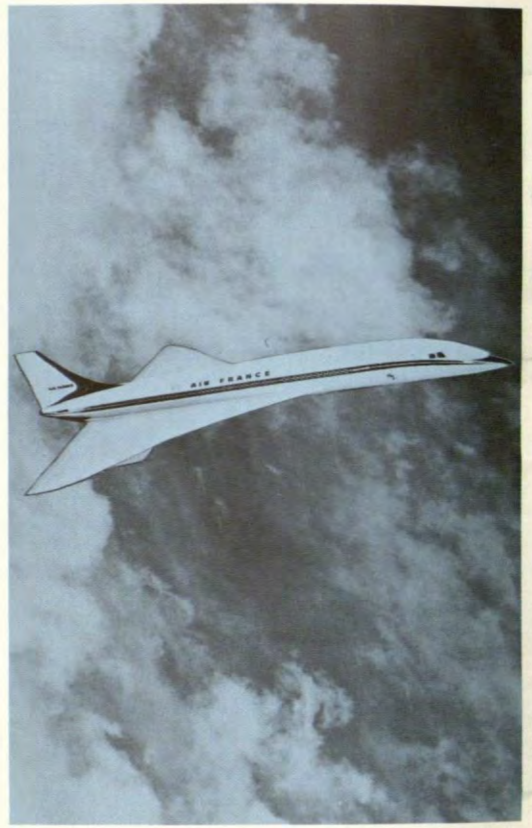
Missiles, Electronics, Hydrospace

The highest degree of technological expertise is required for the exceptional demands of the Missile and Ground Support Equipment market. In this field, PRC is able to meet the exacting requirements of electronic manufacturers who produce sub-systems and assemble final systems for military and NASA applications. Here, exposure extremes, such as spacecraft re-entry temperatures up to 5000°F., and tremendous pressures found beneath the ocean's surface in deep submergence devices, are the rule. PRC's research laboratories have met the challenge with products serving such needs for the past decade. Some of the more important current projects for which PRC products have been selected by prime contractors include: Apollo, Saturn, Sentinel, Sprint, Polaris/Poseidon, ASROC, Shillelagh, Shrike, Walleye, Minuteman 3, Phoenix, Spartan, and Sparrow.

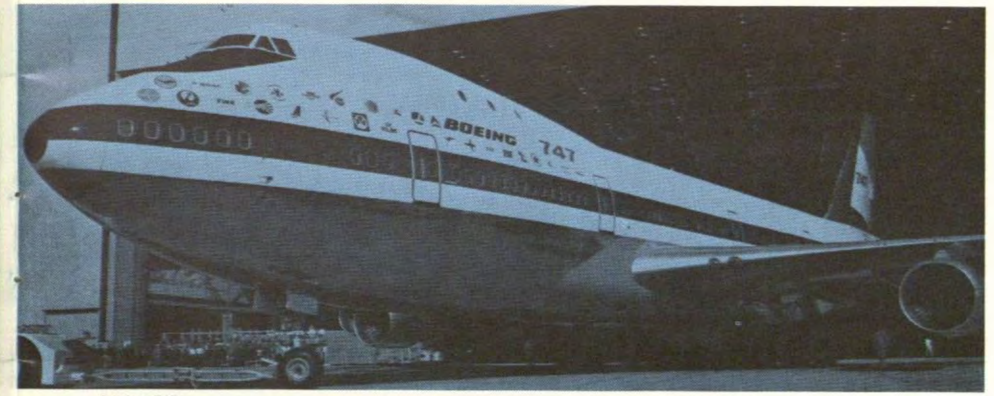
The broadening effects of our growing raw material capability have increased PRC's penetration of all segments of the Aerospace industry. Land vehicles for military purposes and special purpose enclosures for delicate electronic gear are now included in that market also. The system approach (represented by a product for every sealing and coating requirement of the complete unit, together with suitable application methods and equipment) is utilized by PRC in this system-oriented business. PRC's range of products for the Aerospace market includes electrical and thermal insulation compounds and coatings and sealants based on raw materials such as polysulfides, polyurethanes, and silicones. Advanced formulations are offered to the Aerospace customer in combination with the Semco Division products for mixing and dispensing such materials.

Semco Products & Services

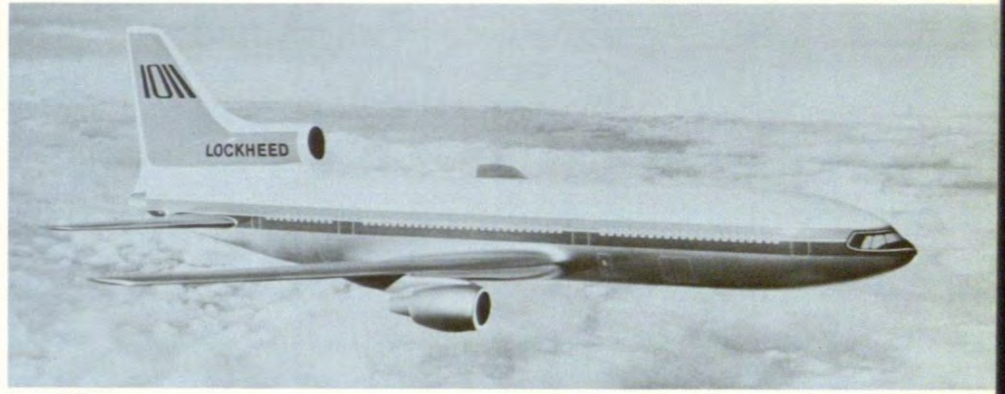
Several major aircraft and missile manufacturers have responded favorably to new customer service approach combining both PRC sealants and Semco application equipment and services. A "package" of materials, prepared for production line use, is sought by these companies as the most efficient course for complex aerospace production lines. Sophisticated performance requirements can lead to materials with application and handling characteristics which are best managed by specialists in this field, such as Semco. The customer can purchase two-component sealants which have been proportioned, mixed, packaged, and frozen to arrest chemical curing and are ready for immediate use after thaw. The Semkit®, a patented multicompartment, self-contained mixing unit, is extremely useful in other aerospace production situations. It is particularly valuable where fluctuations in demand cannot be predicted. The Semkit® unit permits mixing at the time and place of use without the expense and inconvenience involved in the conventional bulk packaging of materials.



Supersonic Concorde

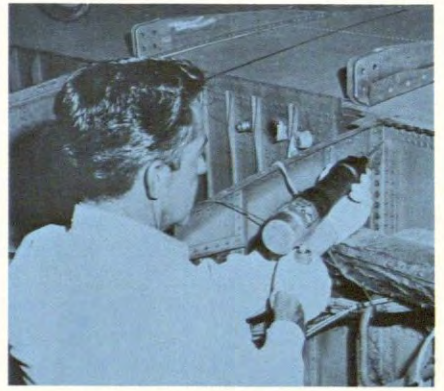


Boeing 747



Lockheed 1011

McDonnell-Douglas DC-10



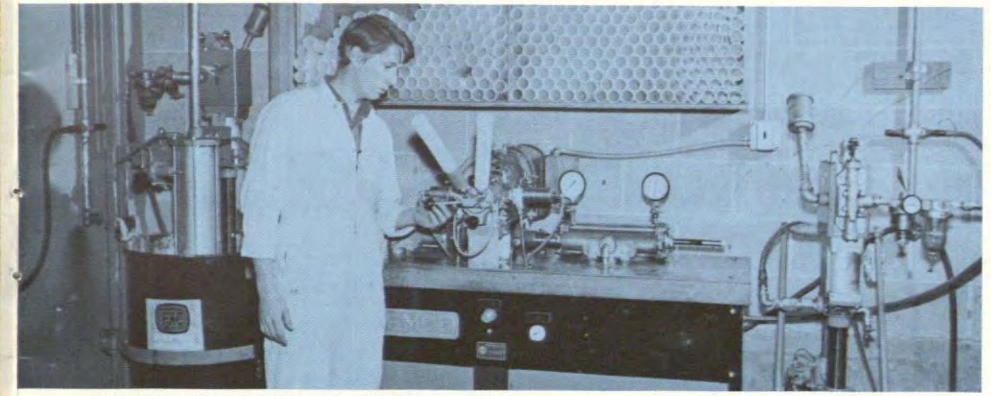
Semco sealant gun seals integral fuel tank

Lockheed "Deep Quest" Submergence System

San Diego Gas & Electric Building, San Diego, California

Commercial Products & Markets

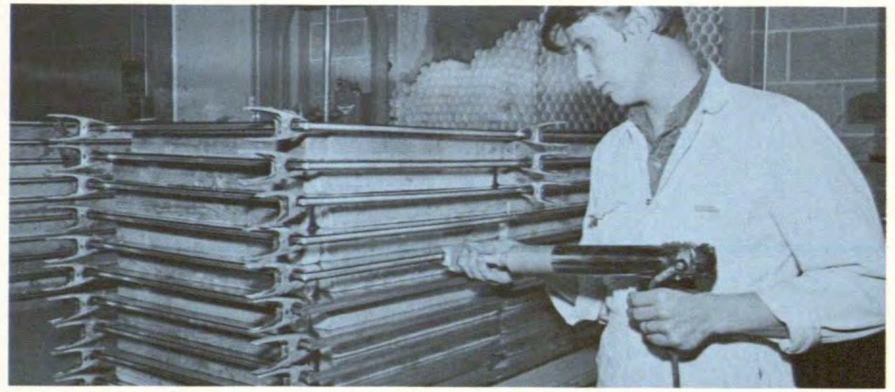
General Motors Building, N.Y.C., mall area



Semco Mixer filling cartridges of insulating glass sealant

Aircraft carrier deck coating and caulking system

Sealing freeway expansion joints



Sealing of insulating glass units

Crocker Citizen's National Bank, Los Angeles, California

Construction

In 1968, the company introduced to the building-construction industry, with unprecedented success, its first major, finished product based on its proprietary polysulfide polymers. The demand for PRC Rubber Calk® 7000 Sealant by architects and contractors was immediate, and performance of the product has been outstanding. PRC Rubber Calk® 7000 Sealant is used for caulking joints in concrete, aluminum, glass, and other materials employed in the construction of buildings. Principal customers are manufacturers and installers of prefabricated building components as well as jobsite contractors. Other members of the PRC Rubber Calk® Sealant family include polysulfide and polyurethane products formulated for specific uses. PRC products for recent major building projects range from traffic resistant sidewalk sealants and curtain wall panel sealants to ultraviolet resistant glazing compounds and coatings for the protection of concrete surfaces. During 1968, PRC building-construction products were tested, approved and utilized in three of the largest buildings in the U.S.A. These projects are the John Hancock Center in Chicago, the General Motors Building in New York and the Bank of America headquarters in San Francisco, where again versatility and top quality performance were absolute requirements. Another growth market, offering a large future potential for PRC sealants for expansion joints and concrete runways, is represented by airport construction. Recent projects of this nature include the McDonnell-Douglas, Tulsa, Oklahoma, facility and the Toronto International Airport.

Industrial

For the industrial field, PRC designs sealant and coating systems which focus on individual customer requirements. Manufacturers of dual-pane insulating window units use large quantities of PRC 408 Insulating Glass Sealant, recognized as the standard of that industry, together with the necessary Semco machinery to mix and apply the product in the factory. Home appliances, mobile travel trailers, heavy-duty trucks, and a wide variety of transportation equipment rely on PRC products for their performance.

Marine

PRC markets a method to preserve the wooden decks of ships with basically four proprietary products developed within the company's laboratories. Included in the product system are an underlayment compound for use between the wooden panels of the deck and the subdeck, a deck caulking sealant for use between deck planks, a highly abrasion-resistant coating, and, finally, an anti-skid coating. All these products are polyurethane based and clearly demonstrate PRC's technical strength in the field of finished product development based on proprietary raw materials. These products constitute a new product group of protective coatings which are in service on many and varied surfaces, providing waterproofing and wear protection. The company's activity in the protection of the wooden decks of U. S. Navy aircraft carriers has continued strongly during the past year. Authorities in this field have recognized the advantages of improved performance and lower over-all costs to the government.

Semco Products & Services

During 1968, Semco introduced two important new products for commercial use. The Model 1408 direct application sealant mixer is specifically designed for the insulating glass manufacturer. It delivers proportioned and blended sealant to the point of application on the glass and metal assembly and thereby reduces manufacturing expense. The demand for the Model 1408 is rapidly increasing.

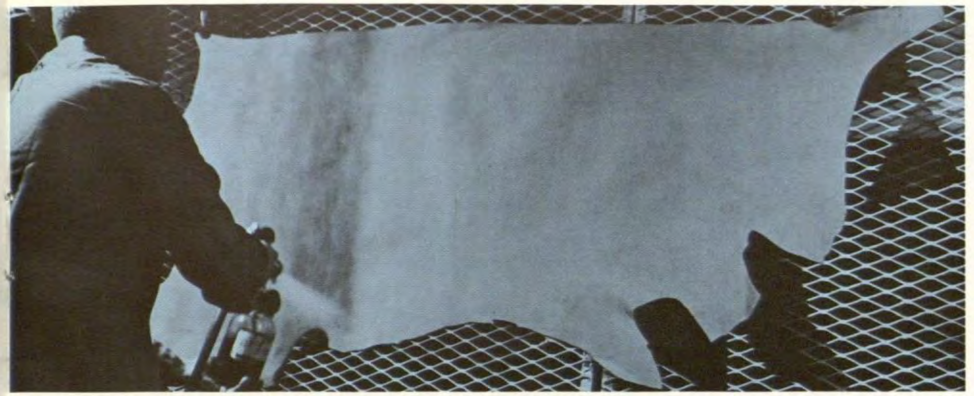
The new Model 1383 high capacity mixing head was designed to meet the need for increased speed in the blending of multipart sealants and adhesives. This technological advance is adaptable to most Semco mixers presently in use in both the commercial and aerospace industries. With the Model 1383 mixing head, the equipment owner's capability is significantly increased. Such improvements are evidence of Semco's leadership in engineering design.

Men's shoes fashioned with Quinn finished leather. The dark, lustrous shoe demonstrates the ultimate in shoe fashion effect.

K. J. Quinn

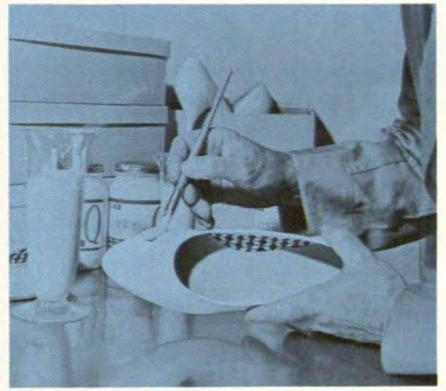
Products & Markets

Seamless flooring in a restaurant

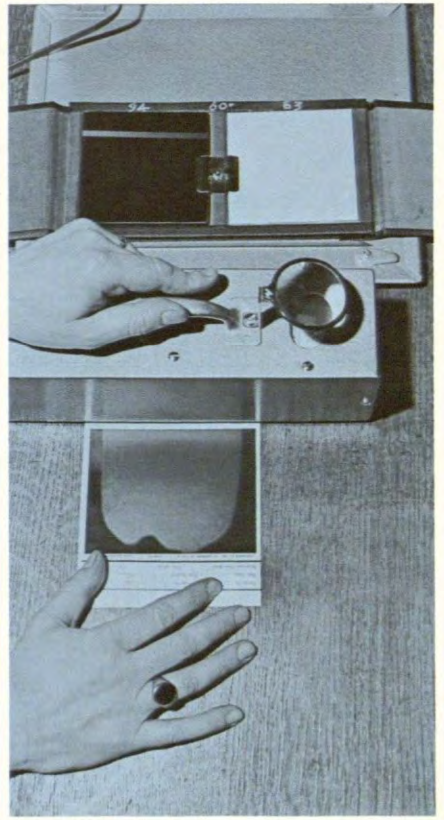


Spray coating operation on cow-hide

Application of coatings at leather processor



Experimental application



Quality control for shoe lustre

Fashion trends are marked by leather garments.

The K. J. Quinn & Company subsidiary manufactures protective and decorative coatings and systems marketed to the shoe and leather industry, poromeric and leather substitute manufacturers, patent leather companies, vinyl and textile manufacturers, and the seamless flooring industry. Quinn's capabilities include the basic finished product development and the production of proprietary acrylic and urethane polymers. Quinn manufactures and markets these systems world-wide.

Newly developed urethane polymers have been tailored to leather needs, resulting in an easy maintenance leather finish known as Weatherfoil®. With the Weatherfoil® finish system, leather can compete successfully with the poromerics and other leather substitutes and still retain the natural features of leather. Additionally, improved urethane polymers have upgraded further the protective and decorative coatings on patent leather.

Quinn has developed and manufactures and markets patent leather finishes, consisting of multiple coat applications of polyurethane polymers, which result in a high lustre, durable and flexible surface. In the past, patent leather sales were reduced by limited use in cold weather months. The patent leather finishes developed by Quinn have overcome most of the undesirable qualities associated with linseed oil finishes. They have made possible year-round consumer use of patent leather shoes and have resulted in the introduction of a broad range of colors and fashion effects. Through Quinn's technology, similar polymer base finish systems are finding wide spread application and acceptance in the leather substitute industry. These coatings modify the poromeric surfaces to be leather-like in character.

Quinn finishes are marketed further to shoe manufacturers to add protection, styling effects and durability to the shoe. Acrylic polymer developments have improved these finish systems resulting in a new product line known as GT™. This GT™ finishing system increases the water resistance and durability superior to prior systems.

Q-Thane® polymers and vinyl coatings have expanded Quinn's marketing scope into the vinyl formulating and converting field as well as the textile industry. Dry cleanable coatings that retain their water-resistant characteristics afford Quinn continued growth opportunity.

Polyurethane Q-Thane® polymers have been a major growth area along with Decko® PVA chips supplied to the seamless flooring industry. These products have achieved success in industrial outlets as well as the do-it-yourself kits marketed to the retail trade.

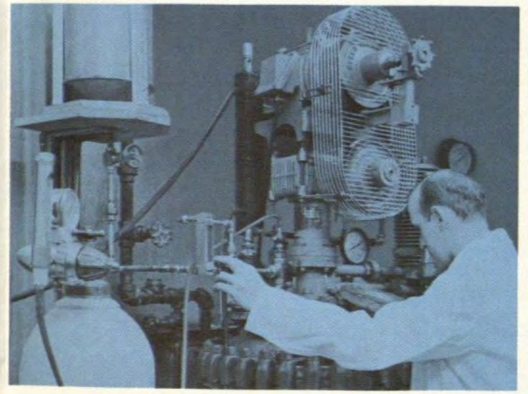
Development projects are underway which are expected to lead to new industrial applications such as flexible, durable coatings for fabrics, wall coverings, and similar materials.

Research and Development Laboratory Module, Burbank.

Research And Development

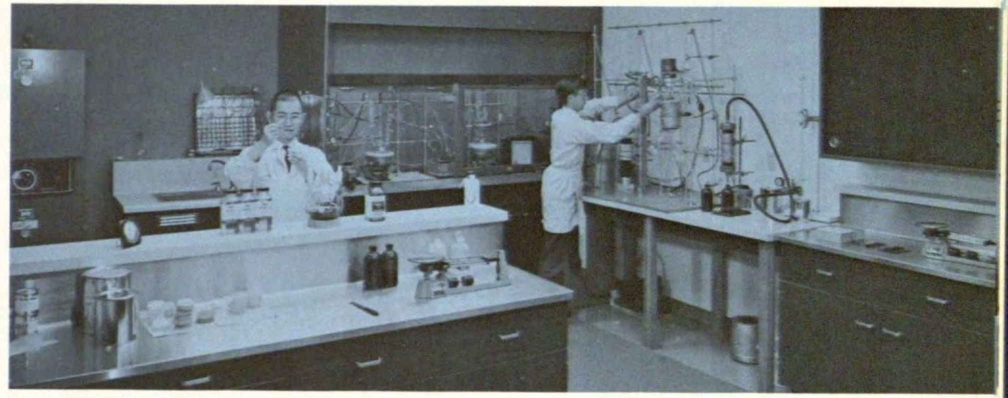
Making separations in the analytical laboratory

Universal Physical Tester



Acrylic Polymer Pilot Plant

Analytical Work Bench



Experimental Laboratory Module

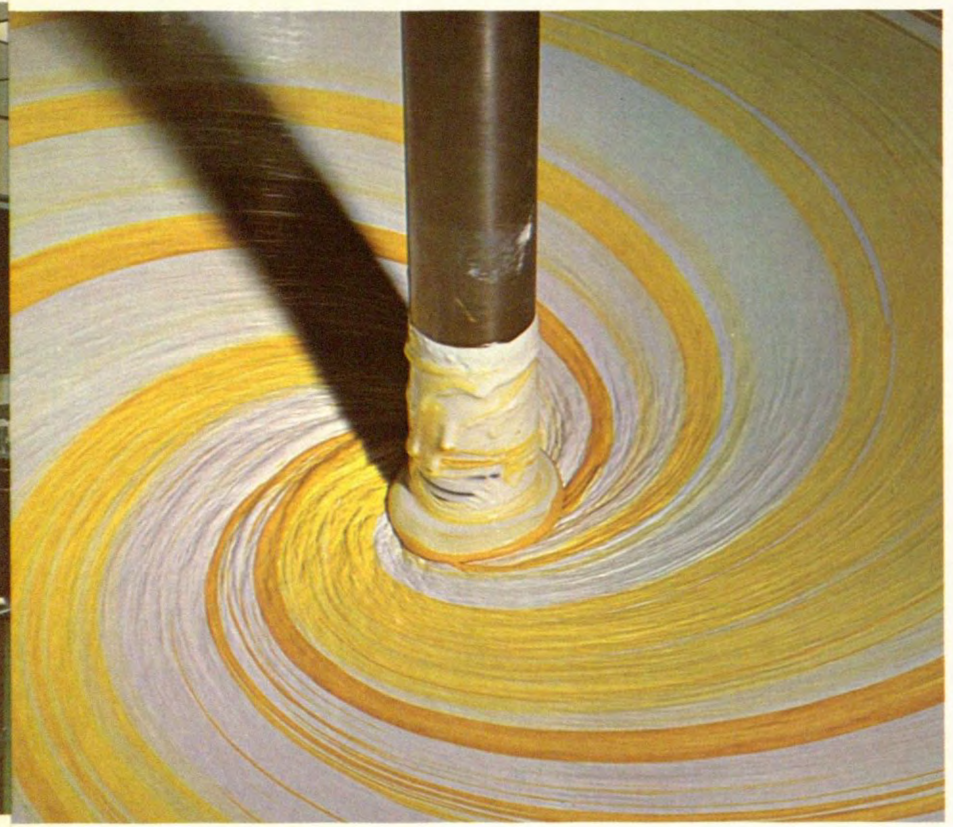
Test Equipment

The company carries on a continuing program of research in basic polymer technology including materials classified as polyurethanes, polysulfides, silicones, and epoxies. Past research has brought into being several synthetic rubber polymers, which are manufactured by the Company and used in the compounding of specialized sealants and coatings. Quinn has recently developed and begun test marketing a new improved series of coatings for leather and poromerics and shoes finishes. These systems have been derived from compounded polyurethane polymers and acrylic emulsion polymers and are being marketed under the names Weatherfoil®, Solcron® and GT™.

Apart from the development of new products and systems, the PRC research program is directed toward the improvement and refinement of existing products and systems and the expansion of their uses and applications. The Company's technical staff, in conjunction with its sales force, devotes a substantial portion of its time to assisting customers in utilizing our products, developing new uses for these products and anticipating customer requirements for new products. Prompt, technically qualified service by the Company's sales and engineering force is required in the aerospace, leather, construction and marine industries. The nature of the processes, products and manufacturing systems requires a high degree of quality control, which is provided by laboratory facilities and technical staff. Certain employees of the Company's foreign subsidiaries also devote a major portion of their time to quality control and research and development efforts.

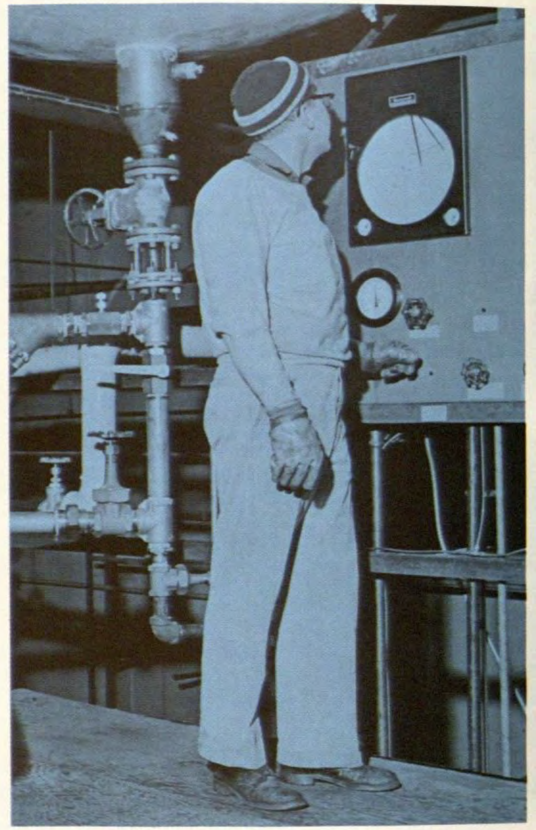
In March 1968, PRC completed construction of a new 20,000 square foot research and development laboratory located in Burbank, California, adjacent to corporate headquarters. The research facilities of Quinn are located at Malden, Massachusetts. Approximately 76 persons (including 40 graduate chemists and engineers) devote the major portion of their time to research and development work. In addition, approximately 20 technicians (including 11 graduate chemists and engineers) are engaged in technical service activities.

During the past year, the Company was granted a patent on one of its polymers. Several other patents are pending.



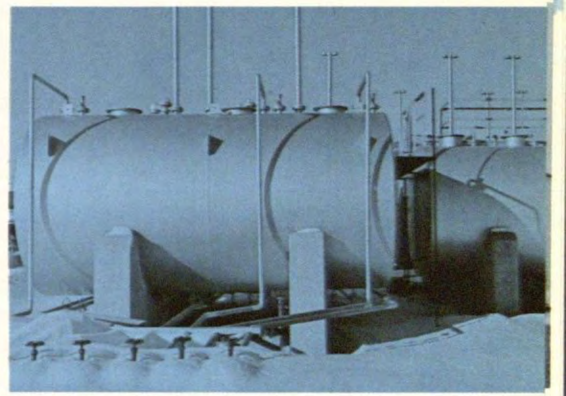
Blending a polysulfide sealant

Manufacturing Facilities

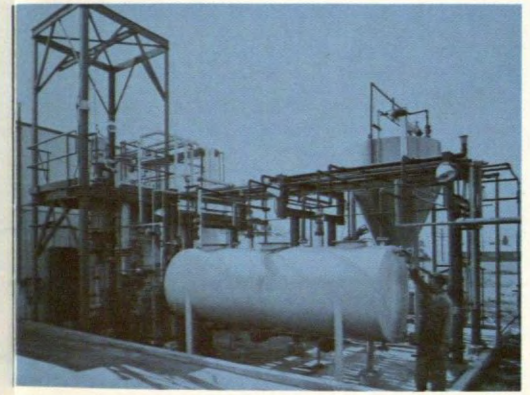


Temperature check on acrylic reactors

Polymer plant, Seabrook, New Hampshire



Solvent tank farm, Malden, Massachusetts



Polymer plant, Glendale, California

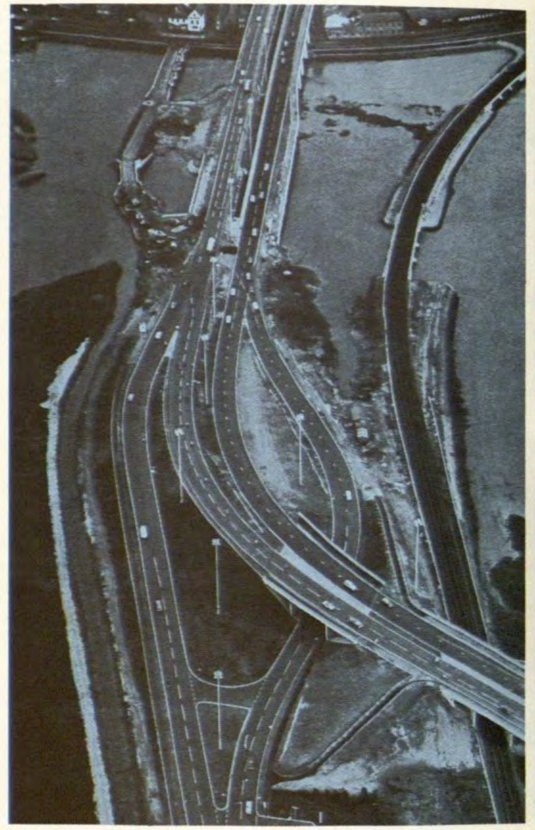
Manufacturing, Glendale, California facility

Aerial view, Malden, Massachusetts facility

The company maintains 437,900 square feet of manufacturing, research and administrative facilities. Manufacturing is carried on in four plants for the PRC products and six plants for the Quinn subsidiary. Geographically, the U.S.A. and Canada are well covered with five locations, and plants are also located in Mexico, Peru, Spain and Germany. Strategic location for purposes of market penetration and source of supply is of paramount importance. The largest plant for PRC products in Glendale, California, and the Quinn factory in Seabrook, New Hampshire, are newly constructed with the latest ideas in industrial efficiency and safety for employees stressed in their designs. Features of the plants are the integrated raw material and finished product capabilities. Manufacturing and quality control are organized under a common structure. This lends an atmosphere of close, intensive technical participation in all phases of production work.

International Operations

Display at International Exhibition in Paris—Le Joint Francais.

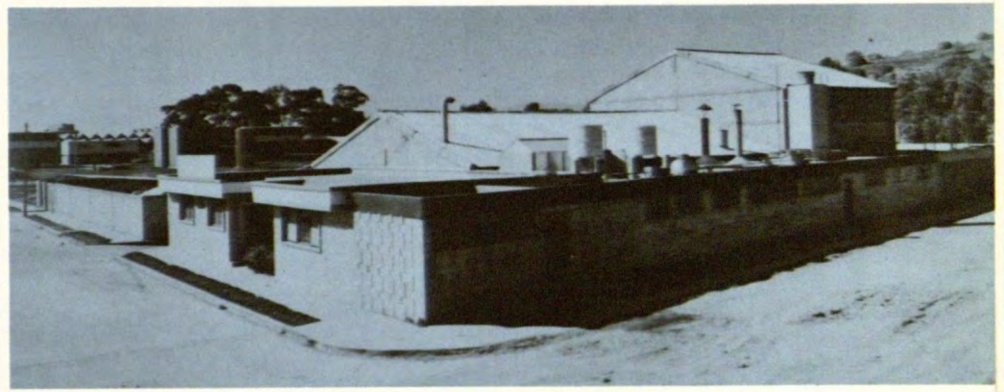


Totton-Redbridge Flyover, Hampshire, England—Highway Sealants by British Paints, Ltd.

Sales and production of PRC and Quinn product lines are carried on in all important industrial countries in the world. PRC products were produced by licensees in record amounts during 1968 in France, England, Denmark and Japan. Quinn's foreign plants also produced the highest volumes in history. Additionally, export sales continued at a high rate particularly in commercial Scandinavian markets. All foreign activities are well

Vauxhall's New Engineering and Styling Center, Luton, England—Sealants by British Paints, Ltd.

Manufacturing facility, Germany



Manufacturing facility, Mexico

established and highly regarded as advanced, quality manufacturers in their respective markets. The addition of Quinn's network of company-owned facilities to the PRC family provides new opportunities for growth through exploitation of product technology in overseas markets.

PRC products are manufactured under license by Le Joint Francais in France for the Common Market countries; British Paints Limited for England, Australia, and other British Commonwealth countries; Lars Foss Kemi for the Scandinavian countries; and The Yokohama Rubber Company for Japan and other Asian markets. Quinn factories are located in Montreal, Canada, Stuttgart, Germany and Barcelona, Spain. Quinn products for Central and South America are manufactured in Mexico and Peru. These products are also manufactured in Australia and Italy. Further developments in other foreign countries are taking place and will result in expansion of the world-wide network of marketing and manufacturing of PRC and Quinn products.

PRODUCTS RESEARCH & CHEMICAL CORPORATION AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEETS, SEPTEMBER 30, 1968 AND 1967

ASSETS

	1968	1967 (Note 1)
CURRENT ASSETS:		
Cash (including $210,125 of certificates of deposit in 1968)	$ 1,046,000	$ 1,194,000
Receivables—		
Trade accounts	$ 4,121,000	$ 3,467,000
Other accounts and notes	445,000	383,000
Less—Allowance for doubtful accounts	(122,000)	(76,000)
	$ 4,444,000	$ 3,774,000
Inventories, at cost (first in, first out) not in excess of market	$ 3,249,000	$ 2,705,000
Prepaid expenses and deposits	$ 248,000	$ 266,000
Total current assets	$ 8,987,000	$ 7,939,000
PROPERTY, PLANT AND EQUIPMENT, at cost:		
Land and improvements	$ 1,131,000	$ 1,044,000
Building and improvements	4,626,000	3,211,000
Machinery and equipment	2,897,000	2,332,000
Furniture and fixtures	351,000	286,000
Motor vehicles	288,000	287,000
Construction in progress	109,000	207,000
	$ 9,402,000	$ 7,367,000
Less—Accumulated depreciation and amortization	3,002,000	2,522,000
	$ 6,400,000	$ 4,845,000
OTHER ASSETS:		
Investments in and advances to foreign affiliates, at cost (Note 1)	$ 91,000	$ 83,000
Notes receivable, due after one year	325,000	356,000
Insurance and annuities	272,000	228,000
Patents and patent rights, at cost less amortization	301,000	387,000
Other	8,000	16,000
	$ 997,000	$ 1,070,000
	$16,384,000	$13,854,000

LIABILITIES

	1968	1967 (Note 1)
CURRENT LIABILITIES:		
Current maturities of long-term debt	$ 679,000	$ 636,000
Notes payable to bank	511,000	34,000
Accounts payable	1,297,000	993,000
Accrued liabilities—		
Compensation	632,000	497,000
Interest, taxes, and other	428,000	311,000
U.S. and foreign income taxes	280,000	862,000
Total current liabilities	$ 3,827,000	$ 3,333,000
LONG-TERM DEBT:		
Unsecured loans, 6 to 7%, due in various installments to 1976	$ 2,045,000	$ 1,753,000
Trust deed and mortgage notes, 4¾% to 7½%, due in various installments to 1978	411,000	426,000
	$ 2,456,000	$ 2,179,000
Less—Current maturities	679,000	636,000
	$ 1,777,000	$ 1,543,000
RESERVE FOR DEFERRED COMPENSATION (Note 2)	$ 163,000	$ 119,000
MINORITY INTEREST IN GERMAN SUBSIDIARY (Note 1)	$ 92,000	$ 60,000
LEASE COMMITMENTS (Note 3)		
STOCKHOLDERS' EQUITY (Notes 1 and 5):		
Preferred stock, $5 par value—Authorized, 1,000,000 shares Outstanding, none	$ —	$ —
Common stock, $2 par value—Authorized, 5,000,000 shares Outstanding, 1,484,998 shares at September 30, 1968, at stated amount	3,142,000	2,708,000
Paid-in surplus	784,000	490,000
Retained earnings	6,599,000	5,601,000
	$10,525,000	$ 8,799,000
	$16,384,000	$13,854,000

The accompanying notes are an integral part of these statements.

CONSOLIDATED STATEMENTS OF INCOME FOR THE YEARS ENDED SEPTEMBER 30, 1968 AND 1967

	1968	1967 (Note 1)
NET SALES	$27,901,000	$23,185,000
COST OF SALES	16,197,000	13,598,000
Gross profit	$11,704,000	$ 9,587,000
OPERATING EXPENSES:		
Selling and general and administrative	6,698,000	5,574,000
Provision for profit-sharing retirement plan and incentive compensation	450,000	450,000
Operating income	$ 4,556,000	$ 3,563,000
OTHER INCOME (EXPENSE):		
Interest expense	(178,000)	(133,000)
Other income, net	74,000	110,000
NET INCOME BEFORE PROVISION FOR INCOME TAXES	$ 4,452,000	$ 3,540,000
Provision for U.S. and foreign income taxes (Note 4)	2,180,000	1,640,000
NET INCOME	$ 2,272,000	$ 1,900,000
PER SHARE	$1.53	$1.28

The accompanying notes are an integral part of these statements.

CONSOLIDATED STATEMENTS OF SURPLUS FOR THE YEARS ENDED SEPTEMBER 30, 1968 AND 1967

PAID-IN SURPLUS

	1968	1967 (Note 1)
BALANCE AT BEGINNING OF PERIOD, as previously reported	$ 218,000	$ 505,000
ADD—Pooled business (Note 1)	272,000	272,000
BALANCE AT BEGINNING OF PERIOD, as restated	$ 490,000	$ 777,000
ADD (DEDUCT):		
Stock options exercised	1,000	57,000
Transfer to common stock for stock splits effected as stock dividends (Note 5)	(219,000)	(344,000)
Fair market value of capital stock issued to employees by pooled business prior to merger, and related tax benefits	791,000	—
Capital stock and merger expenses	(279,000)	—
BALANCE AT END OF PERIOD	$ 784,000	$ 490,000

RETAINED EARNINGS

	1968	1967 (Note 1)
BALANCE AT BEGINNING OF PERIOD, as previously reported	$2,573,000	$2,651,000
ADD—Pooled business (Note 1)	3,028,000	2,333,000
BALANCE AT BEGINNING OF PERIOD, as restated	$5,601,000	$4,984,000
ADD (DEDUCT):		
Net income	2,272,000	1,900,000
Cash dividends, $.266 per share in 1968 and $.213 per share in 1967	(288,000)	(230,000)
Cost of treasury shares acquired in 1966 and reissued in 1967 stock split	—	(1,006,000)
Transfer to common stock for stock split effected as stock dividend (Note 5)	(214,000)	—
Cash dividends by pooled company prior to merger	(77,000)	(47,000)
Fair market value, net of applicable income tax effect, of capital stock issued to employees by pooled business prior to merger	(695,000)	—
BALANCE AT END OF PERIOD	$6,599,000	$5,601,000

The accompanying notes are an integral part of these statements.

CONSOLIDATED STATEMENTS OF SOURCE AND USE OF FUNDS FOR THE YEARS ENDED SEPTEMBER 30, 1968 AND 1967

	1968	1967 (Note 1)
SOURCE OF FUNDS:		
Operations—		
Net income	$2,272,000	$1,900,000
Add—Provisions for depreciation and amortization (straight-line and accelerated methods)	666,000	536,000
	$2,938,000	$2,436,000
Proceeds from long-term debt	799,000	389,000
Proceeds from stock options exercised	1,000	68,000
Other	103,000	178,000
	$3,841,000	$3,071,000
USE OF FUNDS:		
Additions to property, plant and equipment, net	$2,134,000	$1,357,000
Additions to patents and patent rights	—	420,000
Payment of long-term debt	565,000	504,000
Capital stock and merger expenses, net	183,000	—
Cash dividends	365,000	277,000
Other	40,000	67,000
	$3,287,000	$2,625,000
INCREASE IN WORKING CAPITAL	$ 554,000	$ 446,000

The accompanying notes are an integral part of these statements.

NOTES TO FINANCIAL STATEMENTS

(1) Pooling of Interests and Principles of Consolidation—

In September, 1968, K. J. Quinn & Co., Inc. (Quinn) was merged into the Company and incorporated into a new subsidiary and 401,500 of the Company's common shares were issued to Quinn shareholders and a consultant. The merger was accounted for as a pooling of interests and the accompanying statements for 1967 have been restated to include Quinn and its subsidiaries for their twelve months ended September 30, 1967. Quinn's fiscal year ended December 31, and the statements for 1967 which have been included for comparative purposes have not been examined by independent public accountants.

All of the Company's subsidiaries have been included in the consolidated statements after elimination of intercompany transactions and balances. Subsequent to September 30, 1968, the Company agreed to acquire the minority interest in the German subsidiary for approximately $180,000.

(2) Retirement Plans—

In addition to the Company's profit-sharing retirement plans, Quinn has entered into retirement and disability contracts with key employees providing for monthly benefits at age 65 or earlier in case of death. The total estimated liability for benefits under these contracts is approximately $420,000 for which a reserve of $163,000 has been provided as of September 30, 1968, including $44,000 charged to income for the year then ended. Quinn is beneficiary of life insurance policies on lives of employees covered by these contracts with a face amount of $490,000.

(3) Lease Commitments—

The Company's rentals under leases expiring in one to five years aggregate $188,000, including approximately $63,000 for the year ending September 30, 1969.

(4) U.S. and Foreign Income Taxes—

The net income of consolidated foreign subsidiaries in 1967 is after deducting provisions for income taxes based on the tax rates in effect in the particular foreign countries. Provision has been made for additional U.S. taxes that might be payable for 1968 in the event earnings of these subsidiaries are required to be distributed as dividends under Department of Commerce regulations. The investment tax credit, which is not material, has been recorded as a reduction in the provision for U.S. income taxes. Provision for the U.S. income tax surcharge effective January 1, 1968, has been made in the amount of $129,000 for the period ended September 30, 1968.

AUDITORS' REPORT

To the Board of Directors and Shareholders, Products Research & Chemical Corporation:

We have examined the consolidated balance sheet of Products Research & Chemical Corporation (a California Corporation) and subsidiaries as of September 30, 1968, and the related statements of income, surplus, and funds for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying financial statements present fairly the financial position of Products Research & Chemical Corporation and subsidiaries as of September 30, 1968, and the results of their operations and the source and use of funds for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

ARTHUR ANDERSEN & CO.

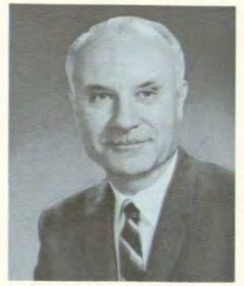
Los Angeles, California,
November 19, 1968.

(5) Common Stock Splits and Stock Option Plans—

In January, 1967, and January, 1968, the Board of Directors approved five-for-four common stock splits effected in the form of dividends. As of September 30, 1968, 107,500 shares of common stock were reserved for issuance under the Company's qualified stock option plan, and options for 55,605 shares were outstanding at $28.80 per share. The options are exercisable on a cumulative basis during a five-year period commencing at the end of the first year.

George Gregory
Chairman of the Board

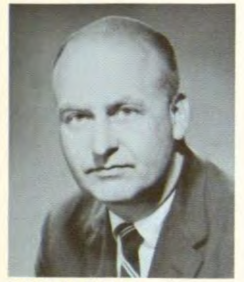
Irvin P. Seegman



Lt. Gen. Donald L. Putt (USAF ret.)

Joseph D. Carrabino, Ph.D.

Floyd W. Wilson



DeWitt W. Markham

John W. Quinn Jr.

Edward Leigh Quinn

Fred Shinagel

Lloyd L. Cooper

CORPORATE DATA

TRANSFER AGENTS

Security Pacific National Bank
Los Angeles

Morgan Guaranty Trust Company
New York

REGISTRARS

Union Bank
Los Angeles

Bankers Trust Company
New York

AUDITORS

Arthur Andersen & Co.
Los Angeles

LEGAL COUNSEL

Leslie & Rubin
Los Angeles

PATENT COUNSELS

Miketta, Glenny, Poms & Smith
Los Angeles

Pennie, Edmonds, Morton, Taylor & Adams
New York

CORPORATE OFFICES

2919 Empire Avenue
Burbank, California

RESEARCH AND DEVELOPMENT LABORATORIES

2820 Empire Avenue
Burbank, California

195-209 Canal Street
Malden, Massachusetts

OPERATING DIVISIONS

PRC PRODUCTS

Western Sales & Manufacturing
5426 San Fernando Road
Glendale, California

Eastern Sales & Manufacturing
410 Jersey Avenue
Gloucester City, New Jersey

Canadian Sales & Manufacturing
PRC Chemical Corporation of Canada, Ltd.
95 Rivalda Road
Weston, Ontario

Semco Division
18881 South Hoover Street
Los Angeles, California

QUINN PRODUCTS

Main Office & Manufacturing
195-209 Canal Street
Malden, Massachusetts

Polymer Manufacturing
Seabrook, New Hampshire

FOREIGN OPERATIONS

K. J. Quinn & Co. (Canada) Ltd.
Montreal, Quebec

Qualitas de Mexico, S.A.
Mexico City, Mexico

Quinn G. m. b. H.
Stuttgart-Leinfelden, West Germany

Quinn Iberia, S.A.
Barcelona, Spain

K. J. Quinn del Peru, S.A.
Lima, Peru

Barham-Quinn, Pty.
Sidney, Australia

Quinn Italiana s.p.a.
Milan, Italy

FOREIGN LICENSEES

British Paints, Ltd.
London, England

Le Joint Francais
Bezons (S & O) France

Lars Foss Kemi
Fredensborg, Denmark

The Yokohama Rubber Co. Ltd.
Tokyo, Japan

BOARD OF DIRECTORS

George Gregory
Chairman of the Board

Irvin P. Seegman
Senior Vice President, Technical Director

Lt. Gen. Donald L. Putt (USAF ret.)
Vice President, United Aircraft Corporation

Joseph D. Carrabino, Ph.D.
Dean of the Executive Program, Graduate School of Business, U.C.L.A.

Floyd W. Wilson
Vice President

DeWitt W. Markham
Vice President

John W. Quinn Jr.
President, K. J. Quinn & Co. Inc. (subsidiary)

Edward Leigh Quinn
Executive Vice President, K. J. Quinn & Co. Inc. (subsidiary)

Fred Shinagel
Associate, Lazard, Frères & Co.

Lloyd L. Cooper
Secretary-Treasurer

OFFICERS

George Gregory
President, Chief Executive Officer

Irvin P. Seegman
Senior Vice President, Technical Director

Floyd W. Wilson
Vice President, Operations

DeWitt W. Markham
Vice President, Eastern Division

Lloyd L. Cooper
Secretary-Treasurer

Gordon M. Bradford
Assistant Corporate Secretary

John W. Quinn Jr.
President
K. J. Quinn & Co. Inc. (subsidiary)

Edward Leigh Quinn
Executive Vice President
K. J. Quinn & Co. Inc. (subsidiary)

Additional copies of this report or further information about the company is available on request to Public Relations Department, 2919 Empire Avenue, Burbank, California 91504.

EXHIBIT 16

Expert Witness Statement for James C. Lamb IV, Ph.D., DABT, ATS
in *Town of Westport and Westport Community Schools vs. Monsanto et al.*

1 BACKGROUND AND QUALIFICATIONS

My credentials are set forth in the attached Curriculum Vitae. I have more than 30 years of experience specializing in general toxicology, carcinogenesis, reproductive and developmental toxicology, risk assessment, and regulatory policy. I have served on numerous scientific and legal panels, and on review boards for government and private organizations. A few of the organizations that I have served on include: three National Academy of Sciences Committees that focused on the topics of Risk Characterization, Hormone-related Toxicants (i.e., endocrine disrupting compounds) and the Health Implications of Perchlorate Ingestion; the U.S. Delegation to the Organization for Economic Cooperation and Development; and International Life Sciences Institute (ILSI).

I have served as an officer for numerous scientific and professional organizations including President of the American Board of Toxicology, the largest toxicology certification in the world, and President of the Academy of Toxicological Sciences, which is a major international toxicology certification organization. Other positions include, for example, President of the Regulatory Safety Evaluation Specialty Section of the Society of Toxicology (SOT), President of the SOT Reproductive and Developmental Toxicology Specialty Section, member of the SOT Congressional Task Force and the SOT TSCA Reauthorization Task Force. I have chaired and belonged to numerous other society committees over the years. In 2011, I was honored by the Mid-Atlantic Society of Toxicology as their Ambassador of Toxicology.

Since the mid-1980's, I have worked as a toxicology and regulatory consultant. Throughout my career I have written and presented reviews of technical and policy issues raised by regulatory agencies, and evaluated data developed for making regulatory decisions. My work includes an understanding and the application of risk assessment for the purpose of determining and evaluating acceptable levels of exposure and risk to a wide range of compounds. In the mid-1980s, I was the Special Assistant to the Assistant Administrator for Pesticides and Toxic Substances in the U.S. Environmental Protection Agency (US EPA) where I served as an advisor on major scientific, legal, and policy issues in toxicology, pesticide regulation, and toxic substances regulation. Prior to that, I was a Biologist and Head for the Fertility and Reproduction Group of the National Toxicology Program (NTP), where I implemented research and testing activities in reproductive and developmental toxicology. I was also a chemical manager at NTP responsible for toxicology and carcinogenesis studies on various substances. My professional work has led to publishing more than 100 book chapters and papers in peer-reviewed journals.

2 MATERIALS REVIEWED

In the development of this expert report, I have reviewed and relied upon various scientific articles and books that are referenced below. I have also considered the various witness statements, exhibits, and complaints in my preparation of this statement and my expert opinions. I reserve the right to revise this report as other information becomes available to me.

3 PRINCIPLES OF TOXICOLOGY

Evaluating the risk of any substance, natural or synthetic, requires knowing both the toxicity and the exposure to that substance. All substances are toxic. Toxicity is the potential of a substance to cause adverse health effects. “Adverse” is generally defined as a finding that causes an overt change in the test subject’s health, or ability to function or reproduce. Enzyme induction, metabolic response to an exogenous substance, transient binding to receptors, or subtle, non-persistent changes in clinical chemistry parameters are not generally considered adverse health findings. Further, the identification of biomarkers is indicative of exposure, but does not necessarily mean that adverse health effects will result.

The potential toxicity of any chemical depends upon both its structure and activity. Fundamental biological processes such as absorption, distribution, metabolism, and excretion can affect a response observed under certain experimental conditions. The route of exposure can influence the absorption, and consequently, distribution of a substance in the body. Therefore, exposure and toxicity data from one route of exposure may not be directly relevant to another route of exposure. In addition, a substance may be changed to a more toxic or less toxic form by the body’s metabolic system. Differences in exposure between animal and human studies, as well as differences in absorption, metabolism, and inherent susceptibility among animal species make it impossible to predict the response in humans merely by evaluating animal toxicity data alone.

Toxicology studies are typically designed to establish both an exposure level that causes an adverse effect and a level at which no adverse effects can be detected (the no-observed-adverse-effect-level or NOAEL) in the test species. Thus, the appearance of toxicity in animal studies is intentional. The lowest dose at which adverse effects occur is the lowest-observed-adverse-effect-level, or LOAEL. Toxicological studies are designed to include dose levels that are expected to cause adverse effects. The presence of effects (or toxicity) does not prove risk without considering the doses or exposures associated with those effects and potential differences in the sensitivity of the test species and humans. The evaluation of effects without consideration of dose is regarded as a characterization of the hazard – not risk – of that chemical. Many classification systems for chemicals, such as listing a chemical as a carcinogen, are limited to the hazard of a chemical. Consequently, these lists or the classification alone are not sufficient to understand the relevance of the particular hazard to human health. This is because the relationship between the dose at which adverse effects occur and potential human exposures are not considered.

Dose-response is a key element in understanding the toxicity of a chemical. As described above, a toxicity study will ideally identify a dose where no effects are seen and several higher doses where adverse effects are observed. This dose-response relationship typically shows that with an increase in dose there is an increase in the severity of the effect. In some cases, at the lowest dose levels no adverse effects are observed. This is described as a threshold response where a sufficient dose is required to produce adverse effects and below which no adverse effects are seen.

It is also important to emphasize the difference between *in vivo* tests (tests done in live animals) and *in vitro* tests (tests conducted in an artificial environment). The merit of *in vitro* tests is their simplicity. *In vitro* experiments can be used to isolate the effect of a chemical on a specific tissue or cell type or to identify a potential mechanism by which an effect occurs at the cellular level. However, *in vitro* tests do not consider metabolism, the route of exposure, or the chemical's disposition within the body. Although more expensive and time consuming than *in vitro* studies, *in vivo* studies account for the body's collective influence on a substance via the processes of absorption, disposition, activation, and deactivation, all of which provides a more complete understanding of a chemical's effect on an organism. Thus, *in vitro* data alone cannot predict findings in the whole animal or human.

Although *in vivo* studies have several advantages over *in vitro* assays, other factors must be taken into account when extrapolating findings to humans. Several differences are known to exist between species and other, as yet unknown, differences may affect study findings. For example, the reproduction and development of offspring in rodent differs from humans on several levels from the duration and hormonal pattern of estrous cycle, to the typical number of offspring, and the age-specific stages of development. Additionally, as a consequence of these differences some species are more or less sensitive than humans in responding to certain exposures. For example, binding to the Ah-receptor has been shown to differ substantially among species (Conner and Aylward 2006). Therefore, *in vivo* data are useful in understanding the potential effects in humans, but the animal models are limited in predicting human responses.

Risk is a function of toxicity, exposure, and dose. The risk to human health from a chemical depends on the inherent toxicity of the chemical, the likelihood of people coming into contact with the chemical, the conditions of such exposure, and the actual dose received. Exposure is not equivalent to dose. Exposure is the potential contact with a chemical. Dose is the amount of the chemical that enters and is absorbed into the body. For example, exposure to a substance in indoor air is determined by many factors: the concentration of the substance in air, the form of the substance in air as gas, vapor, aerosol, or particles, the air flow and turn-over in a room or building, the duration of time in the room/building, the respiration rate, and the absorption of the substance in the respiratory system (from the mucous membranes in the nose and mouth to the alveoli of the lung).

At least some toxicity, some exposure, and a minimum dose are required to result in risk. For example, if the chemical is very toxic, but people are not exposed, there is no risk. Likewise, if there is ample exposure or dose received, but the chemical is essentially nontoxic at that exposure/dose, there is no risk. In addition, if there is exposure to a toxic compound, but the internal dose received by the individual is below a toxic dose, no adverse effects will occur. Many substances cause no adverse effects at low doses, and may even cause beneficial effects, but excessive exposures may cause harm. For example, vitamin A is a teratogen (causes birth defects) in humans under certain exposure conditions. However, every person, including pregnant women, must eat foods containing vitamin A to be healthy. Only excessive doses of vitamin A during pregnancy pose a risk of birth defects. Lower level doses or exposures at other times do not pose this risk. The dose determines the poison.

Experimental evidence in animals can be useful in risk assessment and elucidate potential mechanisms of action for a particular exposure to a particular chemical. Animal data provide support for biological plausibility, but cannot substitute for human data. Human epidemiological data are necessary to establish causation; causation is based on a weight-of-the-evidence evaluation and considers various factors.

4 PRINCIPLES OF REGULATORY TOXICOLOGY AND RISK ASSESSMENT

Regulatory agencies have a mandate to protect public health. Therefore, regulatory levels for compounds that are present in the environment or to which people may be exposed are established with large margins of safety. In fact, when deriving regulatory standards for non-carcinogens, the US EPA sets limits to meet the criterion of "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime" (US EPA 1989). Similarly, for carcinogens, the cancer slope factor is an upper bound on the average risk in a population and is considered health-protective for covering susceptible individuals (US EPA 2005). While an upper bound cancer risk value is used for regulatory purposes, it is also known that the actual risk could be as low as zero.

Risk assessment is one of the methods for establishing these regulatory levels and is conservative by design. Risk assessments rely on conservative exposure assumptions and conservative toxicity factors to derive concentrations of compounds to which individuals can be exposed without risk of adverse effects. Exposure assumptions and toxicity factors are multiplied together, further compounding the conservative nature of the risk estimate. Exceeding regulatory levels does not mean that adverse health effects will occur; nor can these levels be used to predict the potential increase in risk from an exposure for a particular effect.

5 HISTORY OF TOXICOLOGY TESTING

The early history of toxicology can be traced back to ancient times with the identification and use of various poisons (Lane and Borzelleca 2008). However, the use of standard toxicology studies conducted today on various chemicals to assess or predict the potential risk from human exposure is a fairly recent phenomenon. The earliest and most common experimental animal tests were acute toxicity studies designed to evaluate potential irritation or sensitization to workers (Gad et al. 1998). This included an eye irritation test developed in the late 1930s and early 1940s with a summary scoring system proposed by Draize (1944). Dermal sensitization tests were developed in the same time period. These early protocols have had substantial modifications and refinements over time and do not reflect many of the requirements of assays performed today. Even the guinea pig sensitization assay published by Buehler (1964) has since been modified for standardization in the conduct and interpretation of this test (Gad et al. 1998).

Toxicology, like all scientific fields is a continually evolving discipline. Gad (2007) attributes the accelerated development and use of predictive animal testing in the U.S. to three events. First, there was the marketing of an eyelash product, Lash Lure, in the early 1930s; Lash Lure contained a coal tar dye, which caused corneal ulceration and loss of vision. Second, the sale of an antibiotic containing a lethal concentration of diethylene glycol caused over 100 deaths and ultimately led to the passage of the Federal Food, Drug and Cosmetic Act in 1938. The third event was the thalidomide tragedy that highlighted the need for testing for potential teratogenic effects. These and other similar events resulted in the development of regulations and guidance on the types of toxicity studies that needed to be performed (US FDA 2014). The first guidance for industry, the “Black Book” was published in 1949 and focused on food safety because food additives were intentionally present, exposures could last a lifetime, and they were not perceived to provide a benefit, such as drugs. The specific toxicology tests included: acute toxicity (i.e., the LD_{50} or lethal dose that causes death in half of the animals), allergy/sensitization testing, subchronic toxicity (described as subacute), chronic toxicity, and reproductive studies (Lehman et al. 1949). This guidance provided a number of recommendations for the conduct of the studies such as the route of administration, the numbers of experimental animals, and in some cases the interpretation of the results. In 1958, the Food Additives Amendment was passed requiring safety be demonstrated before the marketing of food additives (Merrill 2001). It is important to note that these early toxicity testing recommendations were limited to the US FDA and related to the approval of foods (additives and food-use pesticides), drugs, and cosmetics only.

Only subsequent regulations affected experimental animal testing of products not related to drugs or the food supply and are managed by various governmental agencies with a spectrum of authority to mandate toxicological testing (Merrill 2001). Under the Environmental Protection Agency (US EPA), revisions to (FIFRA) in 1972 and the Toxic Substances Act (TSCA) in 1976 had consequences for toxicity testing of pesticides and industrial chemicals, respectively. Under FIFRA, US EPA manages the review and approval of food-use pesticide registrations which are supported in large part by a battery of toxicology studies ranging from acute and short-term tests to chronic studies and cancer bioassays. In contrast, under TSCA, a company is required to notify US EPA that a new chemical substance will be manufactured and sold. Although available health data need to be submitted to the Agency, no specific testing is required before marketing the chemical. If existing data are limited, US EPA can request testing of a chemical under TSCA under certain conditions. Similarly, no advanced approval or toxicity tests are required under the Occupational Safety and Health Act of 1970 to protect workers who are involved in the manufacture of a new chemical substance. The Consumer Product Safety Commission (CPSC) has oversight regarding the risks of commercial products to consumers. This entails the determination of the hazards and potential risks associated with a product in context of benefit of the product. In addition, the CPSC is responsible for administration of the Federal Hazardous Substances Act, first passed in 1960, that dictates the label warnings for products.

Today, toxicity testing requirements are dependent on the type of product (e.g., drug, industrial chemical), and its use or potential exposure for humans (Lane and Borzelleca 2008). For example, US FDA has fewer requirements for drugs that are administered for a short duration and more extensive testing required for those that will be administered for chronic conditions. In particular, cancer bioassays are only necessary for drugs that will be administered for continuously for at least six months or used repeatedly in an intermittent manner (US FDA 1996). These types of chronic studies or cancer bioassays were first required for drugs, food-use pesticides, and other food additives in the mid-1950s, but are not routinely required for other types of chemicals or products.

How toxicology studies are conducted and the basic requirements for testing have also changed over time, including cancer bioassays (Beyer et al. 2011). As noted above, the first chronic testing requirements for US FDA (i.e., drugs, food additives, including food-use pesticides) were developed in the late 1940s. However, the study design utilized at that time differs substantially from what is required today under the US FDA/ICH guidance for drugs (US FDA 1996, 1997, 2008) or US FDA's Redbook for food additives (US FDA 2007). A few examples of the difference include: number of animals per group (>25 vs. ≥50 animals today), inclusion of a vehicle control group, and histopathology (liver and kidney vs. over 40 organs today). Current chronic studies have additional design requirements that were not even identified when these types of studies were first conducted. These factors include: animal identification, randomization into dose groups, test substance characterization, dose selection to include a maximum tolerated dose as the high dose, and evaluation of organ weights at necropsy. Similar developments occurred with the study design of chronic toxicity testing for non-food chemicals. The first guidance was published by the NCI (1976) and differs from how studies are currently conducted by the NTP (2011). A few examples of these differences include: the number of animals per group (>25 vs. ≥50 animals), inclusion of sentinel animals, and observation of mortality and morbidity. Another element that has changed over time in conducting all types of studies is the development of good laboratory practices (GLPs). GLPs are requirements for study conduct to ensure consistency, reliability, and comparability. Today, GLPs have been further developed to ensure global harmonization in the conduct of studies. GLPs first proposed for experimental animal studies conducted for the US FDA in 1978 and finalized in 1987 (US FDA 1978, 1987), while US EPA's GLPs for testing under TSCA were published in 1983 and adopted for pesticides under FIFRA in 1991 (US EPA 1985, 1991).

In conclusion, toxicity testing was not standardized nor required by regulations until the mid-1950s and this testing was limited to US FDA-regulated products. The specific toxicology studies required, then and now, depend on the type of product being marketed and sold. Furthermore, study designs have also evolved over time. Current study requirements are much more specific and substantial, with studies submitted to regulatory agencies have the additional requirement to be conducted under GLP. The most comprehensive testing historically, as well as the present, is conducted for chronically administered drugs, food additives, and food-use pesticides. However, even today the regulatory requirements for the testing of industrial chemicals are limited.

6 SUMMARY OF PCB TOXICOLOGY TESTING BY MONSANTO

PCBs were manufactured by Monsanto in the United States from 1929 to 1977, with use of PCBs limited to closed uses after 1972. The sales of plasticizer applications, such as use in caulk were halted in August 1970. PCBs were primarily used in industrial applications for thermal insulation, heat transfer, and lubrication because of their fire retardant properties and their resistance to thermal and chemical degradation. Monsanto voluntarily stopped the manufacture of PCBs as a result of reports of PCBs being detected in the environment, not as a result of human health effects. In fact, the Interdepartmental Task Force on PCBs in 1972 stated that "[t]here currently are no toxicological or ecological data available to indicate that the levels of PCBs currently known to be in the environment constitute a threat to human health" (ITF 1972).

The term "PCB" refers to a family of 209 similarly structured chemicals. The defining difference among the 209 PCB types, or PCB congeners, is the number and position of the chlorine atoms in the molecule. The number and location of chlorine atoms on the structure can change the properties of a congener. For instance, congeners with more chlorine atoms are heavier and tend to persist longer in the environment.

Monsanto conducted over 300 studies on various PCB mixtures between 1934 and 1972 (see Table 1, attached). Early studies were conducted to investigate potential dermal effects of various PCB mixtures in workers, the predominate focus of testing at this time being safety in the workplace and industrial hygiene.

While PCBs were still being manufactured and used, no adverse health effects were reported in Monsanto workers nor any workers using PCBs by their suppliers (e.g., General Electric) to suggest potential health effects in humans (Monsanto 1970). Subsequent studies of workers exposed to PCBs demonstrate the greater exposures experienced by these workers (Smith et al. 1980, Lawton et al. 1985, Seegal et al. 2011, Kimbrough et al. 2015). Smith et al. (1980) report that PCB blood levels of workers exposed to Aroclor 1016 and 1242s were elevated compared to a non-PCB worker community or utility workers not exposed to PCBs. Mean concentrations in workers compared to the non-PCB worker community were 8- to 50-times greater for light fraction of PCBs (L-PCB, 89 to 502 ng/mL) and 2- to 4-times greater for the heavy fraction (H-PCB, 22-51 ng/mL). No evidence of illness or symptoms of illness were observed in these workers. Lawton et al. (1985) similarly found a lack of clinical abnormalities or unusual morbidity/mortality in GE workers exposed to PCBs (Aroclor 1242); reported mean PCB concentrations in 1979, three years after PCB exposure terminated, were found to be similar to those reported by Smith et al. (1980): L-PCBs 67.9 ng/mL and H-PCB 19.3-23.7 ng/mL. Seegal et al. (2010) also analyzed serum from GE capacitor workers that had been archived in 1976 and reported comparable concentrations of PCBs: L-PCBs 26.4 ng/mL and H-PCB 9.08 ng/mL. Kimbrough et al. (2015) recently provided an update on the GE workers and concluded that the only finding of an increase in all-cancer mortality for females was likely spurious; no other findings were reported to be due to PCB exposure. PCB exposures of workers are clearly much higher than the general population and have not been shown to exhibit adverse effects attributable to PCB exposure. Therefore, the protection of the work force provides confidence that potential lower exposures to PCBs would not pose a significant health risk.

Monsanto animal toxicity studies included skin irritation studies in rabbits (Flinn 1934). Subchronic studies were conducted by Drinker (1937; 1938a, b; 1939) to evaluate the potential for inhalation toxicity and identify the cause of liver toxicity and skin lesions seen in workers at the Halowax facility. These studies were conducted on a range of chlorinated naphthalenes, chlorinated benzenes, and a chlorinated biphenyl with approximately 68% chlorine. These compounds were heated to temperatures that were considered to be representative of those in industry; a 65% chlorinated diphenyl was heated to 165 °C (329 °F) to achieve the experimental air concentrations. Another consequence of the heating was to generate higher concentrations in the atmosphere than could be realized at room temperature. Rats were exposed to 0.53 mg/m^3 for 4 months with only slight liver damage. Given the limited toxicity observed, it was decided to retain the animals and expose them to a higher concentration of 6.23 mg/m^3 for an additional 3 months. Dr. Drinker (1938a) states that these animals "remained in perfect health," but exhibited microscopic evidence of liver damage and therefore, "cannot be given an absolutely clean bill of health." There was some confusion in these publications regarding the various test materials and one product originally believed to be a chlorinated biphenyl was determined to, in fact, be a mixture containing chlorinated diphenyl benzene. Ultimately, it was concluded that the 68% chlorinated diphenyl "was almost non-toxic" (Drinker 1939) and that "if handled with ordinary precautions as to ventilation should be entirely harmless to workmen."

In 1953, a series of inhalation studies were conducted by Treon (1953) assess the toxicity of several compounds, including Aroclor 1248. Subsequently, additional studies were conducted to evaluate and establish acceptable air concentrations of Aroclors (Treon 1955a, b). The first series of studies investigated the toxicity of Aroclor 1242 and 1254 at air concentrations that approached saturation for seven hours per day: (17 of 24 days at 8.6 µg/L Aroclor 1242; 82 or 83 days over four months at 6.83 µg/L Aroclor 1242 or 5.4 µg/L Aroclor 1254). A second set of studies was conducted to assess potential effects at lower concentrations for an extended period of time: seven hours per day for 150 days over 214 total days at 1.9 mg/m^3 Aroclor 1242 and 1.5 mg/m^3 Aroclor 1254. Treon et al. (1956) noted that "it was necessary to heat these Aroclors in order to increase the rate of volatilization sufficiently to attain the concentrations maintained in these experiments. To the extent that their industrial usage is carried out at ordinary temperatures, the hazard of their inhalation may well be slight or entirely absent." In the experiment where Aroclor 1242 was heated to a minimum of 55°C or 130 °F, animals were exposed for seven months and no adverse effects were reported. Only when Aroclors were heated to 100 °C or higher (212 °F) were effects reported. The results of these experiments were presented at the 1956 meeting of the American Industrial Hygiene Association (Treon et al. 1956) and became the basis of the occupational standard for PCBs.

Starting in the early 1950s, toxicity studies were conducted on a wide range of PCB-containing products. Initially studies included an acute oral study and establishment of a minimum lethal dose for at least one species. By the mid-1950s a battery of studies was often being conducted on products and included: acute oral toxicity, acute dermal toxicity, short-term inhalation, dermal irritation, and ocular (eye) irritation studies. In the late 1960's as standardized protocols were developed, additional toxicity studies were conducted on the various Aroclor mixtures. These studies included subchronic studies, chicken residue studies, and fish toxicity studies. By 1972, when PCBs were withdrawn from open uses, the toxicological database for the three primary Aroclors 1242, 1254, and 1260 included three-generation reproductive studies, developmental studies (1254 and 1260), genotoxicity studies, and two year chronic studies in both rats and dogs.

As seen by the range of tests conducted on various PCB mixtures and the requirements for toxicology testing before 1972, Monsanto conducted the appropriate studies to assess the safety of their workers and potential users of their products. These internal studies were also confirmed by the work of Dr. Drinker at Harvard University and Dr. Treon at The University of Cincinnati. PCBs were not used as drug products, approved as a food additive, nor included as an active ingredient in pesticides applied to food crops (Monsanto 1940, Gissendanner 1968, Papageorge 1971). Therefore, no chronic testing would have been expected within this timeframe.

In 1972, an Interdepartmental Task Force on PCBs reviewed the available data and stated that "[t]here currently are no toxicological or ecological data available to indicate that the levels of PCBs currently known to be in the environment constitute a threat to human health" (ITF 1972).

7 PCBs: SUMMARY OF HEALTH EFFECTS

7.1 Liver Toxicity

Plaintiff experts state that Monsanto knew that PCBs caused systemic toxic effects in experimental animals and refer to the earliest toxicity studies of PCBs that reported liver effects in rodents (Drinker et al. 1938a, b; 1939; Treon 1956). Drinker et al. (1938a) reported liver changes in rats exposed to 0.53 mg/m^3 Aroclor 1268 for 119 days (16 hours per day) including increased swelling and granularity. Toxicity was limited to the liver and was found to reversible, although granular and hyaline material remained. Similar effects were observed by Treon et al. (1956) with slight to moderately severe degenerative changes in the livers of mice, rats and rabbits following exposure to 1.5 mg/m^3 Aroclor 1254, but no pathological changes were seen in experimental animals exposed to 1.9 mg/m^3 Aroclor 1242. Based on exposure for 7 hours per day the daily dose for Aroclor 1242 is approximately 233,000 ng/kg/day.

Cancer bioassays and chronic toxicity studies conducted on Aroclor mixtures or individual congeners have also reported non-carcinogenic liver effects. Liver toxicity was exhibited as hypertrophy, hyperplasia, and other cellular alterations in the liver. Liver effects were reported for Aroclor 1260 (Kimbrough et al. 1972, 1975; Rao and Banerji 1990; Mayes et al. 1998), Aroclor 1254 (Kimbrough 1972, NCI 1978, Mayes et al. 1998), Aroclor 1242 (Mayes et al. 1998), and Aroclor 1016 (Mayes et al. 1998). In the Japanese studies, Ito et al. (1973a, 1974) reported liver effects at some dose level for all three types of PCB mixtures: Kaneclor-300, -400 and -500. However, Nagasaki et al. (1972) only report microscopic changes in the liver for mixture with the highest percent chlorination, Kaneclor-500. The NTP conducted cancer bioassays for three PCB congeners: 118, 126, and 153 (NTP 2010; NTP 2006a, b). Liver toxicity was observed at some dose with each of the three congeners following two years exposure in the diet (note: PCB 153 was not carcinogenic). Although most of the chronic studies reported liver toxicity at the lowest dose administered[1], these doses remain substantially higher than those estimated for students at Westport Middle School. For example, the lowest dose administered in Mayes et al. (1998) was 25 ppm Aroclor 1254 or 1260, which is equivalent to 1,200,000 ng/kg/day.

Liver toxicity is often characterized as a hallmark of PCB exposure; however, this effect is only seen at high doses. Lower exposures, particularly to the lower chlorinated PCB mixtures as reported by Treon et al. (1956) and Ito et al. (1973a), did not exhibit histopathological changes in the livers of experimental animals. Exposures in these experimental studies provide margins of exposure that are orders of magnitude greater than background exposure.

7.2 Immunotoxicity

The plaintiff experts have stated that PCBs are associated with immunotoxic effects. Toxicological studies in animals have reported immunological effects from exposure to high doses of commercial PCB mixtures, although these effects are not consistent across animal species (ATSDR 2000). A number of the studies exploring immunotoxic mechanisms of action are limited by the use of *in vitro* methods (e.g., Levin et al. 2005, Smithwick et al. 2003), use of only a single dose (e.g., Bonnyms and Bastomsky 1976), small numbers of animals per dose group (e.g., Bannister et al. 1987, Smialowicz et al. 1989), or employed routes of exposure (e.g., intraperitoneal or i.p.) that are not directly relevant to potential human exposure (e.g., Arena et al. 2003, Harper et al. 1995). In addition, there are a large number of studies that investigated

[1] The exception being Ito et al. 1973a, where Kaneclor-300 at 100 ppm in the diet did not result in liver hypertrophy or other liver histopathological changes.

the immunological effects of a single congener, which are more difficult to extrapolate to exposures from PCB mixtures (e.g., Harper et al. 1993, Silkworth and Antrim 1985). Furthermore, the majority of the immunotoxic studies have been conducted at doses that far exceed concentrations that might occur from indoor air exposures to PCBs.

Although the i.p. route of exposure is not directly relevant, Davis and Safe (1989) conducted a dose-response study assessing the formation of spleen plaque-forming cells (PFC) in mice for various Aroclor mixtures. This is a commonly used immunological assay that evaluates the response to sheep red blood cell (SRBC) by measuring the production of SRBC-specific antibodies. The authors stated that the lower chlorinated mixtures (i.e., Aroclor 1016, 1232, 1242, and 1248) were not significantly immunotoxic at a dose of 50 mg/kg.

A number of immunotoxicity studies have been conducted using single congeners: PCB 47, 77, 105, 108, 118, 126, 153-156, 159, 168-170, 180, 187, and 189. Like the assays conducted with PCB mixtures, these studies are conducted using very high doses. However, studies of individual congeners must be compared to congener-specific exposures. Of the congeners tested for immunotoxicity (listed above), only three were detected in the congener-specific analysis of Westport Middle School air (i.e., PCB 105, 118 and 153). PFC assays were conducted with all three congeners. No statistically significant increase in PFCs were reported for PCB 153 at a dose of 72 mg/kg (i.p.) (Harper et al. 1994). The lowest doses inducing a PFC response for PCB 105 and 118, were 25 mg/kg and 75 mg/kg, respectively (Harper et al. 1995). These experimental animal doses are substantially greater than the measured air concentrations.

Studies in monkeys suggest that non-human primates are particularly sensitive to PCBs. In fact, the US EPA RfD is based on immune effects in a monkey study (Arnold et al. 1993a, b; Tryphonas et al. 1989, 1991a, b). However, the monkey studies have limitations that undermine their relevance to human health. The immune effects were reported in animals that also exhibited overt PCB toxicity. The immune effects may be secondary to the overt PCB toxicity, to which monkeys are particularly sensitive. Second, these findings are based on only a small number of animals in each dose group and in some cases there is a lack of information on the age and history of these animals (Ulbrich and Stahlmann 2004). Thus, these data may be appropriate for the derivation of a regulatory risk assessment value that is conservative and protective of human health, but they lack relevance for characterizing risks from known human PCB exposures.

Given the limitations with the experimental animal data it is difficult to extrapolate these findings to the types of immune responses reported in epidemiology studies (which also have limitations). More importantly, the high doses needed to induce immunotoxic effects in experimental animals are of questionable relevance to human exposures.

7.3 Reproductive and Developmental Toxicity

Plaintiff experts claim that PCB mixtures cause a range of effects on the mating and reproductive ability of experimental animals, as well as effects on offspring.

Adverse effects on reproduction and development have been described in animal studies of various PCBs, primarily at relatively high and maternally toxic doses. Many of the animal studies have been conducted using an injection routes of administration (i.e., intraperitoneal, subcutaneous, or even intratesticular), which is inappropriate for predicting hazards from environmental exposure. These studies are not discussed further.

Of the animal species that have been used in reproductive or developmental toxicity studies, monkeys appear particularly sensitive to these adverse reproductive effects, as do mink. Monkeys appear to be more sensitive than humans to a number of adverse effects from PCBs, and may not be a good test model for predicting toxic effects in humans. Although mink may be considered a sensitive "indicator species" for wildlife, the principal study demonstrating adverse reproductive effects involved feeding the carp from the Great Lakes to the mink (Restum et al. 1998). The carp were reported to contain between 0.25 and 1 ppm PCBs and contained other compounds, both known (e.g., DDD/DDT) an unknown (e.g., mercury), that likely confounded the results; therefore, the observed effects cannot be ascribed to PCBs alone.

Reproductive toxicity studies have been conducted in rats, mice or rabbits administered Aroclor 1254 (Overmann et al. 1987), Aroclor 1260 (Seiler et al. 1994), and a PCB congener (Huang et al. 1998a, b). A mouse study was conducted using Aroclor 1016, but this study is limited by a single dose, inappropriate statistical analyses based on individual pups (not litters), and findings of unknown biological significance (Gupta et al. 2000).

Although some reproductive effects have been reported in these studies, they were seen at fairly high dose levels. For example, Overmann et al. (1987) exposed rats Aroclor 1254 at doses up to 269 ppm (approximately 14 mg/kg/day) from mating through weaning of their pups. Based on other data, this is considered an excessively toxic dose to rats and decreased the number of impregnated rats that delivered a litter, lowered pup birth weight, and increased pup mortality. The mid-dose level (1.4 mg/kg/day or 1,400,000 ng/kg/day) was reported to slightly decrease pup growth; the data show transient developmental delay at this exposure level. Neurobehavioral effects in the offspring were observed at all dose levels.

Seiler et al. (1994) administered Aroclor 1260 orally to rabbits for 12 to 15 weeks prior to artificial insemination and during gestation at a dose of 4 mg/kg three times per week (1.7 mg/kg/day). No differences in fertilization rate or incidence of pre- and post-implantation losses was reported. Although a 20% higher loss of blastocysts was noted on GD 6 compared to controls, it was speculated that this may be due to embryotoxic effects of PCBs (Seiler et al. 1994). It should be noted that few historical data exist to evaluate the biological significance of a change in this parameter.

A reproductive toxicity study in male mice fed diets containing 3 or 30 ppm 3,3',4,4' TCB (approximately 0.45 or 4.5 mg/kg/day) did not report any reproductive effects (Huang et al. 1998a). Although *in vitro* sperm fertilizing ability was reported to be reduced in the high dose group at 17 weeks only, this finding was slight and it did not correlate with any adverse reproductive findings in the *in vivo* study. By itself, the *in vitro* finding is not considered evidence of an adverse effect. In a follow-on study in female mice, reproduction was affected at the high dose (30 ppm) (Huang et al. 1998b). Thymic atrophy in the offspring was also reported at this dose. However, this specific congener was not detected in the congener analysis of select air samples at Westport Middle School.

A developmental study of Aroclor 1254 was conducted with weanling male rats treated with 0.1 to 25 mg/kg/day by gavage for 5, 10 or 15 weeks (Gray et al. 1993). There were no effects on testosterone levels testicular interstitial fluid, tests weights, testicular sperm numbers or sperm mobility. Body and organ weight depression was noted at 25 mg/kg/day and cauda epidydimal sperm was reduced at this dose level after 15 weeks of dosing. The testis is not a sensitive target tissue for Aroclor 1254 and limited findings were present only at a high and markedly systemically toxic dose level (Gray et al. 1993).

Monsanto conducted three-generation reproductive studies in rats for three of the Aroclor mixtures: 1242, 1254, and 1260 (IBT 1971f, j, k). For the second generation of rats, mating indices and pregnancies were affected at the highest dose of 100 ppm in the diet for Aroclor 1242 and Aroclor 1254, but the mid-dose of 10 ppm in the diet did not cause any reproductive toxicity (approximately 6 mg/kg/day and 0.6 mg/kg/day, respectively). No effect on reproduction was reported for Aroclor 1260 in any of the three generations.

Arnold et al. (1995) administered 0, 5, 20, 40, or 80 µg/kg/day Aroclor 1254 to Rhesus monkeys. A decreased number of implantations and increases in infant death were reported, but no dose-trend was observed and the numbers of animals per treatment group were small. These exposures caused clinical signs of toxicity and hematological and clinical chemistry changes to the mothers in the pre-breeding period, but no body weight loss was noted in the mothers. No changes in gestation lengths were noted in this study (compared to historical control data in the published literature). Additionally, an evaluation of animals from the same study by Bryce et al. (2000) found no treatment related effects on the mothers on menstrual frequency, cycle length or menstrual duration. Among surviving infants, there were no treatment-related effects on birth weight or on overall growth. Some limitations in this study include an unknown reproductive history for the monkeys, and potential previous exposure to experimental testing (Arnold et al. 1995). Previous monkey studies by Allen's group (as cited in Arnold et al. 1995) have also found effects on impregnation of monkeys fed Aroclor 1248 in the diet. Dose levels were relatively higher and more marked maternal toxicity was seen in these studies.

Overall, while some studies have reported reproductive or developmental toxicity in experimental animal studies, these effects are observed at doses that are greater than those that would be experienced from indoor air at Westport Middle School.

7.4 Endocrine Disruption

Plaintiff experts have claimed that PCBs cause endocrine disruption and are associated with a range of effects from diabetes to thyroid changes.

Diabetes has been identified as a disease potentially associated with PCB exposure. However, few animal studies are available, in part due to limitations of a rodent study modeling the development and progression of diabetes in humans. Existing animal studies have investigated related or precursor conditions such as insulin-resistance (Gray et al. 2013), assess mixtures of various substances (not PCBs alone) (Ruzzin et al. 2010), or are *in vitro* studies focusing on potential modes of action (Fischer et al. 1999). Gray et al. (2013) reported that there was an association between PCB exposure and obesity-induced insulin resistance in mice based on the administration of a single dose level for 20 weeks, 9.6 mg/kg/day Aroclor 1254. Given the single dose level, this study does not provide information on the dose-response relationship and whether or not a threshold exists for this effect. This is a critical point since this dose is orders of magnitude greater than background exposures in the general population. Epidemiology studies are mixed and overall do not demonstrate a causal association between PCBs and Type 2 diabetes (Everett et al. 2011). Furthermore, no significant increase in mortality from diabetes mellitus has been reported in several cohorts of workers exposed to higher levels of PCBs (Kimbrough et al. 2015, Ruder 2014, Pesatori et al. 2013, Prince et al. 2006).

Conflicting evidence exists for thyroid modulating effects of PCB exposure in animal studies and is not considered to be relevant to humans. Some studies of PCBs administered during development have reported a reduction in circulating T4 (Bowers et al. 2004, Corey et al. 1996, Crofton et al. 2000, Crofton and Rice 1999). Other studies have provided mixed results or failed to show an alteration in thyroid hormone levels (Arnold et al. 1997, Cocchi et al. 2009, Haave et al. 2011, Ness et al. 1993, Schantz et al. 1995). In most studies, effects on T4 were reversible and returned to normal in animals between 45 and 90 days old (Corey et al. 1996; Goldey et al.

1995; Morse et al. 1994, 1996). Although decreases in T4 plasma levels are reversible, the lower levels of T4 at a specific period in development may be the cause of ototoxicity in rats. It is important to note that the rat is a poor animal model for evaluating thyroid responses to chemicals because they have very low reserves of circulating T3 and T4 compared to humans and developmental differences exist between a newborn rat pup and a human fetus.

Several PCB congeners have induced weak estrogen-like responses in female reproductive tissue in vivo (Gellert 1978, Jansen et al. 1993, Li and Hansen 1995) and have been proposed as a mechanism for developmental toxicity (Seegal et al. 2005). However, weak responses observed in these types of assays could not be differentiated from normal estrogenic responses in normally functioning animals. Some *in vitro* studies have demonstrated direct neurochemical effects of PCBs in the absence of endocrine influences and metabolic enzymes (Kodavanti et al. 1996, Lee and Opanashuk 2004). Therefore, hormonally-mediated pathways are not likely a universal mechanism for these effects.

Overall, the data for endocrine disrupting effects from PCB exposure are inconsistent and are not sufficient to show that PCBs cause endocrine effects including diabetes, thyroid hormones, and estrogen-mediated developmental toxicity.

7.5 Cancer

Cancer bioassays have been conducted on various PCB mixtures and a few select congeners (Brunner et al. 1997/Mayes et al. 1998; Ito et al. 1973a, b, 1974; Kimbrough et al. 1975; Kimura and Bara. 1973, Nagasaki et al. 1972; NCI 1978; Norback and Weltman 1985; NTP 2006a, 2006b, 2006c, 2006d, 2010; Rao and Banerji 1988, Schaeffer et al. 1984). The first cancer bioassays were conducted by Monsanto (IBT 1971l,m, n) with studies from Japan published shortly thereafter (Nagaski et al. 1972; Ito et al. 1973a, b,1974; Kimura and Bara 1973). The most comprehensive and well-conducted study, according to today's standards, is the Brunner et al. (1997) study, published in the peer-reviewed literature as Mayes et al. (1998). This study investigated the carcinogenic potential in rats for four Aroclors: 1016, 1242, 1254, and 1260 as administered in the diet. The Aroclors were reported to differ in tumorigenic potential and interestingly, tumor suppressing for mammary tumors. In particular, neither Aroclor 1016 nor Aroclor 1242 produced a significant increase in carcinomas. In contrast, Aroclor 1254 and 1260 caused an increase in hepatocellular carcinomas that were statistically significant at ≥50 mg/kg/day and 100 mg/kg/day, respectively.

In those studies where an increased incidence in cancer was reported, liver cancer was detected most frequently and found to be statistically significantly elevated compared to control animals (Nagasaki et al. 1972; Ito et al. 1973a, b; Kimbrough et al. 1975; Schaeffer et al. 1984; Norback and Weltman 1985, Mayes et al. 1998). In the NTP studies of individual congeners (PCB 118, 126, and 153) or mixtures of these same congeners, an increased incidence of liver, lung, uterine, mouth, or pancreatic tumors were detected for PCB 118, PCB 126 or mixtures containing these congeners (NTP 2006a, c, d, 2010). PCB 153, when tested alone, was reported to induce toxic effects, but was not concluded to cause tumors (NTP 2006b). In studies that have demonstrated an association between PCB exposure and tumorigenicity, scientists have concluded that PCBs act as promotors. This means that use of a linearized model for carcinogenicity is extremely conservative and that a threshold model would be more appropriate.

As discussed below, PCBs have been classified as carcinogens; however, these types of classification generally are a hazard-based assessment and do not consider the dose-response in the induction of cancer. In the few cases where cancer bioassays were conducted using multiple dose levels and induced cancer at some dose, it is clear that carcinomas generally occur at higher doses. The lack of cancer at lower doses supports a threshold for cancer. For example, Ito et al. (1973a) report hepatocellular carcinoma only at the highest dose of Kanechlor 500 administered to mice (500 ppm in the diet); no carcinomas were reported at 100 or 250 ppm. Similarly, hepatocellular carcinomas were reported at ≥50 ppm Aroclor 1254 in the diet (≥2,400,000 ng/kg/day), but not at 25 ppm (Mayes et al. 1998). The NTP studies of individual congeners also show a threshold for the induction of cancer with only the highest dose (4,600 µg/kg/day) of PCB 118 and doses of ≥300 ng/kg/day PCB 126 resulting in a statistically significant increase in cholangiocarcinoma (NTP 2010, 2006a).

As noted above, certain PCB mixtures or congeners have been found to induce cancer at some dose, in select animal species. In order to place these and similar observations of carcinogenicity in context, researchers in California have complied the Cancer Potency Database (CPDB) that currently contains cancer data on over 1,500 chemicals[2]. Publications using data from the CPDB provide comparisons of the hazards from exposure to chemicals commonly found in our food or drinking water (Ames et al. 1987, Ames et al. 1990 Gold et al. 2001). For example, exposure to PCBs were found to pose less of a hazard in comparison to chemicals found in bacon, coffee, potatoes, mushrooms, celery or mangos. Similarly, based on typical exposure to beer or wine, Gold et al. (2001) estimated that the cancer hazard from ethyl alcohol was greater than from intake of PCBs in the mid-1980s.

Overall, the findings from cancer bioassays for the various PCB mixtures and individual congeners do not provide a consistent pattern of carcinogenicity. Only a few studies report an

[2] https://toxnet.nlm.nih.gov/cpdb/

increased incidence of cancer, while others failed to report an increase in cancer. These differences appear to be dependent on the type of PCB (mixture or congener) being administered, the dose administered, the animal species, and the gender of the animal. The doses that have been observed to induce cancer are orders of magnitude greater than background exposures to PCBs.

8 PCB CANCER CLASSIFICATION

As noted above, one of the elements in conducting regulatory risk assessments is an evaluation of the potential carcinogenicity of a compound. This evaluation can be based on epidemiological evidence, experimental animal data or both. Depending on the agency conducting the review supporting data can also be considered to characterize the potential carcinogenicity of a compound. Although these classifications can be useful for risk assessment they are not predictive of human cancer risk.

PCB mixtures have been classified by the US EPA based on sufficient evidence of carcinogenicity in animals; human evidence was characterized as inadequate (US EPA 1996). Tiers of cancer slope factors have been derived by the US EPA that in combination with a lifetime average exposure levels can be used to describe the potential cancer risk from PCB exposure. These cancer slope factors are based on a range of assumptions and as acknowledged by the US EPA, "several sources of uncertainty are inherent in the experimental information used in this assessment" (US EPA 1996). Consequently, these cancer potency estimates are useful for regulatory risk assessment, but do not predict individual cancer risks.

In 1978, IARC concluded that the evidence for carcinogenicity in humans was limited and in experimental animals the evidence was sufficient. In 2013, IARC re-evaluated the evidence and concluded that there is "sufficient evidence in humans for the carcinogenicity of PCBs" based on the consistent association for melanoma in workers (Lauby-Secretan et al. 2013, IARC 2015). The conclusion regarding evidence in experimental animals was maintained as sufficient. Sufficient evidence was found for the congeners PCB-126 and PCB-118, and the PCB mixtures: Aroclor 1260, Aroclor 1254, and Kanechlor 500. The evidence for the carcinogenicity of other PCB mixtures containing lower chlorinated congeners (e.g., Aroclor 1242, Clophen 30) was determined to be "limited."

IARC's assessment of carcinogenicity is essentially a hazard classification and does not consider the dose-response of a compound in context of potential exposures. This is acknowledged in the preamble of the IARC monographs, where the evaluations are described as "judgements about the evidence for or against carcinogenicity provided by the available data" (IARC 1991 preamble). IARC clearly states that "no recommendation is given with regard to regulation or legislation." Therefore, an IARC classification describes the potential for a compound to cause cancer at some undefined dose, but is not useful in predicting the potential cancer risk of an individual or the cancer risk at any particular dose. Furthermore, the conclusions reached in a particular monograph are based on the opinions of the expert working group and are not necessarily the opinions of IARC or the World Health Organization (WHO).

Cancer classifications do not necessarily consider the type of cancer reported or associated with the exposure of interest. For example, the only consistent finding for carcinogenicity in PCB cancer bioassays is liver cancer, although liver cancers have not been observed in all studies and the responses are affected by the species, strain, gender, Aroclor mixture, and dose administered. No other tumor endpoint has been consistently reported in the animal studies, including melanoma, breast cancer, or non-Hodgkin's lymphoma (NHL). In the most recent review of epidemiological data by IARC, the cancer classification was limited to melanoma. Although an association with NHL and breast cancer were considered biologically plausible and some increased risks were reported, "the associations were not consistent and were considered as providing limited evidence" (Lauby-Secretan et al. 2013). Data on other cancer sites were considered to be even more limited and not sufficient to reach any conclusions regarding an association with PCBs.

9 PRODUCT LABELING AND WARNINGS BY MONSANTO

It has been alleged that Monsanto denied the toxicity of PCBs in the interest of maintaining product sales. Monsanto actively conducted toxicity testing starting in 1934 to characterize the potential toxicity of Aroclor mixtures and other PCB-containing products. As described above, these tests were conducted in conjunction with industrial hygiene measures to control and minimize exposures to workers. Information on and recommendation for adequate ventilation was provided by Monsanto to other companies using their products, such as General Electric.

Monsanto product labels consistently indicated that PCB products should be used with caution as they contained chlorinated hydrocarbons. Cautionary statements are found on labels for Aroclor products from 1954 and 1959[3] and included the following statements:

- Caution! Avoid prolonged and repeated contact with skin
- Avoid prolonged breathing of vapors or mists

Later labels provide recommendations for washing skin or flushing eyes with water if contact occurs. Other labels specifically include warnings not to use these products in systems related to

[3] The date of these labels is supported by the use of city code and not a zip code in Monsanto's address. Zip codes were only introduced in 1963.

food production, food-related products, food wrapping, food containers, pharmaceuticals, or animal feed stuffs. By 1970, labels included a warning that the "This product contains polychlorinated biphenyls, which some studies have shown may be an environmental contaminant. Extreme care should be taken to prevent any entry into the environment through spills, leakage, use, disposal, vaporization, or otherwise."

As early as 1934, some product brochures or technical bulletins contained a brief description of the toxicity of Aroclors. In particular, control of vapors by ventilation was noted. From 1960 onwards, summaries of the toxicology considerations were further elaborated and dermatological effects were included. Monsanto's description of the toxicity in these documents are consistent with the toxicity studies conducted from the late 1930s to the late 1950s. In 1970, Monsanto added a description of environmental hazards in the product brochures or technical bulletins.

These labels and product brochures reflect the state of knowledge at the time. The early studies by Drinker (1937; 1938a, b; 1939) and Treon (1953, 1955a, b) showed that the potential toxicity of PCBs could be managed with appropriate ventilation and limiting dermal contact. Monsanto's continued testing of various PCB products supported this assessment. Thus, the cautions and warnings provided by Monsanto represent what was known about the toxicity of PCBs.

Until the first reports by Jensen (Anonymous 1966) were received regarding PCBs in the environment and with the Yusho contamination in 1968, PCBs were not "generally regarded either as hazardous chemicals or as potential environmental contaminants" (PHTS 1972). It is important to note that while the Yusho incident involved PCBs, the chloracne and other effects have been attributed to a contaminant, chlorinated dibenzofuran (ITF 1972, Masuda and Yoshimura 1984). Following these events Monsanto initiated and conducted additional toxicity tests to understand long term effects and potential reproductive and developmental toxicity. In 1977, Monsanto voluntarily stopped the manufacture of PCBs as a result of reports of PCBs being detected in the environment, not as a result of human health effects.

10 PLAINITFF EXPERT CLAIMS

Dr. Olson and Dr. Matson both cite publications of occupational worker exposure to PCBs as support for evidence of systemic toxicity. However, many of the workers in these studies were exposed to mixtures of compounds and the observed toxicity ultimately was attributed to other compounds – not PCBs. For example, Swann workers manufacturing chlorinated diphenyl (PCBs) were observed to develop chloracne, which was found to be due to an impurity in the benzene that produced styrene, the ultimate cause of the skin condition (Flinn 1934, Jones and Alden 1936, Schwartz 1936). Jones and Alden (1936) noted: "the finished product, chlorinated diphenyl, did not, either experimentally or actually produce any cutaneous or sebacaceous irritation." Yellow atrophy of the liver was reported in workers exposed to both Aroclors and Halowax (containing chlorinated naphthalene); but these effects have been attributed to chlorinated naphthalene exposure and are consistent with the liver toxicity seen in animals exposed to these compounds (Flinn and Jarvik 1936, 1938; Greenburg 1939).

Meigs et al. (1954) is also cited by the plaintiff experts as evidence that "low" levels of PCBs induce effects, specifically chloracne. This study involves workers exposed to PCBs from a leaking heat exchange system and as a consequence of heating the PCBs, contaminants, such as polychlorinated dibenzofurans (PCDFs) may have been produced (James et al. 1993). Therefore, these observations cannot be attributed to PCBs alone as PCDFs are more likely the cause of the chloracne.

It should be noted that many of the non-cancer health effects alleged to be associated with PCBs by the plaintiffs are supported by limited data, are often inconsistent across studies, or are a high dose phenomenon. For example, Miller et al. (1944) and Von Wedel et al. (1943) are cited as evidence of PCBs inducing liver toxicity. In several of the experiments reported by Miller et al. (1944) routes of exposure were used (i.e., subcutaneous or directly to the cornea) that are not relevant to the potential exposure to PCBs in schools. Regarding the more relevant routes of exposure, dermal and feeding studies, the doses administered were far greater than would be experienced from PCBs at Westport Middle School. The lowest dermal dose reported to cause microscopic liver changes was 34.5 mg chlorinated diphenyl administered daily to rats for 25 days (8.63 mg/kg/day). Similar microscopic liver changes were also seen following the feeding study, but these doses were even higher at 138 mg per day, compared to the 34.5 mg per day dermal dose. Von Wedel et al. (1943) employed even larger doses (only sufficient details are provided for the dermal route of exposure), where 300, 600 or 900 mg Aroclor was applied to the skin of rabbits daily for four months (the lowest dose approximately equal to 150 mg/kg/day). Furthermore, in some cases, the skin was occluded with a celluloid guard or a type of cold cream, in order to reduce the potential for simultaneous inhalation and ingestion exposure to the PCBs; however, these treatments may have enhanced the dermal penetration of PCBs. Therefore, the studies reporting liver toxicity administered PCBs at doses that were orders of magnitude greater than could potentially be achieved at Westport Middle School.

Drs. Olson and Herrick, state that PCBs are immunotoxic or suppress the immune system, but do not address the fact that the effects seen in experimental animals are generally limited to high doses or routes of exposure (e.g., subcutaneous or intraperitoneal) that are less relevant to human with potential inhalation exposures. Another factor, as identified in the animal studies cited by Dr. Olson, is the presence of PCDFs in some mixtures which induced more severe toxicity (Vos and Koeman 1970, Vos and Beems 1971, Vos 1972). In fact, Aroclor 1260 was the least toxic PCB mixture in comparison to the Clophen or Phenoclor mixtures. Clinically relevant changes, such as thymic atrophy, have only been reported in some animal studies at high doses (Arena et al. 2003, Silkworth et al. 1984). Similarly, Vos and Beems (1971), cited by Dr. Olson, reported thymic atrophy as a common finding in rabbits administered approximately 40 mg/kg/day[4] directly to the skin – this dose is greater than the highest dose administered in most of the cancer bioassays.

Dr. Olson cites several reproductive studies of rats, rabbits, doves and chickens to indicate a potential concern for developmental and reproductive effects. It is important to note that the study summaries submitted to US FDA and the abstract/publication by Keplinger et al. are based on the same studies conducted on behalf of Monsanto. In Monsanto's rat reproductive studies, effects were seen only at 100 ppm in the diet for Aroclor 1254 and 1242 and no reproductive toxicity reported for Aroclor 1260. No reproductive effects were seen at 10 ppm Aroclor 1242 and 1254, which is equivalent to a daily dose of 600,000 ng/kg/day. Dr. Olson also cited Villeneuve et al. (1971) stating that Aroclor 1254 caused "[a]bortions, maternal deaths, and stillbirths were reported at oral doses as low as 12.5 mg/kg body weight/day." This citation and article provided actually reports a study that investigated enzyme activity in pregnant rabbits exposed to Aroclor 1254 and 1221 at doses of 1 and 10 mg/kg/day (not 12.5 mg/kg/day). More importantly, reproduction was not affected by either Aroclor 1221 or 1254 at the highest dose, 10 mg/kg/day. Finally, the majority of the studies cited by Dr. Olson are chicken and dove studies and he does not provide any rationale for the relevance of avian studies to human health.

Plaintiff experts claim that PCBs cause a variety of endocrine disrupting effects, including diabetes, suppression of thyroid hormones, and alteration of sex hormone function. Dr. Olson cites two meta-analyses of human studies as support for PCBs being a risk factor for causing diabetes (Song et al. 2016, Tang et al. 2014). Dr. Olson does not explicitly state that PCB cause diabetes. In addition, he does not cite any experimental animal studies in support of a link between PCB exposure and diabetes. Both of the meta-analyses include cross-sectional studies, which by design cannot show that the exposure preceded the disease and consequently, cannot be used to establish a causal association. Therefore, the pooled relationship for the cross-sectional studies in Song et al. (2016) is not a scientifically reliable basis for establishing a causal association between PCBs and type 2 diabetes. Tang et al. (2014) included 8 cross-sectional

[4] Described as 118 mg x 27 applications (Vos and Beems 1970), which based on a 2 kg body weight for a rabbit over a 38-day test period is equivalent to 41.9 mg/kg/day.

studies out of 11 total studies on total PCBs (not the 23 reported by Dr. Olson) in their meta-analysis; however, a separate estimate of the risk is not provided for these studies and the impact of these studies on the overall risk cannot be assessed. Although Song et al. (2016) report a statistically significant relative risk between PCBs and type 2 diabetes (based on pooling the prospective studies), the two most heavily weighted studies (indicated by the size of the black squares in Figure 3) – both of are study populations with known exposures to other organic compounds (Vasiliu et al. 2006; Wang et al. 2008). Vasiliu et al. (2006) investigated the Michigan Polybrominated Biphenyl (PBB) cohort and Wang et al. (2008) report on the Yucheng cohort, with known exposure to PCDFs. Therefore, it is difficult to attribute these findings solely to PCBs. Additionally, there are some questions about combining the underlying studies in the meta-analyses without consideration of a common measure of exposure and the various congeners measured in each study. Overall, these findings are also inconsistent with the lack of an observed effect on mortality from diabetes in workers exposed to high levels of PCBs (Kimbrough et al. 2015, Ruder 2014, Pesatori et al. 2013, Prince et al. 2006).

The evidence presented for other endocrine-related effects are scant - Dr. Olson cites one review article for adverse effects on the thyroid. Duntas and Stathatos (2015) only state that PCBs have been associated with – not causing – tumorigenesis/goiterogenesis and thyroid autoimmunity. The majority of the discussion relates to possible mechanism for thyroid disruption based on data for two congeners: PCB 118 and 153, and exposure to a mixture of compounds that includes PCBs. It should also be noted that some of the reviewed studies are *in vitro* assays and not directly relevant to assessing human health. Further, Dr. Olson has not shown that the doses discussed in this review (only PCB 118 was detected in the congener-specific samples) are relevant to the potential exposures at Westport Middle School.

The plaintiff experts, Drs. Olson and Herrick, predominately rely on the reviews by U.S. EPA and IARC to support the potential cancer risk of PCBs. However, the findings from cancer bioassays for the various PCB mixtures and individual congeners do not provide a consistent pattern of carcinogenicity. Only a few studies report an increased incidence of cancer, while others failed to report an increase in cancer. These differences appear to be dependent on the type of PCB (mixture or congener) being administered, the dose administered, the animal species, and the gender of the animal. Importantly, the doses that have been observed to induce cancer are orders of magnitude greater than those potentially experienced at Westport Middle School. Dr. Olson does not provide any specific risk estimates for the Westport Middle School, but does describe the US EPA risk estimates associated with a specific level of water or air concentration. Dr. Olson does not make clear that these are conservative risk estimates, not absolute predictions of the rate of cancer in a population exposed to the specified concentrations.

The recent classification by IARC (2015) is cited by plaintiff experts as evidence of the carcinogenicity of PCBs. IARC concluded that there is "sufficient evidence in humans for the carcinogenicity of PCBs" based on the consistent association for melanoma in workers (Lauby-Secretan et al. 2013, IARC 2015). In experimental animals, it was concluded that sufficient evidence was available for the congeners PCB-126 and PCB-118, and the PCB mixtures: Aroclor 1260, Aroclor 1254, and Kanechlor 500. The evidence for the carcinogenicity of other PCB mixtures containing lower chlorinated congeners (e.g., Aroclor 1242, Clophen 30) was determined to be "limited." However, it is important to recognize that IARC's assessment of carcinogenicity is essentially a hazard classification and does not consider the dose-response of a compound in context of potential exposures. The observation of cancer at high doses for certain PCB mixtures or congeners may not be relevant for all exposures.

Dr. Olson also cites data based on the effects reported from the Yusho incident and further states that other contaminants may contribute to the health effects of PCBs. In both the Yu-Cheng and Yusho rice oil poisoning cases, the victims were highly exposed to more highly toxic PCDFs, as well as to PCBs, and other compounds such as polychlorinated quaterphenyls the toxicity of which has not been well characterized. There is scientific consensus that the adverse effects were predominately due to exposures to the PCDFs rather than to the PCBs (Borak and Israel 1997, Seegal 1996, Masuda and Yoshimura 1984). Therefore, data from these studies cannot be relied on to establish or demonstrate causation for exposure to PCBs. Dr. Olson mentions that PCDFs are present at low levels in PCB mixtures and further, that because polychlorinated dibenzodioxins (PCDDs) are formed from combustion of PCBs they are also of concern. However, no data are provided to demonstrate the presence of either PCDFs or PCDDs at Westport Middle School. In the absence of measured concentrations for these compounds, the exposure to PCDDs or PCDFs and any potential health risks is mere speculation.

Dr. Olson concludes that Monsanto knew that PCBs caused systemic toxicity in humans and experimental animals in the 1930s and that chronic studies should have been conducted and "would have documented the wide range of cancer and non-cancer effects that are known to be caused by low level exposures to PCBs." This conclusion is not supported by typical study designs for long term testing before the mid-1970s nor is it confirmed by the findings reported in the studies that have been conducted. As described above, the conduct of a toxicological study and the requirements for the study design have changed over time. Therefore, if a study had been conducted in an earlier timeframe it is difficult to know exactly how that study would have been conducted. This is supported by the variability of studies that have been conducted on PCBs over time: ranging from Treon et al. (1956) who exposed a variety of animals (e.g., 1 cat, 6 guinea pigs, 10 rats), to the NCI (1978) cancer bioassay that employed Fischer 344 rats, 24 of each gender, and ending with the Mayes et al. (1998) study that was conducted using a modern study design where 50 Sprague-Dawley rats of each gender were exposed. Further, the results of all cancer bioassays that have been conducted on the various PCB mixtures and specific congeners, clearly show differences based on the PCB tested, the gender of the animal, and the dose administered. Thus, it is extremely unlikely that an earlier study would have shown particular effects, since even the current studies do not provide consistent evidence for adverse effects.

11 PCBs: EXPOSURE TO PCBS IN THE WESTPORT PUBLIC SCHOOL SYSTEM

The US EPA (2016) has developed exposure levels for the evaluation of PCBs in indoor school air. These exposure levels (summarized in Table 1 below) have taken into account exposure to average background concentrations of PCBs. The air concentrations are based on the non-cancer reference dose (RfD) for Aroclor 1254. An RfD does not predict the risk of health effects in humans, but is used as a comparison for average daily exposure. Exceeding the RfD does not mean that adverse health effect will occur.

The basis and development of the exposure levels for PCBs in indoor school air are designed to be protective from a public health perspective and rely on very conservative assumptions about toxicity. US EPA specifically note that these values “should not be interpreted nor applied as “bright line” or “not-to-exceed” criteria, but may be used to guide thoughtful evaluation of indoor air quality in schools.” It is also noted on the US EPA website that a previous version of this page was titled “Recommended Public Health Levels for PCBs in Indoor School Air” and that the current description as “Exposure Levels for Evaluation of PCBs” better reflects that purpose of these concentrations.

Table 1: US EPA’s Exposure Levels for Evaluation of PCBs in School Indoor Air[5]

Preschool		Elementary School	Middle School	High School	Adult
1 - <3 yrs old	3 - <6 yrs old	6 - <12 yrs old	12 - <15 yrs old	15 - <19 yrs old	19+ yrs old
100 ng/m^3	200 ng/m^3	300 ng/m^3	500 ng/m^3	600 ng/m^3	500 ng/m^3

A series of monkey studies were used to derive the RfD for Aroclor 1254 (Arnold et al. 1993a, b; Tryphonas et al. 1989, 1991a, b). While these studies represent the most sensitive effect in the

[5] https://www.epa.gov/pcbs/exposure-levels-evaluation-polychlorinated-biphenyls-pcbs-indoor-school-air

most sensitive species, these findings may not be relevant for predicting potential health effects from inhalation exposures. The monkeys were administered a gelatin capsule contain Aroclor 1254; therefore, this was an oral exposure and a bolus daily dose of the PCB mixture. In addition, it is well recognized that the monkey is a sensitive animal model and may be more sensitive than humans to PCB-induced effects.

Inhalation toxicology studies and chronic oral studies that administered PCBs in diet may be more relevant in a comparison of low level, long term exposure. Two series of inhalation toxicity studies have been conducted nearly twenty years apart (Drinker 1938a, b; Treon 1956). Drinker (1938a, b) administered Aroclor 1268 at 0.53 mg/m^3 (equivalent to 530,000 ng/m^3) to rats for 16 hours per day for approximately 4 months. No significant toxicity was reported. The maximum reported air concentration (2,400 ng/m^3, Music Appreciation room) in the Westport Middle School after September 2011 (following remediation) is over 200-times lower than the air levels in the Drinker study. In second set of studies, Treon (1956) exposed rats to 1.9 mg/m^3 (1,900,000 ng/m^3) Aroclor 1242 or 1.5 mg/m^3 (1,500,000 ng/m^3) Aroclor 1254 with limited liver toxicity observed following exposures 5 days per week for 30 weeks. The maximum detected air concentrations in Westport following remediation range is 790-times lower than the air concentrations administered in the Treon study for Aroclor 1242 and 625-times lower than the concentration for Aroclor 1254.

As described above, several chronic studies or cancer bioassays have been conducted where PCB mixtures were administered by diet. Dietary administration provides a lower more constant exposure to the PCBs compared to a gelatin capsule and therefore, may be more relevant for comparing doses in indoor air. For example, Mayes et al. (1998) conducted a study with four Aroclor mixtures and reported liver cancer for some mixtures. Based on the highest dose administered for Aroclor 1242 (a lower chlorinated PCB mixture), 4,900,000 ng/kg/day, which did not induce a statistical significant increase in carcinomas. Margins of exposure for doses administered in the cancer bioassays are substantial compared to background exposures to PCBs.

In addition, the homolog analysis of air samples in the Westbrook Middle School shows that lower chlorinated congeners predominate. Based on several samples with the highest reported air concentrations, between 35.57% and 97.08% of the total PCB air concentration is comprised of tetrachlorobiphenyls, trichlorobiphenyls, and dichlorobiphenyls. Few samples even indicated any significant presence of the higher chlorinated congeners, such as hexachlorinated or heptachlorinated biphenyls. This distribution of homologs is not comparable to Aroclor 1254 or 1260, which contain higher fractions of the higher chlorinated biphenyls. Therefore, these commercial mixtures are likely to overestimate any potential cancer risk from exposure to PCBs at Westport Middle School. Furthermore, US EPA (1996), recommends that the cancer risk from inhalation of evaporated congeners be assessed using the cancer slope factor for Aroclor 1242, a lower chlorinated PCB mixture.

Finally, several samples were analyzed to measure the air concentrations of individual congeners. NTP conducted cancer bioassays for two congeners, PCB 118 and 126, which were concluded to cause cancer in female rats (NTP 2010, 2006a). As noted above, not all doses administered to the animals produced carcinomas. Only the highest dose, 4,600 µg/kg/day PCB 118 resulted in a statistically significant increase in cholangiocarcinoma. Based on the maximum detected concentration for this congener, 10 ng/m^3 (Room 212), a significant margin of exposure exists. PCB 126 was not detected in the samples analyzed at Westport Middle School.

Overall, US EPA's exposure levels for the evaluation of PCBs in school indoor air are based on several conservative assumptions that overestimate the potential risks from air concentrations at Westport Middle School. These assumptions are reasonable for the protection of public health, but are not useful in predicting potential risks.

12 SUMMARY OF OPINIONS

- All chemicals or substances, if tested at a high enough concentration or under certain exposure conditions, exhibit toxicity.
- Toxicology as a science has evolved over time and study protocols to assess potential toxicity and predict potential effects in humans have likewise developed over the last several decades.
- The regulatory requirements for toxicological testing are dependent on the type of product (e.g., drug, pesticide) and the duration and amount of potential human exposure. Even today limited toxicology testing is required for industrial chemicals.
- Monsanto conducted hundreds of toxicology studies on the Aroclor mixtures and other PCB-containing products. These studies were used to develop workplace exposure standards.
- Experiments with PCB vapors in laboratory animals required heating these mixtures to temperatures that are greater than those that would likely be achieved in a classroom.
- Systemic toxicity in experimental animal studies, generally presented as liver toxicity occurs at doses that are significantly greater than background exposure to PCBs.
- Immunotoxicity studies of PCB mixtures and congeners are limited by the methods used and are not directly relevant to assessing potential effects in humans. Even if they were relevant the doses are orders of magnitude greater than those potential experienced at Westport Middle School.
- Reproductive and developmental effects have been reported in experimental animal studies of PCBs, but are generally observed at doses greater than potential exposures at Westport Middle School.
- Endocrine disrupting effects (i.e., diabetes, suppression of thyroid hormones and alteration of sex hormones) are inconsistent and have not been shown to be causally link with PCB exposure.

- The long-term animal studies on PCBs fail to show an increase in melanoma, breast cancer or hematopoietic tumors.
- The long-term animal data on PCB mixtures and individual congeners show that the carcinogenic potency of the less chlorinated PCB congeners is lower than the carcinogenic potency of the more chlorinated PCB congeners based on these high dose studies. Aroclor 1016 and 1242, lower chlorinated PCB mixtures, have not be shown to be carcinogenic.
- Numerous studies were conducted by Monsanto demonstrating good stewardship. The labels and warnings provided to clients regarding the toxicity of PCBs reflect the state of knowledge at that time.
- Air concentrations were measured at Westport Middle School and some individual measurements exceed the US EPA prudent air levels for 6 to <12 year olds. The US EPA exposure levels for the evaluation of indoor school air are based the most conservative animal studies rather than toxicology studies that may be more relevant to the risk of disease in humans.

I adopt, affirm and certify as true under pains and penalties of perjury the entirety of my expert witness report submitted in this case. All facts are of my personal knowledge, except those facts which are referenced to sources therein. For those facts, I relied upon the sources identified, as is set forth in the report.

James C. Lamb, IV

James C. Lamb, IV, Ph.D., DABT, ATS
June 30, 2016

Table 1: Summary of Monsanto Toxicity Testing of PCB Products

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Flinn (1934)	Aroclor 1262 Aroclor 1268 Aroclor Special (75% diphenyl) Aroclor 1248 Aroclor 1248 Aroclor 1269 Aroclor 1269 Aroclor 1269 Aroclor 1269 Aroclor 1248 Aroclor 1260 Aroclor 1262	skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits skin irritation in rabbits
Drinker (1938a)	Chlorinated diphenyl #1268 Mixture of chlorinated diphenyl and chlorinated diphenyl benzene	subchronic inhalation subchronic inhalation
Drinker (1938b)	Chlorinated diphenyl #4465 Chlorinated diphenyl	subchronic inhalation subchronic inhalation
Halpern (1948)	Aroclor, 11.5% Aroclor, 100%	human skin irritation/sensitization human skin irritation/sensitization
Halpern (1949)	Aroclor, 11.5% Aroclor, 100%	human skin irritation/sensitization human skin irritation/sensitization
Scientific Associates (1951a)	Pydraul F-9	acute oral toxicity study, minimum lethal dose (MLD), rabbits
Scientific Associates (1951b)	Pydraul F-9	acute oral toxicity study, MLD, rats
Halpern (7/1951?)	Pydraul F-9	human skin irritation and sensitization
Treon (1953)	Pydraul F-9, at 1050° Pydraul F-9, at 1250° Aroclor 1248, at 1050° Aroclor 1248, at 1250° Pydraul F-9 Aroclor 1248	subacute inhalation toxicity subacute inhalation toxicity subacute inhalation toxicity subacute inhalation toxicity skin irritation skin irritation
Scientific Associates (1953a)	Aroclor 1254	acute oral toxicity, LD_{50}
Scientific Associates (1953b)	Aroclor 1242	acute oral toxicity, LD_{50}
Scientific Associates (1954a)	OS-54 (Pydraul) OS-54 (Pydraul) OS-54 (Pydraul)	acute oral toxicity, LD_{50} acute inhalation eye irritation
Scientific Associates (1954b)	OS-57 OS-57 OS-57 OS-57 OS-57	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Scientific Associates (1955a)	Pydraul F-9 Pydraul F-9 Pydraul F-9 Pydraul F-9 Pydraul F-9	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Scientific Associates (1955b)	OS-63 OS-63 OS-63 OS-63 OS-63	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Treon (1955a)	Aroclor 1242, subchronic (3 weeks) Aroclor 1242, subchronic (up to 11.5 weeks) Aroclor 1254, subchronic (up to 11.5 weeks)	inhalation toxicity inhalation toxicity inhalation toxicity
Treon (1955b)	Aroclor 1242, long-term (7 months) Aroclor 1254, long-term (7 months)	inhalation toxicity inhalation toxicity
Treon (1955c)	Pydraul F-9, acute (4 hr) Pydraul F-9, acute (0.5 hr) Pydraul F-9, acute (2 hr) Pydraul F-9, acute (1 hr) Pydraul F-9, acute (3.25 hr)	mist inhalation mist inhalation mist inhalation mist inhalation mist inhalation
Scientific Associates (1955c)	Pydraul 600 Pydraul 600 Pydraul 600 Pydraul 600 Pydraul 600	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Scientific Associates (1955d)	Pydraul 600	acute oral toxicity, LD_{50}
Younger Laboratories (1956)	Pydraul AC (OS-67) Pydraul AC (OS-67) Pydraul AC (OS-67) Pydraul AC (OS-67) Pydraul AC (OS-67) Pydraul AC (OS-67)	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1957a)	OS-81 OS-81 OS-81 OS-81 OS-81 OS-81 OS-83 OS-83 OS-83 OS-83 OS-83 OS-83	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1957b)	Aroclor 1270 Aroclor 1270 Aroclor 1270 Aroclor 1270 Aroclor 1270 Aroclor 1270	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation
Younger Laboratories (1958a)	OS-95 OS-95 OS-95 OS-95 OS-95	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Younger Laboratories (1958b)	Pydraul 625	acute vapor inhalation
Younger Laboratories (1958c)	Aroclor 1268 Aroclor 1268 Aroclor 1268 Aroclor 1268 Aroclor 1268	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1958d)	OS-95, Sample 17, OS-95, Sample 17 OS-95, Sample 102 OS-95, Sample 102	acute skin toxicity, MLD skin irritation acute skin toxicity, MLD skin irritation
Younger Laboratories (1958e)	OS-95, thermal decomposition products at 1000°	acute vapor inhalation
Younger Laboratories (1962a)	Aroclor 1232 Aroclor 1232	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962b)	Aroclor 1221 Aroclor 1221	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962c)	Aroclor 1248 Aroclor 1248	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962d)	Aroclor 1242 Aroclor 1242	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962e)	Aroclor 1262 Aroclor 1262	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962f)	Aroclor 1254 Aroclor 1254	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962g)	Aroclor 1260 Aroclor 1260	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962h)	Aroclor 4465 Aroclor 4465 Aroclor 4465 Aroclor 4465	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation
Younger Laboratories (1962i)	Aroclor 1268 Aroclor 1268	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1962j)	Aroclor 2565 Aroclor 2565	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1963a)	Pyranol 1470 Pyranol 1470	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1963b)	Interteen PPO Interteen PPO Interteen PPO Interteen PPO Interteen PPO	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
IBT (1963a)	Aroclor 1248	subacute skin toxicity
IBT (1963b)	Aroclor 1242	subacute skin toxicity
IBT (1963c)	Aroclor 1268	subacute skin toxicity
IBT (1963d)	Aroclor 1254	subacute skin toxicity
IBT (1963e)	Aroclor 1221	subacute skin toxicity
IBT (1963f)	Aroclor 4465	subacute skin toxicity

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Younger Laboratories (1963c)	MCS-300 MCS-300 MCS-300 MCS-300 MCS-300	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1964a)	FH-145 FH-145 FH-145 FH-145 FH-145 FH-145	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1964b)	MCS-295 (Therminol FR-0, Aroclor) MCS-295 (Therminol FR-0, Aroclor) MCS-295 (Therminol FR-0, Aroclor) MCS-295 (Therminol FR-0, Aroclor) MCS-295 (Therminol FR-0, Aroclor)	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1964c)	FH-159 FH-159 FH-159 FH-159 FH-159	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1964d)	Pydraul 280 Pydraul 280 Pydraul 280 Pydraul 280 Pydraul 280	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1964e)	Pydraul 312 Pydraul 312 Pydraul 312 Pydraul 312 Pydraul 312	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1966a)	Pydraul 135 Pydraul 135 Pydraul 135 Pydraul 135 Pydraul 135 Pydraul 135	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1966b)	MCS 404 MCS 404 MCS 404 MCS 404 MCS 404 MCS 404	acute oral toxicity, LD_{50} acute oral toxicity, MLD acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1966c)	MCS 90 MCS 90 MCS 90 MCS 90 MCS 90	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1966d)	Santosafe 300 (MCS 528) Santosafe 300 (MCS 528)	acute oral toxicity, LD_{50} acute skin toxicity, MLD

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Younger Laboratories (1966e)	Pydraul AC Pydraul AC	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966f)	Pydraul 280 Pydraul 280	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966g)	Pydraul 135 Pydraul 135	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966h)	Pydraul 625 Pydraul 625	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966i)	MCS 153 MCS 153	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966j)	MCS 404 MCS 404	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1966k)	Pydraul F9 Pydraul F9	acute oral toxicity, LD_{50} acute skin toxicity, MLD
Younger Laboratories (1967a)	Pydraul 230 Pydraul 230 Pydraul 230 Pydraul 230 Pydraul 230	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1967b)	Santicizer 1706 (XA-140)	acute oral toxicity, LD_{50}
Younger Laboratories (1969a)	Santosafe 300 (MCS-528) Santosafe 300 (MCS-528) Santosafe 300 (MCS-528) Santosafe 300 (MCS-528)	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation
Younger Laboratories (1969b)	Pydraul 312 Pydraul 312 Pydraul 312 Pydraul 312	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation
IBT (1969a)	Aroclor 1242 Aroclor 1254 Aroclor 1260 Aroclor 5460	30-day Tissue Collection Study in rats 30-day Tissue Collection Study in rats 30-day Tissue Collection Study in rats 30-day Tissue Collection Study in rats
IBT (1969b)	Aroclor 1242 Aroclor 1254 Aroclor 1260 Aroclor 5460	30-day Tissue Collection Study in chickens 30-day Tissue Collection Study in chickens 30-day Tissue Collection Study in chickens 30-day Tissue Collection Study in chickens
Younger Laboratories (1969c)	MCS 900 MCS 900 MCS 900 MCS 900 MCS 900	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
IBT (1969c)	Aroclor 1242 Aroclor 1254 Aroclor 1260 Aroclor 5460	Four day fish toxicity study Four day fish toxicity study Four day fish toxicity study Four day fish toxicity study

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Younger Laboratories (1969d)	MCS 9001 MCS 9001 MCS 9001 MCS 9001 MCS 9001	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970a)	Pydraul 281 Pydraul 281 Pydraul 281 Pydraul 281 Pydraul 281	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970b)	Pydraul MCS 1009 Pydraul MCS 1009 Pydraul MCS 1009 Pydraul MCS 1009 Pydraul MCS 1009	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970c)	MCS 999 MCS 999 MCS 999 MCS 999 MCS 999	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
IBT (1970)	Aroclor 1242 Aroclor 1254 Aroclor 1260	Toxicity, reproduction, and residue study, chickens Toxicity, reproduction, and residue study, chickens Toxicity, reproduction, and residue study, chickens
Younger Laboratories (1970d)	Aroclor 6062 Aroclor 6062 Aroclor 6062 Aroclor 6062	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation
Younger Laboratories (1970e)	Aroclor 6037 Aroclor 6037 Aroclor 6037 Aroclor 6037 Aroclor 6037	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970f)	Aroclor 4273 Aroclor 4273 Aroclor 4273 Aroclor 4273 Aroclor 4273	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970g)	Aroclor 6040 Aroclor 6040 Aroclor 6040 Aroclor 6040 Aroclor 6040	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970h)	Aroclor 6070 Aroclor 6070 Aroclor 6070 Aroclor 6070 Aroclor 6070	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
Younger Laboratories (1970i)	Aroclor 6090 Aroclor 6090 Aroclor 6090 Aroclor 6090 Aroclor 6090	acute oral toxicity LD_{50} acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970j)	MCS 975 (Pydraul 625-A) MCS 975 (Pydraul 625-A) MCS 975 (Pydraul 625-A) MCS 975 (Pydraul 625-A) MCS 975 (Pydraul 625-A)	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970k)	Pydraul AC-A (winter grade-23) Pydraul AC-A (winter grade-23) Pydraul AC-A (winter grade-23) Pydraul AC-A (winter grade-23) Pydraul AC-A (winter grade-23)	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
Younger Laboratories (1970l)	Pydraul AC-A Pydraul AC-A Pydraul AC-A Pydraul AC-A Pydraul AC-A	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute vapor inhalation
IBT (1971a)	MCS 1016	acute vapor inhalation
IBT (1971b)	Aroclor 1221 Aroclor 1221 Aroclor 1221 Aroclor 1221 Aroclor 5442 Aroclor 5442 Aroclor 5442 Aroclor 5442 MCS 1016 MCS 1016 MCS 1016 MCS 1016	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation
IBT (1971c)	Aroclor 1242	toxicity, reproduction, and residue study, chickens
Younger Laboratories (1971)	Aroclor 1272 Aroclor 1272 Aroclor 1272 Aroclor 1272	acute oral toxicity, LD_{50} acute skin toxicity, MLD skin irritation eye irritation
IBT (1971d)	Aroclor 1254	teratogenicity study, rats
IBT (1971e)	Aroclor 1260	teratogenicity study, rats
IBT (1971f)	Aroclor 1242	three generation reproduction study, rats
IBT (1971g)	Aroclor 1242	two-year chronic oral toxicity study, dogs
IBT (1971h)	Aroclor 1254	two-year chronic oral toxicity study, dogs
IBT (1971i)	Aroclor 1260	two-year chronic oral toxicity study, dogs
IBT (1971j)	Aroclor 1254	three generation reproduction study, rats

Table 1: Summary of Monsanto Toxicity Testing of PCB Products (continued)

Author/Year	PCB Mixture or PCB-containing Product	Study Description
IBT (1971k)	Aroclor 1260	three generation reproduction study, rats
IBT (1971l)	Aroclor 1260	two-year chronic oral toxicity study, rats
IBT (1971m)	Aroclor 1254	two-year chronic oral toxicity study, rats
IBT (1971n)	Aroclor 1242	two-year chronic oral toxicity study, rats
IBT (1971o)	Aroclor 1221	subchronic oral toxicity study, dogs
IBT (No date)	Aroclor 1242	four-day static fish toxicity study
IBT (No date)	Aroclor 1260	four-day static fish toxicity study
IBT (1972a)	Aroclor 1221 Aroclor 5432 Aroclor 5442 Aroclor 5460 MCS 1016	four-day static fish toxicity study four-day static fish toxicity study four-day static fish toxicity study four-day static fish toxicity study four-day static fish toxicity study
Younger Laboratories (1972)	MCS 1230 MCS 1230 MCS 1230 MCS 1230 MCS 1230	acute oral toxicity MLD acute skin toxicity MLD skin irritation eye irritation acute vapor inhalation
IBT (1972b)	Aroclor 1260	mutagenic study, mice
IBT (1972c)	Aroclor 1254	mutagenic study, mice
IBT (1972d)	Aroclor 1242	mutagenic study, mice
IBT (1972e)	MCS 1016	subchronic oral toxicity study, dogs
IBT (1972f)	MCS 1016	subchronic oral toxicity study, rats
IBT (1972g)	Aroclor 1221	subchronic oral toxicity study, rats
IBT (1972h)	MCS 1016	toxicity, reproduction, and residue study, chickens
IBT (1972i)	Aroclor 1221	toxicity, reproduction, and residue study, chickens
IBT (1972j)	Aroclor 1260	acute toxicity study, trout
IBT (1972k)	Aroclor 1242 Aroclor 1254 Aroclor 1260	four-day fish toxicity study four-day fish toxicity study four-day fish toxicity study

13 REFERENCES

Agency for Toxic Substance and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs).

Anonymous. 1966. Report of a new chemical hazard. New Scientist. 32 (525):610.

Ames BN, Magaw R, Gold LS. 1987. Ranking possible carcinogenic hazards. Science. Apr 17;236(4799):271-80.

Ames BN, Profet M, Gold LS. 1990. Dietary pesticides (99.99% all natural). Proc Natl Acad Sci U S A. Oct;87(19):7777-81.

Arena SM, Greeley EH, Halbrook RS, Hansen LG, Segre M. 2003. Biological effects of gestational and lactational PCB exposure in neonatal and juvenile C57BL/6 mice. Arch Environ Contam Toxicol. 44(2):272-280.

Arnold DL, Bryce F, Stapley R, McGuire PF, Burns D, Tanner JR, Karpinski K. 1993a. Toxicological consequences of Aroclor 1254 ingestion by female rhesus (Macaca mulatta) monkeys. Part 1A. Prebreeding phase: clinical health findings. Food Chem Toxicol. Nov;31(11):799-810.

Arnold DL, Bryce F, Karpinski K, Mes J, Fernie S, Tryphonas H, Truelove J, McGuire PF, Burns D, Tanner JR, et al. 1993b. Toxicological consequences of Aroclor 1254 ingestion by female rhesus (Macaca mulatta) monkeys. Part 1B. Prebreeding phase: clinical and analytical laboratory findings. Food Chem Toxicol. Nov;31(11):811-24.

Arnold DL, Bryce F, McGuire PF, Stapley R, Tanner JR, Wrenshall E, Mes J, Fernie S, Tryphonas H, Hayward S, et al. 1995. Toxicological consequences of Aroclor 1254 ingestion by female rhesus (Macaca mulatta) monkeys. Part 2. Reproduction and infant findings. Food Chem Toxicol. Jun;33(6):457-74.

Arnold DL, Nera EA, Stapley R, Bryce F, Fernie S, Tolnai G, Miller D, Hayward S, Campbell JS, Greer I. 1997. Toxicological consequences of Aroclor 1254 ingestion by female rhesus (Macaca mulatta) monkeys and their nursing infants. Part 3: post-reproduction and pathological findings. Food Chem Toxicol. Dec;35(12):1191-207.

Bannister R, Davis D, Zacharewski T, Tizard I, Safe S. 1987. Aroclor 1254 as a 2,3,7,8-tetrachlorodibenzo-p-dioxin antagonist: effects on enzyme induction and immunotoxicity. Toxicology. 46(1):29-42.

Beyer LA, Beck BD, Lewandowski TA. 2011. Historical perspective on the use of animal bioassays to predict carcinogenicity: evolution in design and recognition of utility. Crit Rev Toxicol. Apr;41(4):321-38.

References (continued)

Bonnyns M, Bastomsky CH. 1976. Polychlorinated biphenyl-induced modification of lymphocyte response to plant mitogens in rats. Experientia. Apr 15;32(4):522-3.

Borak J, Israel L. 1997. Does in utero exposure to PCBs cause developmental toxicity. The occupational and environmental medicine report. J Occup Environ Med. 1997;11:13-8.
Bowers WJ, Nakai JS, Chu I, Wade MG, Moir D, Yagminas A, Gill S, Pulido O, Meuller R. 2004. Early developmental neurotoxicity of a PCB/organochlorine mixture in rodents after gestational and lactational exposure. Toxicol Sci. 2004 Jan;77(1):51-62.

Brunner MJ, Sullivan TM, Singer AW, et. al. 1997. An assessment of the chronic toxicity and oncogenicity of Aroclor-1016, Aroclor-1242, Aroclor-1254, and Aroclor-1260 administered in diet to rats. Study No. SC920192. Chronic toxicity and oncogenicity report. Battelle, Columbus OH. [As cited in US EPA 1996]

Bryce F, Hayward S, Stapley R, Arnold DL. 2000. Consequences of Aroclor 1254 ingestion on the menstrual cycle of rhesus (Macaca mulatta) monkeys. Food Chem Toxicol. Nov;38(11):1053-64.

Buehler EV. 1964. A new method for detecting potential sensitizers using the guinea pig. Toxicol. Appl. Pharmacol. 6:341. [as cited in Gad et al. 1998]

Cocchi D, Tulipano G, Colciago A, Sibilia V, Pagani F, Viganò D, Rubino T, Parolaro D, Bonfanti P, Colombo A, Celotti F. 2009. Chronic treatment with polychlorinated biphenyls (PCB) during pregnancy and lactation in the rat: Part 1: Effects on somatic growth, growth hormone-axis activity and bone mass in the offspring. Toxicol Appl Pharmacol. 237(2):127-36.

Connor KT, Aylward LL. 2006. Human response to dioxin: aryl hydrocarbon receptor (AhR) molecular structure, function, and dose-response data for enzyme induction indicate an impaired human AhR. J Toxicol Environ Health B Crit Rev. 9(2):147-71.

Corey DA, Juárez de Ku LM, Bingman VP, Meserve LA.. 1996. Effects of exposure to polychlorinated biphenyl (PCB) from conception on growth, and development of endocrine, neurochemical, and cognitive measures in 60 day old rats. Growth Dev Aging. 60(3-4):131-143.

Crofton, K.M., and D.C. Rice. 1999. Low-frequency hearing loss following perinatal exposure to 3,3',4,4',5-pentachlorobiphenyl (PCB 126) in rats. Neurotoxicol Teratol. 21(3):299-301.

Crofton KM, Kodavanti PR, Derr-Yellin EC, Casey AC, Kehn LS. 2000. PCBs, thyroid hormones, and ototoxicity in rats: cross-fostering experiments demonstrate the impact of postnatal lactation exposure. Toxicol Sci. 57(1):131-140.

Davis D, Safe S. 1989. Dose-response immunotoxicities of commercial polychlorinated biphenyls (PCBs) and their interaction with 2,3,7,8-tetrachlorodibenzo-p-dioxin. Toxicol Lett. 48(1):35-43.

References (continued)

Draize JH, Woodard G, Calvery HO. 1944. Methods for the study of irritation and toxicity of substances applied topically to the skin and mucous membranes. J Pharmacol Exp Ther. 82:377-390.

Drinker CK, Warren MF, Bennett GA.. 1937. The problem of possible systemic effects from certain chlorinated hydrocarbons. J Ind Hyg Toxicol. 19(7):283-311.

Drinker, C.K. 1938a. Report to Monsanto Chemical Company. September 15, 1938. MONS 048123.

Drinker, C.K. 1938b. Report to Monsanto Chemical Company. September 15, 1938. MONS 003418.

Drinker, C.K. 1939. Further observations on the possible systemic toxicity of certain of the chlorinated hydrocarbons with suggestions for permissible concentrations in the air of workrooms. J Ind Hyg Toxicol. 21(5):155-159.

Duntas LH, Stathatos N. 2015. Toxic chemicals and thyroid function: hard facts and lateral thinking. Rev Endocr Metab Disord. Dec;16(4):311-8.

Everett CJ, Frithsen I, Player M. 2011. Relationship of polychlorinated biphenyls with type 2 diabetes and hypertension. J Environ Monit. Feb;13(2):241-51.

Fischer LJ, Wagner MA, Madhukar BV. 1999. Potential involvement of calcium, CaM kinase II, and MAP kinases in PCB-stimulated insulin release from RINm5F cells. Toxicol Appl Pharmacol. Sep 15;159(3):194-203.

Flinn, F.B. 1934. Report of Dr. Frederick B. Flinn of patch tests made on material received from Stann Research, Inc. May 15, 1934. MONS 062172.

Flinn FB, Jarvik NF. 1936. Action of certain chlorinated naphthalenes on the liver. Exp. Biol. Med. 35(1), pp.118-120.

Flinn FB, Jarvik NF. 1938. Liver lesions caused by chlorinated naphthalene. Am J Epidemiol. 27(1), pp.19-27.

Gad SC. 2007. *Animal models in toxicology.* Boca Raton, FL: CRC Press. [General text – not provided]

Gad SC, Chengelis C, Christopher P. 1998. *Acute toxicology testing.* San Diego, CA: Academic Press. [General text – not provided]

References (continued)

Gellert RJ. 1978. Uterotrophic activity of polychlorinated biphenyls (PCB) and induction of precocious reproductive aging in neonatally treated female rats. Environ Res. 16(1-3):123-130.

Gissendanner W.J. 1968. Letter to Mr. L.A. Owen, The Valspar Corporation. March 18.

Gold LS, Slone TH, Ames BN. 2001. Natural and Synthetic Chemicals in the Diet: A Critical Analysis of Possible Cancer Hazards. In: *Food Safety and Food Quality.* Issues in Environmental Science and Technology 15. R. E. Hester & R. M. Harrison, eds. Cambridge, UK : Royal Society of Chemistry, pp. 95-128.

Goldey ES, Kehn LS, Rehnberg GL, Crofton KM. 1995. Effects of developmental hypothyroidism on auditory and motor function in the rat. Toxicol Appl Pharmacol. 135(1):67-76.

Gray LE Jr, Ostby J, Marshall R, Andrews J. 1993. Reproductive and thyroid effects of low-level polychlorinated biphenyl (Aroclor 1254) exposure. Fundam Appl Toxicol. Apr;20(3):288-94.

Gray SL, Shaw AC, Gagne AX, Chan HM. 2013. Chronic exposure to PCBs (Aroclor 1254) exacerbates obesity-induced insulin resistance and hyperinsulinemia in mice. J Toxicol Environ Health A. 76(12):701-15.

Greenburg L, Mayers, MR, Smith AR. 1939. The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. J Ind Hyg Toxicol. 21, pp.29-38.

Gupta C. 2000. Reproductive malformation of the male offspring following maternal exposure to estrogenic chemicals. Proc Soc Exp Biol Med. Jun;224(2):61-8.

Haave M, Bernhard A, Jellestad FK, Heegaard E, Brattelid T, Lundebye AK. 2011. Long-term effects of environmentally relevant doses of 2,2',4,4',5,5' hexachlorobiphenyl (PCB153) on neurobehavioural development, health and spontaneous behaviour in maternally exposed mice. Behav Brain Funct. 13(7):3.

Halpern LK. 1948. Letter RE: Project W-31 Aroclor (report on patch-testing). September 8, 1948. The Barnard Free Skin and Cancer Hospital. MONS 087913.

Halpern LK. 1949. Letter RE: Project W-31 Aroclor (report on patch-testing). December 22, 1949. The Barnard Free Skin and Cancer Hospital. MONS 087911.

Halpern LK. 1951(?). Letter RE: Project (?) Pydraul F-9 (report on patch-testing). July 14, 1951(?). The Barnard Free Skin and Cancer Hospital. MON 091203.

Harper N, Connor K, Safe S. 1993. Immunotoxic potencies of polychlorinated biphenyl (PCB), dibenzofuran (PCDF) and dibenzo-p-dioxin (PCDD) congeners in C57BL/6 and DBA/2 mice. Toxicology. Jun 11;80(2-3):217-27.

References (continued)

Harper DM, Flessas DA, Reinisch CL. 1994. Specific reactivity of leukemia cells to polyclonal anti-PCB antibodies. J Invertebr Pathol. Nov;64(3):234-7.

Harper N, Connor K, Steinberg M, Safe S. 1995. Immunosuppressive activity of polychlorinated biphenyl mixtures and congeners: nonadditive (antagonistic) interactions. Fundam Appl Toxicol. 27(1):131-139.

Huang A, Powell D, Chou K. 1998a. Pre- and postnatal exposure to 3,3',4,4'-tetrachlorobiphenyl: I. Effects on breeding ability and sperm fertilizing ability in male mice. Arch Environ Contam Toxicol. Feb;34(2):204-8.

Huang A, Lin S, Inglis R, Powell D, Chou K. 1998b. Pre- and postnatal exposure to 3,3',4,4'-tetrachlorobiphenyl: II. Effects on the reproductive capacity and fertilizing ability of eggs in female mice. Arch Environ Contam Toxicol. Feb;34(2):209-14.

Industrial Bio-Test Laboratories, Inc. (IBT). No date. Results of four-day static fish toxicity studies rainbow trout and bluegills. Aroclor 1242 Lot NO KK-475. BTL. No. 72-82.

Industrial Bio-Test Laboratories, Inc. (IBT). No date. Results of four-day static fish toxicity studies rainbow trout. BTL. No. 72-64. Aroclor 1260. MON068738.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963a. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 1248. March 4, 1963. Exhibit K-71.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963b. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 1242. March 27, 1963. Exhibit K-72.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963c. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 1268. March 28, 1963. Exhibit K-73.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963d. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 1254. March 29, 1963. Exhibit K-75.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963e. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 1221. March 28, 1963. Exhibit K-74.

Industrial Bio-Test Laboratories, Inc. (IBT). 1963f. Report to Monsanto Chemical Company. Subacute dermal toxicity of Aroclor 4465. May 17, 1963. MON046519.

Industrial Bio-Test Laboratories, Inc. (IBT). 1969a. Report to Monsanto Company Organic Chemicals Division. 30-day tissue collection study in albino rats with Aroclors. BTL – Aroclor II. April 15, 1969. MONS 048989.

References (continued)

Industrial Bio-Test Laboratories, Inc. (IBT). 1969b. Report to Monsanto Company. Chicken residue studies on Aroclors and various other materials. BTL – Aroclor. April 23, 1969. MONS 089256.

Industrial Bio-Test Laboratories, Inc. (IBT). 1969c. Report to Monsanto Company. Four-day fish toxicity studies on seven materials. June 13, 1969. DSW 264526.

Industrial Bio-Test Laboratories, Inc. (IBT). 1970. Report to Monsanto Company. Toxicity, reproduction and residue study on Aroclor 1242, Lot #AK-255, Aroclor 1254, Lot #AK-38, Aroclor 1260, Lot #AK-3 in white leghorn chickens. June 4, 1970. DSW 003004.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971a. Report of Monsanto Company. Acute vapor inhalation toxicity study with MCS 1016 in albino rats. January 28, 1971. MONS 091297.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971b. Report to Monsanto Company. Acute toxicity with Aroclor 1221, Aroclor 5442, and MCS 1016. March 25, 1971. MONS 067868.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971c. Report to Monsanto Company. Toxicity, reproduction, and residue study on Aroclor 1242, Lot #AK-255 in white leghorn chickens. June 15, 1971. MON 064613

Industrial Bio-Test Laboratories, Inc. (IBT). 1971d. Report to Monsanto Company. Teratogenicity study with Aroclor 1254 in albino rats. September 8, 1971. DSW 399049.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971e. Report to Monsanto Company. Teratogenicity study with Aroclor 1260 in albino rats. September 9, 1971. MONS 068720.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971f. Report to Monsanto Company. Three-generation reproduction study with Aroclor 1242 in albino rats. November 1, 1971. MONS 089318.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971g. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1242 in beagle dogs. November 1, 1971. Exhibit K-79.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971h. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1254 in beagle dogs. November 1, 1971. Exhibit K-80.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971i. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1260 in beagle dogs. November 1, 1971. Exhibit K-81.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971j. Report to Monsanto Company. Three-generation reproduction study with Aroclor 1254 in albino rats. November 1, 1971. DSW 005113.

References (continued)

Industrial Bio-Test Laboratories, Inc. (IBT). 1971k. Report to Monsanto Company. Three-generation reproduction study with Aroclor 1260 in albino rats. November 4, 1971. MONS 044509.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971l. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1260 in albino rats. November 12, 1971. Exhibit K-78.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971m. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1254 in albino rats. November 12, 1971. Exhibit K-77

Industrial Bio-Test Laboratories, Inc. (IBT). 1971n. Report to Monsanto Company. Two-year chronic oral toxicity study with Aroclor 1242 in albino rats. November 12, 1971. Exhibit K-76.

Industrial Bio-Test Laboratories, Inc. (IBT). 1971o. Report to Monsanto Company. Ninety-day subacute oral toxicity study with Aroclor 1221 in beagle dogs. December 30, 1971. MONS 068795.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972a. Report to Monsanto Company. Four-day static fish toxicity studies with Aroclor 1221, Aroclor 5432, Aroclor 5442, Aroclor 5460, and MCS 1016 on bluegills and channel catfish. January 12, 1972. DSW 004005.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972b. Report to Monsanto Company. Mutagenic study with Aroclor 1260 in albino mice. January 13, 1972. MONS 068488.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972c. Report to Monsanto Company. Mutagenic study with Aroclor 1254 in albino mice. January 13, 1972. MONS 068850.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972d. Report to Monsanto Company. Mutagenic study with Aroclor 1242 in albino mice. January 13, 1972. DSW 399467.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972e. Report to Monsanto Company. 90-day subacute oral toxicity study with MCS 1016 in beagle dogs. January 31, 1972. MONS 068740.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972f. Report to Monsanto Company. 90-day subacute oral toxicity study with MCS 1016 in albino rats. April 28, 1972. MONS 087549.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972g. Report to Monsanto Company. 90-day subacute oral toxicity study with Aroclor 1221 in albino rats. April 28, 1972. MONS 068884.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972h. Report to Monsanto Company. Toxicity, reproduction, and residue study on MCS 1016 in white leghorn chickens. June 20, 1972. DSW 004508.

References (continued)

Industrial Bio-Test Laboratories, Inc. (IBT). 1972i. Report to Monsanto Company. Toxicity, reproduction, and residue study on Aroclor 1221 in white leghorn chickens. June 20, 1972. MONS 091234.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972j. Report to Monsanto Company. Results of four-day static fish toxicity studies rainbow trout. Aroclor 1260. September 28, 1972. MONS 031643.

Industrial Bio-Test Laboratories, Inc. (IBT). 1972k. Report to Monsanto Company. Four-day fish toxicity studies with Aroclor 1242, Aroclor 1254, and Aroclor 1260 in bluegills and channel catfish. November 17, 1972. MONS 091278.

International Agency for Research on Cancer (IARC). 1991. Preamble to the IARC Monographs.

International Agency for Research on Cancer (IARC). 2015. IARC Monographs on the evaluation of carcinogenic risk to humans. Polychlorinated and polybrominated biphenyls. Volume 107. World Health Organization.

Interdepartmental Task Force on PCBs (ITF). 1972. Polychlorinated biphenyls and the environment. COM-72-10419. May.

Ito N, Nagasaki H, Arai M, Makiura S, Sugihara S, Hirao K. 1973a. Histopathologic studies on liver tumorigenesis induced in mice by technical polychlorinated biphenyls and its promoting effect on liver tumors induced by benzene hexachloride. J Natl Cancer Inst. Nov;51(5):1637-46.

Ito N, Nagasaki H, Arai M, 1973b. Interactions of liver tumorigenesis mice treated with technical polychlorinated biphenyls (PCBs) and benzene hexachloride (BHC). *New Methods in Environmental Chemistry and Ecological Chemistry.* Tokyo, International Academy Printing Company. pp. 141-147.

Ito N, Nagasaki H, Makiura S, Arai M. 1974. Histopathological studies on liver tumorigenesis in rats treated with polychlorinated biphenyls. Gann. Dec;65(6):545-9.

James RC, Busch H, Tamburro CH, Roberts SM, Schell JD, Harbison RD. 1993. Polychlorinated biphenyl exposure and human disease. J Occup Med. Feb;35(2):136-48.

Jansen HT, Cooke PS, Porcelli J, Liu TC, Hansen LG. 1993. Estrogenic and antiestrogenic actions of PCBs in the female rat: in vitro and in vivo studies. Reprod Toxicol. 7(3):237-248.

Jones JW, Alden HS. 1936. An acneform dermatergosis. Arch Derm Syphilol. 33(6), pp.1022-1034.

References (continued)

Kimbrough RD, Linder RE, Gaines TB. 1972. Morphological changes in livers of rats fed polychlorinated biphenyls: light microscopy and ultrastructure. Arch Environ Health. Nov;25(5):354-64.

Kimbrough RD, Squire RA, Linder RE, Strandberg JD, Montalli RJ, Burse VW. 1975. Induction of liver tumor in Sherman strain female rats by polychlorinated biphenyl Aroclor 1260. J Natl Cancer Inst. 55(6):1453-1459.

Kimbrough RD, Krouskas CA, Xu W, Shields PG. 2015. Mortality among capacitor workers exposed to polychlorinated biphenyls (PCBs), a long-term update. Int Arch Occup Environ Health. Jan;88(1):85-101.

Kimura NT, Bara T. 1973. Neoplastic changes in the rat liver induced by polychlorinated biphenyl. Gann. 64; 105-108. February.

Kodavanti PR, Ward TR, McKinney JD, Tilson HA. 1996. Inhibition of microsomal and mitochondrial Ca2+-sequestration in rat cerebellum by polychlorinated biphenyl mixtures and congeners. Structure-activity relationships. Arch Toxicol. 70(3-4):150-7.

Lane RW, Borzelleca JF. 2008. Harming and helping through time: The history of toxicology. In: *Principles and Methods of Toxicolo*gy. 5th edition. Ed. Hayes, AW. Boca Raton, FL: CRC Press. [General text – not provided]

Lauby-Secretan B, Loomis D, Grosse Y, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Baan R, Mattock H, Straif K. 2013. International Agency for Research on Cancer Monograph Working Group IARC, Lyon, France. Carcinogenicity of polychlorinated biphenyls and polybrominated biphenyls. Lancet Oncol. Apr;14(4):287-8.

Lawton RW, Ross MR, Feingold J, Brown JF Jr. 1985. Effects of PCB exposure on biochemical and hematological findings in capacitor workers. Environ Health Perspect. May;60:165-84.

Lee DW, Opanashuk LA. 2004. Polychlorinated biphenyl mixture Aroclor 1254-induced oxidative stress plays a role in dopaminergic cell injury. Neurotoxicology. 25(6):925-39.

Lehman AJ, Laug EP, et al. 1949. Procedures for the appraisal of the toxicity of chemicals in foods. Food Drug Cosmet Law Q. Sep;4(3):412-34.

Levin M, Morsey B, Mori C, Nambiar PR, De Guise S. 2005. Non-coplanar PCB-mediated modulation of human leukocyte phagocytosis: a new mechanism for immunotoxicity. J Toxicol Environ Health A. 68(22):1977-1993.

Li MH, Hansen LG. 1995. Uterotropic and enzyme induction effects of 2,2',5-trichlorobiphenyl. Bull Environ Contam Toxicol. 54(4):494-500.

References (continued)

Masuda Y, Yoshimura H. 1984. Polychlorinated biphenyls and dibenzofurans in patients with Yusho and their toxicological significance: a review. Prog Clin Biol Res. 137:31-44.

Mayes BA, McConnell EE, Neal BH, Brunner MJ, Hamilton SB, Sullivan TM, Peters AC, Ryan MJ, Toft JD, Singer AW, Brown JF Jr, Menton RG, Moore JA. 1998. Comparative carcinogenicity in Sprague-Dawley rats of the polychlorinated biphenyl mixtures Aroclors 1016, 1242, 1254, and 1260. Toxicol Sci. 41(1):62-76.
Meigs JW. Albom JJ,. Kartin BL. 1954. Chloracne from an unusual exposure to arochlor. JAMA. 154(17), pp.1417-1418.

Merrill, RA. 2001. Regulatory toxicology. In: *Casarett and Doull's Toxicology: The basic science of poisons.* 6th edition. Ed. Klaassen, CD. New York, McGraw-Hill. [General text – not provided]

Miller JW. 1944. Pathologic changes in animals exposed to a commercial chlorinated diphenyl. *Public Health Reports (1896-1970)*, pp.1085-1093.

Monsanto Chemical Company (Monsanto). 1940. Plasticizers and Resins. Specifications and application data. Revised May, 1940.

Monsanto Chemical Company (Monsanto). 1970. The PCB pollution problem. Meeting notes from January 21 and 22. St. Louis Meeting with General Electric.

Morse D, Brouwer A, Klasson Wehler E. 1994. Perinatal accumulation of hydroxylated polychlorobiphenyl metabolites in rats following maternal Aroclor 1254 exposure. Organohalogen Compd. 20:513-515.

Morse DC, Wehler EK, Wesseling W, Koeman JH, Brouwer A. 1996. Alterations in rat brain thyroid hormone status following pre- and postnatal exposure to polychlorinated biphenyls (Aroclor 1254). Toxicol Appl Pharmacol. 136(2):269-279.

Nagasaki H, Tomii S, Mega T, Marugami M, Ito N. 1972. Hepatocarcinogenicity of polychlorinated biphenyls in mice. Gann. Dec;63(6):805.

National Cancer Institute (NCI). 1976. Guidelines for carcinogen bioassay in small rodents. National Cancer Insitute. Carcinogenesis Technical Report Series No. 1. U.S. Department of Health, Education, And Welfare. Public Health Service. National Institutes of Health.

National Cancer Institute (NCI). 1978. Bioassay of Aroclor 1254 for possible carcinogenicity (CAS No. 27323-18-8).

National Toxicology Progam (NTP). 2006a. Toxicology and carcinogenesis studies of 3,3',4,4',5-pentachlorobiphenyl (PCB 126) (CAS No. 57465-28-8) in female Harlan Sprague-Dawley rats (gavage studies).

References (continued)

National Toxicology Progam (NTP). 2006b. Toxicology and carcinogenesis studies of 2,2',4,4',5,5'-hexachlorobiphenyl (PCB 153) in female Harlan Sprague-Dawley (gavage studies).

National Toxicology Progam (NTP). 2006c. Toxicology and carcinogenesis studies of a binary mixture of 3, 3', 4, 4', 5-Pentachlorobiphenyl (PCB 126) (CAS NO. 57465-28-8) and 2, 2', 4, 4', 5,5' -Hexachlorobiphenyl (PCB 153) (CAS NO. 35065-27-1) in female harlan sprague-dawley rats. NIH.

National Toxicology Progam (NTP). 2006d. Toxicology and carcinogenesis study of a binary mixture of 3,3',4,4',5-pentachlorobiphenyl (PCB 126) (CAS No. 57465-28-8) and 2,3',4,4',5-pentachlorobiphenyl (PCB 118) (CAS No. 31508-00-6) in female Harlan Sprague-Dawley rats (gavage studies).

National Toxicology Progam (NTP). 2010. Toxicology and carcinogenesis studies of 2,3',4,4'5-pentachlorobiphenyl (PCB 118) (CAS No. 31508-00-6) in female Harlan Sprague-Dawley rats (gavage studies).

National Toxicology Program (NTP). 2011. Specifications for the conduct of studies to evaluate the toxic and carcinogenic potential of chemical, biological and physical agents in laboratory animals for the National Toxicology Program (NTP). January.

Ness DK, Schantz SL, Moshtaghian J, Hansen LG. 1993. Effects of perinatal exposure to specific PCB congeners on thyroid hormone concentrations and thyroid histology in the rat. Toxicol Lett. 68(3):311-323.

Norback DH, Weltman RH. 1985. Polychlorinated biphenyl induction of hepatocellular carcinoma in the Sprague-Dawley rat. Environ Health Perspect. 60:97-105.

Overmann SR, Kostas J, Wilson LR, Shain W, Bush B. 1987. Neurobehavioral and somatic effects of perinatal PCB exposure in rats. Environ Res. Oct;44(1):56-70.

Panel on Hazardous Trace Substances (PHTS). 1972. Polychlorinated Biphenyls – Environmental Impact. A review by the Panel on Hazardous Trace Substances. March.

Papageorge WB. 1971. Letter to Mr. Allen, Anaconda Aluminum Company. October 4.

Pesatori AC, Grillo P, Consonni D, Caironi M, Sampietro G, Olivari L, Ghisleni S, Bertazzi PA. 2013. Update of the mortality study of workers exposed to polychlorinated biphenyls (Pcbs) in two Italian capacitor manufacturing plants. Med Lav. Mar-Apr;104(2):107-14.

References (continued)

Prince MM, Ruder AM, Hein MJ, Waters MA, Whelan EA, Nilsen N, Ward EM, Schnorr TM, Laber PA, Davis-King KE. 2006. Mortality and exposure response among 14,458 electrical capacitor manufacturing workers exposed to polychlorinated biphenyls (PCBs). Environ Health Perspect. Oct;114(10):1508-14.

Rao CV, Banerji SA. 1990. Effect of feeding polychlorinated biphenyl (Aroclor 1260) on hepatic enzymes of rats. Indian J Exp Biol. Feb;28(2):149-51.

Restum JC, Bursian SJ, Giesy JP, Render JA, Helferich WG, Shipp EB, Verbrugge DA, Aulerich RJ. 1998. Multigenerational study of the effects of consumption of PCB-contaminated carp from Saginaw Bay, Lake Huron, on mink. 1. Effects on mink reproduction, kit growth and survival, and selected biological parameters. J Toxicol Environ Health A. Jul 10;54(5):343-75.

Ruder AM, Hein MJ, Hopf NB, Waters MA. 2014. Mortality among 24,865 workers exposed to polychlorinated biphenyls (PCBs) in three electrical capacitor manufacturing plants: a ten-year update. Int J Hyg Environ Health. Mar;217(2-3):176-87.

Ruzzin J, Petersen R, Meugnier E, Madsen L, Lock EJ, Lillefosse H, Ma T, Pesenti S, Sonne SB, Marstrand TT, Malde MK, Du ZY, Chavey C, Fajas L, Lundebye AK, Brand CL, Vidal H, Kristiansen K, Frøyland L. 2010. Persistent organic pollutant exposure leads to insulin resistance syndrome. Environ Health Perspect. Apr;118(4):465-71.

Schaeffer E, Greim H, Goessner W. 1984. Pathology of chronic polychlorinated biphenyl (PCB) feeding in rats. Toxicol Appl Pharmacol. 75(2):278-288.

Schantz SL, Moshtaghian J, Ness DK. 1995. Spatial learning deficits in adult rats exposed to ortho-substituted PCB congeners during gestation and lactation. Fundam Appl Toxicol. 26(1):117-126.

Schwartz L. 1936. Dermatitis from Synthetic Resins and Waxes. Am J Public Health Nations Health. 26(6), pp.586-592.

Scientific Associates. 1951a. Certificate of Analysis RE: The minimum lethal dose of Pydraul F-9 when fed orally to New Zealand White rabbits. February 19, 1951. Exhibit K-37.

Scientific Associates. 1951b. Certificate of Analysis RE: The minimum lethal dose of Pydraul F-9 when fed orally to laboratory rats. April 17, 1951. Exhibit K-38.

Scientific Associates. 1953a. Certificate of Analysis RE: The acute oral toxicity (LD50) of Aroclor 1254 for rats. November 10, 1953. MONS 060050.

Scientific Associates. 1953b. Certificate of Analysis RE: The acute oral toxicity (LD50) of Aroclor 1242 for rats. December 11, 1953. MONS 037568.

References (continued)

Scientific Associates. 1954a. Certificate of Analysis RE: (A) The acute oral toxicity (LD50) of functional fluid OB-54 for rats (B) Inhalation of OS-54 fumes by rabbits over period of three days (C) Ocular irritatior produced by OS-54. January 13, 1954. Exhibit K-39.

Scientific Associates. 1954b. Certificate of Analysis RE: The toxicological investigation of fluid OS-57. September 13, 1954. Exhibit K-40.

Scientific Associates. 1955a. Certificate of Analysis RE: Toxicological investigation of Pydraul F-9 (FH-103). February 1, 1955. Exhibit K-41.

Scientific Associates. 1955b. Certificate of Analysis RE: Toxicological investigation of fluid OS-63. February 3, 1955. Exhibit K-42.

Scientific Associates. 1955c. Certificate of Analysis RE: Toxicological investigation of Pydraul 600. July 13, 1955. Exhibit K-43.

Scientific Associates. 1955d. Certificate of Analysis RE: Toxicological investigation of Pydraul 600. September 26, 1955. Exhibit K-44.

Seegal RF. 1996. Epidemiological and laboratory evidence of PCB-induced neurotoxicity. Crit. Rev. Toxicol. 26(6):709-737.

Seegal RF, Brosch KO, Okoniewski RJ. 2005. Coplanar PCB congeners increase uterine weight and frontal cortical dopamine in the developing rat: implications for developmental neurotoxicity. Toxicol Sci. 86(1):125-31.

Seegal RF, Fitzgerald EF, Hills EA, Wolff MS, Haase RF, Todd AC, Parsons P, Molho ES, Higgins DS, Factor SA, Marek KL, Seibyl JP, Jennings DL, McCaffrey RJ. 2011. Estimating the half-lives of PCB congeners in former capacitor workers measured over a 28-year interval. J Expo Sci Environ Epidemiol. May-Jun;21(3):234-46.

Seiler P, Fischer B, Lindenau A, Beier HM. 1994. Effects of persistent chlorinated hydrocarbons on fertility and embryonic development in the rabbit. Hum Reprod. Oct;9(10):1920-6.

Silkworth JB, Antrim L. 1985. Relationship between Ah receptor-mediated polychlorinated biphenyl (PCB)-induced humoral immunosuppression and thymic atrophy. J Pharmacol Exp Ther. Dec;235(3):606-11.

Silkworth JB, Antrim L, Kaminsky LS. 1984. Correlations between polychlorinated biphenyl immunotoxicity, the aromatic hydrocarbon locus, and liver microsomal enzyme induction in C57BL/6 and DBA/2 mice. Toxicol Appl Pharmacol. 75(1):156-165.

References (continued)

Smialowicz RJ, Andrews JE, Riddle MM, Rogers RR, Luebke RW, Copeland CB. 1989. Evaluation of the immunotoxicity of low level PCB exposure in the rat. Toxicology. 56(2):197-211.

Smith AB, Schloemer J, Lowry LK, Smallwood AW, Ligo RN, Tanaka S, Strinqer W, Jones M, Glueck CJ. 1980. Cross-sectional medical survey of a group of workers occupationally exposed to polychlorinated biphenyls (PCBs) at an electrical equipment manufacturing plant. U.S. Department of Health and Human Services. December.

Smithwick LA, Smith A, Quensen JF 3rd, Stack A, London L, Morris PJ. 2003. Inhibition of LPS-induced splenocyte proliferation by ortho-substituted polychlorinated biphenyl congeners. Toxicology. 188(2-3):319-333.

Song Y, Chou EL, Baecker A, You NC, Song Y, Sun Q, Liu S. 2016. Endocrine-disrupting chemicals, risk of type 2 diabetes, and diabetes-related metabolic traits: A systematic review and meta-analysis. J Diabetes. Jul;8(4):516-32. Epub 2015 Sep 1.

Tang M, Chen K, Yang F, Liu W. 2014. Exposure to organochlorine pollutants and type 2 diabetes: a systematic review and meta-analysis. PLoS One. Oct 15;9(10):e85556.

Treon JF, Cleveland FP, Shaffer FE, Cappel J, Gahegan T, Wagner W. 1953. The toxicity of fogs formed by dropping Pydraul F-9, Aroclor 1248 and Tricresyl phosphate, upon the surface of heated Inconel (Project 49). March 11, 1953. MONS 055981.

Treon JF, Cleveland FP, Cappel J, Shaffer FE, Atchley RW, Torbeck JP. 1955a. The toxicity of the vapor of Aroclor 1242 and 1254. June 22, 1955. The Kettering Laboratory. MONS 088809.

Treon JF, Cleveland FP, Shaffer FE, Cappel J, Beller RA, Torbeck JP. 1955b. The toxicity of the vapor of Aroclor 1242 and of Aroclor 1254. June 28, 1955. The Kettering Laboratory. MONS 050098.

Treon JF, Cleveland FP, Atchley R. 1955c. Toxicity of a mist generated by the aspiration of Pydraul. July 5, 1955. The Kettering Laboratory. MONS 050186.

Treon JF, Cleveland FP, Cappel JW, Atchley RW. 1956. The toxicity of the vapors of Aroclor 1242 and Aroclor 1254. Am Ind Hyg Assoc Q. 17:204-213.

Tryphonas H, Hayward S, O'Grady L, Loo JC, Arnold DL, Bryce F, Zawidzka ZZ. 1989. Immunotoxicity studies of PCB (Aroclor 1254) in the adult rhesus (Macaca mulatta) monkey--preliminary report. Int J Immunopharmacol. 11:199-206.

References (continued)

Tryphonas H, Luster MI, Schiffman G, Dawson LL, Hodgen M, Germolec D, Hayward S, Bryce F, Loo JC, Mandy F, et al. 1991a. Effect of chronic exposure of PCB (Aroclor 1254) on specific and nonspecific immune parameters in the rhesus (Macaca mulatta) monkey. Fundam Appl Toxicol. 16:773-786.

Tryphonas H, Luster MI, White KL Jr, Naylor PH, Erdos MR, Burleson GR, Germolec D, Hodgen M, Hayward S, Arnold DL. 1991b. Effects of PCB (Aroclor 1254) on non-specific immune parameters in rhesus (Macaca mulatta) monkeys. Int. J. Immunopharmacol. 13(6): 639-648.

Ulbrich B, Stahlmann R. 2004. Developmental toxicity of polychlorinated biphenyls (PCBs): A systematic review of experimental data. Arch Toxicol. 78(5):252-68.
U.S. Environmental Protection Agency (US EPA). 1985. Final TSCA GLP Enforcement Response Policy. Memorandum from A.E. Conroy II, Director. April 9.

U.S. Environmental Protection Agency (US EPA). 1989. Risk assessment guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A). U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (US EPA). 1991. Enforcement response policy for the Federal Insecticide, Fungicide, and Rodenticide Act. Good Laboratory Practice (GLP) regulations. Office of Compliance Monitoring. Office of Pesticides and Toxic Substances. U.S. Environmental Protection Agency. September 30.

U.S. Environmental Protection Agency (US EPA). 1996. PCBs: Cancer dose-response assessment and application to environmental mixtures. EPA/600/P–96/001F. September.

U.S. Environmental Protection Agency (US EPA). 2005. Guidelines for carcinogen risk assessment.

U.S. Environmental Protection Agency (US EPA). 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F. http://www.epa.gov/ncea/efh/report.html

U.S. Environmental Protection Agency (US EPA). 2016. Exposure levels for evaluation of polychlorinated biphenyls (PCBs) in indoor school air. https://www.epa.gov/pcbs/exposure-levels-evaluation-polychlorinated-biphenyls-pcbs-indoor-school-air. Updated February 26.

U.S. Food and Drug Administration (US FDA). 1978. Proposed Rule. Good Laboratory Practice Regulations. 43 Federal Register 60013. December 22.

U.S. Food and Drug Administration (US FDA). 1987. Final Rule. Good Laboratory Practice Regulations. 52 Federal Register 33768. September 4.

References (continued)

U.S. Food and Drug Administration (US FDA). 1996. Guideline for Industry. The need for long-term rodent carcinogenicity studies of pharmaceuticals. ICH S1A. U.S. Department of Health and Human Services.

U.S. Food and Drug Administration (US FDA). 1997. Guideline for Industry. [ICH] S1B Testing for Carcinogenicity of Pharmaceuticals. U.S. Department of Health and Human Services.

U.S. Food and Drug Administration (US FDA). 2007. Guidance for industry and other stakeholders toxicological principles for the safety assessment of food ingredients. Redbook 2000. U.S. Department of Health and Human Services. Center for Food Safety and Applied Nutrition. July 2000; Updated July 2007.

U.S. Food and Drug Administration (US FDA). 2008. Guidance for Industry. [ICH] S1C(R2) Dose Selection for Carcinogenicity Studies. U.S. Department of Health and Human Services.

U.S. Food and Drug Administration (US FDA). 2014. About FDA: Significant Dates in U.S. Food and Drug Law History. http://www.fda.gov/AboutFDA/WhatWeDo/History/Milestones/ucm128305.htm

Vasiliu O, Cameron L, Gardiner J, Deguire P, Karmaus W. 2006. Polybrominated biphenyls, polychlorinated biphenyls, body weight, and incidence of adult-onset diabetes mellitus. Epidemiology. Jul;17(4):352-9.

Villeneuve DC, Grant DL, Phillips WE, Clark ML, Clegg DJ. 1971. Effects of PCB administration on microsomal enzyme activity in pregnant rabbits. Bull Environ Contam Toxicol. Mar-Apr;6(2):120-8.

Von Wedel H, Holla WA, Denton J. 1943. Observations on the toxic effects resulting from exposure to chlorinated naphthalene and chlorinated phenyls with suggestions for prevention. Rubber Age. 53, pp.419-426.

Vos JG. 1972. Toxicology of PCBs for Mammals and for Birds. Environ Health Perspect. Apr;1:105-17.

Vos JG, Beems RB. 1971. Dermal toxicity studies of technical polychlorinated biphenyls and fractions thereof in rabbits. Toxicol Appl Pharmacol. Aug;19(4):617-33.

Vos JG, Koeman JH. 1970. Comparative toxicologic study with polychlorinated biphenyls in chickens with special reference to porphyria, edema formation, liver necrosis, and tissue residues. Toxicol Appl Pharmacol. Nov;17(3):656-68.

Wang SL, Tsai PC, Yang CY, Guo YL. 2008. Increased risk of diabetes and polychlorinated biphenyls and dioxins: a 24-year follow-up study of the Yucheng cohort. Diabetes Care. Aug;31(8):1574-9.

References (continued)

Younger Laboratories. 1956. Certificate of Analysis RE: Toxicological investigation of Pydraul AC (OS-67). August 3, 1956. Exhibit K-45.

Younger Laboratories. 1957a. Certificate of Analysis RE: Toxicological Investigation of: (1) Hydraulic Fluid OS-81 – sample no. 1, (2) Hydraulic Fluid OS-83, sample no. 2. Monsanto Project Number: Y-57-1. February 26, 1957. Exhibit K-46.

Younger Laboratories. 1957b. Certificate of Analysis RE: Toxicological investigation of Aroclor 1270 ammonia(?) reaction product. July 9, 1957. Exhibit K-26.

Younger Laboratories. 1958a. Certificate of Analysis RE: Toxicological Investigation of OS-95, sample no. 17. Monsanto Project Number: Y-58-4. February 22, 1958. Exhibit K-47.

Younger Laboratories. 1958b. Certificate of Analysis RE: The toxicity of the thermal decomposition products of 'Pydraul 625'. September 29, 1958. Exhibit K-48

Younger Laboratories. 1958c. Certificate of Analysis RE: Toxicological investigation of the following compounds: (1) Polychlorinated biphenyl (Hydrolyzed Aroclor 1268), sample no. 119 (2) Diglycidyl fiber of tetrachlorobisphenol A, sample no. 120 (3) Diglycidyl fiber of polychlorinated biphenyl, sample no. 121. Monsanto Project Number: Y-58-39. October 15, 1958. MONS 038285.

Younger Laboratories. 1958d. Certificate of Analysis RE: Toxicological Investigation of OS-95, Monsanto Sample Number 102, 17. Monsanto Project No. Y-58-29. October 20th, 1958. Exhibit K-49.

Younger Laboratories. 1958e. Certificate of Analysis RE: The toxicity of the thermal decomposition products of OS-95. Monsanto Project N0. Y-58-46. December 8, 1956. Exhibit K-50.

Younger Laboratories. 1962a. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1232. Monsanto Sample Number 54. Monsanto Project No. Y-62-52. June 6, 1962. Exhibit K-27.

Younger Laboratories. 1962b. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1221. Monsanto Sample Number 43. Monsanto Project No. Y-62-41. June 13, 1962. Exhibit K-28.

Younger Laboratories. 1962c. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1248. Monsanto Sample Number 37. Monsanto Project No. Y-62-35. June 13, 1962. Exhibit K-29.

References (continued)

Younger Laboratories. 1962d. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1242. Monsanto Sample Number 36. Monsanto Project No. Y-62-34. June 19, 1962. Exhibit K-30.

Younger Laboratories. 1962e. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1262. Monsanto Sample Number 40. Monsanto Project No. Y-62-38. June 25, 1962. Exhibit K-31.

Younger Laboratories. 1962f. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1254. Monsanto Sample Number 38. Monsanto Project No. Y-62-36. June 25, 1962. Exhibit K-32.

Younger Laboratories. 1962g. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1260. Monsanto Sample Number 39. Monsanto Project No. Y-62-37. June 25, 1962. Exhibit K-33.

Younger Laboratories. 1962h. Certificate of Analysis RE: Toxicological investigation of: Aroclor 4465. Monsanto Sample No. 46. Monsanto Project No. Y-62-44. July 3, 1962. MONS 035098.

Younger Laboratories. 1962i. Certificate of Analysis RE: Toxicological investigation of: Aroclor 1268. Monsanto Sample Number 44. Monsanto Project No. Y-62-42. June 9, 1962. Exhibit K-34.

Younger Laboratories. 1962j. Certificate of Analysis RE: Toxicological investigation of: Aroclor 2565. Monsanto Sample No. 45. Monsanto Project No. Y-62-43. July 17, 1962. Exhibit K-35

Younger Laboratories. 1963a. Certificate of Analysis RE: Toxicological investigation of: Pyranol 1470. Monsanto Sample Number 21. Monsanto Project No. Y-63-11. March 4, 1963. Exhibit K-51.

Younger Laboratories. 1963b. Certificate of Analysis RE: Toxicological investigation of: Interteen PPO. Monsanto Sample Number 22. Monsanto Project No. Y-63-12. March 4, 1963. Exhibit K-36.

Younger Laboratories. 1963c. Certificate of Analysis RE: Toxicological investigation of: MCS-300. Monsanto Sample No. 112. Monsanto Project No. Y-63-88. December 19, 1963. Exhibit K-52.

Younger Laboratories. 1964a. Certificate of Analysis RE: Toxicological investigation of: FH-145. Monsanto Sample No. 7. Monsanto Project No. Y-64-7. February 13, 1964. Exhibit K-54.

Younger Laboratories. 1964b. Certificate of Analysis RE: Toxicological investigation of: MCS-295 (Therminol FR-0). Monsanto Sample No. 57. Monsanto Project No. Y-64-49. June 13, 1964. Exhibit K-55.

References (continued)

Younger Laboratories. 1964c. Certificate of Analysis RE: Toxicological investigation of: FH-159. Monsanto Sample No. 87. Monsanto Project No. Y-64-77. July 20, 1964. Exhibit K-56.

Younger Laboratories. 1964d. Certificate of Analysis RE: Toxicological investigation of: Pydraul 280. Monsanto Sample Number 102. Monsanto Project No. Y-64-91. August 11, 1964. Exhibit K-57.

Younger Laboratories. 1964e. Certificate of Analysis RE: Toxicological investigation of: MCS 312 (Pydraul 312). Monsanto Sample Number 146. Monsanto Project No. Y-64-133. November 12, 1964. Exhibit K-58.

Younger Laboratories. 1966a. Certificate of Analysis RE: Toxicological investigation of: MCS 395 (Pydraul 135). Monsanto Sample Number 244. Monsanto Project No. Y-65-213. January 10, 1966. Exhibit K-59.

Younger Laboratories. 1966b. Certificate of Analysis RE: Toxicological investigation of: MCS-404. Monsanto Sample No. 245. Monsanto Project No. Y-65-214. January 12, 1966. Exhibit K-53.

Younger Laboratories. 1966c. Certificate of Analysis RE: Toxicological investigation of: MCS-90. Monsanto Sample No. 176. Monsanto Project No. Y-66-151. October 17, 1966. Exhibit K-60.

Younger Laboratories. 1966d. Certificate of Analysis RE: Toxicological investigation of: MCS-528 (Santosafe 300). Monsanto Sample No. 190. Monsanto Project No. Y-66-165. October 17, 1966. Exhibit K-68.

Younger Laboratories. 1966e. Certificate of Analysis RE: Toxicological investigation of: Pydraul AC. Monsanto Sample Number 183. Monsanto Project No. Y-66-158. November 9, 1966. Exhibit K-66.

Younger Laboratories. 1966f. Certificate of Analysis RE: Toxicological investigation of: Pydraul 280. Monsanto Sample Number 186. Monsanto Project No. Y-66-161. November 9, 1966. Exhibit K-64.

Younger Laboratories. 1966g. Certificate of Analysis RE: Toxicological investigation of: Pydraul 135. Monsanto Sample Number 185. Monsanto Project No. Y-66-160. November 9, 1966. Exhibit K-65.

Younger Laboratories. 1966h. Certificate of Analysis RE: Toxicological investigation of: Pydraul 625. Monsanto Sample Number 187. Monsanto Project No. Y-66-162. November 9, 1966. Exhibit K-67.

References (continued)

Younger Laboratories. 1966i. Certificate of Analysis RE: Toxicological investigation of: MCS-153. Monsanto Sample Number 188. Monsanto Project No. Y-66-165. November 9, 1966. MONS 036471.

Younger Laboratories. 1966j. Certificate of Analysis RE: Toxicological investigation of: MCS-404. Monsanto Sample Number 189. Monsanto Project No. Y-66-162. November 9, 1966. MON036475.

Younger Laboratories. 1966k. Certificate of Analysis RE: Toxicological investigation of: Pydraul F-9. Monsanto Sample Number 184. Monsanto Project No. Y-66-159. November 9, 1966. Exhibit K-61.

Younger Laboratories. 1967a. Certificate of Analysis RE: Toxicological investigation of: Pydraul 230. Monsanto Sample Number 113. Monsanto Project No. Y-67-100. October 13, 1967. Exhibit K-69.

Younger Laboratories. 1967b. Certificate of Analysis RE: Toxicological investigation of: Santicizer 1706 (XA-140). Monsanto Sample Number 118. Monsanto Project No. Y-67-105. October 19, 1967. Exhibit K-70.

Younger Laboratories. 1969a. Certificate of Analysis RE: Toxicological investigation of: Santosafe 300 (MCS-528). Monsanto Sample Number 171. Monsanto Project No. Y-68-134. January 22, 1969. Exhibit MONS 034376.

Younger Laboratories. 1969b. Certificate of Analysis RE: Toxicological investigation of: Pydraul 312, MCS 312, OS 116021. Monsanto Sample Number 172(?). Monsanto Project No. Y-68-135. January 22, 1969. MONS 036487.

Younger Laboratories. 1969c. Certificate of Analysis RE: Toxicological investigation of: MCS-900. Monsanto Sample Number 51. Monsanto Project No. Y-69-41. May 5, 1969. MONS 036493.

Younger Laboratories. 1969d. Certificate of Analysis RE: Toxicological investigation of: MCS-9001. Monsanto Sample Number 68. Monsanto Project No. Y-69-57. July 18, 1969. MONS 038083.

Younger Laboratories. 1970a. Toxicological investigation of: Pydraul 281 – Lot QL-42. Monsanto Sample No. 28, Monsanto Project No. Y-70-25. March 27, 1970. DSW 295734.

Younger Laboratories. 1970b. Certificate of Analysis RE: Toxicological investigation of: MCS-1009. Monsanto Sample Number 47. Monsanto Project No. Y-70-43. May 25, 1970. MONS 035166.

References (continued)

Younger Laboratories. 1970c. Certificate of Analysis RE: Toxicological investigation of: MCS-999. Monsanto Sample Number 49. Monsanto Project No. Y-70-45. May 25, 1970. MONS 035174.

Younger Laboratories. 1970d. Certificate of Analysis RE: Toxicological investigation of: Aroclor 6062. Monsanto Sample Number 80. Monsanto Project No. Y-70-74. August 17, 1970. MONS 034335.

Younger Laboratories. 1970e. Certificate of Analysis RE: Toxicological investigation of: Aroclor 6037. Monsanto Sample Number 120. Monsanto Project No. Y-70-114. December 2, 1970. MONS 034319.

Younger Laboratories. 1970f. Certificate of Analysis RE: Toxicological investigation of: Aroclor 4273. Monsanto Sample Number 122. Monsanto Project No. Y-70-116. December 14, 1970. MONS 035089.

Younger Laboratories. 1970g. Certificate of Analysis RE: Toxicological investigation of: Aroclor 6040. Monsanto Sample Number 129. Monsanto Project No. Y-70-123. December 30, 1970. MONS 034327.

Younger Laboratories. 1970h. Certificate of Analysis RE: Toxicological investigation of: Aroclor 6070. Monsanto Sample Number 131. Monsanto Project No. Y-70-(?). December 30, 1970. MONS 036534.

Younger Laboratories. 1970i. Certificate of Analysis RE: Toxicological investigation of: Aroclor 6090. Monsanto Sample Number 132. Monsanto Project No. Y-70-126. December 30, 1970. MONS 036542.

Younger Laboratories. 1970j. Toxicological inestigation of: MCS 975, Pydraul 625-A. Monsanto Sample No. 184, Monsanto Project No. Y-69-150. January 16, 1970. DSW 585618.

Younger Laboratories. 1970k. Toxicological investigation of: Pydraul AC-A – Winter Grade 23. Monsanto Sample No. 182, Monsanto Project No. Y-69-148. January 16, 1970. DSW 585982.

Younger Laboratories. 1970l. Toxicological investigation of: MCS 976, Pydraul AC-A. Monsanto Sample No. 183, Monsanto Project No. Y-69-149. January 16, 1970. DSW 585992.

Younger Laboratories. 1971. Certificate of Analysis. Toxicological investigation of: Decachlorbiphenyl - Aroclor 1272 – Lot: OR 179021. Monsanto Sample Number 105. Monsanto Project Number Y-51-105. June 28, 1971. MONS 044614.

References (continued)

Younger Laboratories. 1972. Certificate of Analysis RE: Toxicological investigation of: MCS1230 German Mine Fluid. Monsanto Sample Number 187. Monsanto Project No. Y-71-187. January 12, 1972. MONS 044585.

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Dr. Lamb has worked in various federal government positions. Dr. Lamb was the Head of the Fertility and Reproduction Group at the National Toxicology Program (NTP), where he developed new toxicology testing systems, evaluated new systems, and tested substances for reproductive and developmental toxicity. He also served as a chemical manager for general toxicity assessment for various chemicals at the NTP. Dr. Lamb then moved to the U.S. Environmental Protection Agency as the Special Assistant to the Assistant Administrator for Pesticides and Toxic Substances. Dr. Lamb has provided consulting services to numerous clients for over twenty years. Over the years he has worked on issues affecting pesticides, industrial chemicals, consumer products, pharmaceuticals, medical devices, and food additives.

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Marty MS, Neal BH, Zablotny CL, Yano BL, Andrus AK, Woolhiser MR, Boverhof DR, Saghir SA, Perala AW, Passage JK, Lawson MA, Bus JS, Lamb JC, Hammond L. An F_1 –extended one –generation reproductive toxicity study in Crl:CD(SD) rats with 2,4-dichlorophenoxyacetic acid. Toxicol Sci 2013.

Juberg DR, Borghoff SJ, Becker RA, Casey W, Hartung T, Holsapple M, Marty MS, Mihaich EM, Van Der Kraak G, Wade MG, Willett CE, Andersen ME, Borgert CJ, Coady KK, Dourson ML, Fowle III JR, Gray LE, Lamb JC, OrtegoLS, Schug TT, Toole CM, Zorrilla LM, Kroner OL, Patterson J, Rinckel LA, Jones BR. Lessons learned, challenges, and opportunities: The U.S. Endocrine Disruptor Screening Program. ALTEX 2014; 31:63–78.

Reiss R, Neal B, Lamb JC, Juberg DR. Acetylcholinesterase inhibition dose-response modeling for chlorpyrifos and chlorpyrifos-oxon. Regul Toxicol Pharmacol 2012; 63:124–131.

Lamb J, Hentz K, Schmitt D, Tran N, Jonker D, Junker K. A one-year oral toxicity study of sodium stearoyl lactylate (SSL) in rats. Food Chem Toxicol 2010; 48:2663–2669.

Neal BH, Collins JJ, Strother DE, Lamb JC. Weight-of-the-evidence review of acrylonitrile reproductive and developmental toxicity studies. Crit Rev Toxicol 2009; 39(7):589–612.

Lamb JC 4th, Neal BH, Goodman JI. Risk assessment of toxaphene and its breakdown products: time for a change? Crit Rev Toxicol 2008; 38(9):805–815. Review.

Nichols BR, Hentz KL, Aylward L, Hays SM, Lamb JC. Age-specific reference ranges for polychlorinated biphenyls (PCB) based on the NHANES 2001-2002 survey. J Toxicol Environ Health A 2007; 70(21):1873–1877.

Lamb JC, Hentz KL. Toxicological review of male reproductive effects and trichloroethylene exposure: Assessing the relevance to human male reproductive health. Reprod Toxicol 2006; 22(4):557–563.

Carmichael NG, Barton HA, Boobis AR, Cooper RL, Dellarco VL, Doerrer NG, Fenner–Crisp PA, Doe JE, Lamb JC Pastoor TP. Agricultural chemical safety assessment: a multi–sector approach to the modernization of human safety requirements. Crit Rev Toxicol 2006 36(1):1–7.

Cooper RL, Lamb JC, Barlow SM, Bentley K, Brady AM, Doerrer NG, Eisenbrandt DL, Fenner–Crisp PA, Hines RN, Irvine LFH, Kimmel CA, Koeter H, Li AA, Makris SL, Sheets LP, Speijers GJA, Whitby KE. A tiered approach to life stages testing for Agricultural Chemical Safety Assessment. Crit Rev Toxicol 2006 36(1):69–68.

Aylward LL, Lamb JC, Lewis SC. Issues in risk assessment for developmental effects of 2,3,7,8–tetrachlorodibenzo–p–dioxin and related compounds. Toxicol Sci 2005; 87(1):3–10.

Lamb JC, Koeter HBWM, Becker R, Gies A, Davies L, Inoue T, Jacobs A, Lyons G, Matsumoto M, Timm G. Risk management options for endocrine disruptors in national and international programs. Pure Appl Chem 2003; 75(11–12):2549–2553.

Hentz KL, Oredugba BO, Lamb JC. A review of the epidemiological evidence for risk of breast cancer associated with exposure to polychlorinated biphenyls (PCBs). Int J Toxicol 2002; 21(6):526–527.

Brown NA, Lamb JC, Brown SM, Neal BH. A review of the developmental and reproductive toxicity of styrene. Regul Toxicol Pharmacol 2000; 32(3):228–247.

Goodman JI, Brusick DJ, Busey WM, Cohen SM, Lamb JC, Starr TB. Reevaluation of the cancer potency factor of toxaphene: Recommendations from a peer review panel. Toxicol Sci 2000; 55:3–16.

Gray GM, Goldstein BD, Bailar J, Davis DL, Delzell E, Dost F, Greenberg RS, Hatch M, Hodgson E, Ibrahim MA, Lamb JC, Lavy T, Mandel J, Monson R, Robson M, Shore R, Graham JD. The Federal Government's Agricultural Health Study: A criticial review with suggested improvements. Hum Ecol Risk Assess 2000; 6(1):47–71.

Lamb JC, Brown SM. Chemical testing strategies for predicting health hazards to children. Reprod Toxicol 2000; 14(2):83–94.

Lemasters GK, Perreault SD, Hales BF, Hatch M, Hirshfield AN, Hughes CL, Kimmel GL, Lamb JC, Pryor JL, Rubin C, Seed JG. Workshop to identify critical windows of exposure for children's health: reproductive health in children and adolescents work group summary. Environ Health Perspect 2000; 108(3):505–509.

Safe SH, Foster WG, Lamb JC, Newbold RR, Van Der Kraak G. Estrogenicity and endocrine disruption. CAST 2000; p. 16.

Hill MO, Lamb JC. Implications of EPA's proposed policy for its endocrine disruptor screening program: a rose is a rose, but is a flower a rose? EPA Administrative Law Reporter 1999; 13:341–356.

Lamb JC. Endocrine disruptors: the biological basis for concern. ABA Section of Natural Resources, Energy, and Environmental Law Newsletter 1999; 30(4):6–7.

Wilkinson CF, Lamb JC. The potential health effects of phthalate esters in children's toys: A review and risk assessment. Regul Toxicol Pharmacol 1999; 30:140–155.

Moore JA, Callahan M, Chapin R, Daston GP, Erickson D, Faustman E, Foster P, Friedman JM, Goldman L, Golub M, Hughes C, Kavlock RJ, Kimmel CA, Lamb JC, Lewis SC, Lunchick C, Morseth S, Mortensen BK, O'Flaherty EJ, Palmer AK, Ramlow J, Rodier PM, Rudo K, Ryan L, Schewtz BA, Scialli A, Selevan S, Tyl R, Campbell M, Carney E, Faber W, Hellwig J, Murphy SR, Smith MA, Strong PL, Weiner M. An assessment of boric acid and borax using the IEHR Evaluation Process for Assessing Human Developmental and Reproductive Toxicity of Agents. Reprod Toxicol 1997; 11(1):123–160.

Reel J, Lamb J, Neal B. Survey and assessment of mammalian estrogen biological assays for hazard characterization. Fundam Appl Toxicol 1996; 34:288–305.

Moore JA, Daston GP, Faustman E, Golub MS, Hart WL, Hughes C Jr, Kimmel C, Lamb JC, Schwetz BA, Scialli AR. An evaluative process for assessing human reproductive and developmental toxicity of agents. Reprod Toxicol 1995; 9:61–95.

Lamb JC, Chapin RE. Testicular and germ cell toxicity: In vitro approaches. Reprod Toxicol 1993; 7:17–22.

Bossert NL, Reel JR, Lawton AD, George JD, Lamb JC. Reproductive toxicity of triethylene glycol and its diacetate and dimethyl ether derivatives in a continuous breeding protocol in Swiss CD–1 mice. Fundam Appl Toxicol 1992; 18:602–608.

Reel JR, Tyl RW, Lawton AD, Lamb JC. Reproductive toxicity evaluation of acetaminophen in Swiss CD–1 mice using a continuous breeding protocol. Fundam Appl Toxicol 1992; 18(2):233–239.

Reel JR, Tyl RW, Lawton AD, Lamb JC. Reproductive toxicity of sulfamethazine in Swiss CD–1 mice during continuous breeding. Fundam Appl Toxicol 1992; 18:609–615.

Lamb JC. Regulating carcinogenic pesticides. Chemtech 1991; 21(1):43–49.

George JD, Reel JR, Myers CB, Lamb JC, Heindel JJ. Reproductive toxicity of trichloroethylene (TCE) in mouse and rat breeding pairs. Toxicologist 1990; 10(1):209.

Heindel JJ, Gulati DK, Russell S, Reel JR, Lawton AD, Lamb JC. Assessment of ethylene glycol monobutyl and monophenyl ether reproductive toxicity using a continuous breeding protocol in Swiss Cd–1 mice. Fundam Appl Toxicol 1990;15:683–696.

Williams J, Reel JR, George JD, Lamb JC. Reproductive effects of diethylene glycol and diethylene glycol monoethyl ether in Swiss CE–1 mice assessed by a continuous breeding protocol. Fundam Appl Toxicol 1990; 14:622.

Heindel JJ, Gulati DK, Mounce RC, Russell SR, Lamb JC. Reproductive toxicity of three phthalic acid esters in a continuous breeding protocol. Fundam Appl Toxicol 1989; 12:508–518.

Lamb JC. How to implement alternatives to the draize eye irritation test for pesticides. J Toxicol Cutaneous Ocul Toxicol 1989; 8:93–101.

Morrissey RE, Lamb JC, Morris RW, Chapin RE, Gulati DK, Heindel JJ. Evaluation of the reproductive assessment by continuous breeding. Teratology 1989; 39(5):469–470.

Morrissey RE, Lamb JC, Morris RW, Chapin RE, Gultai D, Heindel JJ. Results and evaluations of 48 continuous breeding reproduction studies conducted in mice. Fundam Appl Toxicol 1989; 13(4):747–777.

Treinen KA, Chapin RE, Gulati DK, Mounce R, Morris LZ, Lamb JC. Reproductive toxicity of 2,2–bis (bromomethyl)–1,3–propanediol in a continuous breeding protocol in Swiss (CD–1) mice. Fundam Appl Toxicol 1989; 13:245–255.

Chapin RE, George JD, Lamb JC. Reproductive toxicity of tri–o–cresyl phosphate in a continuous breeding protocol in Swiss (CD–1) mice. Fundam Appl Toxicol 1988; 10:344–354.

Collins JJ, Elwell MR, Lamb JC, Manus AG, Heath JE, Makovec GT. Subchronic toxicity of orally–administered (gavage and dosed–feed) theophylline in Fischer 344 rats and B6C3F1 mice. Fundam Appl Toxicol 1988; 11(3):472–484.

Francis EZ, Kimmel GL, Chitlik L, Christian M, Collins T, Lamb J, Palmer A, Ruddick J, Zenick H. Proceedings, workshop on one- and two-generation reproductive effects studies. J Am Coll Toxicol 1988; 7:911–925.

Lindamood C, Lamb JC, Bristol DW, Collins JJ, Heath JE, Prejean JD. Studies on the short–term toxicity of theophylline in rats and mice. Fundam Appl Toxicol 1988; 10(3):477–489.

Lindstrom P, Harris M, Ross M, Lamb JC, Chapin RE. Comparison of changes in serum androgen binding protein with germinal epithelial damage in infertility induced by di–n–pentylphthalate. Fundam Appl Toxicol 1988; 11(3):528–539.

Morrissey RE, Collins JJ, Lamb JC, Manus AG, Gulati DK. Reproductive effects of theophylline in mice and rats. Fundam App. Toxicol 1988; 10(3):525–536.

Morrissey RE, Lamb JC, Schwetz BA, Teague JL, Morris RW. Association of sperm, vaginal cytology, and reproductive organ weight data with results of continuous breeding reproduction studies in Swiss (CD–1) mice. Fundam Appl Toxicol 1988; 11:359–371.

Morrissey RE, Schwetz BA, Lamb JC, Ross MD, Teague JL, Morris RW. Evaluation of rodent sperm, vaginal cytology, and reproductive organ weight data from national toxicology program 13–week studies. Fundam Appl Toxicol 1988; 11:343–358.

Steele VE, Morrissey RE, Elmore EL, Gurganus–Rocha D, Wilkinson BP, Curren RD, Schmetter BS, Louie AT, Lamb JC, Yang LL. Evaluation of two in vitro assays to screen for potential developmental toxicants. Fundam Appl Toxicol 1988; 11:673–684.

Lamb JC 4th, Chapin RE, Teague J, Lawton AD, Reel JR. Reproductive effects of four phthalic acid esters in the mouse. Toxicol Appl Pharmacol 1987; 88:255–269.

Somkuti SG, Lapadula DM, Chapin RE, Lamb JC, Abou-Donia MD. Reproductive tract lesions resulting from subchronic administration (63 days) of tri-o-cresyl phosphate in male rats. Toxicol Appl Pharmacol 1987; 89:49–63.

Somkuti SG, Lapadula DM, Chapin RE, Lamb JC, Abou-Donia MD. Testicular toxicity following oral administration of tri-o-cresyl phosphate (TOCP) in roosters. Toxicol Lett 1987; 37(3):279–290.

Somkuti SG, Lapadula DM, Chapin RE, Lamb JC, Abou-Donia MD. Time course of the tri-o-cresyl phosphate-induced testicular lesion in F344 rats: Enzymatic, hormonal, and sperm parameter studies. Toxicol Appl Pharmacol 1987; 89:64–72.

Steele VE, Morrissey RE, Lamb JC, Wilkinson BP, Rocha DG, Murphy DD, Elmore EL. Evaluation of two in vitro assays to screen for potential teratogens. Environ Mutagen 1987; 9(Suppl. 8):103.

Agarwal DK, Eustis S, Lamb JC 4th, Jameson CW, Kluwe WM. Influence of dietary zinc on di(2–ethylhexyl)phthalate–induced testicular atrophy and zinc depletion in adult rats. Toxicol Appl Pharmacol 1986; 84:12–24.

Agarwal DK, Eustis S, Lamb JC 4th, Reel JR, Kluwe WM. Effects of di(2–ethylhexyl)phthalate on the gonadal pathophysiology, sperm morphology and reproductive performance of male rats. Environ Health Perspect 1986; 65:343–350.

Birnbaum LS, Harris MW, Miller CP, Pratt RM, Lamb JC. Synergistic interaction of 2,3,7,8–tetrachlorodibenzo–p–dioxin and hydrocortisone in the induction of cleft palate in mice. Teratology 1986; 33:29–35.

Dunnick JK, Harris MW, Chapin RE, Hal, LB, Lamb JC 4th. Reproductive toxicology of methyldopa in male F344/N rats. Toxicology 1986; 41:305–318.

Lamb JC, Harris MW, McKinney JD, Birnbaum LS. Effects of thyroid hormones on the induction cleft palate by 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in C57B1/6N mice. Toxicol Appl Pharmacol 1986; 84:115–124.

Lamb JC, Huff JE, Haseman JK, Murthy AS, Lilja H. Carcinogenesis studies of 4,4'–methylenedianiline dihydrochloride given in drinking water to F344/N rats and B6C3F1 mice. J Toxicol Environ Health 1986; 18:325–337.

Lamb JC, Ross MD, Chapin RE. Experimental methods for studying male reproductive function in standard toxicology studies. J Amer Toxicol 1986; 5:225–234.

Schrader SM, Chapin RE, Turner TW, Ratcliffe JM, Burg JR, Ross MD, Lamb JC. The effect of ethylene dibromide on sperm characteristics. J Androl 1986; 7(2):27.

Steele VE, Elmore EL, Lamb JC, Morrissey RE, Gurganus DJ, Murphy DD, Curren RD, Schmetter BS, Yang LL. Validation of two short–term in vitro assays to identify potential teratogens. Teratology 1986; 33(3):61C.

Yang LL, Steele VE, Lamb JC, Schechtman LM, Curren RD, Conklin PM, Toney S, Elmore EL. Evaluation and validation of two in vitro teratology systems: Results from the first twelve coded compounds. Environ Mutagen 1986; 8(Suppl 6):94.

Agarwal DK, Maronpot RR, Lamb JC 4th, Kluwe WM. Adverse effects of butylbenzylphthalate on the reproductive and hematopoietic systems of male rats. Toxicology 1985; 35:189–206.

Birnbaum LS, Weber H, Harris MW, Lamb JC 4th, McKinney JC. Toxic interaction of specific polychlorinated biphenyls and 2,3,7,8–tetrachlorodibenzo–p–dioxin: Increased incidence of cleft palate in mice. Toxicol Appl Pharmacol 1985; 77:292–302.

Chapin RE, Dutton SL, Ross MD, Lamb JC 4th. Effects of ethylene glycol monomethyl ether (EGME) on mating performance and epididymal sperm parameters in F344 rats. Fundam Appl Toxicol 1985; 5:182–189.

Chapin RE, Dutton SL, Ross MD, Swaisgood RW, Lamb JC 4th. The recovery of the testis over 8 weeks after short–term dosing with ethylene glycol monomethyl ether: Histology, cell specific enzymes, and retetestis fluid protein. Fundam Appl Toxicol 1985; 5:515–525.

Lamb JC 4th. Reproductive toxicity testing: Evaluating and developing new testing systems. J Am Coll Toxicol 1985; 4:163–172.

Lamb JC 4th, Jameson CW, Choudhury H, Gulati DK. Fertility assessment by continuous breeding: Evaluation of diethylstilbestrol and a comparison of results from two laboratories. J AmColl Toxicol

1985; 4:173–191.

Lamb JC 4th, Maronpot RR, Gulati DK, Russell VS, Hommel–Barnes L, Sabharwal PS. Reproductive and developmental toxicity of ethylene glycol in the mouse. Toxicol Appl 1985; Pharmacol 81:100–112.

Reel JR, Lawton HD, Wolkowski–Tyl R, Davis GW, Lamb JC 4th. Evaluation of a new reproductive toxicology protocol using diethylstilbestrol (DES) as a positive control compound. J Am Coll Toxicol 1985; 4:147–162.

Chapin RE, Lamb JC 4th. Effects of ethylene glycol monomethyl ether on various parameters of testicular function in the F344 rat. Environ Health Perspect 1984; 57:219–224.

Chapin RE, Dutton SL, Ross MD, Sumrell BM, Lamb JC 4th. Development of reproductive tract lesions in male F344 rats after treatment with dimethyl methylphosphonate. Experiment Molec Pathol 1984; 41:126–140.

Chapin RE, Dutton SL, Ross MD, Sumrell BM, Lamb JC 4th. The effects of ethylene glycol monoethyl ether on testicular histology in F344 rats. J Androl 1984; 5:369–380.

Chapin RE, Ross MD, Lamb JC 4th. Immersion fixation methods for glycol methacrylate embedded testis. Toxicol Pathol 1984; 12:221–227.

Dunnick JK, Gupta BN, Harris MW, Lamb JC 4th. Reproductive toxicity of dimethyl methyl phosphonate in the male Fischer 344 rat. Toxicol Appl Pharmacol 1984; 72:379–387.

Dunnick JK, Solleveld HA, Harris MW, Chapin J, Lamb JC 4th. Dimethyl methylphosphonate induction of dominant lethal mutations in male mice. Mutat Res 1984; 138(2–3):213–218.

Hudson PM, Yoshikawa K, Ali SF, Lamb JC 4th, Reel JR, Hong JS. Estrogenic activity of chlorodecone (Kepone) on the hypothala–micpituitary axis: Effects on the pituitary enkephalin system. Toxicol Appl Pharmacol 1984; 74:383–389.

Lamb JC 4th, Gulati DK, Russell VS, Hommel L, Sabharwal PS. Reproductive toxicity of ethylene glycol monoethyl ether tested by continuous breeding of CD–1 mice. Environ Health Perspect 1984; 57:85–90.

Weber H, Lamb JC, Harris MW, Moore JA. Teratogenicity of 2.3.7.8–tetrachlorodibenzofuran (TCDF) in mice. Toxicol Lett 1984; 20:183–188.

Weisburger EK, Murthy AS, Lilja HS, Lamb JC. Neoplastic response of F344 rats and B6C3F1 mice to

4,4'–methylenebis (n,n–dimethyl) benzeneamine, 4,4'–oxydianiline and 4,4'–methylenedianiline. J Natl Cancer Inst 1984; 72:1457–1463.

Kluwe WM, Gupta BN, Lamb JC 4th. Comparative effects of 1.2–dibromo–3–chloropropane (DBCP) and its metabolites 3–chloro–1,2–propaneoxide (epichlorohydrin), 3–chloro–1,2–propanediol (alphachlorohydrin) and oxalic acid, on the urogenital system of male rats. Toxicol Appl Pharmacol 1983; 70:67–86.

Kluwe WM, Lamb JC, IV, Greenwell A, Harrington FW. 1.2–Dibromo–3–chloropropane (DBCP)–induced fertility in male rats mediated by a post–testicular effect. Toxicol Appl Pharmacol 1983; 71:294–298.

Sim FRP, Matsumoto N, Goulding EH, Denny KH, Lamb J, Keeler RF, Pratt RM. Specific craniofacial defects induced by Jervine in the cultured rat embryo. Teratog Carcinog Mutagen 1983; 3:111–121.

Ali SF, Hong JS, Wilson WE, Lamb JC 4th, Moore JA, Mason GA, Bondy SC. Subchronic dietary exposure to rats to chlordecone (Kepone) modifies levels of hypothamamic B–endorphin. Neurotoxicology 1982; 3:119–124.

Kimmel CA, Lamb JC 4th, Hardin BD. Approaches to reproductive and development toxicology testing in the National Toxicology Program. Contracept Deliv Syst 1982; 3(3–4):84.

Lamb JC 4th, Moore JA. Effects of phenoxy acid herbicides on male reproductive function. Contracept Deliv Syst 1982; 3(3–4):171.

Lamb JC, Ross MD, Allen KM, Dozier MM, Reel JR. Differential estrotgenic response of the pituitary and uterus to kepone chlordecone in the F–344 rat. Biol Reprod 1982; 26(Suppl. 1):109A.

Korach KS, Lamb JC 4th. Estrogen action in the mouse uterus: differential nuclear localization of estradiol in uterine cell types. Endocrinology 1981; 108:1989–1991.

Lamb JC 4th, Marks TA, Gladen BC, Allen JW, Moore JA. Male fertility, sister chromatid exchange, and germ call toxicity following exposure to mixtures of chlorinated phenoxy acids containing 2,3,7,8–tetrachlorodibenzo–p–dioxin. J Toxicol Environ Health 1981; 8:825–834.

Lamb JC 4th, Marks TA, McConnell EE, Abeywickrama K, Moore JA. Toxicity of chlorinated phenoxy acids in combination with 2,3 7,8–tetrachlorodibenzo–p–dioxin in C57BL/6 male mice. J Toxicol Environ Health 1981; 8:815–824.

Lamb JC 4th, Moore, JA, Marks TA, Haseman JK. Development and viability of offspring of male mice treated with chlorinated phenoxy acids and 2.3.7.8–tetrachlorodibenzo–p–dioxin. J Toxicol Environ Health 1981; 8:835–844.

Lamb JC 4th, Newbold RR, McLachlan JA. Visualization by light microscopy and scanning electron microscopy of reproductive tract lesions in female mice treated transplacentally with diethylstilbestrol. Cancer Res 1981; 41:4057–4062.

Lamb JC 4th, Ingram P. Drying of biological specimens for scanning electron microscopy directly from ethanol. SEM 1979; 3:459–464.

Lamb JC 4th, McLachlan JA. Structural abnormalities on the surface of the female mouse genital tract exposed to diethylstilbestrol. Anat Rec 1979; 193(3):597.

Lamb JC 4th, Newbold, RR, McLachlan JA. Evaluation of the transplacental toxicity of diethylstilbestrol with the scanning electron microscope. J Toxicol Environ Health 1979; 5:599–603.

Suzuki Y, Lamb JC 4th, McLachlan JA. Age dependent morphological changes in the seminal colliculus in male mice: light microscopic and scanning electron microscopic study. Anat Embryol (Berl) 1979; 158:1–12.

Lamb JC 4th, Newbold RR, McLachlan JA. Modulation of the female genital tract by hormones. Scan Electron Microsc 1978; 2:773–778.

Lamb JC 4th, Newbold RR, McLachlan JA. PERI pubertal development of the female genital tract scanning electron microscopic studies. J Toxicol Environ Health 1978; 4(2/3):487.

Lamb JC 4th, Newbold RR, Stumpf WE, McLachlan JA. Transitional changes in the surface epithelium of the cycling mouse vagina, cervix and uterus: Scanning electron microscopic studies. Biol Rep 1978; 19:701–711.

McLachlan JA, Metzler M, Lamb JC 4th. Possible role of peroxidase in the diethylstilbestrol-induced lesions of the Syrian hamster kidney. Life Sci 1978; 23:2521–2524.

McLachlan JA, Lamb JC 4th, Stumpf WW, Newbold RR. Altered surface epithelium in the female mouse genital tract following prenatal exposure to diethylstilbestrol. J Toxicol Environ Health 1977; 3(1–2):366.

McLachlan JA, Newbold RR, Lamb JC. Genital tract abnormalities in mice following gestational exposure to diethylstilbestrol. Environ Health Perspect 1977; 20:240.

Stumpf WE, Hellreich WA, Aumuller G, Lamb JC 4th, Sar M. The collicular recess organ: Evidence for structural and secretory specialization of ventricular lining in the collicular recess. Cell Tissue Res 1977; 184:29–44.

Nopanitaya W, Lamb JC 4th, Grisham JW, Carson JL. Effect of hepatic venous outflow obstruction on pores and fenestrations in sinusoidal epithelium. Br J Exp Pathol 1976; 57:604–609.

Geratz JD, Lamb JC 4th. Influence of bile duct ligation on exocrine pancreatic secretory activity in the rat. Am J Physiol 1974; 228:119–122.

Letters to Editor, Books and Book Chapters

Lamb, JC. Chapter 3.01. Introduction to toxicology testing and evaluation. Comprehensive Toxicology, Second Edition 2010, Volume 3 Toxicology Testing and Evaluation. Lamb JC (ed), Elsevier: Oxford, 2010.

Lamb JL, Hentz KL. Chapter 3. Impact of endocrine disruptor policies and regulations. In: Endocrine Toxicology, Volume 27 in Target Organ Toxicology. Eldridge JS, Stevens JT (eds), New York: Informa Healthcare, 2010.

Lamb JC, Neal BH, Ginevan ME, Bus JS, Mahlburg WM. Herbicide effects on embryo implantation and litter size. Environ Health Perspect 2003; 111(9):A450.

Lamb JC. Current issues in toxicity testing. New endpoints in reproductive toxicology and their relevance to risk assessment. pp. p. 98–99. In: An Evaluation and Interpretation of Reproductive Endpoints for Human Health Risk Assessment. ILSI Press, 1998.

Lamb JC. Introduction to exposures to endocrine–active substances in the human diet. pp. 131–134. In: Human Diet and Endocrine Modulation, Estrogenic and Androgenic Effects. ILSI Press, 1998.

Lamb JC. New endpoints in reproductive toxicology and their relevance to risk assessment. Chapter III–Current Issues in Toxicity Testing. In: Evaluation and Interpretation of Reproductive Endpoints for Human Health Risk Assessment, 1998.

Lamb JC. Testing chemicals for endocrine–modulating activity and using the test data in risk assessments. pp. 220–228. In: Human Diet and Endocrine Modulation, Estrogenic and Androgenic Effects. ILSI Press, 1998.

Lamb JC, Balcomb R, Bens C, Cooper R, Gorsuch, Matthiessen P, Peden-Adams M, Voit E. Hazard identification and epidemiology. Chapter 2, pp. 17–37. In: Principles and Processes for Evaluating Endocrine Disruption in Wildlife, 1998.

Lamb JC, Petersen BJ, Tomerlin R, Barraj LM, Driver JH, Ginevan ME, Pandian MD, Sielken RL, Valez–Flores C. Aggregate exposure assessments for pesticides. pp. D1–D143. In: Aggregate Exposure Assessment. An ILSI Risk Science Institute Workshop Report, 1998.

Lamb JC. Can today's risk assessment paradigms deal with endocrine active chemicals? Inside EPA's Risk Policy Report, Vol. 4, No. 9, September 1997.

Lamb JC, IV. Assessment of risk for chemicals affecting the endocrine system. pp. 5.1–5.10. In: Endocrine Disruptors: Advances in Measuring and Analyzing Their Effects. Guttry P, Savatge LM (eds), Massachusetts: International Business Communications, Inc., 1997.

Stevens JT, Tobia A, Lamb JC, Tellone C, O'Neal F. FIFRA subdivision F testing guidelines: Are these tests adequate to detect potential hormonal activity for crop protection chemicals? J Tox Environ Health 1997; 50:415–431.

Johnson EM, Grabowski CT, Jensh RP, Juchau MR, Kimmel CA, Lamb J, Manson JM, Marks TA, Scott WJ, Sheehan D, Staples RE, Sullivan FM, Trosko TE. Developmental toxicology. pp. 391–402. In: Advances in Modern Environmental Toxicology. Volume XVIII, 1990.

Lamb JC. The design and use of multigeneration breeding studies for the identification of reproductive toxicants. pp. 131–155. In: Toxicology of the Male and Female Reproductive Systems. Washington, DC, Hemisphere Publishing Corp, 1989.

Foster PMD, Lamb JC. Introduction. pp. 1–6. In: Physiology and Toxicology of Male Reproduction. Lamb JC and Foster PMD (eds), Orlando, FL: Academic Press, 1988.

Lamb JC. How EPA weighs risk and benefits in pesticide regulation. pp. 39–51. In: Regulation of Pesticides: Science, Law and Media. Rockville, MD: Government Institutes Inc., 1988.

Lamb JC. Male reproductive toxicity testing. pp. 137–154. In: Physiology and Toxicology of Male Reproduction. Lamb JC, Foster PMD (eds), Orlando, FL: Academic Press, 1988.

Lamb JC. Pesticide regulation related to carcinogenicity. In: ACS Symposium Series. 414 Carcinogenicity and Pesticides: Principles, Issues, and Relationships. Ragsdale NN, Menzer RE (eds),

196th National Meeting of the American Chemical Society, Los Angeles, CA, September 25–30, 1988.

Lamb JC, IV. Fundamentals of male reproductive toxicity testing. pp. 137–154. In: Physiology and Toxicology of Male Reproduction. Lamb JC, IV, Foster PMD (eds), San Diego, CA: Academic Press, 1988.

Lamb JC, IV, Foster PMD. Physiology and toxicology of male reproduction. In: Physiology and Toxicology of Male Reproduction. Lamb JC, IV, Foster PMD (eds), San Diego, CA: Academic Press, 1988.

Lamb JC, IV, Chapin RE. Experimental models of male reproductive toxicology. pp. 85–115. In: Target Organ Toxicology Series: Endocrine Toxicology. Thomas JA, Korach KS, McLachlan JA (eds), New York: Raven Press, 1985.

Reel JR, Lamb JC. Reproductive toxicology of chlordecone (kepone). pp. 357–392. In: Thomas JA, Korach KS, McLachlan JA (eds), Target Organ Toxicology Series: Endocrine Toxicology, New York: Raven Press, 1985.

Lamb JC, IV and Moore JA Effects of phenoxy acid herbicides and TCDD on male reproductive function. pp. 269–286. In: Male Fertility and its Regulation. Lobl TJ, Hafez ESE (eds), Boston: MTP Press, Ltd., 1984.

McLachlan JA, Newbold RR, Korach KS, Lamb JC, IV, Suzuki Y. Transplacental toxicology: Prenatal factors influencing postnatal fertility. pp. 213–232. In: Kimmel CA, Buelke–Sam JB (eds), Developmental Toxicity, New York: Raven Press, 1981.

Lamb JC, IV, Newbold RR, Stumpf WE, McLachlan JA The development of the luminal surface of the vagina, cervix and uterus of the mouse. Vol. II, pp. 355–360. In: Scanning Electron Microscopy. Johari OM, Becker RP (eds), Biological Applications of the SEM, 1977.

Stumpf WE, Lamb JC, IV, Hellreich MA, Aumuller G. Scanning electron microscopy of the collicular recess, the collicular recess organ and the velum medullar anterius of the brain. Vol. II, pp. 579–586. In: Scanning Electron Microscopy. Johari OM, Becker RP (eds), Biological Applications of the SEM, 1977.

Technical Reports

George JD, Myers CB, Lamb JC. Final contract report: Fertility assessment by continuous breeding. NTP–86–__. NTIS PB 86, 1986.

George JD, Reel JR, Myers CB, Lawton AD, Lamb JC, IV. Methoxy acetic acid: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program,

NTP–86–040, 1986. NTIS No. PB–86–164274/as.

George JD, Reel JR, Myers CB, Lawton AD, Lamb JC, IV. Trichloroethylene: Reproduction and fertility assessment in F344 rats when administered in the feed. NTP–86–085, 1986.

Gulati, D.K, Lamb JC, IV. 1986. Final contract report: Fertility assessment by continuous breeding. NTP–86–__. NTIS PB 86.

Gulati DK, Hommel–Barnes L, Russell S, Poonacha KB, Lamb JC, IV. 9–aminoacridine hydrochloride: Reproduction and fertility assessment in CD–1 mice when administered in feed. National Toxicology Program, NTP–86–022, 1986. NTIS PB–86–163128/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Ethylene glycol monomethyl ether: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–023, 1986. NTIS PB–86–163136/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Propantheline bromide: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–001, 1986. NTIS PB–86–160330/as.

Gulati DK, Hommel–Barnes L, Welch M, Russell S, Lamb JC, IV. Propylene glycol monomethyl ether: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–062, 1986. NTIS PB–86–170578/as.

Gulati DK, Mounce RC, Shaver S, Russell S, Poonacha KB, Lamb JC, IV. 2,2–Bis(bromomethyl)–1,3–propanediol: Reproduction and fertility assessment in CD–1 mice when administered in feed. NTP–86–063, 1986.

Gulati DK, Hommel–Barnes L, Welch M, Russell S, Poonacha KB, Lamb JC, IV. Ethylene glycol: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. NTP 86–078, 1986.

Heindel JJ, Lamb JC, Chapin RE, Gulati DK, Hope E. Reproductive toxicity testing by continuous breeding test protocols in Swiss (CD–1) Mice. NTIS PB 89–152425, 1989.

Reel JR, Lawton AD, Myers CB, Lamb JC, IV. Trichloroethylene: reproduction and fertility assessment in F344 rats when administered in microcapsules in the feed. National Toxicology Program. NTP–86–085, 1986. NTIS No. PB–86–190782/as.

Reel JR, Lawton AD, Myers CB, Lamb JC, IV. Triethylene glycol diacetate: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–039, 1986. NTIS No. PB–86–161999/as.

George JD, Reel JR, Myers CB, Lawton AD, Lamb JC, IV. Trichloroethylene: Reproduction and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. NTP–86–068, 1985. NTIS No. PB–86–173150/as.

George JD, Reel JR, Myers CB, Lawton AD, Lamb JC, IV. Tricresyl phosphate: Reproduction and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. NTP–86–052, 1985. NTIS No. PB–86–167277/as.

Gulati DK, Chambers R, Shaver S, Poonacha KB, Russell S, Lamb JC, IV. Di–n–propylphthalate: Reproduction and fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. NTP–85–188, 348 pp, 1985. NTIS PB 85–247856/as.

Gulati DK, Chambers R, Shaver S, Sabharwal PS, Lamb JC. Di–n–octylphthalate: Reproduction and fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. NTP–85–140, 287 pp, 1985. NTIS No. PB85–218147.

Gulati DK, Chambers R, Shaver S, Sabharwal PS, Lamb JC, IV. Theophylline: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–85–09, 330 pp, 1985. NTIS No. PB85–204659/as.

Gulati DK, Choudhury H, Chambers R, Lamb JC, IV. Lead acetate trihydrate: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–85–098, 283 pp, 1985. NTIS No. PB85–203032/as.

Gulati DK, Choudhury H, Chambers R, Poonacha KB, Sabharwal PS, Lamb JC. Diethylstilbestrol: Fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. NTP–85–016, 225 pp, 1985. NTIS No. PB85–167674/as.

Gulati DK, Choudhury H, Chambers R, Sabharwal PS, Lamb JC. Methyl salicylate: Fertility assessment in CD–1 mice when administered by gavage. National Toxicology Program. NTP–85–022, 180 pp, 1985. NTIS No. PB85–164283/as.

Gulati DK, Hommel L, Poonacha KB, Russell V, Russell S, Lamb JC Ethylene glycol monobutyl ether: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–85–155. 340 pp, 1985. NTIS No. 85–226827/AS.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. 2,2–Bis(bromomethyl)1,2–propanediol reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–063,1985. NTIS PB–86–168341/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Ethylene glycol: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–86–078, NTIS PB–86–177383/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, and Lamb JC, IV. 1985. Ethylene glycol monomethyl ether acetate: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–85–320, 1985. NTIS PB–86–139565/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Ethylene glycol monomethyl ether: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program, NTP–85–214. 321 pp, 1985. NTIS PB–86–120128/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Oxalic acid: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–85–322, 1985. NTIS PB–86–167053/as.

Gulati DK, Hommel L, Russell S, Poonacha KB, Lamb JC, IV. Propylene glycol: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–85–321, 1985. NTIS PB–86–140662/as.

Gulati DK, Hommel L, Russell V, Sabharwal PS, Lamb JC, IV. Ethoxy acetic acid: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–85–080. 313 pp, 1985. NTIS No. PB85–197960/as.

Gulati DK, Maunce R, Shaver S, Poonacha KB, Lamb JC, IV. Di–n–pentylphthalate: Reproduction and fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. NTP–85–213, 322 pp, 1985. NTIS 86–118999.

Gulati DK, Russell VS., Hommel L, Poonacha KB, Sabharwal PS, Lamb JC, IV. Caffeine: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–85–097. 243 pp, 1985. NTIS No. PB85–205052/as.

Gulati DK, Russell V, Hommel L, Poonacha KB, Sabharwal PS, Lamb JC, IV. Sodium saccharin: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National

Toxicology Program. Technical Report NTP–85–078, 197 pp, 1985. NTIS No. PB85–188258/as.

Reel JR, George JD, Lawton AD, Myers CB, Lamb JC, IV. Bisphenol A: Reproduction and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. NTP–85–192, 344 pp, 1985, NTIS 86–103207.

Reel JR, Lawton AD, George JD, Lamb JC. Diethylene glycol: Reproduction and fertility assessment in CD–1 mice when administered in the drinking water. National Toxicology Program. NTP–85–107, 242 pp, 1985. NTIS No. PB85–212926/as.

Reel JR, Lawton AD, George JD, Lamb JC, IV. Triethylene glycol dimethyl ether: Reproduction and fertility assessment in CD–1 mice when administered in the drinking water. National Toxicology Program. Technical Report NTP–85–007, 194 pp., 1985. PB85–150456/as.

Reel JR, Lawton DA, Lamb JC, IV. Acetaminophen: Reproduction and fertility assessment in CD–1 mice when administered in water. National Toxicology Program. Technical Report NTP–85–095, 207 pp, 1985. NTIS No. PB85–204667/as.

Reel JR, Lawton AD, Myers CB, Lamb JC, IV. Di–n–hexyl phthalate: Reproduction and fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. NTP–85–187. 244 pp, 1985. NTIS No. PB–85–249332/as.

Reel JR, Lawton AD, Myers CB, Lamb JC, IV. Ethanol: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. NTP–85–334, 1985. NTIS No. PB–86–144979/as.

Gulati DK, Choudhury H, Chambers R, Poonacha KB, Sabharwal PS, Lamb JC, IV. Theobromine: Fertility assessment in CD–1 mice when administered in feed. National Toxicology Program. Technical Report NTP–84–265, 253 pp, 1984. NTIS No. PB85–120368.

Gulati DK, Russell VS, Hommel L, Poonacha KB, Sabharwal PS, Lamb JC 2–Ethoxyethanol: Fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–84–264, 275 pp, 1984. NTIS No. PB85–118651.

Gulati DK, Russell VS., Hommel L, Poonacha KB, Sabharwal PS, Lamb JC, IV. Ethylene glycol: Fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–84–155, 234 pp, 1984. NTIS PB 84 241108.

Reel JR, Lawton AD, and Lamb JC, IV. Diethylphthalate: Reproduction and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. Technical Report NTP–84–262, 187 pp, 1984. NTIS No. PB85–118636.

Reel JR, Lawton AD, Lamb JC, IV. Diethylene glycol monoethyl ether: Reproduction and fertility assessment in CD–1 mice when administered in the drinking water. National Toxicology Program. Technical Report NTP–84–406, 179 pp, 1984. NTIS No. PB85–137123.

Reel JR, Lawton AD, Lamb JC, IV. Diethylhexyl phthalate (DEHP): Reproduction and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. Technical Report NTP–84–079, 217 pp, 1984. NTIS PB 84 181734.

Reel JR, Lawton AD, Lamb JC, IV. Di–n–butyl phthalate: Reproductive and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. Technical Report NTP–84–411, 197 pp, 1984. NTIS PB85–144798.

Reel JR, Lawton AD, Lamb JC, IV. Ethylene glycol monophenyl ether: Reproductive and fertility assessment in CD–1 mice when administered in the feed. National Toxicology Program. Technical Report NTP–84–410. 244 pp, 1984. NTIS PB85–146140/AS.

Reel JR, Lawton AD, Lamb JC, IV. Triethylene glycol: Reproduction and fertility assessment in CD–1 mice when administered in drinking water. National Toxicology Program. Technical Report NTP–84–407, 187 pp, 1984. NTIS No. PB85–137073.

Reel JR, Wolkowski–Tyl R, Lawton AD, Lamb JC. Bisphenol A: Reproduction and fertility assessment in CD–1 mice when administered via subcutaneous silastic implants. National Toxicology Program. Technical Report NTP–84–015, 182 pp, 1984. NTIS PB 84 155308.

Reel JR, Woldowski–Tyl R, Lawton AD, Lamb JC, IV. Caffeine: Reproductive and fertility assessment in CD–1 mice when administered in the drinking water. National Toxicology Program. Technical Report NTP–84–158, 203 pp, 1984. NTIS PB 85 101202.

Reel JR, Wolkowski–Tyl R, Lawton AD, Lamb JC. Dibromochloropropane: Reproduction and fertility assessment in CD–1 mice when administered by gavage. National Toxicology Program. Technical Report NTP–84–263, 202 pp, 1984. NTIS No. PB85–118644.

Reel JR, Wolkowski–Tyl R., Lawton AD, Lamb JC, IV. Lead acetate (PbAc): Reproduction and fertility assessment in CD–1 mice when administered in the drinking water. National Toxicology Program. Technical Report NTP–84–108, 208 pp, 1984. NTIS PB 84 208016.

Reel JR, Wolkowski–Tyl R, Lawton AD, Lamb JC, IV. Methyl salicylate: Reproduction and fertility assessment in CD–1 mice when administered by gavage. National Toxicology Program. NTP–84–156, 207 pp, 1984. NTIS PB 84 241140.

Reel JR, Wolkowski–Tyl R, Lawton AD, Lamb JC, IV. Sulfamethazine: Reproductive and fertility assessment in CD–1 mice when administered via the diet. National Toxicology Program. Technical Report NTP–84–092. 218 pp, 1984. NTIS PB 84 192160.

Reel JR, Wolkowski–Tyl R, Lawton D, Lamb JC. Diethylstilbestrol (DES): Reproduction and fertility assessment in Cd–1 mice when administered in feed. National Toxicology Program. Technical Report NTP–83–284, 205 pp, 1983. NTIS PB 84 136746.

Lamb JC, IV (Chemical Manager). Toxicology and Carcinogenesis Studies of 1,2–Dichloropropane (propylene dichloride) (CAS No. 78–87–5) in F344/N Rats and B6C3F1 Mice. National Toxicology Program. Technical Report No. 263, NIH Publ. No. 86–2519, 182 pp.

Lamb JC, IV (Chemical Manager). NTP Technical Report on the carcinogenesis Bioassay of 4,4'–Methylenedianiline dihydrochloride (CAS No. 13552–44–8) in F344/N rats and B6C3F1/N mice. National Toxicology Program. Technical Report No. 81–143. NIH Publication No. 82–2504, 182 pp, 1982.

Lamb JC, IV, Moore JA, Marks TA. Evaluation of 2,4–dichlorophenoxyacetic acid (2,4–D), 2,4,5–trichlorophenoxyacetic acid (2,4,5–T), and 2,3,7,8–tetrachlorodibenzo–p–dioxin (TCDD) toxicity in C57BL/6 mice: Reproduction and fertility in treated male mice and evaluation of congenital malformations in their offspring. National Toxicology Program. Technical Report No. NTP–80–44, 1980. NTIS PB 86–132750.

Abstracts

Patterson J, Becker R, Borghoff S, Casey W, Dourson M, Fowle J, Hartung T, Holsapple M, Jones B, Juberg D, Kroner O, Lamb J, Mary s. Mihaich E, Rinckel L, Van Der Kraak G, Wade M, Willett C. Workshop on lessons learned, challenges, and opportunities: The U.S. Endocrine Disruptor Screening Program. Poster presented at Society for Risk Analysis, 2013.

Patterson J, Becker R, Borghoff S, Casey W, Dourson M, Fowle J, Hartung T, Holsapple M, Jones B, Juberg D, Kroner O, Lamb J, Mary s. Mihaich E, Rinckel L, Van Der Kraak G, Wade M, Willett C. Workshop on lessons learned, challenges, and opportunities: The U.S. Endocrine Disruptor Screening Program. Poster presented at Society for Risk Analysis, 2013.

Neal B, Staveley J, Freeman E, Williams A, Lamb J, DeSesso J. Weight of the evidence (WoE) evaluation of endocrine disruptor screening program tier 1 assays: Lessons learned. Poster presented at SETAC, 2013.

Hentz KL, Williams A, Lamb JC. Endocrine disruption: Weight of the evidence for low-dose effects of TCDD on sperm counts. Poster presented at Society of Toxicology Annual Meeting, 2013.

Hentz KL, Lamb JC. Proposed mechanism of action for toxicity in N-acetylcysteine overdose. Poster presented at Society of Toxicology Annual Meeting, 2011.

Neal B, Marty MS, Coady K, Lamb JC. 2,4-Dichlorophenoxyacetic acid (2,4-D): Evaluation of endocrine modulating potential. Poster presented at Society of Toxicology Annual Meeting, 2011.

Lamb JC, Walker CL, Neal BH, Klaunig JE. Inhibition of gap junction intercellular communication (GJIC) in mouse liver cells by technical toxaphene and toxaphene congeners. Poster presented at Society of Toxicology Annual Meeting, 2010.

Marty S, Lamb J. The evolution of the extended one-generation study design for agricultural and industrial chemical hazard identification. Roundtable session at Society of Toxicology Annual Meeting, 2010.

Lamb J, Ryan B, Gaylor D, Hentz K, Gerhart J. Derivation of an acceptable daily intact (ADI) using a benchmark dose (BMD) approach for a veterinary pharmaceutical residue in food-producing animals. Poster presented at Society of Toxicology Annual Meeting, 2007.

Neal B, Strother DE, Collins JJ, Lamb J.C. Acrylonitrile: evaluation of reproductive and developmental toxicity. Poster presented at Society of Toxicology Annual Meeting, 2006.

Lamb JC. Interviewing skills for a position in the private sector. Poster presented at Society of Toxicology Annual Meeting, 2005.

Lamb JC. Incorporating life stage testing into agricultural chemical safety assessment. Poster presented at Society of Toxicology Annual Meeting, 2004.

Norenberg KM, Hentz KL, Neal BH, Lamb JC. Evaluation of a common mechanism of action for dithiocarbamates. Toxicologist 2002; 66, 17S.

Oredugba BO, Hentz KL, Lamb JC. Review of toxicity data and assessment of the margin of exposure for Di–butyl Phthalate (DBP) as an inert ingredient in a generic drug. Toxicologist, 2002.

Soto AN, Hentz KL, McCarty JD, Lamb JC. Evaluation of the estrogenic activity of pyrethroid pesticides. Toxicologist 2002.

Lamb JC. Assessing the human health risks from exposures to hormonally active agents. International Symposium on Environmental Endocrine Disruptors. December 1999.

Lamb JC. Reproductive Toxicology. Ethylene glycol monomethyl ether. Swiss CD–1 mice at 0.0, 0.1, 0.2, 0.4% drinking water. Environ Health Perspect 1997; 105(Supplemental 1).

Lamb JC, George J, Reel J, Myers C, Lawton AD. Trichloroethylene. Environ Health Perspect 1997; 105(Supplemental 1).

Lamb JC. Risk assessment and risk management of worker exposures to pesticides: The next generation: Introduction. Fundamental and Applied Toxicology 1996; 30:1(2):308.

Lamb JC. Molecular mechanisms in hormonal carcinogenesis: Update and challenges for future research: Introduction. The Toxicologist 1993; 13:1.

Lamb JC. Endocrine tumorigenesis and the implications in risk assessment. The Toxicologist 1992; 12:2.

Lamb JC, Chapin RE, Singh DV. Gonadal control, growth factors, and tumorigenesis and their implications in risk assessment: Introduction. The Toxicologist 1992; 12:1.

George JD, Reel JR, Meyers CB, Lamb JC, Heindel JJ. Reproductive toxicity of trichloroethylene (TCE) in mouse and rat breeding pairs. The Toxicologist 1990; 10:209.

Morrissey RE, Lamb JC, Morris RW, Chapin RE, Gulati DK, Heindel JJ. Evaluation of the reproductive assessment by continuous breeding protocol. Teratology 1989; 39:469–470.

Collins JJ, Lamb JC, Manus AG, Heath J, Makovec T. Subchronic toxicity of orally–administered theophylline (gavage and dosed–feed) in F344 rats and B6C3F1 mice. The Toxicologist 1988; 8:345.

Lamb JC, IV Schwartz J. Pesticide regulatory issues. Abstracts of Papers American Chemical Society 1988; p. 196.

Lindstrom P, Harris M, Ross M, Lamb JC, Chapin R. Di–n–pentylphthalate (DPP) induced infertility: Correlation with Serum Androgen Binding Protein (sABP). The Toxicologist 1988; 8:55.

Morrissey RE, Lamb JC, Schwetz BA, Teague JL, Morris RW. Association of Sperm, Reproductive Organ Weight and Vaginal Cytology (SMVCE) Data with Fertility of Swiss (CD–1) Mice. The Toxicologist 1988; 8:248.

Elmore EL, Morrissey RE, Lamb JC, Rocha DG, Wilkinson BP, Murphy DD, Steele VE. Screening of coded teratogens in two in vitro assays. In Vitro 1987; 23:43A.

Gulati DK, Mounce RC, Poonacha KB, Lamb JC. Reproductive Toxicity of 3 Phthalate Esters in CD–1 Mice. The Toxicologist 1987; 7:577.

Lamb J Identification of occupational and environmental hazards to male reproduction. Amer. Chem Soc. Abstracts, Denver, CO, April 1987.

Lamb J. Scientific evaluation procedures: How EPA views the weight of scientific evidence on law while making regulatory decisions. Amer Chem Soc. Abstracts, Denver, CO, April 1987.

Lamb JC. Pesticide residue tolerances – The Government viewpoint. Amer. Chem Soc. Abstracts, New Orleans, LA, September 1987.

Lindstrom P, Harris M, Ross M, Lamb JC, Chapin R. Changes in Serum Androgen Binding Protein (ABP) indicate germinal epithelial damage. The Toxicologist 1987; 7:4.

Chapin RE, Gray TJB, Dutton SL, Lamb JC. The effects of 2,5–hexanedione (2,5–HD), and mono–(2–ethylhexyl)phthalate (MEHP) on Sertoli–cell enriched cultures. The Toxicologist 1986; 6:289.

George JD, Reel JR, Myers CB, Lawton AD, Lamb JC. Reproductive toxicity of methoxyacetic acid (MAA) in the drinking water to mouse breeding pairs. The Toxicologist 1986; 6:293.

Gulati DK, Hommel–Barnes L, Welch M, Poonacha KB, Lamb JC. Reproductive toxicity of 7 glycol ethers and oxalic acid. The Toxicologist 1986; 6:293.

Gulati DK, Mounce RC, Poonacha KB, Lamb JC. Reproductive toxicity of 3 phthalate esters in CD–1 mice. The Toxicologist 1986; 7:144.

Lamb JC, Chapin RE, Teague, J., Lawton AD, Reel JR. Reproductive toxicity of DEP, DBP, and DHP studied by a continuous breeding protocol. The Toxicologist 1986; 6:293.

Lamb JC, Gulati DK, George JD. Evaluation of reproductive effects of phthalate esters and glycol ethers using a continuous breeding protocol. Toxicology 1986. Presented at the 1986 Annual Meeting of the European Society of Toxicology, Harrogate, England).

Lindstrom, P., Harris, M., Ross M, Lamb JC, Chapin RE. Changes in serum androgen binding protein (ABP) indicate germinal epithelial damage. The Toxicologist 1986; 7:1. (The student presenting this poster won the SOT Reproductive and Developmental Toxicology Specialty Section Award for Excellence.)

Somkuti SG, Lapadula DM, Chapin RE, Lamb JC, and Aboudonia MB 1986. Testicular toxicity of tri–o–cresyl phosphate (TOCP) in F344 rats. The Toxicologist 6:290.

Somkuti SG, Lapadula DM, Chapin RE, Lamb JC, Aboudonia MB. The morphogenesis of ultrastructural changes of the tri–o–cresyl phosphate (TOCP)–induced testicular lesion in F344 rats. The Toxicologist 1986; 6:290.

Lindamood C, Lamb JC, Bristol DW, Collins JJ, Heath JE. Preliminary range—Finding studies on theophylline toxicity in rats and mice. The Toxicologist 1986; 6:123.

Agarwal DK, Eustis S, Lamb JC, Reel JR, Kluwe WM. Correlation of dose–dependent functional pathophysiological changes induced by di–(2–ethylhexyl)–phthalate (DEHP). The Toxicologist 1985; 5:117. (Also at SOT Annual Meeting, 1985).

Birnbaum LS, Harris MW, Miller CP, Pratt RC, Lamb JC, IV. Teratogenicity of TCDD in mice: Enhancement by hydrocortisone. The Toxicologist 1985; 5:201. (Also at SOT Annual Meeting, 1985).

Chapin RE, Dunnick JK, Harris MW, Lamb JC, IV. Reproductive toxicity of methyl DOPA in male F344 rats. J Androl 1985; 6:61.

Chapin RE, Swaisgood RR, Lamb JC, IV. Testicular sorbitol dehydrogenase activity increases after exposure to different toxicants. The Toxicologist 1985; 5:182. (Also at SOT Annual Meeting, 1985).

Chapin RE, Swaisgood RR, Lamb JC, IV. Testicular sorbitol dehydrogenase as a predictive indicator of testicular toxicity in F344 rats. J Androl 1985; 6:62.

Dunnick JK, Harris MW, Hall LB, Chapin RE, Lamb JC, IV. Reproductive toxicity of methyl DOPA in the male Fischer 344/N rat. The Toxicologist 1985; 5:188. (Also at SOT Annual Meeting, 1985).

Reel JR, Lawton AD, Tyl RW, Lamb JC, IV. Reproductive toxicity of dietary diethylhexylphthalate (DEHP) in mouse breeding pairs. The Toxicologist 1985; 5:117. (Also at SOT Annual Meeting, 1985).

Reel JR, Lawton AD, Wolkowski–Tyl R, Davis GW, Lamb JC, IV. Evaluation of a new reproductive toxicology protocol using diethylstilbestrol as a positive control compound. J Am Coll Toxicol 1985; 4(2):147–162.

Birnbaum LS, Harris MW, McKinney JD, Lamb JC. Toxic interaction of TCDD with thyroxin: Enhanced incidence of cleft palate in mice. The Pharmacologist 1984; 26:232. (1984 ASPET Meeting).

Chapin RE, Dutton SL, Ross MD, Lamb JC. Ethylene glycol monomethyl ether (EGME) as a testicular toxicant. J Androl 1984; 5:P13.

Chapin RE, Dutton SL, Ross MD, Lamb JC The testicular toxicity of ethylene glycol monomethyl ether (EGME) as characterized by mating success, sperm parameters, and histopathology. The Toxicologist 1984; 4:136 (1984 SOT Meeting).

Choudhury H, Lamb JC, IV, Gulati DK, Chambers RC, Sabharwal PS. Reproductive toxicity of theobromine in mice studied by a new continuous breeding protocol. The Toxicologist 1984; 4:191. (1984 SOT Meeting).

Kluwe WM, Maronpot RR, Lamb JC, IV, Agarwal DK. Adverse effects of butyl benzyl phthalate on bone marrow and the male reproductive system. The Toxicologist 1984; 4:136, 1984. (1984 SOT Meeting).

Lamb JC, IV, Harris MW, Weber H, McKinney JD, Birnbaum, L. Potentiation of 2,3,7,8–tetrachlorodibenzo–p–dioxin (TCDD) induced cleft palate (CP) by triiodothyronine (T3) in C57B1/6 (B6) mice. Biol Rep 1984; 30(suppl. 1):164. (1984 Society for the Study of Reproduction Meeting).

Lamb JC, Russell VS, Hommel L, Gulati DK, Sabharwal PS. Reproductive toxicity of ethylene glycol (EG) studies by a new continuous breeding protocol. The Toxicologist 1984; 4:136. (1984 SOT Meeting).

Reel JR, Lawton AD, Wolkowski-Tyl R, Lamb JC, IV. Validation of a new reproductive toxicology protocol using diethylstilbestrol (DES) as a model compound. The Toxicologist 1984; 4:136. (1984 SOT Meeting).

Agarwal D, Eustis S, Lamb J, Kluwe W. Relationship between Zinc and testicular atrophy induced by di–2(ethylhexyl)phthalate (DEHP). The Pharmacologist 1983. (1983 ASPET meeting).

Chapin R, Dutton S, Ross M, Lamb J. The pathogenesis of male reproductive tract lesions induced by 3–dimethyl methylphosphonate in F–344 rats. North Carolina Chapter, Society of Toxicology, 3rd Annual Meeting, 1983.

Dunnick JK, Harris MW, Gupta BN, Chapin RE, Lamb JC, IV. Reproductive toxicity of dimethyl methylphosphonate (DMMP) in the male Fischer 344 rat. The Toxicologist 1983; 3:19. (1983 Society of Toxicology meeting).

Greenwell A, Harrington F, Gupta B, Maronpot R, Lamb JC, Kluwe W. Interactions of 1,2–dibromo–3–chloropropane with the male reproductive system. North Carolina Chapter, Society of Toxicology, 3rd Annual Meeting, 1983. (Honorable Mention of Best Poster Competition).

Lamb JC, Ross MD, Dozier M, Allen K, Keel JR. Morphological and biochemical responses to continuous chlorlecone exposure. North Carolina Chapter, Society of Toxicology, 3rd Annual Meeting, 1983.

Kimmel CA, Lamb JC, IV, Hardin BD. Approaches to reproductive and developmental toxicology testing in the National Toxicology Program. Arch Androl 1982; 9:46.

Kimmel CA, Lamb JC, IV, Hardin BD. Approaches to reproductive and developmental toxicology testing in the National Toxicology Program. Contraceptive Delivery Systems 1982; 3:151A.

Kluwe WM, Gupta B, Lamb JC. Comparative effects of 1,2–dibromo–3–chloropropane (D) and its metabolites epichlorohydrin (E), alphachlorohydrin (A) and oxalic acid (O) in the urogenital tract. The Toxicologist 1982; 2:136. (1982 ASPET meeting).

Lamb JC, IV, Moore JA. Effects of phenoxy acid herbicides on male reproductive function. Arch Androl 1982; 9:47.

Lamb JC, IV, Moore JA. Effects of phenoxy acid herbicides on male reproductive function. Contraceptive Delivery Systems 1982; 3:297A.

Lamb JC, Harris MW, McConnell EE, Jameson CW, Allen JD, Ross MS, Moore JA. Effects of subchronic exposure to chlordecone on the fertility of female rats. North Carolina Chapter, Society of Toxicology, Second Annual Meeting, Research Triangle Park, North Carolina, January 1982.

Lamb JC, Ross MD, Allen KM, Dozier MM, Reel JR. Differential estrogenic response of the pituitary and uterus to Kepone (chlordecone) in the Fischer (F344). Rat Biol Reprod 1982; 26(suppl. 1):109A.

Lamb JC, IV, Marks TA, Moore JA. Evaluation of the toxicity of phenoxy acid mixtures in male mice. North Carolina Chapter, Society of Toxicology, 1st Annual Meeting, Research Triangle Park, NC, February 1981.

Lamb JC, IV, Korach KS. Differential uptake of labeled estradiol by various cell types of the mouse uterus. Endocrinology 1980; 106 (suppl.):128.

Lamb JC, IV, McLachlan JA. Structural abnormalities in the lumen of the female mouse genital tract following prenatal exposure to Diethylstilbestrol (DES). Anat Rec 1979; 193:597.

Lamb JC, IV, Suzuki, Y, McLachlan JA. Analogous structures in the male and female genital tract of mice treated in utero with diethylstilbestrol. Environ Health Perspect 1979; 33:318–319.

McLachlan JA, Lamb JC, IV, Stumpf WE. Altered surface epithelium in the female mouse genital tract following prenatal exposure to Diethylstilbestrol. J Tox Environ Health 1977; 3:366.

McLachlan JA, Newbold RR, Lamb JC, IV. Genital tract abnormalities in mice following gestational exposure to DES. Environ Health Perspect 1977; 20:240.

Stumpf WE, Hellreich MA, Aumuller G, Sar M, Lamb JC, IV. The Collicular Recess Organ, the Collicular Recess, and the Velum Medullar: Ependymal Specializations and Secretion. Ant Rec 1977; 189:273.

Lamb JC, IV, Nopanitaya W, Shinoda BA. Influence of vagotomy on duodenal fat absorption. Proceedings, 33rd Annual Electron Microscopy Society America, pp. 410–411, Las Vegas, NV, 1975.

Geratz JD, Lamb JC, IV. Reduced sensitivity of the rat pancreas to secretagogues following ligation of the proximal common bile duct. American Pancreatic Study Group, Chicago, IL, October 1974.

Geratz JD, Lamb JC, IV. Influence of bile duct ligation on exocrine pancreatic secretory activity in the rat. American Pancreatic Study Group, Chicago, IL, November 1973.

PRIOR EXPERIENCE

- The Weinberg Group
  Executive Vice President, 2008
  Senior Vice President, The Weinberg Group, 2003–2008

- BBL Sciences, Blasland, Bouck & Lee
  Senior Vice President, 2000–2003
  Vice President, 1999–2000

- Jellinek, Schwartz & Connolly, Inc.

Vice President, Scientific and Technical Services, 1993–1999
Vice President, Toxicology and Environmental Sciences, 1991–1993
Director, Toxicology and Environmental Sciences, 1988–1991

- U.S. Environmental Protection Agency
  Special Assistant to the Assistant Administrator for Pesticides and Toxic Substances, 1985–1988

- National Institute of Environmental Health Sciences, National Toxicology Program
  Biologist and Head, Fertility and Reproduction Group, 1980–1985

- University of North Carolina, UNC School of Health
  Adjunct Associate Professor, Biohazard Program, Department of Parasitology and Laboratory Practice, 1985–1989

- National Institute of Environmental Health Sciences
  Senior Staff Fellow, National Toxicology Program, 1979–1980
  Developmental Pathologist, 1977–1979

- University of North Carolina
  Cancer Research Center, Research Associate, 1977–1979
  Department of Anatomy and Cancer Research Center, N.R.S.A. Postdoctoral Fellow, 1976–1977
  Department of Pathology, N.I.H. Pre–doctoral Trainee, 1973–1975
  Department of Chemistry, Teaching Assistant, 1972–1975
  Department of Pathology, Research Assistant, 1972–1973

PROFESSIONAL AFFILIATIONS

- Academy of Toxicological Sciences, Fellow, 2006–present
  – Board Member, 2009–2011
  – Vice President, 2011–2012
  – President, 2012–2013
  American Bar Association, Vice Chair, Special Committee on Science & Technology, 1996

- American Board of Toxicology
  – President and Chairman of the Board, 1988–1989
  – Vice President, 1987–1988
  – Board Member, 1986–1990
  – Diplomate, 1981–present

- American Chemical Society
- American College of Toxicology
- Endocrine Society
- International Life Sciences Institute, HESI, Agricultural Chemical Safety Assessment Committee, Co–chair Life Stages Task Force, 2001–2006
- International Life Sciences Institute, HESI, Developmental and Reproductive Toxicology Task Group, Academic Advisor, 1996–present
- Johns Hopkins University School of Public Health and Hygiene, Risk Sciences and Public Policy Institute, Science Advisory Board and Adjunct Faculty, Member 1997–2001
- Society of Toxicology
  – Member, TASCA Task Force, 2010–present
  – Elected Member, Awards Committee, 2008–2010
  – Member, Congressional Task Force, 2009–present
  – Member, Professional Needs Assessment Task Force, 2008–2011
  – President of the Regulatory and Safety Evaluation Specialty Section, 2009–2010; Vice President, 2008–2009; VP–Elect, 2007–2008
  – Strategic Communication Committee, 2006–2007
  – Committee on Public Communications, Member, 1997–2001
  – Regulatory Affairs and Legislative Assistance Committee Member, 1992–1995; Chair, 1993–1995
  – Reproductive Toxicology Specialty Section Member, President, 1992–1993; Vice President, 1991–1992; Vice President Elect, 1990–1991; Awards Committee, 1985–1986; Nominations Committee, 1995
  – Risk Assessment Specialty Section Member
  – North Carolina Chapter Member, Newsletter Editor, 1982; Councilor, 1983–1985; Secretary/Treasurer, 1985–1987
  – Capital Area Chapter Member, 1986–present
  – Liaison to the American Board of Toxicology, 1988
- Toxicology Education Foundation
  – Trustee, 2002–2005
  – Secretary-Treasurer, 2003–2005
- OECD Committee on Validation of Test Methods, Observer, In Utero Testing Committee, 2003–2005

- National Academy of Sciences/ National Research Council
  – Committee on the Health Implications of Perchlorate Ingestion, National Academy of Sciences and National Research Council, Commission on Life Sciences, Board on Environmental Studies and Life Sciences, Member, 2003–2005
  – Committee on Hormone–Related Toxicants in the Environment, National Academy of Sciences and National Research Council, Commission on Life Sciences, Member 1995–1999
  – Committee on Risk Characterization, National Academy of Sciences and National Research Council, Commission on Behavioral Sciences and Education, Member, 1994–1996

JAMES C. LAMB IV, PH.D.
LISTING OF TESTIMONY AT TRIAL, DEPOSITION

Below is a list of cases in which I have testified as an expert at a trial or have been deposed.

Depositions or Testimony at Trial

1. Edward Colella (Plaintiff) v. Monsanto, Co., et al. (Defendant) Missouri Circuit Court, Twenty-First Judicial Circuit, St. Louis County Cause No. 09SL-CC01972, Division No. 15; and Nishida, Nicholas White, Individually and as Surivior of Mark White, Deceased, and Alison Tucker (Plaintiffs) v. Monsanto Co., et al. (Defendant) Missouri Circuit Court, Twenty-First Judicial Circuit, St. Louis County Cause No. 09SL-CC01964, Division No. 15; Deposed on March 23, 2011.

2. Jacqueline Smith, Virginia Pierce, and Mark Rametta (Plaintiffs) v. Monsanto Co. et al (Defendant): Superior Court Division, Los Angeles County, California; BC 459771; Deposed on behalf of the Defendants Attorney: Tom Goutman, White and Williams LLP, One Penn Plaza, 250 W. 34th Street, Suite 4110, New York, NY 10119 and Adam Miller, Husch Blackwell, LLP, 190 Carondelet Plaza, Suite 600, St. Louis, MO 63105. Deposed on February 5, 2013. Testified on May 15, 2014.

3. Michael E. Williams, et al. (Plaintiffs) v. Monsanto Company, et al. (Defendants): Superior Court Division, Los Angeles County, California; BC 461315; Deposed on behalf of the Defendants Attorney: Anthony N. Upshaw, ESQ, McDermott, Will & Emery, LLP, 333 Avenue of the Americas, Suite 4500, Miami, Florida 33131-4336. Testified on behalf of the Defendants Attorney: Lawrence P. Riff, ESQ, Steptoe & Johnson, LLP, 633 West Fifth Street, Suite 700, Los Angeles, California 90071. Deposed August 22, 2014. Testified on March 13, 2015.

4. Town of Lexington (Plaintiffs) v. Pharmacia Corporation, et al. (Defendants): District Court District of Massachusetts; 12-CV-11645; Deposed on behalf of the Defendants Attorney: Brandon Arber and Richard L. Campbell, Campbell, Campbell, Edwards & Conroy, One Constitution Center, 3rd Floor, Boston, MA 02129. Deposed on January 28, 2015.

5. Hampton-Hammonds (Plaintiffs) vs. Monsanto et al. (Defendants): Missouri Circuit Court, Twenty-first Judicial Circuit, St. Louis County; 10SL-CC03437; Testified on behalf of the Defendants Attorney: Thomas M. Goutman, ESQ, White and Williams, LLP, 1650 Market Street, One Liberty Place, Suite 1800, Philadelphia, PA 19103. Testified on March 19, 2015.

6. Guenther-Montgomery (Plaintiffs) vs. Monsanto et al. (Defendant's): Superior Court, Los Angeles County, California; BC 480068 (Private Trial); Testified on behalf of the Defendant's Attorney: Christopher M. DiMuro, Esq., White and Williams, LLP, 1650 Market Street, Suite 1800, Philadelphia, PA 19103. Testified on April 21, 2015.

JAMES C. LAMB IV, PH.D.
LISTING OF TESTIMONY AT TRIAL, DEPOSITION, OR LEGISLATIVE HEARING
(continued)

7. Hearon (Plaintiff) vs. Monsanto et al. (Defendant's): Missouri Circuit Court, Twenty-First Judicial Circuit, St. Louis County (Private Trial); Testified on behalf of the Defendant's Attorney: Thomas M. Goutman, White and Williams, LLP, 1650 Market Street, One Liberty Place, Suite 1800, Philadelphia, PA 19103. Testified on May 27, 2015.

8. Dublin (Plaintiff) vs. Monsanto et al. (Defendant's): Missouri Circuit Court, Twenty-First Judicial Circuit, St. Louis County. Testified on behalf of the Defendant's Attorney: Thomas M. Goutman, White and Williams, LLP, 1650 Market Street, One Liberty Place, Suite 1800, Philadelphia, PA 19103. Testified on June 24, 2015. Deposed on August 18, 2015 (Dublin II). Testified on Sept 24 and 25, 2015 (Dublin II).

EXHIBIT 17

VIDEO DEPOSITION
JAMES R. OLSON, PhD

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS,
Plaintiffs,
- vs - Civil Action No.
1:14-CV-12041-DJC
MONSANTO COMPANY,
SOLUTIA INC., and
PHARMACIA CORPORATION,
Defendants.

Video deposition of JAMES R. OLSON, PhD, taken pursuant to the Federal Rules of Civil Procedure, at Salvatore's Garden Place Hotel, 6615 Transit Road, Williamsville, New York, on August 24, 2016, commencing at 10:08 a.m., before LORI K. BECK, CSR, RDR, CRR, Notary Public.

Job No: 111860

Q. Okay. Well, I was asking how you -- how you assess the literature.

You're assessing the literature in this case, are you not? That's one of your jobs?

A. Yes.

Q. And -- and in assessing that literature, do you rely upon the -- the so-called Hill criteria?

A. In this case, I'm look -- I -- I was not asked to look at causation.

Q. Okay. So you are not going to give any opinion in this case that PCBs cause -- do cause cancer.

A. I --

MR. LAND: Objection, misstates testimony, mischaracterization.

THE WITNESS: Again, in the way I referred to the -- for example, cancer and the risk of cancer with PCB exposure, I really -- I relied on the recent IARC review of that question and their conclusion that PCBs can be now classified as a known human carcinogen based on animal research and human studies.

BY MR. GOUTMAN:

associations.

MR. LAND: I'll object to that as calling -- to the extent that it calls for a legal conclusion.

BY MR. GOUTMAN:

Q. Now, sir, I think you've agreed with me earlier that associations can be causal and noncausal, right?

A. Again, the term -- I -- I -- I guess what I'd like to clarify is as a toxicologist, I do not address the issues of causation in -- in what I do for a living, and that is as a professor of pharmacology and toxicology.

I -- I just -- I don't --

Q. Fair enough, and you're not --

A. -- talk about causation.

Q. And I just want to be clear that you're not going to be doing it in this case, right?

A. Correct.

Q. Okay. That's all I wanted to establish.

Now, I think we've fixed Exhibit 2, so, sir, is that your retention letter and the two bills that you've sent out so far?

MR. GOUTMAN: Did -- did you get a reformed anyone in this case? There are about a dozen depositions, more than that, that have been taken.

MR. LAND: Objection, overbroad.

THE WITNESS: I don't believe so.

BY MR. GOUTMAN:

Q. Have you reviewed the reports of any of the environmental consultants?

A. I got -- I did get some reports from experts that -- that were involved with the case.

Q. Which ones?

A. Lamb, Michel (phonetic), Starr, and Saxon.

Q. Okay. But you got -- you did not receive any of the reports that would -- that commented upon the levels of PCB in -- in the Westport Middle -- Middle School; is that correct?

A. That's correct. Nothing specific to Westport.

Q. So you wouldn't be able to comment, sir, about whether those levels, whatever they are, are -- have been shown to cause adverse health effects.

A. With regard to Westport, I do not have those -- those data, but I did review the extensive document that the EPA published on -- in 2012 on PCBs in schools. This study was -- involved six schools in the New York City area.

Q. Yes, we'll -- we'll get to that.

A. Okay.

Q. I was talking about Westport.

A. Again, specifically for Westport, I have not looked at any data.

Q. You'll be happy to see me flipping over pages of my outline.

You're familiar with the concept of dose-response as a toxicologist, right?

A. Yes.

Q. You probably learned that in Toxicology 101 as a -- as a student, right?

A. Correct.

Q. It's a fundamental principle of toxicology.

A. That's right.

Q. And what is -- how would you define dose-response? And you can quote Paracelsus if you want.

A. Well, I do quote Paracelsus in my teaching.

James R. Olson, PhD

Q. And the quote is what?

A. All substances are poisons. There is none which is not a poison. It's simply the dose that differentiates a poison from a remedy.

Q. So it's true, is it not, that all substances are toxic at some dose?

A. That's correct.

Q. There is a difference between dose and exposure, is there not?

A. That's correct.

Q. And exposure -- and you correct me if -- if you hold otherwise, but exposure is really the opportunity for a dose.

That is to say, there is a substance somewhere where there is a potential for a -- a dose. Is that a fair --

A. That's correct.

Q. -- characterization?

A. You actually use the terms I use when I teach.

Q. Well, there you go. So do I get an A?

A. Well, for that question.

Q. For that question. Before that, I probably was getting an F.

substances in the American population?

A. Well, the published literature provides information that's probably more -- more extensive and quantitative, because the published literature may have taken a larger blood sample, so they have a greater percentage of the samples having detectible levels of a given congener.

Q. With -- with respect to the NHANES data, you'd agree -- I think we've already covered this -- that they cover about a couple hundred substances, right?

A. That's correct.

Q. And many of those substances, in your view, have been associated with cancer, correct?

A. Correct.

Q. Are -- are you willing to say that many of those substances cause cancer, or as a toxicologist, you would not want to use that word?

A. As a toxicologist, I would refer to an association, been associated with an adverse effect, and with greater exposure, there's greater risk.

Q. Okay. And you'd agree with me that many of those substances have been associated with

James R. Olson, PhD

BY MR. GOUTMAN:

Q. Right. And they go on to say that you can't make any judgments as to the concentrations of PCBs.

You can't say that these results set forth in Exhibit 3 are representative of the concentrations of PCBs in other schools, right? That's what it says.

A. Yes, that's what it says.

Q. Now --

MR. GOUTMAN: Did you find that?

(Discussion off the record.)

BY MR. GOUTMAN:

Q. Do you -- were you made aware of the congener-specific analyses done in the air in the Westport building?

A. No. I don't have that information.

Q. Do you know whether congeners that you identify in your report as being associated with adverse health effects -- whether they were detected in the Westport building?

A. No, I don't.

Q. Do you know, if they were detected, whether they were detected at levels that are associated or were associated in the scientific literature with adverse health effects?

A. I don't have that information.

Q. And without that information, you can't make any scientific statements as to whether anyone at the Westport school was at an increased risk because of exposure to those congeners that you discuss in your report, correct?

A. Again, I don't have the data from Westport, so I cannot specifically talk about Westport with regard to the -- the data that you're asking about.

Q. So --

MR. GOUTMAN: I'll take that up after lunch so we can find that, okay, Chris?

MR. DiMURO: Yes.

BY MR. GOUTMAN:

Q. You in your report talk about some historical issues in terms of what was known about PCB toxicity, and I'd like to cover this quickly.

You state that there was some concern -- correct me if I'm wrong -- in the 1930s about PCBs and their relationship with a dermatological condition known as chloracne; is that correct?

James R. Olson, PhD

Q. How do you know?

A. Because it's -- they -- if they were able to do a study that lasted 130 days, they could have extended it for the lifetime of the animal.

Q. I see. Can you cite for me any written document, whether from industry or government, that stated in the '30s, '40s, '50s, or '60s that it was required that industrial chemicals like PCBs be subject to long-term, chronic animal bioassays?

A. No, I can't -- I can't, but I know the U.S. were following the thalidomide episode. The USDA became very focussed on safety testing.

And so that the standard did change in the early 1960s because of thalidomide and the need to develop safe -- safety data prior to going into the clinic with anything that's intentionally being used in humans.

Q. That's drugs?

A. That's correct.

Q. Food additives, right?

A. Correct.

Q. I -- I was talking about industrial chemicals like PCBs that were used in things like transformers.

James R. Olson, PhD

You're not aware of any standard, whether governmental or industry, that would have required long-term or chronic animal bioassays before putting it on the market, are you?

A. No requirement, no.

Q. Or any standard. Any recommendation.

A. I don't -- I don't know of a standard, no.

MR. LAND: Objection, compound.

BY MR. GOUTMAN:

Q. Any recommendation from any source? Again, for industrial chemicals, not drugs or food additives.

A. No, but again, the -- the science does -- does evolve, and what was happening in the drug industry was something that should have been adopted by Monsanto in testing PCBs because of their inherent toxicity.

Q. That -- that's your opinion.

A. That's correct.

Q. But -- but you can't cite any historical document that would set forth Dr. Olson's standard of care, correct?

A. That's correct.

Q. Well, we'll get to that. In any event, as -- with respect to the inhalation test, you are familiar -- Dr. Drinker and also Dr. Treon 20 or so years later, in order to volatilize the PCBs at high enough concentrations, had to heat them, correct?

A. Correct.

Q. And that's because PCBs generally have very low vapor pressures, right?

A. It depends on the congener, but in general, the higher -- especially the higher chlorinated ones have a low vapor pressure.

Q. So what they reported -- I'm just turning to the conclusion here. If you'd go to page 298 bottom, it says:

"In the basis of these experiments and on many field determinations of different compounds in the air of workrooms" -- by the way, I -- the other substances they tested were naphthalenes, correct? Different kinds of naphthalenes, right?

A. Yes, they were looking at a -- a series of halogenated aromatics --

Q. Right.

A. -- including naphthalenes.

these opinions as to standards, but today we are convinced they are safe."

Did I read that correctly?

A. Yes, that's what the publication states.

Q. So what -- to paraphrase, is what Dr. Drinker telling the world and telling Monsanto is that PCBs can be safely manufactured as long as appropriate industrial hygiene safeguards are maintained? Would that be a fair statement?

MR. LAND: Objection, misleading, mischaracterization.

THE WITNESS: Well, that's what he is stating in this document, and again, it -- it -- you know, there were other studies done with chlorinated biphenyls in this study, such as oral-feeding studies where --

BY MR. GOUTMAN:

Q. Right.

A. -- where rats were dying from PCB exposure.

Q. Well, from what they thought was PCBs.

A. If it was the same material, correct.

Q. Well, it's the same --

James R. Olson, PhD

Q. Motion to strike, unresponsive.

Let me just ask for a clean answer, and we can do this as long as necessary.

Are you aware of anything in the peer-reviewed literature or a government directive that recommended or suggested long-term chronic testing by Monsanto of its PCBs prior to 1970?

A. I -- I can't point to such a recommendation today at this time.

Q. Now, Dr. Drinker -- let me have Drinker -- why don't we have Flinn and Jarvik, '38. By the way, let me just ask you while we're searching for that:

Are you aware of anything -- any document or anything in the published, peer-reviewed literature that suggested that PCBs might be carcinogen -- carcinogenic prior to 1970?

A. The Bennett report in 1937 discussed the pathology that was observed in the liver.

Again, these were not chronic, long-term exposures of -- to -- inhalation exposures to PCBs, but they described a range of adverse effects on the liver, including presence of mitotic figures, which, you know, could -- you know, could be a

A. I -- I believe so.

Q. So as of 1939, Monsanto was being told by the preeminent public health expert Dr. Drinker that its most highly chlorinated Aroclor, 68 percent, is almost nontoxic, correct?

A. Correct, but it's stating beyond that that PCBs with 50 to 55 percent chlorine are a greater potential health concern.

Q. Move -- move to strike as unresponsive.

My question was: As of 1939, Dr. Drinker of Harvard University was telling Monsanto that its most highly chlorinated Aroclor, Aroclor 1268, was almost nontoxic, true or false?

A. That's what the report states.

MR. GOUTMAN: Could I have Drinker '38, please? No.

BY MR. GOUTMAN:

Q. Is there any suggestion in Drinker '39 that PCBs cause cancer?

A. Not to my knowledge.

Q. Is there any statement in Bennett '38 of finding any kind of tumor, whether benign or malignant?

A. No.

MR. LAND: Same objections, plus asked and answered.

THE WITNESS: I -- I -- I would believe they wouldn't be elevated in temperature, but again, I'm not sure how the formulations contained in the caulk are -- are -- are made.

BY MR. GOUTMAN:

Q. Do you know if furans have been found in the Westport school?

A. I don't know.

Q. Do you know if furans -- you don't know, therefore, whether furans have any relevance at all to this litigation, do you?

A. I answered the first question. I'm not sure what you're meaning by the second question.

Q. Well, let me -- I'll withdraw it, then.

So in any event, in 1956, Monsanto, in this article that was published for all the world to see, is being told that PCBs at ordinary temperatures -- for PCBs at ordinary temperatures, the hazards from their inhalation may very well be slight or entirely absent; is that correct?

A. That's what this paper by Treon states.

Q. Is there any suggestion in this paper or anything else that Dr. Treon ever published or wrote that suggested that longer term PCB studies were called for?

MR. LAND: Objection, calls for speculation, overbroad.

THE WITNESS: I don't know.

BY MR. GOUTMAN:

Q. These studies, by the way, would be called subchronic; is that correct? They're something like seven-month studies?

A. It's a 90-day study. Greater than a 90-day study could be considered subchronic.

Q. Okay. And Drinker's was also subchronic, correct?

A. Correct.

Q. So these were not short, one-day studies. These were pretty lengthy studies, correct?

A. That's true.

Q. And both Dr. Drinker and Dr. Treon were telling Monsanto that its product could be manufactured safely, right?

MR. LAND: Objection, mischaracterization.

THE WITNESS: Again, I'm not sure what

James R. Olson, PhD

we've also reviewed the fact that PCBs, like every other industrial chemical -- every other substance, will cause systemic toxicity at the right dose, correct?

A. Correct.

Q. And the mere fact that a substance will cause systemic toxicity is not a basis for removing it from the market, because then nothing would be on the market, correct?

MR. LAND: Objection, speculation.

THE WITNESS: Yes, and hypothetically, if -- if exposures are -- are low enough with any agent that can produce an adverse effect, you know, there can be reduced risk at -- the lower the exposure is to these agents.

BY MR. GOUTMAN:

Q. That wasn't my question. My question is that it's certainly not your position that any substance capable of causing systemic toxicity should be removed from the market, correct?

A. That's true.

MR. LAND: Objection, incomplete hypothetical.

BY MR. GOUTMAN:

James R. Olson, PhD

animals, i.e., cause liver injury.

That -- that's the systemic toxicity that you say Monsanto was aware of in the 1930s, right?

MR. LAND: Objection, mischaracterization of testimony, compound question.

BY MR. GOUTMAN:

Q. I mean, that's what Dr. Drinker found, right?

A. That's what he was focussing on --

Q. Right.

A. -- yes.

Q. Okay. Did he find anything else?

A. Again, he was primarily looking at the liver injury because of what was observed in workers that had died of liver injury.

Q. Okay. So -- well, let me -- let me approach it this way:

If you were to go to my house, I can assure you that Mrs. Goutman, below our sink, has all sorts of stuff that will cause systemic injury if I were to open it up and drink it, okay?

Is it the same in Dr. Olson's house?

A. I would assume so.

Q. Yes. And should those substances --

those products be taken off the market because they will cause systemic injury?

MR. LAND: Objection, speculation, incomplete hypothetical.

THE WITNESS: Well, that -- that in and of itself does not constitute banning. They have intended uses --

BY MR. GOUTMAN:

Q. Okay.

A. -- and if those uses are -- the intended uses are -- are followed, then use of the product should be acceptable.

Q. And number 3 -- I want to get through this here. "Based on these early findings, Monsanto should have conducted more comprehensive, long-term studies in laboratory animals exposed to lower levels of PCBs."

First of all, we've already covered that you have found nothing -- no document which contains a recommendation from anyone, be it government, independent researchers, that Monsanto perform more comprehensive, long-term studies at any time in the '30s, '40s, '50s, or '60s, correct?

MR. LAND: Objection, asked and answered.

THE WITNESS: Again, I answered that earlier.

BY MR. GOUTMAN:

Q. And the answer was no, correct?

A. No.

Q. And when you say "conducted more comprehensive, long-term studies," exactly what are you talking about?

A. I'm talking about doing extended studies for the lifetime of the animal, because if PCBs were intended to be used in an open application where essentially long-term, lifetime exposures could occur, it would be important to understand the health effects with prolonged commercial use of PCB-containing products.

Q. Okay. So -- but you -- you have -- I think you've testified earlier that you can cite to no government or industry standard that would have required such test to have been performed, correct?

MR. LAND: Objection, mischaracterization of testimony.

THE WITNESS: Neverthe --

BY MR. GOUTMAN:

Q. Is that correct?

James R. Olson, PhD

A. Correct.

Q. Okay.

A. But nevertheless, with the knowledge that these products would be in -- in a wide range of applications, would necessitate a company taking the position to look at the long-term effects of these agents.

Q. And that's -- that's Dr. Olson's standard. It's not a standard that you can -- can cite any historical documents to, right? To -- to substantiate, correct?

MR. LAND: Objection, vague and ambiguous.

BY MR. GOUTMAN:

Q. Am I correct? I think we've been over this.

A. We have been over it, and clearly for pharmaceutical agents, this is -- was required in the early '60s, and I -- I am familiar with that.

Q. But PCBs were never used as a pharmaceutical, correct?

A. No, they weren't.

Q. Okay. So otherwise, then, am I correct that the opinion you're stating in point number 3 that Monsanto should have conducted more

James R. Olson, PhD

Q. You didn't. Which -- which -- should -- should Monsanto be judged by the standards of today, or should they be judged by the contemporaneous standards of when they were making the products in the '30s, '40s, '50s, and '60s? Simple question.

MR. LAND: Same objection.

THE WITNESS: Again, the -- the issue is doing what was -- what was right based upon the available data, and the studies suggest that, again, if you're intending for long-term use of a product, that's -- that was -- that would be what would be expected to be tested.

The standards may not be -- I can't point to a standard that says that that should be done.

BY MR. GOUTMAN:

Q. You can't --

MS. EVANGELISTI: Can we take a break?

MR. GOUTMAN: Let me just finish this line.

MS. EVANGELISTI: Okay.

BY MR. GOUTMAN:

Q. You can't cite to any standards from the '30s, '40s, '50s, and '60s that might have been published in industrial hygiene journals, in

James R. Olson, PhD

academic press, in peer-reviewed articles that set forth that it was the standard of -- to test industrial chemicals like PCBs with long-term, chronic animal bioassays, correct?

MR. LAND: Objection, asked and answered.

THE WITNESS: I -- no, I can't state any.

MR. GOUTMAN: Okay.

(A recess was then taken at 1613.)

(On the record at 1625.)

BY MR. GOUTMAN:

Q. I just want to backtrack. I'm sorry, but I forgot to show you a paper.

Remember we were discussing this yellow atrophy of the liver?

A. Yes.

Q. And we had discussed independent university scientists investigating whether PCB -- whether that -- the case of yellow atrophy of the liver could be attributable to PCBs, correct?

A. Right.

Q. And one of the university professors who investigated that was Dr. Cecil Drinker of Harvard, correct?

A. Yes.

James R. Olson, PhD

Q. Yes.

A. -- studied during that period of time in the '30s, '40s, and '50s.

Q. Right. So your answer to my question is yes, correct? That is to say that had Monsanto conducted or -- or commissioned to conduct -- to conduct studies of ambient dosage levels, you're not saying they would have found anything.

A. Correct.

Q. Okay.

A. Current ambient levels, yes.

Q. And you say they would have found cancer; is that correct?

A. In a lifetime exposure study to PCB 12 -- or Aroclor 1254, yes.

Q. We've gone through the ways in which study parameters have evolved from the '30s to post-1970; is that correct?

We -- we discussed that? I don't want to revisit that issue.

A. We did discuss that.

Q. Am I correct that the science of toxicology, like other sciences and disciplines, has evolved and advanced in the last century?

EXHIBIT 18

October 11, 1937.

"Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects.

Repeated bodily contact with the liquid Aroclors may lead to an acne-form skin eruption.

Suitable draft ventilation to control the vapors evolved at elevated temperatures, as well as protection by suitable garments from extensive bodily contact with the liquid Aroclors, should prevent any untoward effect."

In talking with Dr. Kelly before these three paragraphs were written, we agreed that they might as well be phrased so that they could be used not only in the Aroclor booklet, but quoted in correspondence as that may be necessary.

L.A. Watt

EXHIBIT 19

Resins, synthetic aroclors

The AROCLORS

Physical Properties and Suggested Applications

APPLICATION DATA BULLETIN No. P-115

43-04-00

Manufactured by

MONSANTO CHEMICAL COMPANY
ST. LOUIS, U. S. A.

New York · Boston · Chicago · San Francisco
Los Angeles · Detroit · Birmingham
Charlotte · Montreal · London

FOREWORD

The Aroclors have won a prominent place in the field of synthetics with unique properties to fill requirements not met by materials heretofore available. They have found usefulness in widely differing fields of activity where their properties are of especial value.

Following is a description of the properties of eleven Aroclors, each of which is representative of a series. For almost every Aroclor described in this bulletin there is a dark-colored grade of otherwise approximately the same physical and chemical characteristics. These darker products carry a lower price and can frequently be used where color is not important.

A study of this brief description will suggest means of employing the Aroclors in perfecting still other products, development of which has been delayed by the lack of a material that exactly fulfills particular requirements.

The Aroclors are produced exclusively by Monsanto Chemical Company.

General Properties

The Aroclors range in form and appearance from mobile oily liquids to fine white crystals and hard transparent resins. They are non-oxidizing, permanently thermoplastic, of low volatility and non-corrosive to metals. They are not hydrolyzed by water or alkalies. The viscous liquids and the resins will not support combustion when heated alone.

The crystalline Aroclors are relatively insoluble, but the liquid and resinous products are soluble in most of the common organic solvents, thinners and oils. The main exceptions are that all the Aroclors are insoluble in water, glycerine or the glycols, and Aroclor 5460 is insoluble in the lower molecular weight alcohols. Aroclor 4465 is only partly soluble in the lower alcohols.

The excellent electrical properties, fire resistance and inertness of the Aroclors make them useful in many applications not mentioned in this bulletin.

The properties imparted by the Aroclors and their usefulness for particular applications vary in regular gradients over the series so that the selection of the right Aroclor for a specific use can generally be made simply by a comparison of the physical properties of the several Aroclors.

TABLE

GENERAL PHYSICAL PROPERTIES

Form	Aroclor 1242 Practically colorless mobile oil	Aroclor 1248 Yellow tinted oily liquid	Aroclor 1254 Yellow tinted viscous oil	Aroclor 1260 Light yellow soft sticky resin
Color—NPA	0.5 Max.	0.5 Max.	1.0 Max.	1.0 Max.
Acidity—Maximum (Mgm. KOH per Gm.)	0.01	0.01	0.01	0.015
Coefficient of Expansion cc/cc/°C	0.000678 (25°–65°C)	0.000702 (25°–65°C)	0.000661 (25°–65°C)	—
cc/cc/°F	0.000377 (77°–149°F)	0.000389 (77°–149°F)	0.000367 (77°–149°F)	—
Density—Specific Gravity 25°/25°C (77°/77°F)	1.378 to 1.388	1.447 to 1.457	1.538 to 1.548	1.618 to 1.629
Pounds per Gallon—25°C (77°F)	11.50	12.08	12.83	13.50
Distillation Range—ASTM D-20 Mod. °C	322°–365°C Uncorr.	330°–370°C Uncorr.	365°–390°C	385°–420°C
°F	612°–689°F Uncorr.	626°–698°F Uncorr.	689°–734°F	725°–788°F
Evaporation Loss—%—ASTM D-6 Mod. 163°C 5 hrs.	3.04 to 3.64	3.0 to 4.0	1.06 to 1.28	—
100°C 6 hrs.	—	—	0.4	0.0 to 0.2
Flash Point—Cleveland Open Cup °C	176°–180°C	193°–196°C	None	None
°F	348°–356°F	379°–384°F		
Fire Point—Cleveland Open Cup °C	334°C	None	None	None
°F	633°F			
Pour Point—ASTM °C	−17.7° to −20.7°C	−7°C	8° to 12°C	26° to 36°C
°F	−0.2° to −5.2°F	19.4°F	46° to 54°F	79° to 97°F
Softening Point—ASTM °C	—	—	—	—
°F	—	—	—	—
Refractive Index—D-line—20°C	1.627–1.629	1.630–1.631	1.637–1.639 at 25°C	—
Viscosity—Saybolt Universal Sec. (ASTM—D-88) 210°F (98.9°C)	34.0–34.6	36.0–37.0	43.5–48.5	70–82
130°F (54.4°C)	49–56	69–78	260–400	2600–4500
100°F (37.8°C)	80–93	185–240	1800–3800	—

MONS 080136

OF SOME OF THE AROCLORS

Aroclor 1262 Light yellow sticky clear resin	Aroclor 1268 Pale yellow opaque brittle resin	Aroclor 1270 White crystal-line powder	Aroclor 4465 Yellow trans-parent brittle resin	Aroclor 5442 Yellow trans-parent sticky resin	Aroclor 5460 Yellow trans-parent resin	Aroclor 2565 Brown-black opaque resin
1.2 Max.	—	—	1.5 Max.	—	2.0 Max.	—
0.02	—	0.175	0.05	0.028	0.07	1.26
0.000640 (25°–90°C) 0.000355 (77°–194°F)	— —	— —	0.000611 (25°–65°C) 0.000339 (77°–149°F)	0.00123 (25°–99°C) 0.000683 (77°–210°F)	0.00179 (25°–124°C) 0.000994 (77°–255°F)	0.000656 (25°–65°C) 0.000364 (77°–149°F)
1.646 to 1.653	1.804 to 1.811	1.944 to 1.960	1.712 to 1.723	1.432 to 1.447	1.740 to 1.745	1.721 to 1.740
13.72	15.13	16.24	14.28	11.96	14.50	14.41
373°–404°C Uncorr. 703°–759°F Uncorr.	— —	450°–460°C 842°–860°F	Requires vacuum Requires vacuum	— —	Requires vacuum Requires vacuum	— —
0.48 to 0.56 —	0.15 to 0.24 —	0.0 to 0.1 —	0.23 to 0.29 —	2.0 0.012	0.025 1.51 to 1.71 (at 260°—5 hrs.)	0.21 to 0.24 —
None	None	None	None	247°C 477°F	None	None
None	None	None	None	>350°C >662°F	None	None
34.9° to 38.0°C 95° to 100.4°F	— —	— —	— —	46°C 115°F	— —	— —
— —	135° to 160°C (hold pt.) 275° to 320°F (hold pt.)	294° to 300°C (hold pt.) 561° to 572°F (hold pt.)	60° to 66°C 140° to 151°F	48.5° to 53°C 119° to 127° F.	100° to 105.5°C 212° to 222°F	66° to 72°C 149° to 162°F
1.6501–1.6517	—	—	1.664–1.667	—	1.660–1.665	—
90–103	—	—	92–156 (266°F or 130°C)	313.5	—	—
600–850 at 160°F —	— —	— —	— —	— —	— —	— —

MONS 080137

Adhesiveness

The Aroclor resins adhere strongly to smooth surfaces — to glass and metal or to smooth varnished or lacquered surfaces.

The softer Aroclors are suggested for difficult adhesive problems where a flexible non-drying waterproof material is necessary.

The Aroclor adhesives are thermoplastic; are readily applied hot without solvent; do not require high temperatures for easy application, and are set immediately upon cooling.

Corrosion

The Aroclors show practically no corrosive effect on metals within normal ranges of temperature and only very slight corrosion even at elevated temperatures, as shown in the following table:

	Penetration — inches/year at 325°C (617°F)	
	Aroclor 1248	Aroclor 1254
Mild steel	0.0028	0.0045
Yellow brass	0.00047	0.0030
Copper	0.00145	0.0650

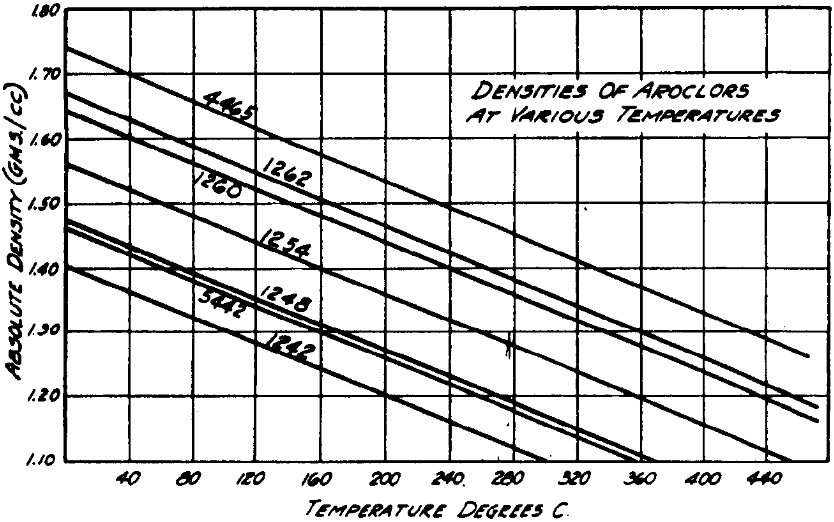
Density

All the Aroclors are heavier than water, a valuable property for many applications. Densities are shown in Figure 1.

Electrical Properties

The Aroclors have extremely interesting electrical characteristics: high dielectric constant, resistivity, dielectric strength, and low power factor.

FIG. 1



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Specific Heat and Thermal Conductivity

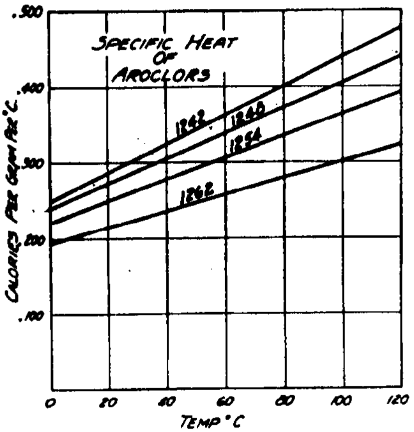
The specific heat at different temperatures of several of the Aroclors is shown in Figure 2. This, together with the thermal conductivity data given in Table II, is of value in calculations involved in the use of Aroclor as a high temperature-low pressure fluid heat transfer medium.

TABLE II

Thermal Conductivity of Aroclor 1248

Temperature °C	Temperature °F	Density g/cc.	Thermal Conductivity Btu./Hr./Sq. Ft./°F/Ft.	Viscosity Saybolt Univ. Sec.
30	90	1.441	0.0613	360
60	140	1.411	0.0698	60
100	212	1.370	0.0800	36

FIG. 2



Non-Drying Properties

The Aroclors are non-drying, and when they are exposed to the air, even in thin films, no noticeable oxidation or hardening takes place. However, when used as ingredients of lacquers, they do not retard the rate of drying of the lacquer films. Quick drying varnishes and paints may be made with Aroclor resins.

Nonflammability

The viscous Aroclor oils and the resins do not support combustion when heated alone, even at their boiling points — temperatures above 350°C. Most of the Aroclors flux readily with resinous and pitch-like materials to give a product having a decreased fire hazard. When incorporated in nitrocellulose films the Aroclors retard the rate of burning.

Stability

Toward Alkalies

The Aroclors are remarkably resistant to the action of either hydrolyzing agents or high temperature. They are not affected by boiling with sodium hydroxide solution.

Toward Acids

Experiments were made to determine whether hydrogen chloride is evolved during the treatment of Aroclors with sulfuric acid. Aroclor 1254 (selected as typical) was stirred with an equal volume of ten per cent sulfuric acid for a period of 150 hours. Any gases escaping from the reaction flask had to pass through a trap filled with silver nitrate solution, which solution would give a precipitate of silver chloride if any HCl came in contact with it. After 150 hours of treatment, neither the trap solution nor the acid layer in the treating flask showed any hydrogen chloride present. Even prolonged treatment (255 hours) with concentrated sulfuric acid indicated only a slight trace (too small for quantitative measurement) of hydrogen chloride in the acid layer.

Toward Heat

Because of their stability to heat, the Aroclors are useful heat-transfer media. Aroclor 1254 and particularly the less viscous Aroclor 1248 are recommended for this purpose because they may be heated at temperatures up to 325°C (617°F) in a closed system for long periods without appreciable decomposition and are at the same time noninflammable.

Toward Oxidation

When Aroclor is subjected to a bomb test at 140°C with 250 pounds per square inch oxygen, there is no evidence of oxidation as judged by development of acidity or formation of sludge.

Solubility

The Aroclor oils and resins are easily soluble in most of the common organic solvents and drying oils. The hard crystalline materials are in general less soluble than the Aroclor oils or softer resins. All Aroclors are insoluble in water. Solubilities of some of the Aroclors in the more common substances are shown in Table III.

The solubility of sulfur in Aroclor 1260 is shown in Figure No. 3. Compatibility data on Aroclors in nitrocellulose lacquers are shown on page 16.

Thermoplasticity

The Aroclors are permanently thermoplastic. They apparently undergo no condensation or hardening upon repeated melting and cooling. The clear Aroclor resins are now being produced with softening points up to 105°C. The opaque crystalline solids are produced with initial melting points up to approximately 290°C.

FIG. 3

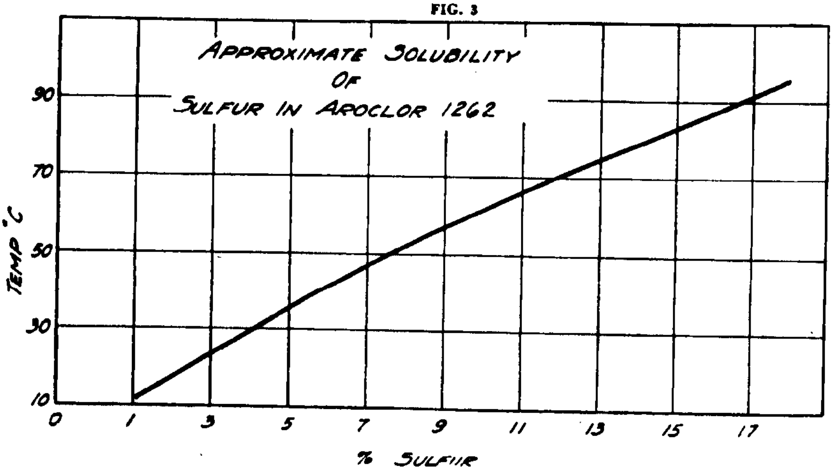


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TABLE III — Solubility of Aroclors in 100 Milliliters of Various Solvents

Type of Solvent / Aroclor	1242 Cold	1242 Hot	1248 Cold	1248 Hot	1254 Cold	1254 Hot	1270 Cold	1270 Hot	4465 Cold	4465 Hot
Acid										
Acetic Acid	S	S	—	—	S	S	—	—	SS	S
Oleic Acid	S	S	—	—	S	S	—	—	S	VS
Benzoic Acid	10.0 31°C	—	10.0 31°C	—	—	—	—	—	—	—
Aldehyde										
40% Formaldehyde	I	I	I	I	I	I	I	I	I	I
Furfural	VS	VS	VS	VS	VS	VS	SS	SS	VS	VS
Amine										
Aniline	S	S	—	—	S	S	—	—	VS	VS
Pyridine	132.5 30°C	440 99°C	—	—	114 31°C	425 100°C	—	—	VS	VS
Chlor — derivative										
Amyl chlorides — mixed	S	S	S	S	S	S	—	—	VS	VS
Carbon Tetrachloride	S	S	S	S	S	S	3.65	—	VS	VS
Chloroform	S	S	S	S	S	S	—	—	VS	VS
Dichlorethylene	—	—	—	—	—	—	3.06	—	VS	VS
Ethylene Dichloride	S	S	S	S	S	S	—	—	VS	VS
Monochlorobenzene	S	S	S	S	S	S	2.89	—	VS	VS
Orthodichlorobenzene	—	—	—	—	—	—	—	—	VS	VS
Tetrachlorethane	S	S	S	S	S	S	—	—	VS	VS
Trichlorethane	S	S	S	S	S	S	3.31	—	VS	VS
Trichlorethylene	S	S	S	S	S	S	—	—	VS	VS
Drying Oil										
Tung Oil	S	S	S	S	S	S	—	—	VS	VS
Linseed Oil	S	S	S	S	S	S	—	—	VS	VS
Ester										
Amyl Acetate	S	S	S	S	S	S	—	—	VS	VS
Butyl Acetate	S	S	S	S	S	S	—	—	VS	VS
Cellosolve Acetate	S	S	S	S	S	S	—	—	VS	VS
Cottonseed Oil	S	S	S	S	S	S	—	—	S	VS
Dibutyl Phthalate	S	S	S	S	S	S	—	—	S	VS
Diethyl Phthalate	S	S	S	S	S	S	—	—	S	VS
Ethyl Acetate	S	S	S	S	S	S	—	—	S	VS
Ethyl Lactate	S	S	S	S	S	S	—	—	VS	VS
Ethylene Glycol Diacetate	S	S	S	S	S	S	—	—	VS	VS
Methyl Acetate	S	S	S	S	S	S	—	—	S	S
Tricresyl Phosphate	S	S	S	S	S	S	—	—	SS	S
Ether: Ethyl Ether	S	S	S	S	S	S	S	S	S	—
Ether Alcohol										
Carbitol	224 31°C	307 99°C	VS	VS	173 30°C	259 99°C	—	—	SS	—
Cellosolve	S	S	S	S	S	S	—	—	S	—
Diethylene Glycol	—	—	—	—	—	—	—	—	S	—
p-p' Dihydroxy Ethyl Ether	16.9 32°C	19 99°C	SS	SS	8 30°C	10 100°C	—	—	SS	—
Hydrocarbon										
Benzene	VS	VS	VS	VS	VS	VS	3.5	—	VS	VS
Gasoline	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Kerosene	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Mineral Spirits	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Paraffin	2.0 27.5°C	S	2.0 28°C	S	—	S	—	—	< 5.0	S
Pine Oil	S	S	VS	VS	S	S	—	—	S	S
Toluene	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Turpentine	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Xylene	VS	VS	VS	VS	VS	VS	—	—	VS	VS
Hydroxy — derivative										
Amyl Alcohol	S	S	—	—	S	S	—	—	S	S
n-Butyl Alcohol	S	S	—	—	S	S	—	—	SS	S
Ethyl Alcohol (3-A)	23.3 27°C	80.0 78°C	—	—	10 27°C	28 78°C	—	—	SS	—
Glycerin	I	I	I	I	I	I	I	I	I	I
Methyl Alcohol	42.5 29°C	88.5 64°C	—	—	15 26°C	22.2 64°C	—	—	SS	—
Phenol — 90%	194 30°C	S	—	—	SS	S	—	—	S	S
Ketone										
Acetone	S	S	—	—	S	S	—	—	S	S
Miscellaneous										
Carbon Disulfide	S	S	—	—	S	S	—	—	VS	VS
Nitrobenzene	S	S	—	—	S	S	—	—	VS	—
Water	I	I	I	I	I	I	I	I	I	I

I — Insoluble S — Soluble SS — Slightly Soluble VS — Very Soluble

Figures show grams of Aroclor per 100 milliliters of solvent at 25°C unless otherwise indicated.

FIG. 4

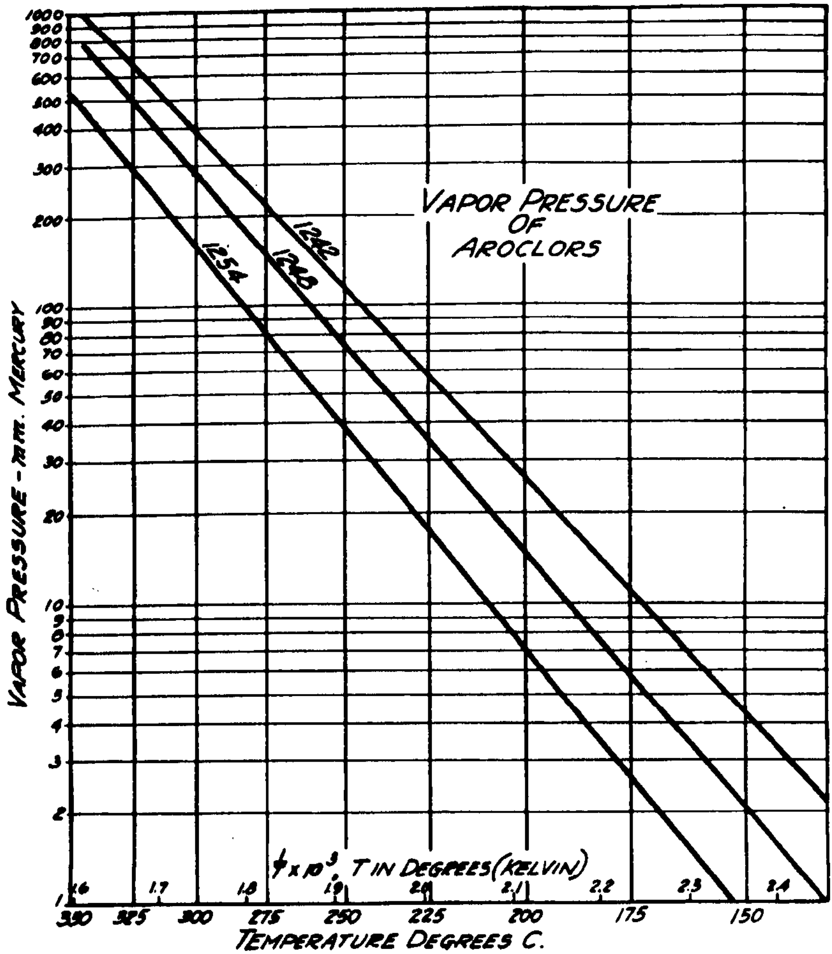

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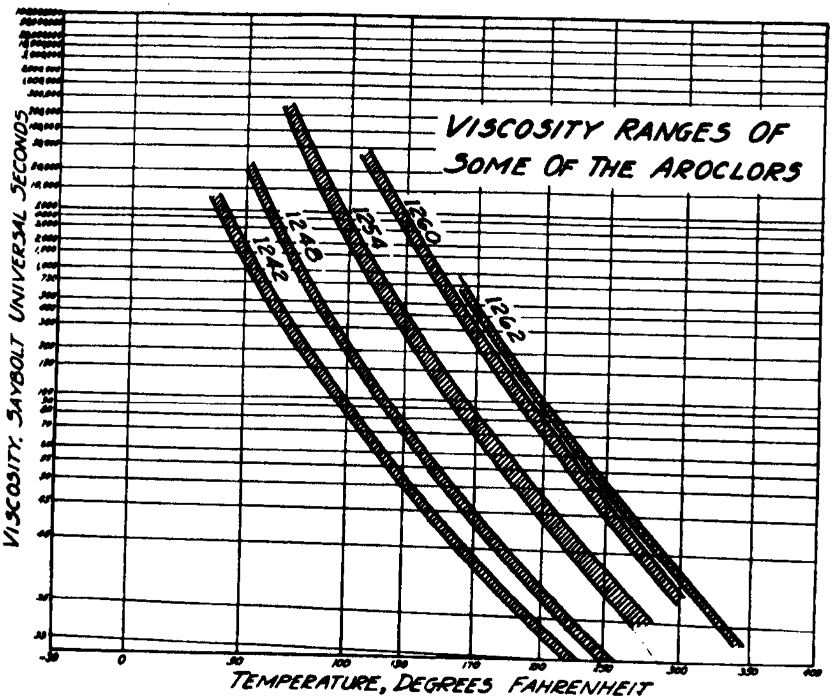
FIG. 5



Toxicity

Experimental work on animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects.

Repeated bodily contact with liquid Aroclors may lead to an acne-form skin eruption.

Suitable draft ventilation to control the vapors evolved at elevated temperatures, as well as protection by suitable garments from extensive bodily contact with liquid Aroclors, should prevent any untoward effect.

Vaporization Loss

The Aroclors have low vaporization losses as shown in the data in the table of physical properties.

APPLICATIONS

Adhesives

The heavier resinous Aroclors, because of their excellent adherence to smooth surfaces, are very adaptable to compounding in water-insoluble adhesives. Aroclors 1260, 1262, 4465 and 5460 are suggested for this use.

Electrical Equipment

Because of their nonflammability, high resistivity and dielectric strength and low power factor, the liquid and resinous Aroclors are extremely useful materials for the electrical industry.

Expansion Medium

Because of their stability under variations in temperature and freedom from gum formation from oxidation, the Aroclors are useful as expanding media in bellows controls and in thermostats.

Hydraulic Medium

Power Transmission

The Aroclors are superior hydraulic media for power transmission. Because of their greater density and E. P. characteristics they approach more closely the theoretical transmission values for mechanical power as illustrated in Figure No. 6. This greater efficiency makes possible a reduction in the size of the hydraulic coupling design.

In order to meet extremely low-temperature weather conditions, it is necessary to adjust the freezing point of the Aroclor selected by the addition of a pour point depressant. Suitable adjustments can be made in the composition to reach a pour point of minus 65°F.

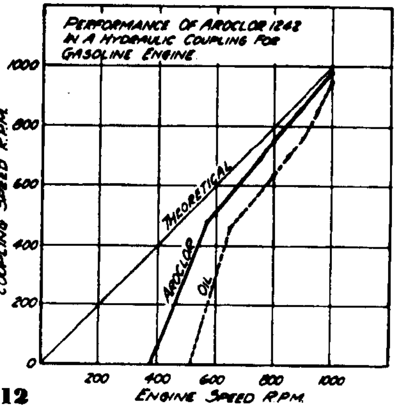
The steepness of the viscosity-temperature curve of the Aroclors is a handicap to the application of Aroclors to many types of fluid transmission. This curve can be flattened to a marked degree by introduction of a viscosity-index corrector. Information will be gladly furnished.

Hydraulic Pressure Medium

It is customary to employ a D. T. Light Oil (mineral base) as a hydraulic medium in many types of pressure operations. A widespread use is in the operation of zinc alloy die casting machines where pressures of 800 to 1500 pounds per square inch are encountered. Condensate from the atmosphere above the liquid level in the breather tank frequently introduces water, which, having a greater density, sinks to the bottom and is drawn into the system. Under the influence of heat and pressure the water causes oxidation of the hydrocarbon oil, forming fatty acids which corrode the pump vanes and the regulating valves of the system, causing loss of pressure, lowered production rate and final shut down for repairs. A break in the hydraulic system around the open flames necessary to maintain the molten condition of the die-casting alloy almost invariably results in a fire with its attendant hazards.

Aroclors 1242 or 1248 are recommended to overcome these difficulties. They are heavier than water, thus excluding it from the system. They are stable — not hydrolyzed under heat and pressure — and thus avoid corrosion and expensive delays for repairs. They are nonflammable, thus adding to the safety of the operators and to continuity of production.

FIG. 6



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Lubrication

High Temperature

The heat-resisting, noninflammable characteristics of the Aroclors make them attractive as lubricants under conditions of high temperature, as, for example, in governor systems of central power stations. Aroclor 1248 is well suited to this application. Straight Aroclor 1254 gave excellent results on a roller bearing test operating at 255°-260°F with much less carbonization or decomposition than the usual spindle oil under the same conditions.

Extreme Pressure

It is a well accepted hypothesis in the lubrication industry that by the addition of certain elements such as chlorine, sulfur and others in the proper form to a lubricating oil, a certain chemical combination takes place with the iron or steel metal bearing surfaces. These surface compositions tend to prevent seizure of the rubbing surfaces under extreme loads and under which loads, if the sole lubricant were a pure mineral oil, seizure or scoring would result at once through film failure.

As an extreme pressure (E. P.) lubricant base added to a petroleum hydrocarbon oil in amounts up to approximately 15% by weight, Aroclors 1248 and 1254 materially increase the load-carrying properties without reducing the viscosity of the resulting composition. These Aroclors represent one of the more adequate carriers for the element chlorine as an extreme pressure base, possessing the following advantages:

1. *Stability.* They are stable, even at higher temperatures, which permits neither separation of components nor appreciable change in physical or chemical properties during long periods of operation and should not cause continued chemical action on metal parts except the particular chemical metal surface combination which is necessary to effect high load-carrying capacities.

2. *Non-volatile.* Many other types of chlorine bearing compounds are so volatile as to render them unfit for long periods of service because of the escape of the elements from the lubricant. The Aroclors are non-volatile at normal temperatures.

3. *Non-oxidizing.* Aroclors do not oxidize or thicken up to an objectionable degree.

4. *Non-corrosive.* Aroclors are non-corrosive toward metal surfaces.

5. *Non-abrasive.* Aroclors exert no abrasion on the machined surfaces.

6. *Non-hydrolysis.* Aroclors do not hydrolyze in the presence of water, thus avoiding the generation of hydrochloric acid.

7. *Compatibility.* Aroclors are completely miscible with mineral oils.

8. *Color.* Aroclors do not darken or change the color of the lubricating oil.

Submerged Lubrication

Under conditions of lubrication subjected to exposure to water displacement such, for example, as lubrication of bridge rollers, a heavier-than-water lubricant can be prepared from mixtures of Aroclor and oil, of which the following are typical examples:

Mix No.	—% by Wt.— Oil*	Aroclor 1148	Pour Point	Gravity at 15.5°C	Approx. lbs./gal.
1	50	50	0°F	1.1263	9.4
2	25	75	+5°F	1.2703	10.6

*Bright Stock: Gravity API 22-23

Viscosity 210° F—160 Secs. Saybolt
Color ASTM—7-8
Flash Point—545°F
Pour Point—15°F

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SUGGESTED USES FOR AROCLORS
in
PLASTICS, PIGMENTS, LACQUERS, PAINTS and VARNISHES

The Aroclors are compatible with most of the common plastic materials (see compatibility table on this page). The degree of flexibility imparted by the Aroclors diminishes progressively in the order of liquid Aroclor — soft resin — hard resin. The hardness of the resulting compositions increases in the same order. Usually a satisfactory balance between flexibility and hardness can be obtained either by selecting the Aroclor of proper physical characteristics or by using a mixture of two or more Aroclors.

Compatibility With Various Materials

Asphalt	C
Benzyl Cellulose	C
Cellulose Acetate	I
Chlorinated Rubber	C
Coumarone and Indene Resins	C
Dammar Resin	C
Ester Gum	C
Ethyl Cellulose	C
Manila Gum	I
Nitrocellulose	C
Paraffin	C
Phenolic Resins	Varies.*
Polystyrene Resins	C
Rosin	C
Rubber	C
Sulfur	C
Vinyl Resins	C

C — indicates compatibility to a degree sufficient to be of value.

I — indicates incompatibility.

* Not compatible in final stage.

Ethyl Cellulose

The Aroclors are very compatible with ethyl cellulose, the liquids imparting great flexibility and the resinous products great hardness. 75 parts by weight of Aroclor 1242 with 100 parts of ethyl cellulose produces great fleixibility and just a slight tackiness. Aroclor 5460 in the same proportion produces a very hard and somewhat brittle composition. Aroclor 4465 produces hard films which are not brittle at ordinary temperature.

For coatings of high gloss and exceptional weathering qualities to be applied to rigid surfaces, compositions containing equal parts by weight of Aroclor 5460 and ethyl cellulose are suggested. If greater flexibility is required, one of the softer Aroclors should be used, either alone or as a replacement for part of the Aroclor 5460 and the proportion of Aroclor should be decreased.

A typical formula is as follows:

Ethyl Cellulose	15%
Aroclor 1260	15%
Toluene	56%
Butanol	14%
	100%

Graphic Arts

The Aroclors are used as vehicles for carrying pigments employed in glass decoration. When the decorations have been applied and the glass is fired, the Aroclors volatilize without carbonization and thus avoid discoloration of the glass. Aroclors 1254 and 4465 are used.

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Aroclor 4465 is a useful resin for compounding rotogravure inks.

A mimeograph ink suitable for use on bond paper may be prepared as follows:

Aroclor 4465	40%
Lubricating Oil (SUV 1200 @ 100°F)	35%
Paraffin Oil (SUV 76 @ 100°F)	20%
Carbon Black	4%
Oil Soluble Dye	1%

Aroclor 4465 may also be used in the preparation of imitation gold leaf. A thin coating of the Aroclor is applied hot to one side of paper. While it is still hot, bronze powder is spread upon the coating. The bronze powder adheres to the Aroclor completely covering the paper. This product is used in making the "gold leaf" letters on books, etc. The paper treated with Aroclor and bronze powder is placed upon the book binding. A hot die is pressed upon it. The Aroclor softens and sticks the bronze to the binding and forms a coating over it to protect it from tarnishing.

Impregnation

The Aroclors may be used to impregnate cloth, paper, wood or asbestos in order to impart moisture and gas resistance, adhesion, insulating properties, alkali or other chemical resistance, flame resistance, or lubricating qualities. For this type of work they are used in combinations with other materials such as waxes, inorganic pigments, asphalt, tars, aluminum stearate, sulphur, etc., in order to obtain exactly the physical characteristics desired for the specific purpose. Aroclors 1254, 4465 and 5460, or the corresponding dark-colored products, are suggested as most applicable.

Moisture Proofing

For use as moisture proof coatings the Aroclors are best combined with waxes, such as paraffin or carnauba, oils such as mineral oil, and resins such as ester gum or other synthetic resins. The simplest compositions contain only Aroclor and paraffin. A moisture proofing compound composed of 96% (by weight) of Aroclor 5460 and 4% of paraffin (melting point 54°C) has an ASTM softening point of about 82° C and is very efficient. Substituting Aroclor 4465 for Aroclor 5460 produces a compound with a softening point of about 58°C.

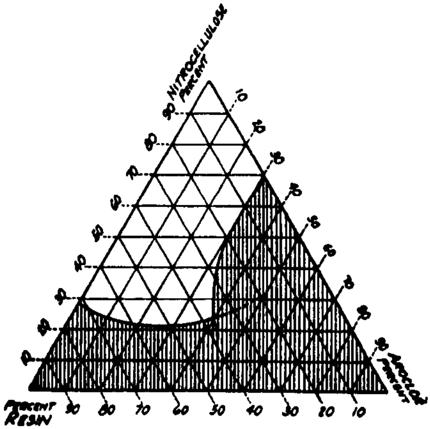
Softening point and viscosity when melted may be further decreased by using mixtures of Aroclors. For example, a composition containing 40% of Aroclor 1260, 56% of Aroclor 5460 and 4% of paraffin will be very soft at ordinary temperatures. Increased proportions of paraffin will also produce softer compounds.

Mold Lubricants

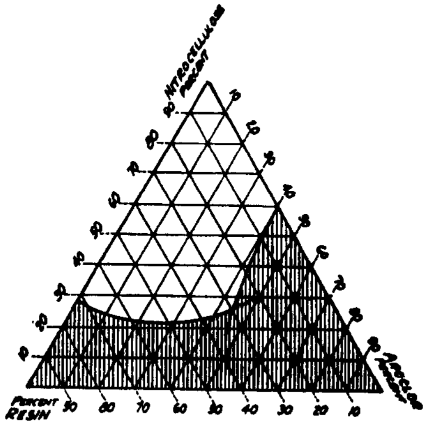
Because of their inertness and low volatility, the Aroclors are excellent mold lubricants. As an example — the addition of 1% of Aroclor 1242 or 5460 to a vinyl formal resin produces great improvement in ease of molding operation as well as in the appearance of the molded pieces. The molded pieces slip easily from the mold and possess extremely high water resistance and good dielectric strength. An excess does not retard hardening action.

The Aroclors are equally applicable to other molding compositions, the particular one to be selected and the method of use being governed, of course, by the molding material and the conditions of operation.

DIAGRAMS SHOWING PRACTICAL COMPOSITION

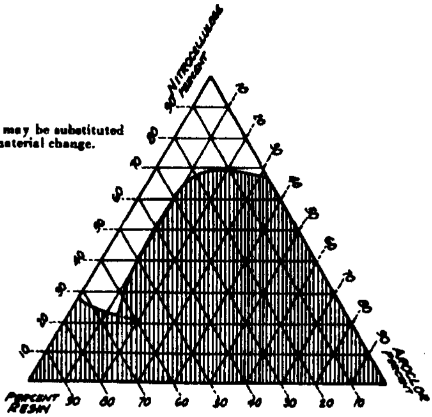


For combinations where the resin is of the phthalic anhydride-glycerol type and where the Aroclor is Aroclor 1262.*



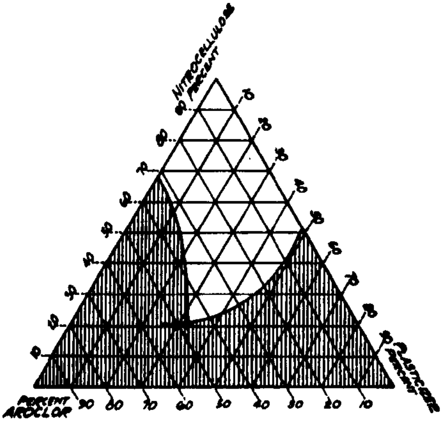
For combinations where the resin is of the phthalic anhydride-glycerol type and where the Aroclor is Aroclor 1254.

*Aroclor 1260 may be substituted without material change.

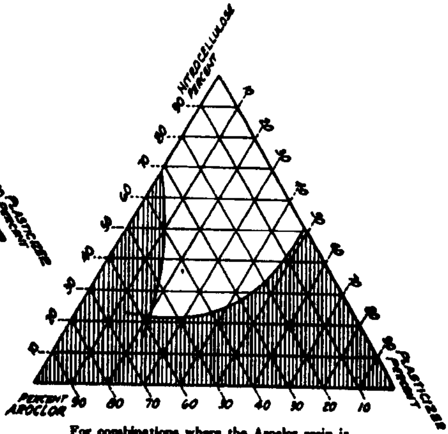


For combinations where the resin is Ester Gum or Amberol and where the Aroclor is Aroclor 1254 or Aroclor 1262.

OF LACQUERS USING AROCLORS 1254 AND 1262



For combinations where the Aroclor resin is Aroclor 1262* and where the plasticizer is Dibutyl Phthalate.



For combinations where the Aroclor resin is Aroclor 1262* and where the plasticizer is Tricresyl Phosphate.

In the trilinear diagrams the compositions, represented by any point in the unshaded areas, are those which produce homogeneous lacquer films. On the other hand compositions represented by points in the shaded areas produce impractical, segregated, brittle or soft films. For detailed information as to the derivation and use of these diagrams reference is made to the following articles:

Jenkins & Foster, "Compatibility Relationships of the Aroclors in Nitrocellulose Lacquers," Ind. Eng. Chem. 23, 1362 (1931).

Hofmann & Reid, "Graphical Methods in Lacquer Technology," Ind. Eng. Chem. 20, 431 (1928); "Formulation of Nitrocellulose Lacquers," Ind. Eng. Chem. 20, 687 (1928).

Nitrocellulose Coatings

The Aroclors function both as plasticizers and resins and may be used alone with the nitrocellulose or in Combinations with other plasticizers or resins. They impart weather resistance, luster, adhesion and decreased burning rate. Their excellent electrical characteristics (high dielectric constant and resistivity and low power factor) and their property of retarding the passage of moisture and gases through nitrocellulose films make the Aroclors of special value in coatings for electrical insulating materials.

The accompanying trilinear diagrams show the practical compatibility limits of Aroclors 1254 and 1262 when used in conjunction with some other resins and plasticizers. Aroclor 1260 gives values almost the same as those shown for 1262. The less viscous Aroclors have greater and the more resinous Aroclors less compatibility than for those shown. (See trilinear diagrams on pages 16 and 17.)

To illustrate the differences possible to obtain by changes in formulation, three formulas are given below. All have excellent durability but the third is much softer and more flexible than the other two. Only the solids contents are given.

The amounts tabulated are parts by weight.

Aroclor Lacquers

	No. 1	No. 2	No. 3
½ second Nitrocellulose (dry)	100	100	100
Dammar resin	80	—	—
Ester Gum	—	80	—
Aroclor 1260	20-39	20	80-70
Dibutyl Phthalate	20- 0	20	—
Tricresyl Phosphate	—	—	39-70

No. 1 and No. 2 have excellent sanding and polishing qualities. No. 3 is very flexible but too soft for sanding.

Where extremely high flexibility is desired, as for example in lacquers for high tension automotive cables, the following composition is suggested: 15 — 20 sec. R. S.

Nitrocellulose	8 parts by weight
Tricresyl Phosphate	10 parts by weight
Aroclor 1242	7 parts by weight

Pigment

Aroclor 1270 is a hard, white crystalline product of high melting point, insoluble in most solvents, resistant to chemicals and to oxidation. When ground to a fine powder it makes an excellent organic pigment for use with the various plastics. It may be used alone or with conventional pigments.

Paints and Varnishes

The Aroclors are soluble in paint and varnish oils and impart properties corresponding to the physical character of the particular Aroclor. The hard resinous Aroclors tend to give increased hardness to the films while the viscous resins impart flexibility.

The Aroclors do not react chemically with oils, hence there is no advantage in heating together in making a varnish. They are best added as a "chill back" or as a cold cut in the thinning operation. As far as incorporation of the Aroclors is concerned, the only reason for heating is to make the Aroclors liquid so that they can be readily mixed with the oils.

Aroclors 4465 and 5460 will produce paints that are very quick drying and yet have excellent durability. The weight of Aroclor used should be from 30% to 50% of the weight of the oils.

Aroclor 1260 is best for short oil varnishes that are required at the same time to be flexible. The Aroclor may be considered to play the same role as oil, with the difference that it does not oxidize and lose its flexibility on exposure. Resins of the alkyd, phenolic or ester gum type, or a harder Aroclor such as 5460, may be used in making varnish formulations. It is suggested that for two parts by weight of oil, one part of Aroclor 1260 and one part of other resin be used. These proportions can be varied as required. The Aroclors impart water and alkali resistance and in these qualities enhance the value of the other resins used in the varnish.

Rubber and Rubber Substitutes

The Aroclors when in a liquid condition have a solvent action on rubber. Aroclors 1254 and 1260 are milled into rubber in order to impart permanent tackiness and adhesion. A small amount of Aroclor 1260 added to hard rubber acts as a plasticizer and reduces the brittleness.

Aroclor 1270, being a hard crystalline material of high melting point, can be ground to a powder and then milled into rubber. The milling temperature being below the melting point of the Aroclor, the latter is dispersed through the mass of rubber and acts as an efficient flame reducer. This same procedure can be used with synthetic rubbers to impart fireproofness. From 5% to 25% of Aroclor 1270 based on the weight of the plastic is required.

Aroclor 1262 is recommended as a plasticizer for crepe rubber resin in paint compositions. Used in concentrations of 5% to 50%, based on the weight of the rubber resin, it increases the gloss and alkali resistance of the film without detracting from its adhesiveness toward steel.

Chlorinated Rubber Finishes

Aroclors 1242, 1254 and 1260 are recommended as plasticizers for chlorinated rubber. They give tough flexible compositions and may be used alone or together with the resins and oils commonly employed in chlorinated rubber formulations. From 40 to 60 parts to each 100 parts by weight of chlorinated rubber is suggested. The Aroclors are especially valuable as finishes for alkaline surfaces such as concrete, brick, stucco, etc., and for acid and alkali resistant coatings.

Vinyl Resins

The Aroclors are compatible with all the vinyl resins. The properties imparted depend upon the particular Aroclor and the vinyl resin used. The selection of the correct Aroclor for a particular use can usually be made by consideration of the physical properties of the Aroclor series.

OTHER PRODUCTS OF OUR PHOSPHATE DIVISION

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Aluminum Oxide Abrasive
Ammonium Phosphates (Mono-, Di-)
Calcium Phosphates (Mono-, Di-, Tri-)
Calcium Pyrophosphate
Diphenyl
Di Sodium Phosphate
Ferro Phosphorus
Mono Sodium Phosphate
Phosphoric Acid
Phosphoric Acid Paste
Phosphorus
Phosphorus Pentoxide
Sodium Ferric Pyrophosphate
Synthetic Detergents
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Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.

EXHIBIT 20

MONSANTO
CHEMICALS — PLASTICS

AN INDIRECT AROCLOR HEATER for UNIT CHEMICAL OPERATIONS

Monsanto Technical Bulletin No. O-130 October, 1955
Monsanto Chemical Company, Organic Chemicals Division, St. Louis 1, Mo.

*Aroclor** 1248 (chlorinated biphenyl) is an ideal nonflammable liquid phase heat-transfer medium for temperatures up to 600° F.

This bulletin contains a magazine reprint which describes the physical properties of *Aroclor* 1248 and illustrates the design and operation of heaters that have been used successfully by Monsanto plants for many years. The units described are gas fired and the capacities are in the range of 200,000 to 400,000 B.t.u. per hour.

Larger commercial installations using *Aroclor* 1248 have capacities ranging up to 2,000,000 B.t.u. per hour. Also small electrically heated stationary and portable units with capacities around 40,000 B.t.u. per hour are in service.

Although the magazine reprint contained first appeared in 1949, the basic information is still valid. Since that time Monsanto has developed a considerable amount of engineering data on heat transfer applications of *Aroclor* 1248. Those interested in such information are invited to correspond with the Organic Chemicals Division of Monsanto.

Monsanto does not manufacture heat-transfer equipment using Aroclor fluids. It supplies only the *Aroclor* 1248 needed. Several leading manufacturers of heating equipment are in a position to build or offer *Aroclor* heating units to meet specific requirements.

*Reg. U.S. Pat. Off.

Reprinted from INDUSTRIAL AND ENGINEERING CHEMISTRY, Vol. 41, Page 1341, July 1949

An Indirect Aroclor Heater for Unit Chemical Operations

MEADE McARDLE[1], L. C. GARRETT, AND P. G. BENIGNUS[2]
Monsanto Chemical Company, Anniston, Ala.

The characteristics of Aroclor 1248 indicate that it is an ideal liquid phase heat-exchange medium for temperatures up to 300° C. This article discusses its properties and illustrates the design and operation of heaters that have been used successfully by Monsanto plants during the past seven years.

IN CERTAIN manufacturing processes of the Monsanto Chemical Company, it was necessary to employ a noncombustible heat-transfer medium at pressures of 30 pounds per square inch or less and temperatures up to 300° C. The following general properties of a heat-exchange medium were required:

Freedom from fire hazards.
Viscosities to permit pumping at room temperatures.
Boiling point sufficiently above 300° C. to assure a liquid condition at all times.
Stability against heat, with enough safety factor to accommodate accidental overheating.
Controllable vaporization losses.
Freedom from corrosive action against valves, piping, tank jackets, etc., made of cast iron and steels, bronze, and stainless steel.
Freedom from toxicity hazard.

Aroclor, chlorinated biphenyl (registered in U. S. Patent Office), was selected. The pertinent physical characteristics relative to its use as a heat-transfer medium are given in Table I.

FREEDOM FROM FIRE HAZARDS

FLASH POINT. Limitations of this test for the prediction of the fire hazard of relatively nonvolatile organic fluids have been recognized by the American Society for Testing Materials committee (*3, 4*).

FIRE POINT is a more significant measurement. The Underwriters' Laboratories (*10*) state that fire tests more truly reflect the (lack of) fire hazard of Aroclor.

SPONTANEOUS IGNITION TEMPERATURE. The combustion-resisting qualities of Aroclor 1248 are indicated by its high spontaneous ignition temperature of 704° C. (1299° F.) determined by Sullivan, Wolfe, and Zisman (*9*), using the convenient apparatus described by Sortman, Beatty, and Heron (*8*).

Under conditions of industrial use the spontaneous ignition temperature will be determined by factors including the nature of the hot surface, the amount of liquid impinging on it, the volume of enclosed space, and the ventilation.

An accidental failure in a heating system demonstrated the nonflammability of Aroclor 1248 and its freedom from the hazard of fire propagation. An operator's failure to start the circulation of the heat-transfer medium when the gas heater was on resulted in excessive coil temperatures and caused the lower coil to soften and sag into the fire chamber. A weld ruptured and Aroclor 1248 poured into the red-hot fire chamber in contact with the flame. Dense smoke arose from the heater but there was no external fire. After the gas flame was cut off, the smoking stopped.

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SPRAY FLAMMABILITY. When a tube ruptures in a liquid heat-transfer system under high pressure, a spray or mist forms. The possible fire hazard under these conditions requires considerations not covered by the foregoing discussions relative to the material in the liquid form. In their comprehensive study of flammability of the higher boiling liquids and their mists, Sullivan, Wolfe, and Zisman (*9*) determined the spray flammability limit of numerous materials in accordance with the percentage of oxygen required for combustion. This value was then correlated with the results of incendiary firing tests of the fluids conducted at the Naval Proving Ground, Dahlgren, Va. The oxygen requirement for Aroclor 1248 combustion in the spray flammability limit studies was found to be 64%. Fluids requiring over 45 to 50% oxygen in the spray test failed to cause a fire in the incendiary test. These results establish the nonflammable and noncombustible qualities of Aroclor 1248.

VISCOSITY CONSIDERATIONS

COLD FLOW. For most inside installations centrifugal pumps will handle Aroclor at reduced rates without preheating. Experience confirms this. Outside installations have been started at 0° C. by heating the pump and feed line until circulation through

TABLE I. PHYSICAL PROPERTIES OF AROCLOR 1248

		° C.	(° F.)
Appearance	Practically colorless mobile liquid		
Absolute density, g./ml.	1.44	30	(86)
	1.41	60	(140)
	1.37	100	(212)
	1.27	200	(392)
	1.17	300	(572)
Absolute viscosity, centipoises	112	30	(86)
	17.5	60	(140)
	4.2	100	(212)
	0.99	200	(392)
	0.47	300	(572)
Thermal conductivity, B.t.u./hour/sq. foot/° F./foot	0.0613	30	(86)
	0.0698	60	(140)
	0.0800	100	(212)
Distillation range, A.S.T.M. D-20, ° C.	340-375		
Flash point, Cleveland open cup, A.S.T.M. D 92-46, ° C.	193-196		
Fire point, Cleveland open cup, A.S.T.M. D 92-45	None		
Pour point, A.S.T.M. D-7, ° C.	−7		
Coefficient of expansion, ml./ml./° C. (25–65° C.)	0.000702		
Specific volume, ml./g.	0.694	30	(86)
	0.700	60	(140)
	0.725	100	(212)
	0.787	200	(392)
	0.860	300	(572)
Specific heat, cal./g./° C.	[illegible]	[illegible]	[illegible]
	[illegible]	100	(212)
	[illegible]	200	(392)
	[illegible]	300	(572)
Vapor pressure, mm. Hg	[illegible]	37.8	(100)
	0.16	100	(212)
	2.9	150	(302)
	19.0	200	(392)
	300.0	300	(572)

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Table II. Stability of Aroclor 1248 Heated for 30 Hours

Temperature, ° C.	Mg. of HCl per Gram of Aroclor
280	0.070
300	0.186
310	0.199
320	0.222
330	0.248

Table III. Stability of Aroclor 1248 Continuously Heated at 280° and 330° C.

Hours	Mg. of HCl per Gram of Aroclor	
	280° C.	330° C.
30	0.070	0.248
60	0.118	0.510
90	0.169	0.923
120	0.194	1.141
150	0.261	1.302

Table IV. Gas Analysis of Aroclor 1248 Heated 4 Hours at 260° C. and 210 Pounds per Square Inch Pressure

Gas	%
Carbon dioxide	None
Carbon monoxide	None
Oxygen (derived from air)	20.2
Methane	0.2
Hydrogen chloride	None
Chlorine	None
Acidity (% by weight HCl)	
Prior to exposure	0.007[illegible]
After exposure	0.0075

the heater had been effected so that the system could operate normally.

BOILING POINT

Operating experience has shown that the boiling point of Aroclor 1248 (340° C. at 760 mm.) is enough above the 300° C. operating limit to prevent trouble from this cause. At the maximum operating temperature the vapor pressure is less than 0.5 atmosphere.

HEAT STABILITY

In order to establish a maximum practical operating temperature, the stability of the material when heated to elevated temperatures in the presence of iron was noted. A slow stream of nitrogen was passed over the hot Aroclor to sweep the decomposition products into a caustic trap. The amount of acidic material was determined and calculated as hydrochloric acid. The results given in Table II indicate the stability of Aroclor 1248 when individual samples were heated for 30 hours at the given temperatures. The decomposition is very low at temperatures up to 300° C.

The stability of Aroclor-1248 in contact with iron continuously heated at 280° and 330° C. is indicated by Table III. These test results indicate that Aroclor 1248 in contact with iron can be used satisfactorily at temperatures up to 300° C.

The National Board of Fire Underwriters (*10*) reported that "decomposition of the product [Aroclor 1248] was not appreciable at temperatures below 400° C., but became increasingly apparent at higher temperatures."

Their workers analyzed the decomposition products of Aroclor 1248 heated in the presence of hot iron at 459° C. and also heated in an iron cylinder at 340° C. fitted with an internal gas burner so that the gas flame impinged directly on the surface of the Aroclor. Analysis of the gases produced under these conditions included 0.6% carbon monoxide, 0.17% oxygen (derived from the air), 0.99% hydrogen chloride, 2.1% combustible gas calculated as methane, 0.002% chlorine, and no phosgene.

The same workers studied the stability of Aroclor when heated for 4 hours in an iron pipe at 260° C. under an internal pressure of 210 pounds per square inch, resulting from the introduction of compressed air. Following this treatment and cooling, the gases removed from the system were analyzed. The acidity of the Aroclor was determined prior to and after exposure to these conditions.

The results given in Table IV reflect an extremely small amount of decomposition under conditions similar to those selected for the practical use of Aroclor 1248 as a heat-transfer medium.

In actual practice using the type of heating unit described below there has been no evidence of hydrochloric acid effect and no carbon deposits have been noted in the heater, pipes, or valves. The heaters have been operated successfully with combustion gases at approximately 600° C. in contact with the coils.

At one time, a spiral coil type of heater was built and through faulty design a burner tunnel was located 1.5 inches from the 2-inch steel pipe coil. The radiation from the white-hot refractory tunnel and the direct impingement of the flame on the pipe caused the pipe to glow a dark red for a space of about 2 inches. This unit was operated almost 3 months before a circulation stoppage occurred. When the line was opened lumps of carbon were found to have come loose and moved forward to lodge in the globe valves. The lumps measured about 1 × 2.5 cm. and one face was formed to fit the pipe curvature. No hydrochloric acid effect was noted and the system was put back into operation after the burner location was changed.

CONTROLLABLE VAPORIZATION LOSSES

The heating systems in which Aroclor 1248 is used are sealed except for the expansion tank, which has a loose cover or a vent pipe. Because this tank is separated from the stream by a substantial length of pipe, the temperature in the tank remains low.

In the light of the relatively low vapor pressure values for Aroclor 1248 (7), and as it is unlikely that the expansion tank will ever reach even the 1-mm. state (130° C.), there should not be a measurable loss of Aroclor from the system. Actual experience bears out this contention.

Other Losses. Although Aroclor darkens on use, its characteristics remain the same and replacement has not been found necessary after 7 years of continuous use. Accidental leaks or spills constitute the only observed losses.

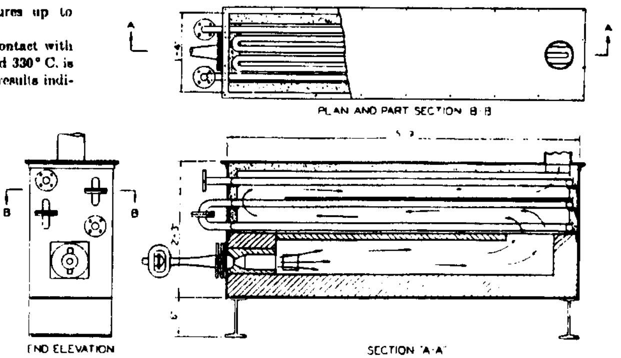

Figure 1. Heater

Table V. Resistance of Structural Materials to Aroclor 1248

Metals	At 25° C.	At 125° C.	Metals	At 25° C.	At 125° C.
Aluminum	R	R	Zinc	R	R
Copper	R	D	Mild steel	RR	R
Magnesium	RR	R	Phosphor bronze	R	D
Nickel	RR	R	Red brass	D	D
Silver	R	R	Stainless steel	RR	RR
Tin	R	R	Yellow brass	R	Re

RR. Excellent resistance, less than 1.0×10^{-6} cm. per day penetration or 0.00014 inch per year.
R. Good resistance, penetration between 1.0×10^{-6} and 10×10^{-6} cm. per day or between 0.00014 and 0.0014 inch per year.
D. Doubtful resistance, penetration between 10×10^{-6} cm. per day and 100×10^{-6} cm. per day or between 0.0014 and 0.014 inch per year.
e. Following letter indicating resistance, signifies material may be better than indicated if totally immersed, as weight loss is believed to come from oxidation of part of test strip exposed to air.

FREEDOM FROM CORROSIVE ACTION

The resistance of various metals (7) at 25° and 125° C. is given in Table V.

Similar studies made at 325° C. (6) indicate that the penetration, in inches per year, for mild steel is 0.0028; for yellow brass, 0.00047; for copper, 0.00145.

Many years of practical operating experience with Aroclor 1248 as a heat-transfer medium have shown that the material is practically noncorrosive to valves, piping, tank jackets, etc., made of cast iron and steels, bronze, and stainless steel.

FREEDOM FROM TOXICITY HAZARD

Aroclor 1248 is a very stable, unreactive liquid. If the material is spilled on the skin, there are no noticeable ill effects; however, it is well to wash the skin with soap and water after contact.

A skin burn resulting from accidental contact with hot Aroclor should be treated in the normal procedure used for hot oil burns. Aroclor adhering to the burned area need not be removed immediately unless treatment of the burn demands it; in this case soap and water or repeated washings with a vegetable oil (linseed oil) should be used.

The vapors emitted by Aroclor 1248 heated to elevated temperatures are injurious to the liver on prolonged exposure and should not be breathed. Drinker (5) indicated that 0.5 mg. of Aroclor 1248 per cubic meter of air is the maximum safe amount permissible in workrooms.

In commercial heat-transfer installations, the presumption is that the Aroclor is in a closed system free from leaks. Accordingly, there should be no opportunity for workers to come in contact with vapors from the hot heat-transfer medium.

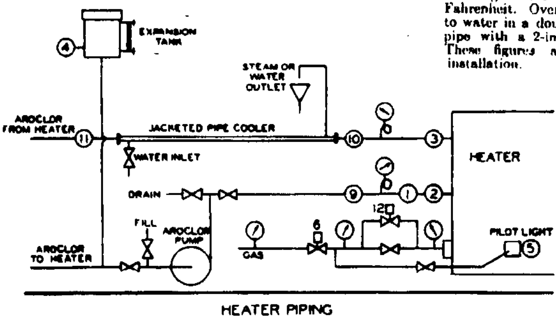

Figure 2. Cooler, Pump, and Expansion Tank

DESIGN AND CONSTRUCTION

Heating System. The heating system required to utilize Aroclor 1248 as the exchange medium includes a heater (Figure 1), cooler, pump, and expansion tank (Figure 2), and control and safety circuits (Figure 3).

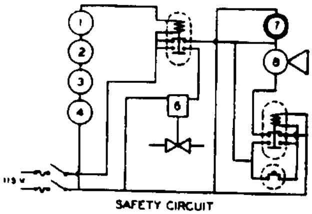

Figure 3. Control and Safety Circuit

Heater Design. The general requirements of the heater are compactness, ease of construction and service, and avoidance of direct flame impingement on the tubes.

Direct flame impingement is prevented by directing the gas flame through an enclosed channel with half-thickness fire brick protecting the tubes above until the high temperature of the flame is reduced by heat conducted through these bricks and radiated to the two bottom coils. The size of the heater is reduced to a minimum by using only 4.5 inches of insulating fire brick in the hottest areas and 2 inches of Eagle No. 66 insulation on the cooler spots.

Two sizes of units are used: One has a maximum capacity of 200,000 B.t.u. per hour, as shown in Figure 1. The larger has a range of 200,000 to 400,000 B.t.u.

The small size consists of 90 feet of 1-inch standard weight steel pipe made into three coils of six pipes each and connected in series. The larger size consists of 144 feet of 1.5-inch standard weight steel pipe arranged in the same fashion. Results of tests on the small-size heater covering temperatures from 150° to 300° C. show temperature rises to 10° to 20° C. in the Aroclor while circulating at a rate of 13 to 20 gallons per minute. The outlet gas temperature is consistently within 75° C. of the outlet Aroclor temperature. It is observed that the bottom two coils absorb the major part of the heat. The small unit indicates 50 to 60% efficiencies for capacities up to 200,000 B.t.u. per hour when a natural gas of 1000 B.t.u. per cubic foot is burned. A Surface Combustion Company high pressure inspirator and tunnel burner set is used in this installation.

Over-all heat-exchange coefficients (U) for the furnace are in the range of 7 to 10 B.t.u. per hour per square foot per degree Fahrenheit. Over-all heat-exchange coefficients for Aroclor 1248 to water in a double pipe heat-exchanger made from 1.25-inch pipe with a 2-inch pipe jacket are in the 120 to 180 range. These figures are calculated from test results on this installation.

Cooler. A very useful adjunct to the system is a double pipe cooler on the outlet of the heater shown in Figure 2. By turning water into the jacket, the Aroclor can be cooled and the temperature of the system lowered. This is helpful when it is necessary to cool a batch before removing it or when an exothermic reaction starts to get out of control.

Pump. The pump for circulating the Aroclor 1248 may be any one of a number of standard centrifugal units designed for hot liquid service.

Table VI. Piping Detail

(Dimensions in inches)

Pipe	1/4 through 3/4	Schedule 80, A.S.T.M. A53 or A106
	1 through 6	Schedule 40, A.S.T.M. A53 or A106
Construction	1/4 through 3/4	Screwed
	1 through 6	Flanged
		Bend in shop and field where possible. Must be cleaned to remove scale
Ells, tees, and reducers	1/4 through 3/4	Forged steel screwed. Crane 300d series
	1 through 6	Welded fittings. Crane 300e
Flanges	1 through 6	Series 30 (to match valves)
Bolts		Machine bolts A.S.A. B-18.2 with hexagonal nuts for service below 500° F. Above use alloy steel. Crane triplex A.S.T.M. A96
Unions	1/4 through 3/4	Crane 252h forged stee
Dope		Crane 425 high temperature thread compound
Gaskets		Soft iron ring flat or corrugated
Shut-off valves	1/4 through 3/4	Crane 3600W, screwed, gate
	1 through 2	Crane 3015W, flange, gate
	2 1/2 through 6	Crane 33XR, flange, gate
Control valves	1/4 through 3/4	Crane 3040 XR, screwed, globe
	1 through 2	Crane 3050 XR, flange, globe
	2 1/2 through 6	Crane 151 XR, flange, globe
Check valves	1/4 through 3/4	Crane 3074 X, screwed
	1 through 2	Crane 3086 X, flanged
	2 through 6	Crane 159 X, flanged
Safety valves	3/4	Consolidated 1670 RW, screwed
Relief valves	1 1/2 through 3	Consolidated 1612 W, flanged
Valve stem packing		Goetze 1401D or Durametallic D-110
Gage and glass	1/2 gage	Type 100 PCPR Marsh 0-100 lb./sq. inch gage siphon with Crane 222H bar stock valve. Jerguson Series R20 Reflex type liquid level gage
Strainers	1/4-3/4	821 Yarway threaded
	1 through 3	822 Yarway flanged

The Dayton Dowd Type C pump is an example of the type required. It should be made of cast steel and have a water-cooled stuffing box and water-cooled bearings. The stuffing box should have room for at least six rings of packing and a lantern ring. Durametallic No. D-110 or Garlock No. 234 may be used for packing the pump. An open impeller is desirable, as it will handle the cool, more viscous liquid on starting the system better than will a closed impeller. Enough horsepower for the most viscous conditions is required.

Piping System and Expansion Tank. The detail of the piping system for Aroclor 1248 used up to temperatures of 300° C. (572° F.) and 100 pounds per square inch pressure is given in Table VI. The valves and specialties given indicate the type required. All piping larger than 0.75 inch is flanged or welded; experience has shown that hot Aroclor penetrates screwed joints of the larger sizes. Steel and cast steel are used throughout.

The system requires an expansion tank located at the highest level of the installation. The size of this tank is normally about 25% of the capacity of the Aroclor system. Connections with valves, made on either side of the pump, enable the operator to connect a flexible hose and to pump in or out as required.

For operation in locations where the Aroclor temperature may drop to where the attendant viscosities may make pumping impractical in the system as designed, it may be desirable to steam-jacket the Aroclor circulating lines to facilitate rapid start-up. Suitable safety provisions, such as safety pop-off valves, must be installed in the steam jacket system to prevent pressure ruptures which would develop if any condensate remained in a closed system during high temperature operation.

In order to establish operating conditions and to check the operation of the heater itself, it is often desirable to measure the temperatures of the Aroclor in and out of the heater and cooler. Items 9, 10, and 11 (Figure 2) provide for this. They may be dial thermometers or mercury bulb thermometers of any commercially available type recommended for the service.

Table VII. Safety and Control Equipment

1.	High pressure alarm (detects stoppage of pipe)	Mercoid DA-31, open circuit on high pressure. Actual settings depend on individual layout
2.	Low pressure alarm (detects stoppage of pump)	Mercoid DA-31-3, open circuit on low pressure. Actual settings depend on individual layout
3.	Thermostat (detects excessive heating hence obstruction of flow)	Fenwal 18003. Contacts open on temperature increase
4.	Float switch (detects leakage from system)	Mercoid Figure 40. S.P. switch. Open at low level
5.	Flame failure system (cuts off gas if pilot flame goes out)	Combustion Control Corp. Fireye FF6. Flame failure control for manual ignition gas burner systems
6.	Gas valve (cuts off in case preceding devices act)	General Control Corp. K-10-2. Closes with current off
7.	Red light (alarm)	Killark VA-1 60 W. or Benjamin 7013-V
8.	Horn (sounds alarm)	Edwards 312
	Alarm relay	Type C-1104 1-NO, 1-NC watertight (1)
	Stop horn relay	Type C-1104 1-NO, 1-NC, watertight (1)
	Stop horn button	1-HA-4 (2)
9.	Thermometer well (visual check of heater performance)	0-350° C. mercury bulb thermometer
10.	Thermometer well (visual check of heater performance)	0-300° C. mercury bulb thermometer
11.	Thermometer well (visual check of cooler performance)	0-360° C. mercury bulb thermometer
12.	Solenoid valve	General Control K-10-2. Controls Aroclor temperature to meet demands of system

For automatic temperature control a solenoid valve, item 12, is indicated in a by-pass arrangement with a manually operated needle valve. The needle valve is adjusted to give almost enough heat to meet the requirements and the actual control is carried on by the solenoid valve, which opens and closes as directed by a temperature-control instrument connected to the equipment being heated.

One unit was set up with temperature control using a Leeds & Northrop Model S all-electric control with droop corrector. Very close control over a wide range of heat demand resulted, when a throttling range adjustment of 4 was used on this control device.

Safety Circuit. Figure 3 shows a safety circuit which automatically protects the system by closing off the gas supply in the event of faulty operating conditions. Provision is made for shutting off the warning horn while the system is being put back into operation after a safety shutdown.

A detailed list of the safety and control equipment is given in Table VII. The equipment named indicates the type required.

ACKNOWLEDGMENTS

The authors are grateful to A. M. Ellenburg of Monsanto's Research Laboratory at Anniston, Ala., for furnishing many of the technical data about Aroclor 1248 and for assistance in preparing the manuscript.

LITERATURE CITED

(1) Allen Bradley Co., Milwaukee, Wis., *Bull.* 700.
(2) *Ibid.*, *Bull.* 800.
(3) Am. Soc. Testing Materials, *Proc. Am. Soc. Testing Materials*, 34, 53 (1934).
(4) Am. Soc. Testing Materials, "Standards on Petroleum Products and Lubricants," 1945.
(5) Drinker, C. K., *J. Ind. Hyg. Toxicol.*, 21, 155 (1939).
(6) Monsanto Chemical Co., Anniston, Ala., private communication, April 13, 1944.
(7) Monsanto Chemical Co., St. Louis, Mo., *Monsanto Tech. Bull.* P-115 (August 1947).
(8) Sortman, C., Beatty, H., and Heron, S., Ind. Eng. Chem., 33, 357 (1941).
(9) Sullivan, M. V., Wolfe, J. K., and Zisman, W. A., *Ibid.*, 39, 1607 (1947).
(10) Underwriters' Laboratories, Chicago, Ill., "Miscellaneous Hazards," No. 2498, 1934.

Received August 27, 1948. Presented before the Meeting-in-Miniature, Alabama Section, American Chemical Society, December 8, 1948.

AN INDIRECT AROCLOR HEATER FOR UNIT CHEMICAL OPERATIONS

Monsanto Technical Bulletin No. O-130
October, 1955

MONSANTO
CHEMICALS -- PLASTICS

For further information on the products described in this bulletin contact the nearest Monsanto office.

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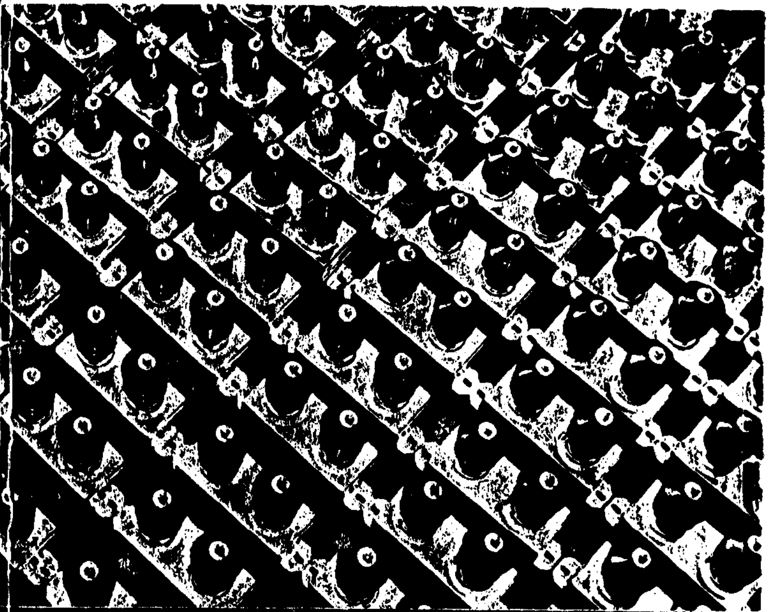

AROCLOR FOR CAPACITORS

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INTRODUCTION

The Aroclor* dielectrics are a range of chlorinated diphenyls produced by Monsanto for the manufacture of impregnated paper capacitors. These products are generically known as 'askarels', that is, synthetic fire resistant insulating liquids which, if decomposed by an electric arc, evolve only non-explosive gaseous mixtures.

The Aroclor liquids were first used in the United States in 1931 and to-day they are extensively used in the capacitor industry throughout the world. Monsanto has been producing Aroclor at its Newport plant since 1951.

There are three grades of Aroclor, identified by their code numbers: *Aroclor 1242* (Commercially known as Trichlorodiphenyl) the most economically attractive, is essential for outdoor capacitors in a low temperature environment, but is the most difficult to handle in production.

Aroclor 1248 (Commercially known as Tetrachlorodiphenyl) is a compromise between the economic advantages of 1242 and the ease of handling of 1254.

Aroclor 1254 (Commercially known as Pentachlorodiphenyl) is the easiest to handle in production and is sometimes chosen for capacitors to operate in exceptionally hot environments, but does not gain the maximum economic advantage.

Advantages of using Aroclor Reduced size capacitors are possible for a given rating; fluorescent lighting units are a particular application in which this is utilised.

Reduced raw material cost arising from the smaller quantity of paper and foil needed in manufacture.

* Aroclor is a Registered Trade Mark.

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Reduced labour content because of the fewer windings required.
Increased through-put from a given plant capacity with existing labour force.

Higher stress operation of capacitors is possible because of a more uniform permittivity in the capacitor.

Longer life capacitors are produced because of the high stability and resistance to oxidation of Aroclor.

Small fire hazard because Aroclor is fire-resistant.

PROPERTIES

Values for the most important properties of the Aroclor dielectrics are given in the Table.

Typical properties of the Aroclor dielectrics

(These values do not constitute a specification)

Property	Aroclor 1242	Aroclor 1248	Aroclor 1254
Relative Density at 20/20°C	1·385	1·456	1·549
Pour Point (°C)	-19	-7	+10
Viscosity at 60°C (cS)	3·5	5·2	10·2
Coefficient of expansion °C	0·00070	0·00074	0·00069
Specific heat at 75°C (J/g °C)	1·24	1·16	1·08
Thermal conductivity at 75°C (W/m °C)	0·1039	0·1003	0·0974
Evaporation loss (%) (2 h at 125°C)	0·12	0·07	0·03
Flash Point (°C) ASTM D93/62	154 (min)	164 (min)	204 (min)
Fire Point	None	None	None
Refractive Index n_D^{25}	1·6240	1·6285	1·6370
Inorganic chlorides (ppm)	0·1 (max)	0·1 (max)	0·1 (max)
Acid number (mgKOH/g)	0·01 (max)	0·01 (max)	0·01 (max)
Water content (ppm)	35 (max)	35 (max)	35 (max)
Permittivity at 20°C and 50 c/s	5·97	5·59	5·04
Permittivity at 100°C and 50 c/s	4·83	4·67	4·25
Loss tangent at 100°C and 50 c/s	0·018	0·015	0·010
D.C. resistivity at 100°C and 500 V/mm after 1 min. electrification (TΩ cm)	6·0	7·0	8·0
Dielectric strength at 20°C (kV) (B.S. 148:1959)	50 (min)	60 (min)	70 (min)

Composition Aroclor is made by the chlorination of diphenyl to predetermined chlorine contents which are indicated as a percentage by the last two digits in the code number e.g. Aroclor 1248 contains 48% chlorine by weight. Each Aroclor contains a range of chlorodiphenyls with differing numbers of hydrogen atoms substituted by chlorine, and in each of these chlorodiphenyls there is abundant isomerism.

Physical properties *Viscosity* The viscosity-temperature characteristics of the Aroclor liquids are shown in Figure 1. It can be seen that Aroclor 1254 is the most viscous at all temperatures and Aroclor 1242 the least. The differences between the three grades are greatest at lower tempera-

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ture and become less as the temperature is raised. As previously explained, Aroclor consists of a number of homologues and consequently each grade does not have a sharply defined melting point, but remains liquid over a wide temperature range. Instead, their viscosities increase smoothly but sharply as the temperature is reduced. Aroclor 1242 has the lowest pour point of all three grades.

Vapour Pressure It can be seen that Aroclor 1242 has the greatest vapour pressure at a given temperature and Aroclor 1254 the least, and this needs to be considered when deciding the temperature of Aroclor during degasification and impregnation. The vapour pressure of Aroclor varies with absolute temperature according to the usual logarithmic law. The variation of the vapour pressures of the Aroclor dielectrics with temperature is shown in Figure 2.

Chemical properties The chemical inertness of Aroclor is outstanding. The liquids are not oxidised by exposure to air or oxygen even under extreme conditions of temperature and pressure, nor do they react with moisture. When subjected to a bomb test at 140°C in oxygen at a pressure of 250 p.s.i.g. (17 kg/cm²), there was no evidence of oxidation as judged by development of acidity or formation of sludge. They can withstand many years of service in electrical equipment at high temperatures without oxidation.

Aroclor is manufactured to a rigid specification ensuring a low initial value for free acidity and free chlorides. Tests have shown that these low values are maintained even when the liquids are heated for prolonged periods in the presence of air and moisture at temperatures of 100°C.

Aroclor 1242 is slightly sensitive to ultra-violet light, which can result in the formation of traces of ionic contaminants. The other grades are relatively unaffected by exposure to light.

Aroclor undergoes no decomposition at temperatures up to 175°C. At much higher temperatures, or when subjected to arcs, the principal decomposition products are carbon and hydrogen chloride.

Laboratory tests and practical experience have shown that phosgene, chlorine, or hydrocarbons are not formed as decomposition products of Aroclor.

Electrical properties The laboratory methods used to measure the electrical properties of the Aroclor dielectrics are described in Appendix A.

Permittivity (*Dielectric 'constant'*) The permittivity of Aroclor is higher than that of mineral oil, which accounts for the size reduction

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and increase in stress that is possible. Stresses of 15 to 17 V/μm are common with Aroclor and higher values are reported.

Since chlorinated diphenyls are polar compounds, their permittivities are highly temperature-dependent. This is illustrated in the upper part of Figure 4, which shows the variation with temperature of the permittivity of each of the three grades of Aroclor. These readings were taken at a frequency of 50 c/s and an electric stress of 1 V/μm.

At the lowest temperatures, all three grades have a permittivity of about 2·8, since, because of the very high viscosity, there is no contribution from dipole orientation polarizability. As the temperature is increased, the permittivity begins to increase when the viscosity becomes sufficiently reduced to allow the molecular dipoles to orientate themselves in the alternating electric field. The temperature at which this increase in permittivity begins is dependent upon both the grade of Aroclor, being lowest for Aroclor 1242, and the frequency of the applied field.

As the temperature is further increased, the permittivity passes through a maximum, and then decreases. This decrease in permittivity with increase of temperature is due mainly to the disturbance of the alignment of the dipoles by thermal agitation. The maximum permittivities attained vary with the grade of Aroclor, being greatest for Aroclor 1242 and least for Aroclor 1254. With Aroclor 1242 the permittivity of this series reaches a maximum, and a further reduction in chlorine content causes a reduction in permittivity, as shown in Figure 3.

Although the permittivity of Aroclor 1242 is of a high order, continued research on these products has revealed the possibility of obtaining even higher permittivities with this class of material. It is likely therefore, that the final word has not been written on this subject and that improved products will become available in this field in the course of the next few years.

Loss Tangent The loss tangent, or power factor, of Aroclor is also highly temperature dependent. This is illustrated in the lower part of Figure 4, which shows how the loss tangents plotted here on a logarithmic scale of each of the three grades of Aroclor vary with temperature.

The curve for each grade of Aroclor consists of a peak due to absorption associated with the transition in permittivity, followed by a region where the loss tangent steadily increases with temperature. In this latter region, the loss tangent follows the increase in fluidity with increasing temperature and is highly dependent upon the purity of the Aroclor. The temperature at which the peak occurs is about 19° below the pour point.

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The loss tangent of Aroclor is greater than that of fresh mineral oil, but by selection of a paper of lower density the loss tangent of the impregnated capacitor can be minimised without sacrificing the economic advantages. Furthermore, the internal temperature does not rise beyond acceptable values.

D.C. Resistivity The values quoted in the table are typical for Aroclor as produced, but they can be improved by vacuum dehydration and values of 20 to 50 T Ω cm at 100°C are common. The values for Aroclor 1242 and 1248 are lower than 1254 because a given amount of contamination reduces the d.c. resistivity more with a liquid of lower viscosity and higher permittivity.

The variation of the d.c. resistivity of the 3 grades of Aroclor with temperature is shown in Figure 5.

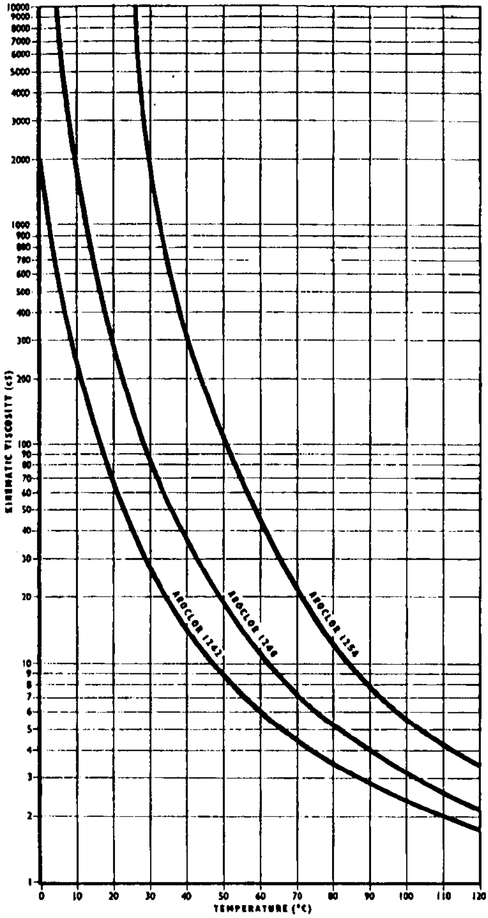

Figure 1 The viscosity-temperature characteristics of the Aroclor dielectrics

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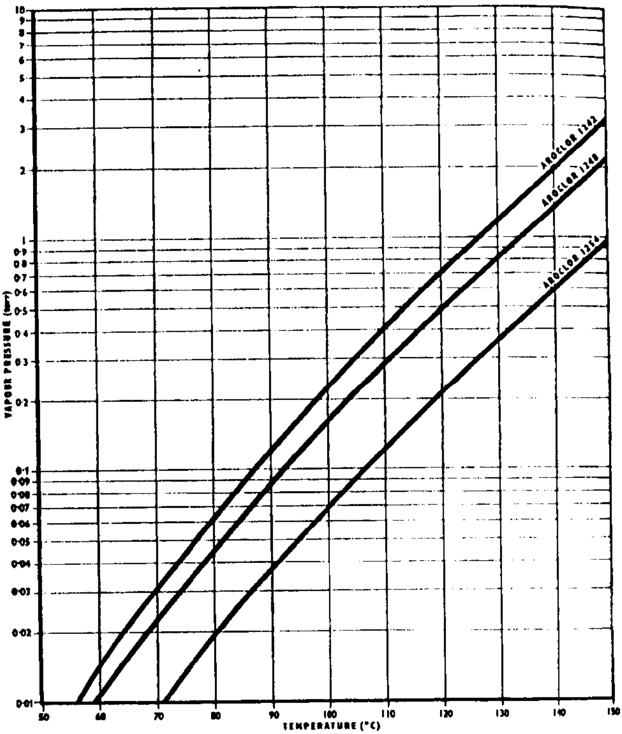


Figure 2 The variation of the vapour pressure of the Aroclor dielectrics with temperature

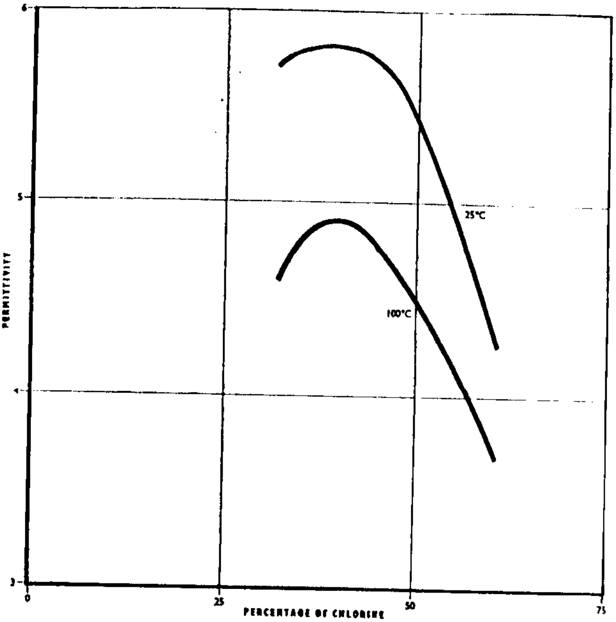
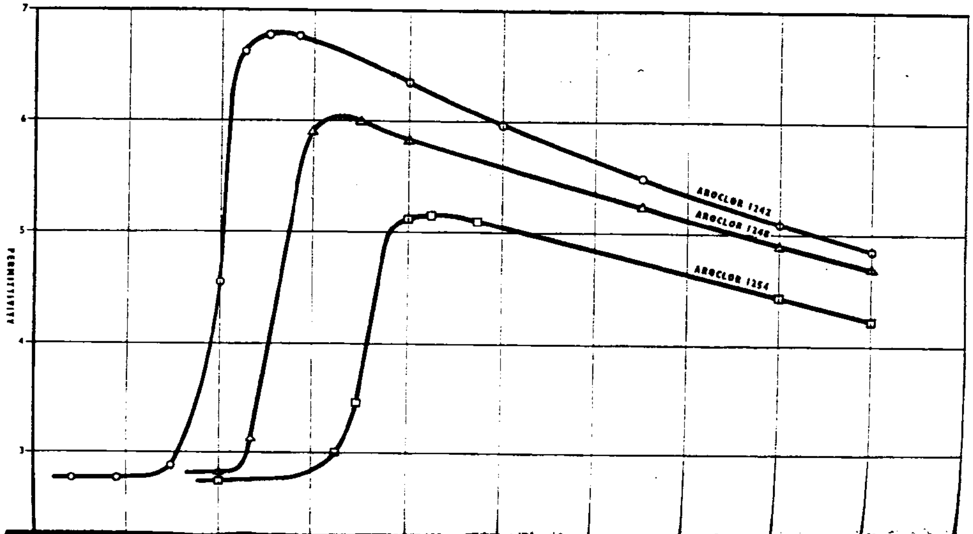


Figure 3 The variation of permittivity with chlorine content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PERMITTIVITY
AROCLOR 1242
AROCLOR 1248
AROCLOR 1254

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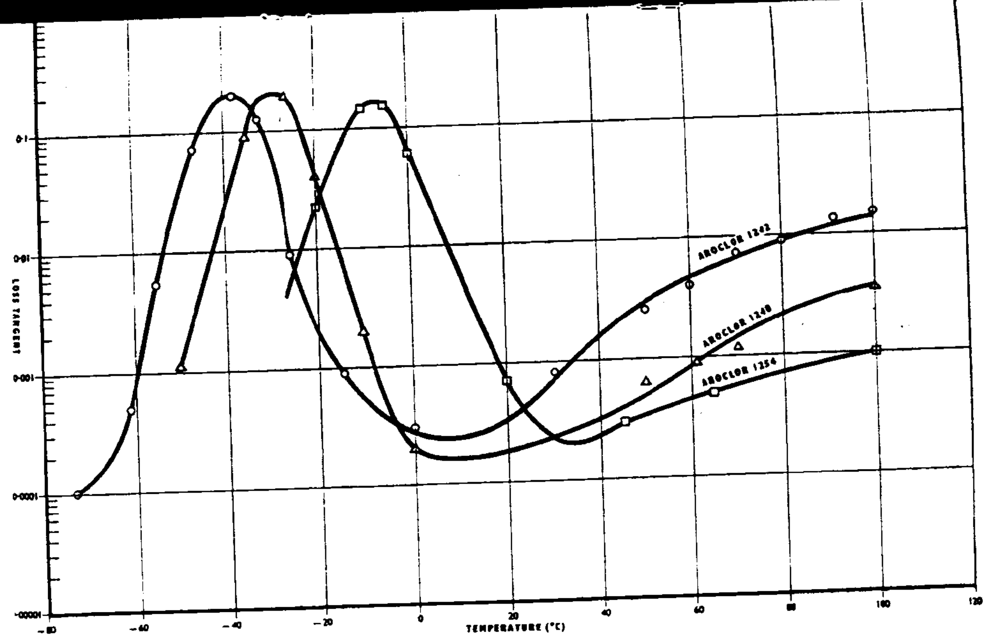

Figure 4 The variation of the permittivity and dielectric loss angle of Arocolor with temperature

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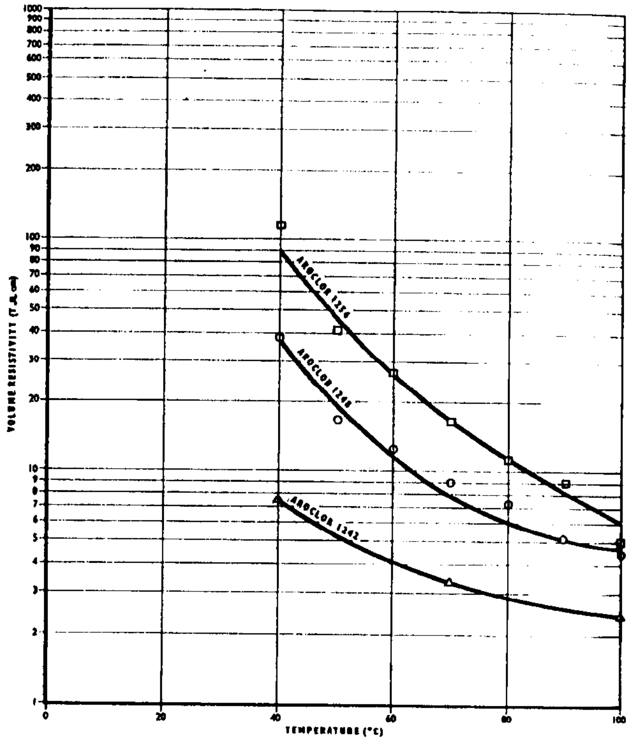

Figure 5 The variation of the DC resistivity of the Aroclor dielectrics with temperature

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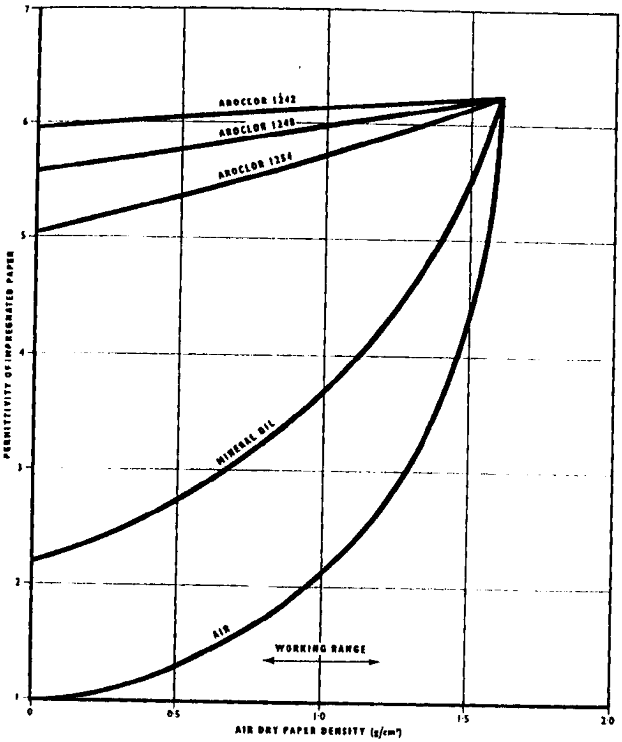

Figure 6 The permittivity of paper impregnated with Aroclor

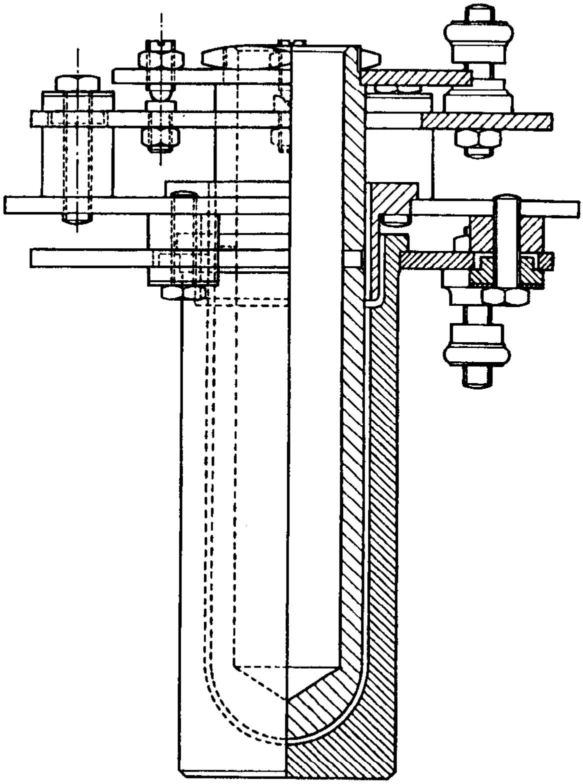

Figure 7 The Monsanto dielectric test cell

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CONSTRUCTION

CONSTRUCTION OF AROCLOR CAPACITORS

Paper Kraft paper is strongly recommended since it has nearly 5 times the acid neutralising properties of rag tissue.

The permittivity of impregnated paper depends upon the density of the paper as well as the permittivity of the impregnant. This relationship is shown in Figure 6 for the 3 grades of Aroclor and for mineral oil, the values being calculated at a temperature of 20°C. Since paper impregnated with Aroclor 1242 has the highest permittivity, the least area of windings is needed to obtain a given value of capacitance and the greatest economy is obtained.

It is advantageous to use low density paper since it has been shown both theoretically and practically that such paper gives the least dielectric loss in a capacitor. This effect arises from the distribution of electrical stress between the cellulose fibres and the impregnant and is in addition to, and independent of, any losses in the impregnant itself.

Most manufacturers of capacitor tissue are familiar with Aroclor and have developed suitable grades for use with it.

Assembly of capacitors It cannot be emphasised too strongly that every material that comes into contact with Aroclor must be carefully checked for compatibility. Aroclor is a good solvent for many thermoplastics and elastomers and the resulting solution has a high dielectric loss tangent. Materials which must be considered include the major insulation, the lead-through insulators, any means of sealing the container and the residues from the manufacturing process e.g. fluxes left after soldering.

The windings should be sealed with a suitable adhesive such as gum arabic or Gloy. Connection tags if of copper should be tinned, otherwise stainless steel can be used. Soldering should be kept to a minimum and where possible the special cored solders which have been developed by manufacturers for use with Aroclor should be employed. Opaque bushings must be used because of the slight light sensitivity of some grades of Aroclor, particularly Aroclor 1242.

PRODUCTION

PRODUCTION OF AROCLOR CAPACITORS

Although the production of Aroclor impregnated capacitors is generally similar to that of oil impregnated units, and similar plant may be used, there are several differences in detail and these are described in the following sections.

If an oil plant is to be changed to Aroclor, no special cleaning is necessary, although it is advisable to rinse the plant first with Aroclor which is subsequently discarded. It must be noted at this point and always borne in mind that Aroclor has a very considerable detergent effect. That is to say that since the density is nearly twice that of oil, any dirt existing in the system will be washed out due to the greater density effect of the Aroclor.

Earth treatment The main difference between Aroclor and oil capacitor impregnation plant is the earth treatment section. Aroclor, as received in drums, is suitable for filling into capacitors after vacuum treatment but it is generally advisable to have an earth treating facility available to treat any Aroclor which could become contaminated during the process cycle. For example if capacitors are filled by a flooding technique, then Aroclor which is unused and which is returned to the system will be found to be slightly contaminated and earth treatment is advised. For this to be fully appreciated, it must be realised that the Aroclor liquids are more susceptible to contamination than their mineral oil counterpart. Because of their higher solvent action and higher permittivity, the contamination level which would be acceptable in mineral oil and which is commonly encountered in an impregnation plant will be unacceptable for Aroclor.

The earth treatment can be carried out in two principal ways. In the first place the earth is contained in a column and the liquid is circulated until the contamination is removed.

Alternatively, activated earth is added to the liquid in a container and it is stirred to ensure intimate mixing and then the earth is filtered through a normal paper filter. In both cases either Fullers' Earth or activated alumina may be used and each must be thoroughly dried. It has been found by experience in laboratory tests that the earth may be pacified by heating to excessive temperatures, and the optimum treatment is about 150°C for 6 hours. The activated material is then added to the Aroclor to be treated at a level of .2% - 2% by weight. The use of freshly activated earth gives a controlled high quality of material from the treatment stage. However, there still exists the problem of separating the earth and here the column technique has a considerable advantage, since circulation through the column does not necessitate further filtration. This method has the disadvantage that the column gradually becomes less active during its life and there is not always the same degree of control over the treatment process.

Impregnation It is customary to store the capacitor liquid in a large tank the size of which depends on whether the material is delivered in drums or tankers. It is strongly recommended that these storage tanks be lagged and heated since at low temperatures difficulty would be encountered in pumping the Aroclor 1254 and in certain extremes of temperature even Aroclor 1242 can become unpumpable. After transfer from the storage tank the liquid is first earth treated and mixed with any unused liquid drawn back from the capacitor impregnation tank, if applicable. The treated liquid is then subjected to vacuum drying and de-gassing in exactly the same way as with mineral oil and after this process it is passed to the final storage vessel where it is held before being passed to the impregnation section. Aroclor capacitors may be vacuum impregnated by a manifold technique in which the liquid is piped individually to each capacitor can and this is perhaps more suitable for the larger power factor correction capacitors. Alternatively, they may be filled by a flooding technique which is more applicable to the smaller fluorescent lighting capacitors. Here the capacitors can be loaded in wire cages and completely immersed in the liquid in the same way as with mineral oil. For the actual impregnation cycle the following temperatures are recommended:

Aroclor 1242	70- 80°C
Aroclor 1248/1254	90-100°C

The lower impregnation temperatures are recommended for Aroclor 1242 since as this process is carried out under vacuum the losses will be greater with a liquid which is more volatile.

After the impregnation cycle has been completed the vessel should be cooled to below 50°C before being opened and this is to avoid the unpleasant fumes of Aroclor escaping into the work-shop. The capacitors should then be sealed as quickly as possible and degreased before final painting and testing.

Toxicity precautions and the handling of Aroclor is dealt with in a separate section but workers handling the liquid, or capacitors coated with it, are advised to wear rubber gloves or use barrier cream.

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PERFORMANCE

PERFORMANCE OF AROCLOR CAPACITORS

A.C. capacitors at low ambient temperatures If a capacitor is continuously energised before and whilst subjected to a low temperature environment it operates satisfactorily because the heat produced in the dielectric balances the heat lost from the case. A self-compensating process exists such that if the temperature of the dielectric falls the losses increase, and more heat is generated to establish a new equilibrium. Tests have shown that a capacitor impregnated with Aroclor 1254 can operate continuously energised in ambient temperatures down to -60°C, and it was found that such capacitors satisfactorily survived whilst installed outdoors during the winter 1962-3.

If, however, a capacitor is subjected to a low temperature environment first and then energised it may be damaged by discharges occurring in voids formed by the contraction of the dielectric before it has time to heat up sufficiently. Cases when this might occur are in street lighting capacitors during winter, or capacitors installed in a plant that has been shut down during winter holiday periods. For this reason, the following minimum ambient temperatures are suggested for the 3 grades:

Aroclor 1254 - 7°C
Aroclor 1248 -28°C
Aroclor 1242 -45°C

For operation at still lower temperatures a blend of Aroclor 1254 and trichlorobenzene has been used.

D.C. capacitors Aroclor is also used in d.c. capacitors but it has been found that at the high stresses used the service life of the capacitor tends to be reduced if the working temperature is raised above 40°C. This can be overcome by using stabilisers in the Aroclor to overcome the slight electrochemical degradation which tends to take place. Generally the effect is proportional to the quantity of stabiliser used and up to 1 per cent of anthraquinone, or 1,8 dichloroanthraquinone, and 2 per cent of azobenzene have been used.

TOXICITY

TOXICITY AND HANDLING PRECAUTIONS

Aroclor made by Monsanto has been used for over 33 years without causing any toxic effects, but it must be handled with care.

These precautions should be observed:

1 Avoid skin contact. Protect the hands, preferably by oil-resistant gloves.

2 If skin contact should occur, wash off with soap and water.

3 If hot Aroclor must be handled in a closed or confined area provide exhaust ventilation or wear an approved respirator.

4 If Aroclor gets in the eyes, flush with large amounts of water. In the event that irritation persists refer the patient to a Physician.

5 Infrequent exposure to Aroclor vapour will not cause any ill effect, but prolonged exposure to a high vapour concentration should be avoided.
If these precautions are neglected acne may develop and excessive exposure may cause liver damage.

APPENDIX A

LABORATORY MEASUREMENTS ON AROCLOR

The Monsanto dielectric test cell There are many test cells available for measuring the electric properties of liquid dielectrics, but since most of these were designed for use with mineral oil, Monsanto has designed a test cell especially for use with Aroclor. This design of cell is used in our laboratories and is available for sale to customers. It is essentially a three terminal cell with cylindrical stainless steel electrodes separated by a 1 mm gap. Figure 7 shows details of the construction of this cell.

The procedure for cleaning and filling the cell Great care must be taken to ensure careful cleaning for Aroclor measurements with this or any other cell. The Monsanto cell is designed for easy cleaning and accurate assembly.

The Monsanto cell is first cleaned by a series of thorough washings as follows:

1 A wash with benzene
2 A thorough washing with detergent and hot tap water
3 Repeated rinsing with hot tap water
4 6 rinses in distilled water
5 2 rinses in analytical grade acetone

During the wash with the powder detergent a soft hair brush is used and all parts of the electrodes are thoroughly brushed. The cell is then dried in an air oven at 130°C for 30 minutes. Finally it is rinsed twice with the Aroclor to be measured before filling a third time, when the electrical measurements are taken.

Measurements The temperature at which the electrical properties are made is measured by a thermometer resting in the central well of the cell. For routine tests a temperature of 100°C is used.

Permittivity and loss tangent are measured first with a transformer bridge at a stress of 1 V/μm and at mains frequency of 50 c/s. D.C. resistivity is then measured with an electronic megohmmeter one minute after the application of a stress of 0·5 V/μm. If repeated readings of d.c. resistivity are performed on the same quantity of Aroclor in the cell, a gradual increase is noted. It is therefore recommended that if a repeat measurement of resistivity is required, the cell be emptied, thoroughly cleaned, and then refilled.

MONS 078579

Process control measurements For operating an impregnation plant, it is convenient to be able to measure the electrical properties of the Aroclor without the necessity of taking samples, and a cell can be incorporated in the system e.g. in a flow line. It should be arranged that there is a turbulent flow of Aroclor through the gap between the electrodes except when a measurement is being taken so that adequate cleaning of the electrode surfaces occurs. To obtain the same value of d.c. resistivity with a plant cell and with a laboratory cell it is necessary for the Aroclor to be (1) stationary whilst the measurement is made, (2) subjected to the electric field for one minute, and (3) at the same temperature.

APPENDIX B

COMPATIBILITY TESTING METHOD

Procedure If the material is available in a laminar form or is a surface coating, a piece 25 mm square is cut from a sheet. Other materials are selected so that the sample taken is present at the same concentration as in the finished article. The sample is put into a glass jar that has previously been cleaned and dried in the following sequence:

1 Wash in benzene
2 Wash with hot water and detergent
3 Six rinses with distilled water
4 Rinse twice with analytical grade acetone
5 Dry in an oven at 130°C for 1 hour

To this jar, and to a similar one without a specimen within it, are added 50 ml of Aroclor. The jars are then closed with ground glass lids and aged in an oven at 100°C for 7 days.

After ageing, the jars are removed from the oven and the electrical properties of the Aroclor in both the specimen jar and the control jar are measured at 100°C according to the method described in Appendix A. The specimens are examined for swelling or other signs of deterioration, and any colour change of the Aroclor is noted.

Results The Aroclor in which the sample has been immersed must not experience a decrease in resistivity below 1·0 terohm cm.

Information on materials which have been tested is available on request.

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Technical Service

The technical service staff of Monsanto is always ready to provide additional information on the use of the materials indicated in this report, and to assist manufacturers in the solution of particular problems ensuing from their application.

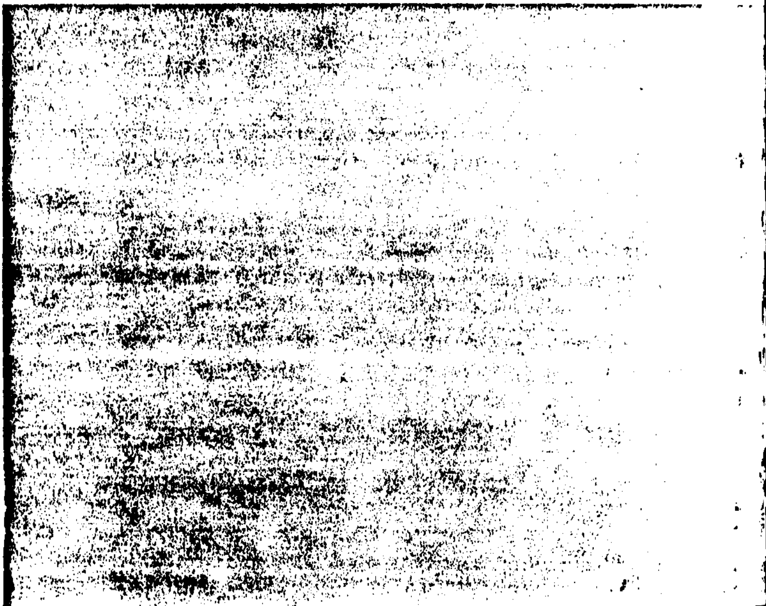
Front cover illustration by courtesy of
Industria Condensatori
Applicazioni Elettroelettroniche
Milano

Every effort has been made to ensure that the information in this publication is reliable, but as the conditions under which it may be applied are beyond our control, we cannot accept responsibility for any results of its use.

Forme No. P.B. [illegible]
Published by Monsanto Chemicals Limited.

Printed in England by Oxley Press Ltd., Nottingham
TECHNICAL SERVICE BULLETIN [illegible]
Reprinted March [illegible]
This edition supersedes all previous editions

MONS 078581



MONSANTO HOUSE 10 18 VICTORIA STREET LONDON SW1

MONS 078582

EXHIBIT 22

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS,

Plaintiffs,

- vs - Civil Action No.
1:14-C-12041-DJC

MONSANTO COMPANY,
SOLUTIA INC., and
PHARMACIA CORPORATION,

Defendants.

Video deposition of ROBERT SUGARMAN, PhD, PE, taken pursuant to the Federal Rules of Civil Procedure, at Salvatore's Garden Place Hotel, 6615 Transit Road, Williamsville, New York, on August 25, 2016, commencing at 10:11 a.m., before LORI K. BECK, CSR, RDR, CRR, Notary Public.

Job no. 111866

dangers of breathing PCBs that had volatilized in its technical bulletins distributed to customers?

A. I don't recall specifically. I -- I'd have to look at them again.

Q. Let's take a look at page 7 of your report, the Monsanto technical bulletin you reference.

A. Oh.

Q. Would you agree that Monsanto warned its customers about the dangers of breathing PCBs that had volatilized in the technical bulletins that it provided to its customers as set forth on page 7 of your report?

MR. LAND: Objection, misleading. You may answer.

THE WITNESS: That is correct. This is taken from a technical bulletin, and it does talk about the exposure varying with volatility and the hazard of that toxic exposure.

BY MR. HAASE:

Q. Okay. And on labels including five-gallon cans, would you agree that Monsanto warned its customers about the dangers of breathing PCBs that had volatilized?

EXHIBIT 23

T E C H N I C A L B U L L E T I N

AROCLOR® PLASTICIZERS

A series of inert, chemically-resistant, fire-retarding plasticizers compatible with wide variety of resins.

TECHNICAL BULLETIN O/PL-306A

Monsanto

AROCLOR®
PLASTICIZERS

A series of inert, chemically-resistant, fire-retarding plasticizers compatible with wide variety of resins.

TECHNICAL BULLETIN O/PL-306A

CAUTION: see sections entitled Toxicity and Safe Handling, and Environmental Hazzards, on page 12.

"Nothing contained herein is to be construed as a recommendation to use any product in conflict with any patent. MONSANTO MAKES NO WARRANTIES AS TO THE FITNESS OR MERCHANTABILITY OF ANY PRODUCTS REFERRED TO, no guarantee of satisfactory results from reliance upon contained information or recommendations, and disclaims all liability for any resulting loss or damage."

Organic Chemicals Division/800 N. Lindbergh Blvd./St. Louis, Missouri 63166

Introduction

The unique Aroclor® plasticizers are among the most versatile chemically produced materials available. One outstanding characteristic — *inertness* — makes Aroclor useful in many ways for many different applications. The major benefits offered by Aroclor include:

- Chemical Resistance
- Fire Retardance
- Compatibility with most resins
- Nonoxidation
- Adhesivity
- Low Cost

Monsanto's Aroclor plasticizers comprise a series of chlorinated biphenyls and chlorinated polyphenyls. They vary from mobile, oily liquids to white crystals and hard, transparent resins.

Twelve of the Aroclor plasticizers, each of which represents a series, are discussed in this bulletin. An understanding of the system for designation of each Aroclor should prove useful in the evaluation of the property gradations among them. The last two digits indicate the approximate weight percentage of chlorine in the product, and the first two digits indicate the type of material, as follows:

12 — chlorinated biphenyls

25 — blend of chlorinated biphenyls and chlorinated triphenyls (75:25)

44 — blend of chlorinated biphenyls and chlorinated triphenyls (60:40)

54 — chlorinated triphenyls

For nearly every Aroclor mentioned, a darker, less-pure grade exists, with about the same physical and chemical characteristics, but lower in price.

Solubility

The Aroclor liquids and resins are readily soluble in most common organic solvents and drying oils. Although all Aroclor plasticizers are insoluble in water, the hard, crystalline materials are generally less soluble than the liquids and softer resins. Solubilities of some Aroclor plasticizers are shown in Table 1.

MONS 075950

TABLE 1

SOLUBILITIES OF AROCLOR® PLASTICIZERS IN VARIOUS SOLVENTS

Solvent	Aroclor 1242 25°C	Aroclor 1242 Hot	Aroclor 1248 25°C	Aroclor 1248 Hot	Aroclor 1254 25°C	Aroclor 1254 Hot	Aroclor 1268 Cold	Aroclor 1268 Hot	Aroclor 4465 Cold	Aroclor 4465 Hot	Aroclor 5460 25°C
Acid											
Acetic Acid	S	S	—	—	S	S	—	—	SS	S	—
Oleic Acid	S	S	—	—	S	S	—	—	S	VS	—
Benzoic Acid	$10.0^{31°C}$	—	$10.0^{32°C}$	—	—	—	—	—	—	—	—
Aldehyde											
40% Formaldehyde	I	I	I	I	I	I	I	I	I	I	—
Furfural	VS	VS	VS	VS	VS	VS	SS	SS	VS	VS	—
Amine											
Aniline	S	S	—	—	S	S	—	—	VS	VS	—
Pyridine	$132.5^{30°C}$	$440^{80°C}$	—	—	$114^{31°C}$	$425^{100°C}$	—	—	VS	VS	—
Chloro derivatives											
Amyl chlorides — mixed	S	S	S	S	S	S	—	—	VS	VS	—
Carbon Tetrachloride	S	S	S	S	S	S	—	—	VS	VS	156
Chloroform	S	S	S	S	S	S	S	S	VS	VS	—
Dichlorethylene	—	—	—	—	—	—	—	—	VS	VS	—
Ethylene Dichloride	S	S	S	S	S	S	S	S	VS	VS	—
Monochlorobenzene	S	S	S	S	S	S	—	—	VS	VS	—
Orthodichlorobenzene	—	—	—	—	—	—	—	—	VS	VS	—
Tetrachlorethane	S	S	S	S	S	S	—	—	VS	VS	—
Trichlorethane	S	S	S	S	S	S	—	—	VS	VS	—
Trichlorethylene	S	S	S	S	S	S	—	—	VS	VS	—
Drying Oil											
Tung Oil	S	S	S	S	S	S	—	—	VS	VS	—
Linseed Oil	S	S	S	S	S	S	I	S	VS	VS	—
Ester											
Amyl Acetate	S	S	S	S	S	S	S	S	VS	VS	—
Butyl Acetate	S	S	S	S	S	S	S	S	VS	VS	—
"Cellosolve"[*] Acetate	S	S	S	S	S	S	—	—	VS	VS	—
Cottonseed Oil	S	S	S	S	S	S	—	—	VS	VS	—
Dibutyl Phthalate	S	S	S	S	S	S	S	S	S	VS	—

MONS 075951

Diethyl Phthalate	S	S	S	S	S	S	—	—	S	VS	—
Ethyl Acetate	S	S	S	S	S	S	SS	SS	S	VS	—
Ethyl Lactate	S	S	S	S	S	S	I	S	VS	VS	—
Ethylene Glycol Diacetate	S	S	S	S	S	S	—	—	VS	VS	—
Methyl Acetate	S	S	S	S	S	S	SS	SS	S	S	—
Tricresyl Phosphate	S	S	S	S	S	S	—	—	SS	S	—
Ether: Ethyl Ether	S	S	S	S	S	S	S	S	S	—	—
Ether Alcohol											
*Carbitol**	$224^{31°C}$	$307^{80°C}$	VS	VS	$173^{26°C}$	$259^{30°C}$	I	S	SS	—	—
Cellosolve	S	S	S	S	S	S	I	S	S	—	—
Diethylene Glycol	—	—	—	—	—	—	—	—	S	—	—
p,p'-Dihydroxy Ethyl Ether	$16.9^{23°C}$	$19^{33°C}$	SS	SS	$8^{30°C}$	$10^{100°C}$	—	—	SS	—	—
Hydrocarbon											
Benzene	VS	VS	VS	VS	VS	VS	S	S	VS	VS	143
Gasoline	VS	VS	VS	VS	VS	VS	—	—	VS	VS	—
Kerosene	VS	VS	VS	VS	VS	VS	SS	S	VS	VS	—
Mineral Spirits	VS	VS	VS	VS	VS	VS	S	S	VS	VS	—
Paraffin	$2.0^{27.5°C}$	S	$2.0^{26°C}$	S	—	S	—	—	5.0	S	—
Pine Oil	S	S	VS	VS	S	S	S	S	S	S	—
Toluene	VS	VS	VS	VS	VS	VS	S	S	VS	VS	142
Turpentine	VS	VS	VS	VS	VS	VS	S	S	VS	VS	—
Xylene	VS	VS	VS	VS	VS	VS	S	S	VS	VS	178
Hydroxy derivatives											
Amyl Alcohol	S	S	—	—	S	S	SS	S	S	S	—
n-Butyl Alcohol	S	S	—	—	S	S	I	SS	SS	S	—
Ethyl Alcohol (3-A)	$23.3^{29°C}$	$88.0^{70°C}$	—	—	$10^{27°C}$	$28^{75°C}$	I	I	SS	—	—
Glycerine	I	I	I	I	I	I	I	I	I	I	—
Methyl Alcohol	$42.5^{29°C}$	$88.5^{60°C}$	—	—	$15^{26°C}$	$22.2^{85°C}$	—	—	SS	—	—
Phenol — 90%	$194^{30°C}$	S	—	—	SS	S	SS	S	S	S	—
Ketone: Acetone	S	S	—	—	S	S	I	I	S	S	260
Miscellaneous											
Carbon Disulfide	S	S	—	—	S	S	S	S	VS	VS	—
Nitrobenzene	S	S	—	—	S	S	—	—	VS	—	—
Water	I	I	I	I	I	I	I	I	I	I	—

I — Insoluble SS — Slightly Soluble S — Soluble VS — Very Soluble.

Figures show grams of Aroclor per 100 milliliters of solvent at 25°C unless otherwise indicated.

*Trademark of Union Carbide Corp.

TABLE 2

CHEMICAL AND PHYSICAL PROPERTIES OF REPRESENTATIVE AROCLOR® PLASTICIZERS AND RESINS

Property	*Aroclor 1221*	*Aroclor 1232*	*Aroclor 1242*	*Aroclor 1248*	*Aroclor 1254*
Appearance	Clear, mobile oil	Clear, mobile oil	Clear, mobile oil	Clear, mobile oil	Light-yellow viscous liquid
Color, maximum	*100 APHA	*100 APHA	*100 APHA	*100 APHA	*100 APHA
Chlorine, percent	20.5-21.5	31.5-32.5	42	48	54
Acidity, mg KOH/g, maximum	*0.014	*0.014	*0.015	*0.010	*0.010
Moisture, ppm, maximum	—	—	*50	*50	*50
Ave. Coefficient of Expansion, cc/cc/°C	0.00071 (15°-40°C)	0.00073 (25°-100°C)	0.00068 (25°-65°C)	0.00070 (25°-65°C)	0.00066 (25°-65°C)
Specific Gravity	*1.182-1.192 (25°/15.5°C)	*1.270-1.280 (25°/15.5°C)	*1.381-1.392 (25°/15.5°C)	*1.405-1.415 (65°/15.5°C)	*1.495-1.505 (65°/15.5°C)
Density, pounds per gallon, 25°C	9.85	10.55	11.50	12.04	12.82
Distillation Range, °C, corrected (ASTM D-20, modified)	275-320	290-325	325-366	340-375	365-390
Evaporation Loss, %, 100°C, 6 hours (ASTM D-6, mod.) 163°C, 5 hours	1.0-1.5	1.0-1.5	0-0.4 3.0-3.6	0-0.3 3.0-4.0	0-0.2 1.1-1.3
Flash Point (Cleveland Open Cup), °C °F	141-150 286-302	152-154 305-310	176-180 348-356	193-196 379-384	None to boiling point
Fire Point (Cleveland Open Cup), °C °F	176 349	238 460	None to boiling point	None to boiling point	None to boiling point
Pour Point (ASTM E-97), °C °F	1 (crystals) 34 (crystals)	—35.5 —32	—19 2	—7 19.4	10 50
Softening Point (ASTM E-28), °C °F	—	—	—	—	—
Refractive Index, n D-20 20°C	1.617-1.618	1.620-1.622	1.627-1.629	1.630-1.631	1.639-1.641
Viscosity, Seconds Saybolt Universal (ASTM D-88) 100°F (37.8°C) 130°F (54.4°C) 210°F (98.9°C)	*38-41 35-37 30-31	*44-51 39-41 31-32	*82-92 49-56 34-35	185-240 *73-80 36-37	1800-2500 260-340 *44-48

*Monsanto Specifications.

Aroclor 1260	*Aroclor 1262*	*Aroclor 5442*	*Aroclor 4465*	*Aroclor 2565*	*Aroclor 5460*	*Aroclor 1268*
Light-yellow, soft, sticky resin	Light-yellow sticky, viscous resin	Clear yellow sticky resin	Clear, light-yellow, resin	Black, opaque, brittle resin	Clear, yellow-to-amber, brittle resin or flakes	White to off-white powder
*150 APHA	*150 APHA	*2 NPA (molten)	*2 NPA (molten)	—	*2 NPA (molten)	*1.5 NPA (molten)
60	61.5-62.5	42	65	65	58.5-60.6	68
*0.014	*0.014	0.05	0.05	1.4	0.05	0.05
*50	—	—	—	—	—	—
0.00067 (20°-100°C)	0.00064 (25°-65°C)	0.00123 (25°-99°C)	0.00061 (25°-65°C)	0.00066 (25°-65°C)	0.00179 (25°-124°C)	0.00067 (20°-100°C)
*1.555-1.566 (90°/15.5°C)	*1.572-1.583 (90°/15.5°C)	1.470 (25°/25°C)	1.670 (25°/25°C)	1.734 (25°/25°C)	1.670 (25°/25°C)	1.804-1.811 (25°/25°C)
13.50	13.72	12.24	13.91	14.44	13.91	15.00
385-420	390-425	215-300 (4 mm. Hg)	230-320 (4 mm. Hg)	—	280-335 (5 mm. Hg)	435-450
0-0.1 0.5-0.8	0-0.1 0.5-0.8	0.01 0.2	0-0.02 0.2-0.3	0.2-0.3	0.03	0-0.08 0.1-0.2
None to boiling point	None to boiling point	247 477	None to boiling point	—	None to boiling point	None to boiling point
None to boiling point	None to boiling point	> 350 > 662	None to boiling point	—	None to boiling point	None to boiling point
31 88	30-38 90	46 115	—	—	—	—
—	—	*46-52 115-126	*60-66 140-151	*66-72 149-162	*98-105 208-222	*150-170 (hold 302-338 point)
1.647-1.649	1.6501-1.6517	—	1.664-1.667	—	1.660-1.666	—
3200-4500 *72-78	600-850 (160°F; 71°C) *88-100	300-400	90-150 (266°F; 130°C)	—	—	—

*Monsanto Specifications.

Density

All the Aroclor plasticizers are heavier than water, a valuable property for many applications. Densities are shown in Figure 1.

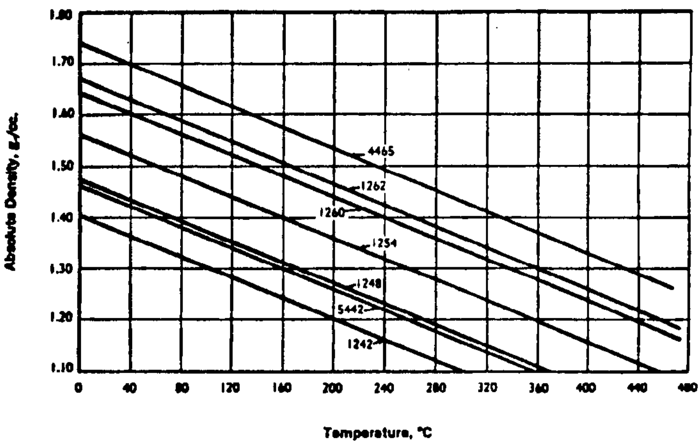


Fig. 1 — Densities of Aroclor® Plasticizers at Various Temperatures

Specific Volume

The specific volume of Aroclor 1248 at different temperatures is as follows:

Temperature (°F)	*Aroclor® 1248 Specific Volume (ml/g)*
0	0.674
100	0.699
200	0.726
300	0.755
400	0.790
500	0.828
600	0.870

Volatility

The low vaporization loss of Aroclor plasticizers is indicated in Table 3.

TABLE 3

VAPORIZATION RATES OF AROCLOR® PLASTICIZERS

Plasticizer (Surface area: 12.28 sq. cm.)	*Wt. Loss (g)*	*Exposure at 100°C (hr.)*	*Vaporization Rate (g/sq. cm./hr.)*
Aroclor 1221	0.5126	24	0.00174
Aroclor 1232	0.2572	24	0.000874
Aroclor 1242	0.0996	24	0.000338
Aroclor 1248	0.0448	24	0.000152
*Cloralin**-42-S	0.0745	48	0.000126
Dioctyl phthalate	0.0688	48	0.000117
*Dutrex*** 25	0.0256	24	0.000087
Aroclor 1254	0.0156	24	0.000053
Shell Dutrex 20	0.0047	24	0.000016
Aroclor 1262	0.0039	24	0.000013
Aroclor 1260	0.0026	24	0.000009
Aroclor 4465	0.0064	72	0.000007
Aroclor 5442	0.0039	72	0.000004
Aroclor 5460	0.0032	72	0.000004
Tricresyl phosphate	0.0010	24	0.000003

It is concluded that the vaporization rates of Aroclor plasticizers — especially the most widely used 1254 and 1260 — compare most favorably with the similar constants of other plasticizers selected specifically for these tests because of their low vaporization rates.

*Trademark of [illegible], Inc.
**Trademark of Shell Oil Co.

The vapor pressures of several Aroclor plasticizers are indicated in Figure 2 over the temperature range 150° to 300°C.

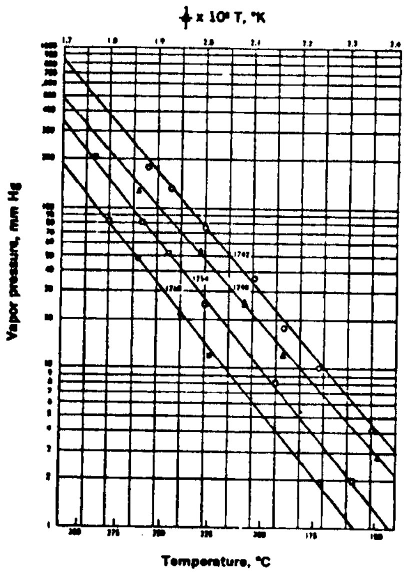


Fig. 2 — Vapor Pressures of Aroclor® Plasticizers

The estimated vapor pressures of several Aroclor plasticizers at 100°F shown in the following table were determined by extrapolation from the values shown in Figure 2.

Approximate Vapor Pressure of Aroclor® Plasticizers Estimated at 100° F (37.8° C)

Aroclor 1232	0.005 mm. Hg
Aroclor 1242	0.001 mm. Hg
Aroclor 1248	0.00037 mm. Hg
Aroclor 1254	0.00008 mm. Hg

Viscosity

The viscosities of the Aroclor plasticizers vary according to whether the base material is a biphenyl or a polyphenyl and on the degree of chlorination. In general the low-chlorinated biphenyls have the lowest viscosities (Figure 3).

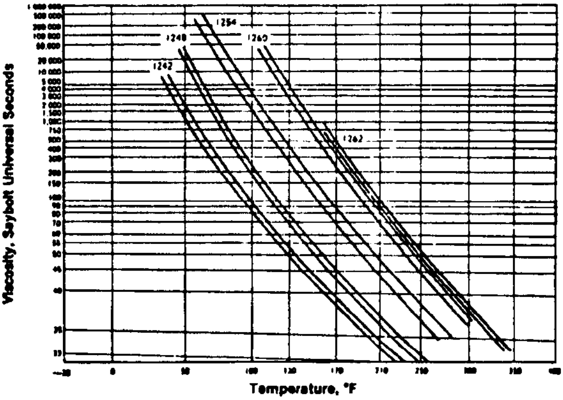


Fig. 3 — Viscosity Ranges of Some Aroclor® Plasticizers

Inhalation

At ordinary temperatures the Aroclor chlorinated polyphenyls have not presented industrial toxicological problems. The hazard of potential toxic exposure varies with their volatility: the lower-chlorinated, more-volatile ones present more of a potential problem from the standpoint of both inhalation and skin contact. When Aroclor plasticizers are used at elevated temperatures, engineering controls must be applied, either by the use of closed systems or by effective local-exhaust ventilation together with general workroom exhaust.

Vapor of the liquid Aroclor plasticizers at room temperature should not be breathed in a confined space, and no vapor of any Aroclor evolved at elevated temperatures should be allowed to be dispersed into the general workroom.

Inhalation tests on animals indicate that the maximum safe concentration of vapor is in the range of from 0.5 to 1.0 milligram of the lower-chlorinated Aroclor plasticizers per cubic meter of air. The threshold limit values (maximum allowable concentration for an 8-hour working day) set by the American Conference of Government Hygienists are 1.0 milligram of the lower-chlorinated Aroclor compounds per cubic meter of air and 0.5 milligram of the more-highly-chlorinated compounds, such as Aroclor 1254, per cubic meter of air.

Skin Contact

Schwartz patch tests on 200 volunteers showed that Aroclor 1254 was neither a primary skin irritant or a sensitizer.

Prolonged or repeated skin contact with the Aroclor plasticizers must be avoided by the use of gloves and protective garments, because of the possible occurrence of a condition called chloracne. Although reports of this condition caused by Aroclor are rare, it can be produced by excessive skin contact. If any Aroclor is spilled on the skin the skin should be washed in the usual manner with a soap solution.

A burn caused by contact with a hot Aroclor should be treated like any ordinary burn. Aroclor plasticizer adhering to the burned area need not be removed immediately, unless treatment of the burn demands it, in which case either soap and water or repeated washings with a vegetable oil are recommended.

MONS 075959

Environmental Hazards

Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, Aroclor 1268, Aroclor 4465, and Montar 1 all contain polychlorinated biphenyls (PCB) of various types and in varying amounts. PCB residues in small amounts have been found in the environment and some studies have indicated that they may be harmful to certain forms of animal life. Extreme care should therefore be taken by all users of PCB-containing products to prevent any entry into the environment through spills, leakage, use, disposal, vaporization or otherwise. Further, the products in which PCB materials are used, or which are formulated using PCB materials as a component, should be given careful study to eliminate the possibility that PCB might reach the environment as a result of use in a given application.

Some specific applications where the use of PCB should definitely be avoided are in paints and sealants for swimming pools, paints and waterproofing agents in silos and other buildings where food products for humans or animals are stored, and as a component of any container or wrapping used in the packaging of food products.

MONS 075960

Freight Classification

Aroclor 1221, 1232, 1242, 1248, 1254, 1260, 1262	Synthetic Resin, Liquid, NOIBN

Rail Classification

Aroclor 1268, 4465, 5442, 5460	Synthetic Resin, Other Than Liquid, NOIBN

Truck Classification

Aroclor 1268	Synthetic Resin, Powder, NOI
Aroclor 4465, 5442, 5460	Synthetic Resin, Lumps or Solid Mass, NOI

Shipping Regulations None

Standard Containers

Aroclor 1221	Tank car, 520-lb. steel drum, 50-lb. can
Aroclor 1232	Tank car, 550-lb. steel drum, 50-lb. can
Aroclor 1242, 1248, 1254, 1260, 1262	Tank car, 600-lb. steel drum, 50-lb. can
Aroclor 1268	200-lb. fiber drum, 25-lb. fiber drum
Aroclor 4465	500-lb. steel drum, 50-lb. can
Aroclor 5442	450-lb. steel drum, 50-lb. can
Aroclor 5460 (flaked)	50-lb. bag

MONS 075961

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3/70

MONS 075962

EXHIBIT 24

ROBERT HERRICK

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
___________________________/

DEPOSITION OF ROBERT F. HERRICK
Boston, Massachusetts
Thursday, August 18, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 111668

You know, this research group has published a whole series of papers, and so if I can just refresh my --

Q. Sure.

A. -- memory on this one, as to what exactly this one addressed.

(Witness reviews document.)

MS. EVANGELISTI: Can you read the question back.

(The record was read.)

Q. By "exposure data," I mean measurements of PCBs in environmental matrices.

A. I would agree. This one doesn't directly report the results of air sampling.

Q. Okay. So have you cited -- we've gone through some of the papers that have investigated the relationship between PCB contamination and PCB blood levels and discussed the authors' conclusions about the magnitude of those differences, and the potential health consequences.

Did you cite any papers that purport to demonstrate that PCBs found in buildings causes health problems?

A. I didn't cite any. That's partly because there really haven't -- those studies haven't been done.

Q. Are you aware of any studies that would verify a hypothesis that the PCB levels found in the Westport Middle School caused health problems?

MS. EVANGELISTI: Vague. Incomplete hypothetical.

A. To my knowledge, those studies have never been done.

Q. You're aware that the kids in Westport remained in that school until June of 2015; is that correct? Do I have that right?

A. I think so. I think it is. I don't recall the exact date.

Q. Do you think the kids were sick?

MS. EVANGELISTI: Objection. Incomplete hypothetical. Vague.

A. You know, I don't really know that I have -- that I'm in the position or really have the information to make any kind of a

EXHIBIT 25

Expert Report of Christine T. Wood, Ph.D.

Town of Westport and Westport Community Schools
v.
Monsanto Company, Solutia Inc., and Pharmacia Corporation

June 30, 2016

Introduction

This report summarizes the work undertaken by Exponent® Failure Analysis Associates in connection with human factors issues in the above-referenced case. I certify that this report is true under pains and penalties of perjury. All facts are of my personal knowledge, except those facts which are reference to sources therein. For those facts, I relied upon the sources identified, as set forth in the report.

Construction of the Westport Middle School began in the late 1960s and the school opened on September 14, 1970.[1] The Town of Westport hired Drummey Rosane Anderson Inc. as the architect for the Westport Middle School project on February 21, 1968.[2] Drummey Rosane Anderson's specifications for the school included guidance about the type of caulking to be used in the school,[3] and, in May 1969, the architect approved sub-contractor National Waterproofing Co.'s proposed brand of caulking to fulfill those requirements.[4] National Waterproofing Co. installed caulking at Westport Middle School beginning around May 1969 and completed installation in September 1970, when the school opened.[5] The Town of Westport closed the middle school in September, 2015.[6] In August of 1970, Monsanto terminated the sale of polychlorinated biphenyls (PCBs) for open uses, including plasticizer applications.[7]

Plaintiffs Town of Westport and Westport Community Schools allege that PCBs, specifically Aroclor 1248 and 1254, used as plasticizers in products, including window caulk, were used in the construction of Westport Community Schools and that they contaminated school building structures, soil, and air, resulting in property damage.[8] The plaintiffs claim that Monsanto (and its predecessor companies), as manufacturers of PCBs, failed to provide adequate warnings of PCBs' ability to "contaminate adjacent materials, dust, air, interior surfaces, exterior surfaces, and soil."[9]

I have been asked to address the human factors considered in determining when a warning should be provided for a product, and the application of these factors to PCBs and PCB-containing caulk at issue in this case. I have been asked to address whether it is reasonable for a bulk supplier of PCBs, which are used as a plasticizer in a finished good, to rely on the manufacturer of the finished good (window caulk) to warn end-users about hazards of the finished good.

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[1] WSTPRTSCHL008281; CCECRESEARCH-WESTPORT002934
[2] WSTPRTSCHL008115; WSTPRTSCHL011217
[3] WSTPRTSCHL010419; WSTPRTSCHL010602
[4] WSTPRTSCHL005478; WSTPRTSCHL005486
[5] WSTPRTSCHL008270; WSTPRTSCHL007249; WSTPRTSCHL008069
[6] Deposition of Michelle Duarte, 3/30/2016, pp. 216-217
[7] Deposition of Robert G. Kaley, II, 4/5/16, ("Kaley Vol 1"), pp. 211-213; Deposition of Robert G. Kaley, II, 4/6/16, ("Kaley Vol 2"), pp. 419-420; Kaley, Exhibit 61; LEXOLDMON000317 - LEXOLDMON000318
[8] Plaintiffs' First Amended Complaint, p. 14. Plaintiffs' First Amended Complaint, ¶¶ 2, 4, 78, 114, 121-122
[9] Plaintiffs' First Amended Complaint, ¶¶ 77-80, 94(e),118(c)

Training and Qualifications

My name is Christine T. Wood. I received a B.A. degree from Stanford University in 1971 graduating with Distinction and Honors in Psychology. In 1974, I received my Ph.D. in Experimental Psychology, also from Stanford University. Central to the field of Experimental Psychology is the study of human information processing including learning, memory, attention, vision, and perception. The capabilities and limitations of human information processing are systematically analyzed from infancy to late adulthood to better understand how these processes develop, operate, and change.

Over the past 30 years, there has developed a sizable literature on behavioral responses to risk communications. Significant reviews of and annotated guides to the literature for different periods can be found in McCarthy et al. (1984), Ayres et al. (1994; 1998), and Miller & Lehto (2001). Some of the factors considered in the scientific literature include the likely effectiveness of providing a warning about a particular hazard, labeling directives presented in relevant standards and guidelines, and the likely effect of formatting and the inclusion of specific warning elements on compliance.

The scientific literature on risk communication referenced above, and in the specific studies cited in my report, includes data gathered in laboratory settings, focus groups, surveys, and analysis of real world data. The significant body of literature to which these studies belong allows for scientific investigation as to what, when, where, and how warnings could be provided and the likely impact they are to have on human behaviors. The scientific underpinnings that shape attention and response to risk communications provide important, and in some instances, surprising insights about people's efforts to control their exposure to hazards.

I apply the scientific literature on risk communication to the development of safety information and to the assessment of the impact of warnings. I have previously done assessments of warnings provided by bulk suppliers of raw materials, including chemicals, as well as finished goods, such as medical devices, pharmaceuticals, and consumer products. I have published papers on changes in risk communication over decades specifically related to voluntary standards and federal regulations governing a manufacturer's labeling requirements (e.g., Wood et al., 2006) and the factors that influence whether a warning will change behavior (e.g., Ayres et al., 1989; re-published in Human Factors Perspectives on Warnings, 1994). I have analyzed real world data to measure changes in injury rates related to the introduction of a warning (e.g., Arndt et al., 1998). I have also published peer-reviewed papers contrasting labeling guidance among government regulatory agencies (e.g., Sala et al., 2010).

Currently, I am a Principal Scientist at Exponent, a scientific and engineering consulting firm, where I have worked since 1988. A list of my publications and additional information about my professional experience are contained in my resume. Exponent in 2016 charges a rate of $490 an hour for my time.

Methodology

When asked to discuss the warnings and other risk communication accompanying a product, I consider, among other things, the audience to whom this communication is directed and what knowledge the recipients of the communication already possess about the information provided. I consider the conditions that may affect the likelihood that the communication will be noticed, read, understood, and acted upon by those who purchased the product. The opinions contained in this report are based on my education, training and experience and on my review of materials listed in an attachment to my report. I reserve the right to supplement this report and to expand or modify my opinions based on review of material as it becomes available through ongoing discovery. Should I be asked to testify in this case, I plan to use excerpts and charts from the materials I have cited in my report.

Opinions and Scientific Bases

Warnings provided by Monsanto about PCBs during the time when Westport schools were constructed and earlier were appropriate and reasonable in the manner in which the information was disseminated, formatted, and worded.

Assessing the adequacy of historical warnings for products used in the 1960s must take into account the practices and requirements of the time in which they appeared, as well as the state of knowledge about any hazards that, with the benefit of hindsight, might today suggest the appropriateness of a warning. It is common for product warnings to change over time as the scientific understanding about the uses of a product, or its effect on the environment and on people, evolves. Moreover, the culture and practice of providing warnings has changed over time, independent of what was known about specific hazards. Products in the workplace, consumer products, food and drugs, and industrial chemicals, for instance, each have a separate history of the use of warnings as a safety measure. Products currently used in the workplace and in households in the United States often come with extensive safety information. The presentation of large amounts of such material was not always the case, however; and this practice was not common in the first half of the 20th century,[10] when Monsanto was beginning to produce PCBs and offer them for sale to other companies and through its distributors.[11]

Warnings from Monsanto were disseminated to its customers and potential customers through application/technical bulletins and through warning labels placed on containers of PCBs.[12] The wording used to describe skin contact and inhalation and dust hazards[13] was consistent with language contained in guidance from the Manufacturer's Chemist Association (MCA), from the time the MCA's language was first introduced in 1946[14] to 1970, when Monsanto ceased selling PCBs for use in plasticizers.[15] Warning labels were appropriately kept brief and concise, which

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[10] Diedrich et al. (2001); Wood et al. (2006)

[11] Deposition of William Papageorge (TOWOLDMON0002926- TOWOLDMON0003166) ("Papageorge"), pp. 351-352; Deposition of R. Emmett Kelly (LEXOLDMON001527 – LEXOLDMON001779) ("Kelly"), pp. 4, 23; Erickson & Kaley (2011); Durfee (1976), pp. 297-298; Kaley Vol. 1, pp. 48-49

[12] Kelly, pp. 136-137, 149; Kaley Vol 1., pp. 95-96

[13] Kelly, pp. 144-147; LEXOLDMON001926; LEXOLDMON001928-LEXOLDMON001929; Kaley Vol 1., p. 97; Kaley Exhibit 4 (TOWOLDMON0001620, LEXOLDMON1189)

[14] Manual L-2, pp. 25, 58

[15] Guide to Precautionary Labeling of Hazardous Chemicals, Sixth Edition, p. 48; Guide to Precautionary Labeling of Hazardous Chemicals, Seventh Edition, pp. 53, 58, 61

reduces the cognitive effort required to process the information and increases the accuracy of recall of the information.[16]

Monsanto's use of application/technical bulletins provided a format to disseminate more detailed and more technical information about PCB hazards to customers and potential customers. For example, they contained details about the physical properties of PCBs and uses of a product[17] and about the use of ventilation to control vapors and possible need to have workers use respirators.[18] Technical bulletins contained information about the vaporization rates of Aroclor compounds and their volatility.[19] The distribution of warnings in the form of technical bulletins, such as was done by Monsanto for PCBs, was ultimately an approach that was initially mandated for chemical manufacturers by Occupational Safety and Health Administration (OSHA) in 1983 as a hazard communication practice.[20] Manufacturers today are still required to provide technical information, now referred to as Safety Data Sheets, containing specific categories of information about chemicals, including safety information.[21] Monsanto used technical bulletins as a form of communication about PCBs beginning as early as 1937, well before the OSHA requirements.[22]

Chronic adverse health effects that might appear years after exposure to a substance were addressed in labeling in occupational settings generally beginning in the 1980s, and in consumer products beginning in the 1990s, with some exceptions. Compared to acute physical injuries that are more readily understood and visible, long-term health risks are harder to identify, measure, and evaluate. The health messages to address chronic health effects can also be more complex and technical.

Although the labeling of industrial chemicals has had a long history that can be traced back to the 1940s, it was not until 1983 that ANSI Z129.1-1982 (American National Standard for Hazardous Industrial Chemicals – Precautionary Labeling) recommended including serious chronic effects in labeling.[23] Similarly, OSHA's 1983 Hazard Communication Standard, which became fully effective in 1986, mandated that chronic health effects of chemical exposures were to be included in the labeling of hazardous chemicals in the workplace.[24] A "health hazard" was defined as a chemical for which "there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed ***employees*** [emphasis added]."[25] Manufacturers were not required

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[16] Miller (1956); Chen et al. (1997); Wogalter & Usher (1999)
[17] Kelly, pp. 137-138; Kaley Exhibits 6 (TOWOLDMON0005568- TOWOLDMON0005569) and 7 (TOWOLDMON0046313 - TOWOLDMON0046314, TOWOLDMON0046316)
[18] E.g., LEXOLDMON001925; LEXOLDMON003175; LEXOLDMON003176; Kaley Exhibits 6 (TOWOLDMON0005608) and 7 (TOWOLDMON0046321 - TOWOLDMON0046322)
[19] E.g., TOWOLDMON0046268, TOWOLDMON0046313, TOWOLDMON0046314, TOWOLDMON0046316
[20] https://www.osha.gov/dsg/hazcom/finalmsdsreport.html (accessed: 5/5/2015); 29 CFR 1910.1200
[21] 29 CFR 1910.1200; https://www.osha.gov/Publications/OSHA3514.html (accessed: 5/5/2015); https://www.osha.gov/dsg/hazcom/finalmsdsreport.html (accessed: 5/5/2015)
[22] Kelly, p. 135
[23] ANSI Z129.1-1982
[24] 48 Fed Reg 53280 (25 November 1983)
[25] 29 CFR 1910.1200

to warn about speculative or theoretical health hazards, but rather ones that had been documented based on at least one scientific study.

For consumer products, it was not until 1988 that Congress amended the FHSA [i.e., Labeling of Hazardous Art Materials Act (LHAMA)][26] to require hazard warning labels for art material that had the potential for posing chronic adverse health effects. Concerns were raised about solvents in oil painting, solders for stained glass, lead in paints and ceramics, and asbestos in talcs and clays. Hazardous art materials intended for use by children were of particular concern.[27] In 1992, over thirty years after the Federal Hazardous Substances Act was first created, amendments were made to supplement the existing regulatory definition of toxic substances to include chronic hazards guidelines.[28] The scope of the regulation included all products subject to the FHSA that may present a chronic hazard.

Monsanto sold PCBs in bulk form.[29] The PCBs were sold directly to hundreds of companies and used in a wide variety of products.[30] Monsanto also sold PCBs to distributors who then resold the material to their customers, who either resold the PCBs or used them as an ingredient in their finished goods.[31] Monsanto's distributors' and customers' needs varied greatly as did their position in the supply chain, from raw products to finished goods.[32] Even within the group of customers who used PCBs as plasticizers, the range of finished goods was broad and included products such as sealants, paints and coatings in addition to caulk.

Human factors scientists typically rely on the work of scientists in other fields (e.g., epidemiologists, microbiologists, toxicologists) to determine whether a health hazard exists, how a health hazard occurs, the level of risk posed by the hazard, and how it can be mitigated. Dr. James Lamb, a toxicologist retained on behalf of Monsanto, has reviewed the content of the warnings about PCBs provided by Monsanto from the 1930s to the 1970s and the toxicity testing and other scientific bases available to inform decisions about the content of warnings about PCBs. He has determined that, in terms of the hazards presented in the messages, the information reflects the state of knowledge at the time.[33] Accordingly, Monsanto provided warnings aimed at the protection of workers, which remained an emphasis throughout its time in the marketplace.

In the latter half of the 1960s, additional concerns about PCBs were raised by a small handful of scientists, who were primarily focused on the environmental impact of PCBs found in wildlife and in waterways.[34] Not until 2009 did the Environmental Protection Agency (EPA) provide

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[26] Federal Hazardous Substances Act [Pub. L. 100-695, 102 Stat. 4568], §23
[27] 57 Fed. Reg. 46669 (9 October 1992)
[28] 57 Fed. Reg. 46669 (9 October 1992)
[29] LEXOLDMON000222
[30] Papageorge, p. 416; LEXOLDMON000929 - LEXOLDMON000952; LEXOLDMON000827 - LEXOLDMON000905
[31] Papageorge, pp. 398-399; LEXOLDMON000169 - LEXOLDMON000170; LEXOLDMON000177 - LEXOLDMON000180; LEXOLDMON000191 - LEXOLDMON000192; LEXOLDMON000261 - LEXOLDMON000273
[32] E.g., see LEXOLDMON000255 - LEXOLDMON000258; LEXOLDMON000261 - LEXOLDMON000273
[33] See Expert Report of James C. Lamb IV
[34] See Appendix A

guidance to schools about the potential for PCBs to be released from window caulkand the associated hazards. Out of an abundance of caution, the agency recommended "practical, common sense steps to reduce exposure [to contaminated caulk]" including:

- Cleaning air ducts
- Improving ventilation by opening windows and using or installing exhaust fans where possible
- Cleaning frequently to reduce dust and residue inside buildings
- Using a wet or damp cloth or mop to clean surfaces
- Not sweeping with dry brooms and minimizing the use of dusters in areas near potential PCB-containing caulk
- Using vacuums with high efficiency particulate air filters
- Washing hands with soap and water often, particularly before eating and drinking
- Washing children's toys often[35]

Federal regulations do not require schools to test for PCBs.[36] In its guidance to schools, issued in December, 2009, the Commonwealth of Massachusetts stated that the presence of PCBs in intact window caulking is not likely to present exposure and health impacts.[37] The guidance recommends conducting air and surface wipe testing near caulking that is deteriorated or damaged to help determine if indoor air levels of PCBs are a concern and if there is a need for more aggressive cleaning.[38] Even nearly forty years after the construction of the Westport school, therefore, the government agencies' cautionary statements concerning the potential hazards of PCBs to the occupants of schools are generally reassuring, offer "common sense steps," and are not alarming in the manner in which the statements are worded.

To avoid the negative consequences of providing warnings that are speculative, it was reasonable for Monsanto to take time to investigate the reports of environmental contamination from PCBs, rather than to immediately issue some type of warning to its customers.

By the 1960s, Monsanto had decades of experience with workers handling PCBs in its plants and that experience demonstrated no chronic adverse health effects from occupational exposures.[39] Technical bulletins state with respect to inhalation, for example, that "at ordinary temperatures the Aroclor chlorinated polyphenyls have not presented industrial toxicological problems."[40] In my review of the reports of Dr. Jack Matson and James Olson,[41] scientists who have been retained by the plaintiffs, I do not find any analysis of or opinions about what was known in the 1950s or 1960s about potential chronic health hazards posed by PCB-containing caulk that would have formed the basis for a warning that the plaintiffs claim was absent. Without medical or scientific evidence in the 1950s and 1960s identifying the existence of chronic adverse health

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35 2009 Sept 25 EPA press release
36 PCBs in Caulk—QA, pp. 9, 14
37 Bureau of Environmental Health, Massachusetts Department of Public Health (MDPH), December, 2009, p. 4
38 Bureau of Environmental Health, Massachusetts Department of Public Health (MDPH), December, 2009, pp. 5-6
39 Kelly, pp 24-26, 122
40 TOWOLDMON0046321, LEXOLDMON000209-225
41 Expert Report of Jack Matson; Expert Report of James Olson

effects from exposure to PCB-containing caulk in schools, there was no scientific basis to support such warnings. Issuing warnings about theoretical hazards has negative impacts on human information processing that have been identified in the scientific literature. A decision to have labeling include remote or hypothetical negative consequences will increase the number of warnings, thereby increasing the amount of information to be processed. Scientists have expressed concern that as the number of warnings grows and the prevalence of warnings increases, people will increasingly ignore warnings.[42] Should the practice of including warnings about uncertain, unproven, or theoretical hazards become widespread, warnings will be viewed increasingly as false alarms, and their impact will be reduced.[43] Other concerns about overwarning identified in the literature include reduced attention to individual messages within warnings; reduced believability or credibility of warnings; and reduced ability to differentiate the relative magnitude of risks.[44]

In the 1960s, Monsanto continued to provide safety information on containers of PCBs such as:[45]

> "Caution! Contains chlorinated hydrocarbons.
> Avoid prolonged breathing of vapors or mists.
> Avoid contact with eyes or prolonged contact with skin.
> If skin contact occurs, remove by washing with soap and water. Following eye contact flush with water.
> If clothing becomes soaked with fluid, launder before wearing again.

In November, 1966, Monsanto learned of Soren Jensen's study, finding what was believed to be PCBs in environmental samples in Sweden.[46] Over the next three years, Monsanto provided Dr. Jensen, government agencies (e.g., FDA, U.S. Department of Interior Fish and Wildlife Services), and other researchers with PCB samples so that they could do further research to clarify whether PCBs were in environmental samples.[47]

Beginning in 1970, Monsanto notified all Aroclor customers and distributors about PCB concerns and developed a plan to discontinue certain Aroclors.[48] Monsanto sent PCB notification letters to its direct customers and distributors in February of 1970 and alerted them of potential environmental contamination in marine aquatic and wildlife environments. The letters stated that "all possible care should be taken in the application, processing, and effluent disposal of these products to prevent them becoming environmental contaminant."[49] Monsanto notified its four distributors (i.e., Central Solvents and Chemicals, Great Western Chemical, Tab Chemicals, and American Mineral Spirits Company) to contact their own customers about these

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[42] McCarthy et al. (1982); Dorris (1991)
[43] Frantz et al. (1999)
[44] Friedmann (1988); deTurck (1995)
[45] Kelly, pp. 144-149; LEXOLDMON001928; Kaley Vol. 1, pp. 95-96; Kaley Exhibit 4 (TOWOLDMON0001622); See also LEXOLDMON00l190
[46] LEXOLDMON000015
[47] LEXOLDMON000137; LEXOLDMON000609; LEXOLDMON000111 - LEXOLDMON000114
[48] LEXOLDMON000191-192, LEXOLDMON000169-170, LEXOLDMON000704
[49] Papageorge, pp. 398-399; LEXOLDMON000169 - LEXOLDMON000170; LEXOLDMON000177 - LEXOLDMON000180; LEXOLDMON000191 - LEXOLDMON000192

issues.[50] Monsanto provided their distributors with sample letters to alert customers about the potential relationship between certain Aroclors and environmental contamination, and instructed these distributors to promptly and simultaneously contact customers.[51]

In March of 1970, Monsanto sent a technical bulletin about Aroclor plasticizers to distributors and customers.[52] The bulletin continued to include steps to avoid inhalation and skin contact hazards and also contained information about environmental hazards. Monsanto's bulletin stated Aroclors, including 1248 and 1254, contained PCBs and that small amounts of PCB residues have been found in the environment and may be harmful to certain animals, and that care should be taken to avoid environmental contamination through accidents, use, disposal, or vaporization.

In May of 1970, Monsanto began dissemination of new language about environmental exposure on labels for containers of PCBs, including Aroclors 1248 and 1254.[53] New labels were to contain the following additional language, and a stick-on label containing this information was to supplement labels on pre-existing inventory:

> This product contains polychlorinated biphenyls, which some studies have shown may be an environmental contaminant. Extreme care should be taken to prevent any entry into the environment through spills, leakage, use, disposal, vaporization or otherwise.[54]

In May of 1970, as well, Monsanto sent letters to the four distributors alerting them that PCB-containing products for plasticizer applications may be the source of alleged environmental contamination, and that they would be discontinued effective August 30, 1970. They informed distributors that Monsanto's direct customers would be notified by June 1, 1970, and that the distributors should contact their customers.[55]

In August of 1970, Monsanto sent its customers who used Aroclors in plasticizer / modifier applications a letter with updated information about PCBs and the most recent technical bulletin (from March 1970[56]) and instructed distributors to relay this information to their customers.[57] They outlined a modified return policy for unopened containers and gave larger (or full) refunds, depending on how soon the item was returned.[58]

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[50] LEXOLDMON000177 - LEXOLDMON000180; LEXOLDMON000192
[51] LEXOLDMON000177 - LEXOLDMON000180; LEXOLDMON000192
[52] Papageorge, pp. 404-405; LEXOLDMON000209 - LEXOLDMON000225
[53] Kelly, p. 147; Papageorge, p. 448; LEXOLDMON001930; LEXOLDMON000243 - LEXOLDMON000252; LEXOLDMON000274
[54] Kelly, p. 147; LEXOLDMON001931
[55] LEXOLDMON000261 - LEXOLDMON000273
[56] Papageorge, pp. 404-405; LEXOLDMON000209 - LEXOLDMON000225
[57] LEXOLDMON000907
[58] LEXOLDMON000908 - LEXOLDMON000911

Monsanto's decision in 1970 to cease sale of PCBs for use in plasticizers and other applications was a stronger response to the concerns about environmental contamination than providing any warnings about the issue.

In August of 1970, Monsanto terminated the sales of PCBs for open uses, including in plasticizer applications.[59] The decision was made in spite of protests by some of Monsanto's most important customers, who relied on Monsanto for the supply of an important ingredient in their own products. The decision was made in recognition of the fact that there were certain uses for which it was difficult for Monsanto to control the ultimate disposal of the PCB materials.[60] Given the state of the science at the time, Monsanto's decision was reached because of concerns about PCBs found in waterways and wildlife,[61] which is a different issue from the possibility of chronic adverse health effects for humans that might be associated with PCBs released from window caulk in schools.

Manufacturers of PCB-containing finished goods, such as window caulk, did not have to rely on Monsanto to learn of concerns about environmental contamination from PCBs in marine aquatic and wildlife environments. The developing information about PCB environmental contamination was widely available in scientific publications and in the public media at the time of construction of Westport schools.

The architectural planning for, and construction of, the Westport school falls squarely into a period of scientific uncertainty and intense activity for Monsanto to discover whether initial reports of the possibility of harmful environmental effects of PCBs were scientifically tenable, and consequently suggested action for Monsanto and the manufacturers of finished goods that used PCBs as ingredients. As discussed below, the construction of the school also falls into a period of avid media reporting about the supposed dangers of PCBs, whether these were scientifically established at the time or not. Ultimately, the Westport school was not completed, however, until after Monsanto had already withdrawn its PCBs from the market for non-totally enclosed applications. Monsanto took appropriate actions as soon as it became aware of the scientific merits of the emerging data – at a time when scientific concerns were focused almost exclusively on the potential impact of fugitive PCBs on wildlife, rather than on PCB leakage from caulks affecting humans.

Given the proximity in time between Monsanto's withdrawal of its PCBs from the market and the construction of the Westport school, there was ample public dissemination in the media of information about the potential hazards of PCBs in waterways and wildlife and, correspondingly, ample public awareness of the potential hazards of PCBs on the part of manufacturers using PCBs as an ingredient in their finished goods. (See Appendix A for examples.) Whereas the state of the science – and, accordingly, the justification for the inclusion of warnings about PCBs, or for the removal of the chemical compound from the market – needed to follow its customary and necessary course of discovery, verification, and replication, the public media are

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[59] Kaley Vol. 1, pp. 211-213; Kaley, Vol. 2., pp. 419-420; Kaley, Exhibit 61; LEXOLDMON000317 - LEXOLDMON000318

[60] See Kaley Vol. 1, pp. 211-212

[61] Kaley Vol. 2, pp. 513, 577-578; Kaley exhibits 54, 56

not obliged to adhere to such a stringent process. As historical examples of public "scares" that did not receive subsequent scientific validation illustrate, the threshold for media reporting is considerably lower than for the scientific acceptance of a causal relationship between a particular stimulus and a hypothesized outcome.[62] At least as early as February 1969, only two months after the general type of caulk to be used in the construction of the Westport school had been specified by the Town of Westport,[63] United States media reports began appearing about PCBs, a "newly reported pollutant … widely used … in plastics, paints, rubber, and fluorescent-lamp installations."[64] At that time, the school had not yet been constructed.[65]

The news story about the "Menacing New Pollutant"[66] attracted attention from coast to coast. A cover story in the San Francisco Chronicle, in February 1969, reported that PCBs "are already entering the bodies of humans," and, citing Dr. Risebrough, "are highly toxic to man."[67] The media coverage of PCBs and their alleged hazards to humans continued throughout 1969 and into 1970. In March of 1969, the Los Angeles Times reported on PCBs, sold under the trade name of "Aroclor," and characterized them as a "global menace."[68] On the opposite coast, in August, the Hartford Times reported about "PCB pollution."[69] Three months later, the first page of Christian Science Monitor reports on "chemical pollution" related to PCBs.[70] It would have been difficult to escape exposure to media coverage about PCBs during the time of the planning for, and construction of, the Westport school. Even though the news media are not bound by scientific principles, which prescribe acceptable levels of statistical certainty and validation through replication, some of the later news articles about PCBs as pollutants continue to caution that "the finger of accusation may be pointing prematurely," and that scientific research into the potential hazards of PCBs "is [not] complete enough yet to draw conclusions"[71] – acknowledging the circumstances in which Monsanto found itself around the time of the planning of the construction of the Westport school. On the one hand, there was as-of-yet lacking scientific evidence of the harmfulness of PCBs in the waterways and explanations for its distribution in the ecosystem, thus making a decision to warn, or even to withdraw a product entirely from the market that possesses many benefits, premature and highly precarious. On the other hand, there was sufficient media coverage about emerging PCB hazards to provide manufacturers of finished goods containing PCBs and the Town of Westport a great amount of material for consideration.

It was reasonable for Monsanto to rely on manufacturers of window caulk containing PCBs to warn about hazards associated with the finished goods.

Dr. Robert Sugarman, an expert working on behalf of the plaintiffs, relies upon information contained in a chapter written by Laughery and Wogalter (2006) that states that a manufacturer

[62] E.g., Lieberman & Kwon (2004)
[63] WSTPRTSCHLO10419
[64] Los Angeles Times, February 26, 1969, p. A22
[65] E.g., WSTPRTSCHL011042; WSTPRTSCHL006870-WSTPRTSCHL006929;WSTPRTSCHL008270
[66] San Francisco Chronicle, February 24, 1969, p. 1
[67] San Francisco Chronicle, February 24, 1969, pp. 1, 20
[68] Los Angeles Times, March 20, 1969, p. E7
[69] The Hartford Times, August 3, 1969, p. 7E
[70] The Christian Science Monitor, November 1, 1969, p. 1
[71] The Hartford Times, August 3, 1969, p. 7E

"must warn customers *and/or consumers* about the anticipated dangers regarding the product's foreseeable use and misuse [emphasis added]." Dr. Sugarman mischaracterizes the Laughery and Wogalter chapter. Those authors do not propose the need for a manufacture of a raw product, such as Monsanto, to communicate directly to end users about hazards associated with the raw product. Laughery and Wogalter instead distinguish between "direct warnings" that are communicated between a manufacture and consumers, and warnings that would come by way of a "learned intermediary," such as a physician, to whom a manufacturer directs warnings, and who decides how risks are controlled for patients.[72]

Bulk suppliers of raw products cannot predict the hazards of every finished good in which their raw material becomes an ingredient. Bulk suppliers of raw material can provide general guidance and warnings through their labeling about hazards and safe handling of the raw material, generally directed at workers who are involved in the transport and handling of the raw material. Ultimately, finished good manufacturers are in the best position to know the composition and function of their finished goods, evaluate their hazards, and understand the proper storage, use, and disposal of these products.

It was reasonable for Monsanto to rely on the manufacturers of window caulk to develop and disseminate any hazard information about window caulk and to control the distribution of the finished goods manufactured with PCBs as one of their ingredients. The existence of a federal regulation, such as the Federal Hazardous Substances Act (FHSA), requiring manufacturers to place hazard warnings on household products from 1960 onward,[73] supports an expectation (including by Monsanto) that window caulk manufacturers would provide hazard labels on their products. It was reasonable, therefore, for Monsanto, as a bulk supplier of a raw material, to rely on manufacturers of window caulk to comply with the federal labeling regulations to warn end-users about hazards of their finished goods.

There are numerous examples of Monsanto's customers having specialized knowledge and staff to be able to assess the hazards of their finished goods and determine appropriate hazard labeling. Many of the companies that were listed as customers of Monsanto as of 1970[74] had industrial research laboratories of their own, employed their own chemists, and made a variety of products.[75] As early as 1956, Armstrong Cork Company, for example, had 70 chemists and Dennison Manufacturing Company had 17 chemists among their technical staff. Some of the industrial research laboratories of Monsanto's customers offered consulting services and advice to others; some performed testing and analysis for others; and some performed research for others.[76] The scientific specialties represented and the presence of laboratories among its customers provides additional assurance to Monsanto that it could rely upon the technical expertise of its customers to identify and warn end-users of hazards associated with the finished goods they manufactured.

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72 Laughery & Wogalter (2006), p, 606
73 Federal Hazardous Substances Labeling Act [Pub. L. 86-613; 74 Stat. 372]
74 Papageorge, p. 416; LEXOLDMON000929 - LEXOLDMON000952
75 See Industrial Research Laboratories of the United States, 1956, 1960, 1965, 1970
76 See Industrial Research Laboratories of the United States, 1956, pp. 41,141

The caulking products identified as examples for use in Westport Middle School,[77] as well, were manufactured by companies that possessed the specialized knowledge to identify hazards of their products and develop labeling appropriate to the contemporary state of scientific knowledge, standards, and regulations. For example, W.R. Grace, to whom Monsanto sold PCBs,[78] was founded in 1854, and operated multiple research laboratories.[79] By the late 1960s, W.R. Grace employed more than 1,200 scientists, technicians, and staff supporting research, including over 200 chemists.[80] Their employees contributed to the scientific community by serving on committees and attending meetings of the Manufacturer's Chemist Association,[81] and performed research published by the National Bureau of Standards, an agency of the U.S. Department of Commerce.[82] Two other companies whose caulking products were identified for use at Westport Middle School (see below), Presstite and Pecora, also had knowledge and resources to conduct scientific research and to understand the hazards, and reporting requirements, associated with the chemical products they produced. Presstite was founded in 1924.[83] Its parent company in 1965, Interchemical Corporation, employed over 200 chemists, including 20 chemists in the Presstite division.[84] Pecora was founded in 1862, and by 1966, had obtained patents, operated research facilities, and developed chemical products.[85]

Westport Middle School bidding documents dated December 11, 1968 specify that caulking and sealing compound materials adhere to Federal Specification TT-S-00230.[86] The version of TT-S-00230 active in 1968 describes performance characteristics (e.g., stability, durability, hardness) for caulking, and allows manufacturers to choose ingredients so long as they meet these criteria.[87] The Westport bidding guidelines that invoke TT-S-00230 state that caulking shall be "Hornflex One-Component" by Grace Construction Materials, "1178 Srucsureseal" by Presstite Products or "Synthacaulk GC-9" by Pecora Chemical Corp, and the general requirements of the document allow contractors to use "equal materials."[88]

Receipts and invoices for caulking have not been produced in the matter and the brand(s) of PCB-containing caulking have not been identified. However, a subcontractor, National Waterproofing Co. submitted to Westport Middle School's architect a request to use PRC 5000, manufactured by Products Research & Chemical Corporation (PRC) and enclosed a copy of the product's technical data sheet for their review.[89] PRC was a direct customer of Monsanto PCBs,

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[77] WSTPRTSCHL010601- WSTPRTSCHL010601; WSTPRTSCHL010469
[78] Kaley, exhibits 43, 57; TOWOLDMON0054518-TOWOLDMON0054519; TOWOLDMON0054521
[79] 1968 WR Grace Product Guide, pp. 1, 3; Industrial Research Laboratories of the United States, 1965, p. 268; Industrial Research Laboratories of the United States, 1970, p. 231
[80] See Industrial Research Laboratories of the United States, 1970; 1968 WR Grace Product Guide, p. 3
[81] Manufacturing Chemists Association Minutes of Environmental Health Advisory Committee Meeting, 4/17/1968; Meeting Of The MCA Board Of Directors, 1/14/69; Proceedings of the 97th Annual Meeting, Manufacturing Chemist's Association, Inc., 6/1969
[82] Clark, et. al (1969)
[83] Presstite Architectural Sealants
[84] Industrial Research Laboratories of the United States, 1965, pp. 309, 439
[85] http://www.pecora.com/about; US Patents 2367347, 2138045, and 2367346
[86] WSTPRTSCHL010419; WSTPRTSCHL010602; WSTPRTSCHL010611
[87] TT-S-00230a, May 5, 1967, Federal specification sealing compound, synthetic-rubber base, single component, chemically curing (for calking, and glazing in building construction)
[88] WSTPRTSCHL010601- WSTPRTSCHL010601; WSTPRTSCHL010469
[89] WSTPRTSCHL005478; WSTPRTSCHL005485-86

and therefore likely received the numerous warning letters that Monsanto provided its customers in the 1970s. They purchased 680,000 pounds of PCBs per year from Monsanto as of March, 12 1969.[90]

As with the caulking manufacturers identified above, and companies to whom Monsanto directly sold PCBs, PRC would have been knowledgeable about the ingredients they used in their products, their function, and the hazards associated with them. In 1970, PRC employed over 40 chemists and conducted research both for itself and to entities requesting its services.[91] During the 1960s, PRC employees were active members of the scientific community. A chief chemist at PRC, for example, was a member of the American Chemical Society, the Society of the Plastics Industry, American Society for Testing and Materials, and presented a paper at a meeting of the Buildings Research Institute.[92] PRC held several patents,[93] including one associated with PRC 5000.[94]

The manufacturers of window caulk had staff with technical knowledge of chemicals and, in many instances, maintained their own laboratories. They would be familiar with the specific formulations of their individual products and would be able to understand the detailed product specifications for Aroclors contained in Monsanto's technical bulletins to be able to determine the warnings to provide for their specific formulations. There were federal regulations requiring hazard labeling of household products. It is reasonable for Monsanto to rely upon the thousands of manufacturers of the huge variety of finished goods containing PCBs to develop any necessary warnings to end users.

Had Monsanto provided warnings recommending corrective actions to schools regarding the treatment of PCB containing window caulk, the information would not have changed the relevant maintenance practices for the ventilation system at the Westport Middle School.

Among its claims, the plaintiffs allege that Monsanto failed to warn about hazards of PCB-Aroclor plasticizers that remain present in "open uses" in schools nationwide and that if Monsanto had provided a warning, the plaintiffs would have taken steps to ensure that PCB-Aroclors were treated differently to prevent potential exposure and contamination of the environment.[95] Neither the plaintiffs nor their experts have specified the types of warnings that should have been provided by Monsanto about PCB-containing window caulk present in schools. The EPA in 2009 suggested that to reduce exposure to PCBs in window caulk, air ducts should be cleaned and ventilation should be improved.[96] Absent any guidance from the EPA (or Monsanto), maintaining clean air ducts and providing properly ventilated classrooms in schools are widely disseminated good practices for the physical environment and conditions of school buildings. In Massachusetts, for example, the condition of HVAC systems and exterior windows

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[90] Kaley, Vol. 2, p. 412; Kaley Exhibit 43
[91] Industrial Research Laboratories of the United States, 1970, pp. 17, 378
[92] New Joint Sealants: Criteria, Design and Materials; Report of a Program Held as Part of the BRI 1962 Spring Conference. Building Research Institute, 1963, pp. iii, 62-68, 81, 225
[93] US2787608, US3225017, US3503930, US3531508
[94] WSTPRTSCHL005485
[95] Plaintiffs' First Amended Complaint, , ¶¶120, 121
[96] 2009 Sept 25 EPA press release

is part of the assessment of the needs and energy efficiency of school buildings.[97] A 2011 Massachusetts School Building Authority report states "Maintenance: clean and properly maintained schools provide quality physical environments for students and teachers."[98] Proper maintenance of windows would include periodic replacement of window caulk, which has a typical life of approximately 5-25 years depending on the formulation.[99]

In this matter, documentation of the physical environment of the Westport Middle School indicates that the air ducts were not properly maintained and classrooms and other rooms were not properly ventilated.[100] Furthermore, the Westport Middle School contained window caulk that appears not to have been replaced since it was originally installed in 1969/1970,[101] many years beyond the expected life of the product. Michael Duarte, the maintenance supervisor for Westport Middle School from approximately 1993 until the closure of the school in 2015,[102] testifies that he and his staff were responsible for maintaining air quality at the school.[103] Mr. Duarte knew that much of the school's primary ventilation system, univents, had not been updated since the school was built.[104] Mr. Duarte was aware that contaminants would recirculate if uninvent parts were broken,[105] and he was responsible for opening, cleaning, maintaining, and changing the filters on univents.[106] Maintenance staff of the Westport Middle School had knowledge of the need for and purpose of good ventilation practices; however, they failed to properly carry out these functions. Had Monsanto provided similar guidance to that of the EPA, it would not have changed the air quality conditions at the Westport Middle School because the staff of the school already understood the importance of maintaining proper ventilation yet failed to achieve the goal .

Summary of Conclusions and Opinions

Based on my review of materials and my education and training, I hold the following opinions with a reasonable degree of scientific certainty:

- Warnings provided by Monsanto about PCBs during the time when Westport schools were constructed and earlier were appropriate and reasonable in the manner in which the information was disseminated, formatted and worded.

- To avoid the negative consequences of providing warnings that are speculative, it was reasonable for Monsanto to take time to investigate the reports of environmental contamination from PCBs, rather than to immediately issue some type of warning.

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[97] Massachusetts School Building Authority, 2011, pp. 24-24
[98] *Ibid*, p. 29
[99] See Expert Report of Maureen Reitman
[100] See Expert Report of Wayne Hubbard
[101] Deposition of Michael Duarte ("Michael Duarte"), pp.104-108
[102] Michael Duarte, pp. 36-39
[103] Michael Duarte, p. 181
[104] Michael Duarte, pp. 116-119, 128-129
[105] Michael Duarte, pp. 184-185
[106] Deposition of Kimberly Ouellette ("Ouelette"), pp. 28-29

- Monsanto's decision in 1970 to cease sales of PCBs for use in plasticizers and other applications was an even stronger response to the concerns about environmental contamination than providing any warnings about the issue.

- Manufacturers of PCB-containing finished goods, such as window caulk, did not have to rely on Monsanto to learn of concerns about environmental contamination from PCBs in marine aquatic and wildlife environments. The developing information about PCB environmental contamination was widely available in scientific publications and in the public media at the time of construction of Westport schools.

- It was reasonable for Monsanto to rely on manufacturers of window caulk containing PCBs to warn about hazards associated with the finished goods.

- Had Monsanto provided warnings recommending corrective actions to schools regarding the treatment of PCB containing window caulk, the information would not have changed the relevant maintenance practices for the ventilation system at the Westport Middle School.

Christine T. Wood

June 30, 2016

List of Materials

- Depositions and exhibits
  - Borins, Lawrence, 2-16-16 exhibits
  - Campbell, George, 4-14-16, and exhibits
  - Colley, Carlos, 4-19-16, and exhibits
  - Dargon, Ann Marie, 4-28-16, and exhibits
  - Duarte, Michael, 4-21-16, and exhibits
  - Duarte, Michelle, 3-30-16, 4-27-16, and exhibits
  - Dutra, Craig, 4-20-16, and exhibits
  - Folsom, Holly, 3-18-16, and exhibits
  - Hand, Jonathan, 4-6-16, and exhibits
  - Hartman, Ross, 4-26-16, and exhibits
  - Hoffman, Paul J., 2-23-16, and exhibits
  - Kaley, Robert, 4-5-16, 4-6-16, and exhibits
  - King, Timothy J., 4-12-16, and exhibits
  - Knutson, Jason, 4-22-16, and exhibits
  - Kopyscinski, Tod E., 4-29-16, and exhibits
  - May Jr., Robert L., 4-25-16, and exhibits
  - McCusker, Peter, 2-19-16, and exhibits
  - Montibello, Stephen 4-7-16, and exhibits
  - Ouellette, Kimberly, 4-11-16, and exhibits
  - Pinck, Jennifer, 3-8-16, and exhibits
  - Pontes, Carolyn M., 3-28-16, and exhibit
  - Timothy, Peter T., 2-14-16, and exhibits
  - Viveiros, Antonio M., 3-29-16, and exhibits
- Plaintiffs' Original Complaint
- Plaintiffs' First Amended Complaint
- LEXOLDMON000001-LEXOLDMON003558
- TOWOLDMON0000001 - TOWOLDMON0003944
- TOWOLDMON0053421 - TOWOLDMON0053423
- Reports
  - Franklin L. Dorman, 5/31/16, and attachments
  - Ross Hartman, 5/31/16, and exhibits
  - Robert F. Herrick, 5/31/16, and attachments
  - Jack V. Matson, Ph.D., PE, 5/27/16, and appendices
  - Robert L. May, Jr., 5/31/16, and exhibits
  - James R. Olson, Ph.D., 5/31/16, and attachments
  - Robert C. Sugarman, PE, 5/31/16, and attachments
- CCECRESEARCH-WESTPORT000001 - CCECRESEARCH-WESTPORT011620

- WSTPRTSCHL000001 - WSTPRTSCHL028419
- WSTPRTSCHL028423 - WSTPRTSCHL056295
- WSTPRT-CARBOLINE000001 - WSTPRT-CARBOLINE000039
- WSTPRT-CGKV000001 - WSTPRT-CGKV000012
- WSTPRT-CONTEST000001 - WSTPRT-CONTEST003170
- WSTPRT-ESSEX000001 - WSTPRT-ESSEX000011
- WSTPRT-FUSS000001 - WSTPRT-FUSS000006
- WSTPRT-KARNAK000001 - WSTPRT-KARNAK000009
- WSTPRT-NATWATER000001 - WSTPRT-NATWATER000007
- WSTPRT-PECORA000001 - WSTPRT-PECORA000007
- WSTPRT-PINCKO00001 - WSTPRT-PINCK000006
- WSTPRT-PPG&PRC000001 - WSTPRT-PPG&PRC000025
- WSTPRT-PRC-DESOTO000001 - WSTPRT-PRC-DESOTO000007
- WSTPRT-PRIVLOGO00001 - WSTPRT-PRIVLOGO00002
- WSTPRT-TREMCO000001 - WSTPRT-TREMCO000010
- WSTPRT-UNITEDTECH000001 - WSTPRT-UNITEDTECH000013
- WSTPRT-WRGRACE000001 - WSTPRT-WRGRACE000114
- Westport008_PDF.csv
- Westport009_PDF.csv
- FAIRHAVEN0000001-FAIRHAVEN0000016
- JCH0000001-JCH0000146
- AMFOGARTY000001 - AMFOGARTY000393
- ARCADIS000001 - ARCADIS002747
- ARCADIS002017.xlsx
- ARCADIS000001.xls
- ARCADIS000002.xls
- ARCADIS000068.xls
- ARCADIS000077.xls
- ARCADIS001842.xls
- ARCADIS001926.xls
- ARCADIS001974.xls
- ARCADIS000706.xlsm
- ARCADIS000866.xlsm
- ARCADIS001230.xlsx
- ARCADIS001981.xlsx
- ARCHITX000001 - ARCHITX000257
- BOA000001 - BOA000052
- CAMPBELLENV000001 - CAMPBELLENV002676

- CGKV-00001 - CGKV-06280
- CGKV-A00000001 - CGKV-A00005336
- CONTEST000001 - CONTEST003160
- DECTAM000001 - DECTAM000764
- DRA000001 - DRA000003
- ENPRO000001 - ENPRO000060
- ESI 00001 - ESI 32801
- LEXCOMN000001 - LEXCOMNO00008
- MSBA_WESTPORT000709-004870
- NORTHSTAR_LVI000001 - NORTHSTAR LVl000485
- Pinck000001 - Pinck001390
- TRIUMVIRATE000001 - TRIU MVIRATE004022
- USE_WAYNE000001 - USE WAYNE000243
- WOODARD000001 - WOODARDO00070
- EPA-WESTPORT000001 - EPA-WESTPORT001313
- MADEP-WESTPORT000001 - MADEP-WESTPORT000046
- MILLISS0000001 – MILLIS0000794
- Massachusetts School Building Authority 2010 Needs Survey Report
- Westport v. Monsanto - Document Productions.docx

- Anderson, D. W., Hickey, J. J., Risebrough, R. W., Hughes, D. F., & Christensen, R. E. (1969, Apr.). Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. The Canadian Field-Naturalist, 83(2), pp. 91-112.
- Anonymous (1966, Dec 15). Report of a new chemical hazard. New Scientist, 32(525), 612.
- Anonymous (1967, Jan. 30). Conservationists have another chemical to worry about. Chemical Engineering, p. 52.
- Barnes, I.R. (1969, Aug. 17). That Infamous Bug-Killer. The Washington Post, p. 155 .
- Bengelsdorf, I. (1969, Feb. 26). New Pollutant Found Among Fish and Birds. Los Angeles Times, p. A22.
- Bengelsdorf, I. (1969, Mar. 20) Scientific Sleuths Have Nailed Another Global Lifetaker. Los Angeles Times, p. E7.
- Clede, B. (1969, Aug. 3). New Puzzle Posed by PCB Pollution. The Hartford Times, p. 7E
- Cowen, R.C. (1969, Nov. 1). The insidious nature of chemical pollution. The Christian Science Monitor, p. 1.
- Holden, A. V., & Marsden, K. (1967). Organochlorine pesticides in seals and porpoises. Nature, 216, 1274-1276.

- Holmes, D. C., Simmons, J. H., & Tatton, J. O. (1967). Chlorinated hydrocarbons in British wildlife. Nature, 216, 227-229.
- Jensen, S., Johnels, A.G., Olsson, M., and Otterlind, G. (1969). DDT and PCB in marine animals from Swedish waters. Nature, 224, 247-250.
- Koeman, J. H., Ten Noever De Brauw, M. C., De Vos, R. H. (1969). Chlorinated biphenyls in fish, mussels and birds from the river Rhine and the Netherlands coastal area. Nature, 221, 1126-1128.
- Perlman D. (1969, Feb. 24). A Menacing New Pollutant. San Francisco Chronicle, pp. 1, 20.
- Risebrough, R. W. (1969) Chlorinated hydrocarbons in marine ecosystems. In: M. W. Miller and G. G. Berg (eds.). Chemical Fallout. Charles C. Thomas, Springfield, Illinois, pp. 5-23.
- Risebrough, R. W., Rieche, P., Peakall, D. B., Herman, S. G., and Kirven, M. N. (1968). Polychlorinated biphenyls in the global ecosystem. Nature, 220:1098-1102.
- Risebrough, R.W. (1969, Feb. 24). Presentation at “Man’s Chemical Invasion of the Ocean: An Inquiry” symposium in La Jolla, California. (cited in Bengelsdorf, I. (1969, Feb 26) New pollutant found among fish and birds. Los Angeles Times, p. A22)
- Risebrough, R.W. (1969, June 4-6) Chlorinated hydrocarbons in marine ecosystems. Paper presented at First Rochester Conference on Toxicity, University of Rochester. Rochester, New York.
- Tarrant, K. R. and Tatton, J. O'G. (1968). Organochlorine pesticides in rainwater in the British Isles. Nature 219: 725-727.
- Widmark, G. (1969) Possible interference by chlorinated biphenyls. J. Assoc. Off. Anal. Chem 50(5):1069.
- "Ratchet mechanism." U.S. Patent 2,138,045, issued November 29, 1938.
- 29 CFR 1910.1200
- 48 FR 53280, 1983
- 57 FR 46669, 1992
- About: Innovations in sealants since 1862. Retrieved from http://www.pecora.com/about (accessed 3/2/16).
- American National Standard for hazardous industrial chemicals – precautionary labeling (ANSI Z129.1-1982). (1982). New York: American National Standards, Institute, Inc.
- Chen, Y. C., Gilson, R. D., & Mouloua, M. (1997). Perceived risk dilution with multiple warnings. *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting*, 831-835.
- Clark, J. E., Fulmer, G. E., Neuman, R. C., & Slater, J. A. (1969). Outdoor Performance of Plastics. 2. Tensile and Flexural Properties (No. NBSIR-10-014). National Bureau of Standards Gaithersburg MD.
- deTurck, M. A. (1995). Developing and defending product warnings: A communication theory perspective. Product Safety & Liability Reporter, 23, 274-281.

- Diedrich, F. J., Wood, C. T., & Ayres, T. J. (2001). Trends in federally mandated warning labels for consumer products. Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting, 838-842.
- Dorris, A. L. (1991). Product warnings in theory and practice: Some questions answered and some answers questioned. In Proceedings of the Human Factors Society 35th annual meeting (pp. 1073-1077). Santa Monica, CA: Human Factors Society.
- Durfee, R. L., Contos, G., Whitmore, F. C., Barden, J. D., & Hackman, E. E. (1976). PCBs in the United States Industrial Use and Environmental Distribution.
- Erickson, M. D., & Kaley II, R. G. (2011). Applications of polychlorinated biphenyls. Environmental Science and Pollution Research, 18(2), 135-151.
- Federal Hazardous Substances Labeling Act [Pub. L. 86-613; 74 Stat. 372]
- Frantz, J. P., Rhoades, T. P., Young, S. L., & Schiller, J. A. (1999). Potential problems associated with overusing warnings. In Proceedings of the Human Factors and Ergonomics Society 43rd annual meeting (pp. 916-920). Santa Monica, CA: Human Factors and Ergonomics Society.
- Friedmann, K. (1988). The effect of adding symbols to written warning labels on user behavior and recall. Human Factors, 30, 507-515.
- George, G., & Seegman, I. P. (1957). *U.S. Patent No. 2,787,608*. Washington, DC: U.S. Patent and Trademark Office.
- Goldman, G. K., & Morris, L. (1970). *U.S. Patent No. 3,531,508*. Washington, DC: U.S. Patent and Trademark Office.
- Good, F. C. (1945). U.S. Patent No. 2,367,346. Washington, DC: U.S. Patent and Trademark Office.
- Good, F. C. (1945). U.S. Patent No. 2,367,347. Washington, DC: U.S. Patent and Trademark Office.
- Gribbin, J.H. (Ed.). (1965). Industrial Research Laboratories of the United States (12th ed.). National Research Council of the National Academy of Sciences.
- Gribbin, J.H., and Krogfus, S.S. (Ed.). (1960). Industrial Research Laboratories of the United States (Vol. 844) (11th ed.). National Research Council of the National Academy of Sciences.
- Laughery, K.R., & Wogalter, M.S. Wogalter (2006). The warning expert in civil litigation in M. S. Wogalter (Ed.), *Handbook of warnings* (pp. 605-615). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Lester, M., Mallard, P. A., & Seegman, I. P. (1965). *U.S. Patent No. 3,225,017*. Washington, DC: U.S. Patent and Trademark Office.
- Lieberman, A. J., & Kwon, S. C. (1998). Facts Vs. Fears: A Review of the Greatest Unfounded Health Scares of Recent Times. Am Cncl on Science, Health.
- Manufacturing Chemists Association Minutes of Environmental Health Advisory Committee Meeting, 4/17/1968.
- Manufacturing Chemists' Association. (1946). *Warning Labels. Manual L-2: Illustrative Warning Labels for Hazardous Chemicals.* Washington, D.C.
- Manufacturing Chemists' Association. Labels, & Precautionary Information Committee. (1961). *Guide to precautionary labeling of hazardous chemicals. Manufacturing Chemists' Association Sixth Edition*. Washington, D.C.

- Manufacturing Chemists' Association. Labels, & Precautionary Information Committee. (1970). *Guide to precautionary labeling of hazardous chemicals. Manufacturing Chemists' Association Seventh Edition*. Washington, D.C.
- Massachusetts Department of Public Health. (2009). An information booklet addressing PCB-containing materials in the indoor environment of schools and other public buildings. Prepared by the Bureau of Environmental Health.
- Mauk, J. F. (Ed.). (1956). Industrial Research Laboratories of the United States (Vol. 379) (10th ed.). National Research Council of the National Academy of Sciences.
- McCarthy, R. L., Robinson, J. N., Finnegan, J. P., & Taylor, R. K. (1982). Warnings on consumer products: Objective criteria for their use. In Proceedings of the Human Factors Society 26th annual meeting (pp. 98-102). Santa Monica, CA: Human Factors Society.
- Meeting of the MCA Board of Directors, 1/14/69.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81-97.
- Morris, L., Seegman, I. P., & Thompson, R. E. (1970). *U.S. Patent No. 3,503,930*. Washington, DC: U.S. Patent and Trademark Office.
- New Joint Sealants: Criteria, Design and Materials; Report of a Program Held as Part of the BRI 1962 Spring Conference. Building Research Institute (1963), 62-68
- Presstite Division / American-Marietta Company. (undated). Presstite Architectural Sealants. El Segundo, CA.
- Proceedings of the 97th Annual Meeting, Manufacturing Chemist's Association, Inc., 6/1969.
- Rosselot, G., and White, M. (Ed.). (1970). Industrial Research Laboratories of the United States (13th ed.). National Research Council of the National Academy of Sciences.
- TT-S-00230a, May 5, 1967, Federal specification sealing compound, synthetic-rubber base, single component, chemically curing (for calking, and glazing in building construction).
- U.S. Department of Labor. Occupational Safety & Health Administration. (2004) *Hazard Communication in the 21st Century Workplace.* Retrieved from https://www.osha.gov/dsg/hazcom/finalmsdsreport.html (accessed: 5/5/2015)
- U.S. Department of Labor. Occupational Safety & Health Administration. *OSHA Brief Hazard Communication Standard: Safety Data Sheets*. Retrieved from https://www.osha.gov/Publications/OSHA3514.html (accessed: 5/5/2015)
- U.S. Environmental Protection Agency. (2009). EPA announces guidance to communities on PCBs in caulk of buildings constructed or renovated between 1950 and 1978 EPA to gather latest science on PCBs in caulk, Retrieved from: http://yosemite.epa.gov/opa/admpress.nsf/d0cl5618525a9efb85257359003fb69d/28c8384eea0e67ed8525763c0059342f!OpenDocument&Highlight=2 (accessed: 11/13/2014)
- U.S. Environmental Protection Agency. PCBs in Caulk—QA. Retrieved from: https://web.archive.org/web/20110205045158/http://www.epa.gov/pcbsincaulk/caulk-faqs.pdf (Accessed: 10/15/14).
- W.R. Grace & Co. (1968). 1968 Grace Product Guide. New York, NY.
- Wogalter, M. S., & Usher, M. O. (1999). Effects of concurrent cognitive task loading on warning compliance behavior. *Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting*, 525-529.

- Wood, C. T., Sala, J. B., Sanders, K., & Cassidy, P. (2006). Trends in consumer product warnings found in voluntary standards. Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting, 1798-1802.
- Any other materials cited in the report

Appendix A
Examples of Scientific Literature, Conferences, and Media Coverage of Environmental Contamination from PCBs in Marine Aquatic and Wildlife Environments, November 1966- November 1969

Scientific literature and conferences	Media coverage
1966 (November 23) Jensen, S. Paper presented at conference of the Swedish Committee for Conservation for Natural Resources, Sweden. (As cited in LEXOLDMON000035- LEXOLDMON000036)	
	1966 (December 15) Anonymous (1966, Dec 15). Report of a new chemical hazard. *New Scientist*, 32(525), 612.
	1967 (January 30) Anonymous (1967, Jan. 30). Conservationists have another chemical to worry about. *Chemical Engineering*, p. 52.
1967 (Oct) Widmark, G. (1969) Possible interference by chlorinated biphenyls. *J. Assoc. Off. Anal. Chem* 50*(5)*:1069.	
1967 (Oct 21) Holmes, D. C., Simmons, J. H., & Tatton, J. O. (1967). Chlorinated hydrocarbons in British wildlife. *Nature*, *216*, 227-229.	
1967 (Dec 30) Holden, A. V., & Marsden, K. (1967). Organochlorine pesticides in seals and porpoises. *Nature*, *216*, 1274-1276.	
1968 (June 4-6) Risebrough, R.W. (1969, June 4-6) *Chlorinated hydrocarbons in marine ecosystems*. Paper presented *at First Rochester Conference on Toxicity*, *University of Rochester.* Rochester, New York.	
1968 (Aug 17) Tarrant, K. R. and Tatton, J. O'G. (1968). Organochlorine pesticides in rainwater in the British Isles. *Nature* 219: 725-727.	
1968 (Dec 14) Risebrough, R. W., Rieche, P., Peakall, D. B., Herman, S. G., and Kirven, M. N. (1968). Polychlorinated biphenyls in the global ecosystem. *Nature*, *220*:1098-1102.	
1969 Risebrough, R. W. (1969) *Chlorinated hydrocarbons in marine ecosystems*. In: M. W. Miller and G. G. Berg (eds.). Chemical Fallout. Charles C. Thomas, Springfield, Illinois, pp. 5-23.	
	1969 (Feb 24) Perlman D. (1969, Feb. 24). A Menacing New Pollutant. *San Francisco Chronicle*, pp. 1, 20.
1969 (Feb 24) Risebrough, R.W. (1969, Feb. 24). Presentation at "Man's Chemical Invasion of the Ocean: An Inquiry" symposium in La Jolla, California. (cited in Bengelsdorf, I. (1969, Feb 26) New pollutant found among fish and birds. *Los Angeles Times*, p. A22)	
	1969 (Feb 26) Bengelsdorf, I. (1969, Feb. 26). New Pollutant Found Among Fish and Birds. *Los Angeles Times*, p. A22.
1969 (March 22) Koeman, J. H., Ten Noever De Brauw, M. C., De Vos, R. H. (1969). Chlorinated biphenyls in fish, mussels and birds from the river Rhine and the Netherlands coastal area. *Nature*, *221*, 1126-	

1128.	
	1969 (March 20) Bengelsdorf, I. (1969, Mar. 20) Scientific Sleuths Have Nailed Another Global Lifetaker. *Los Angeles Times*, p. E7.
1969 (April) Anderson, D. W., Hickey, J. J., Risebrough, R. W., Hughes, D. F., & Christensen, R. E. (1969, Apr.). Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. *The Canadian Field-Naturalist*, *83*(2), pp. 91-112.	
	1969 (Aug 3) Clede, B. (1969, Aug. 3). New Puzzle Posed by PCB Pollution. *The Hartford Times*, p. 7E
	1969 (Aug 17) Barnes, I.R. (1969, Aug. 17). That Infamous Bug-Killer. *The Washington Post*, p. 155.
1969 (Oct 18) Jensen, S., Johnels, A.G., Olsson, M., and Otterlind, G. (1969). DDT and PCB in marine animals from Swedish waters. *Nature*, *224*, 247-250.	
	1969 (Nov 1) Cowen, R.C. (1969, Nov. 1). The insidious nature of chemical pollution. *The Christian Science Monitor*, p. 1.

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Christine T. Wood, Ph.D.
Principal

Professional Profile

Dr. Christine Wood is a Principal Scientist in Exponent's Human Factors practice. She has spent over 25 years researching the impact of safety- and health-related information on human behavior and injury reduction. She has applied the area of human information processing, involving aspects of attention, learning, memory, decision-making, and behavioral response, to risk communications. She has investigated and identified factors that influence compliance with warnings and developed a scientific framework for predicting effectiveness. She has evaluated a wide variety of strategies for dissemination of warnings. Her work includes the analysis, evaluation, and development of safety information for many different products, such as consumer products, medical devices and medications, workplace equipment, and motor vehicles. She has also studied and published papers on the historical use of warnings on products in the United States throughout the twentieth century.

Much of Dr. Wood's work focuses on issues related to child safety. She has applied her knowledge of child development to the analysis of accident patterns that are unique to children. As part of her research, she has conducted numerous studies involving the testing of hundreds of children to better understand their capabilities and methods of interacting with products. The results of her studies have been used in the design of products, development of product design standards, and the evaluation of the child resistance of products. She has also studied and analyzed the knowledge of parents regarding child hazards and the strategies they use to reduce child injury.

Dr. Wood has analyzed injury/illness, adverse event, and accident data available from a wide range of sources such as those gathered by government agencies. She has used quantitative analyses to develop and assess the effectiveness of safety information and dissemination methods. She has presented quantitative analyses of accident patterns for individual products to regulatory agencies for consideration in potential product recalls. She has designed and collected data using written questionnaires, interviews, and group discussions.

Prior to joining Exponent, Dr. Wood held research positions with companies RMC Research Corporation, SRA Technologies, Inc., and the Institute for Mathematical Studies in the Social Sciences where she conducted studies in the areas of measuring the effectiveness of education and training programs and developing a federally-mandated evaluation systems for education programs used nationwide.

Academic Credentials and Professional Honors

Ph.D., Experimental Psychology, Stanford University, 1974
B.A., Psychology, Stanford University (with Distinction and Honors), 1971

Publications

Rauschenberger R, Sala JB, Wood CT. Product warnings and the involuntary capture of attention. Proceedings, Human Factors and Ergonomics Society 59th Annual Meeting, pp. 1423–1427, Los Angeles, CA, 2015.

Rauschenberger R, Wood CT, Sala JB. Human factors and the design of medical devices. In: Bringing your medical device to market. Reiss JB (ed), pp. 215-226, Food and Drug Law Institute, 2013.

Sala JB, Nichols EA, Muhammad R, Lakhiani SD, Rauschenberger R, Wood CT. Government, warnings, safety information: A comparison of inter-agency regulations and guidance. In: Advances in Human Factors, Ergonomics, and Safety in Manufacturing and Service Industries. Karwowski W, Salvendy G (eds), pp. 1047–1056, CRC Press, 2010.

Huntley-Fenner G, Wood CT, Sala JB. Study of the impact of California's Proposition 65 warnings on safety related awareness and behaviors. Society for Risk Analysis Proceedings Abstracts, San Antonio TX, December 9–12, 2007.

Wood CT, Sala JB, Sanders K, Cassidy P. Trends in consumer product warnings found in voluntary standards. Proceedings, 50th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2006.

Sanders KJ, Wood CT, Sala JB. Human factors and the design of medical devices. In: Bringing Your Medical Device to Market, Food and Drug Law Institute, Second Edition. Reiss JB (ed), pp. 197–204, Washington DC, 2006.

Arndt SR, Wood CT, Delahunt PB, Wall CT. Who's in the back seat? A study of driver inattention. Proceedings, 50th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA, 2006.

Diedrich FJ, Wood CT, Ayres TJ. Analysis of trends in federally mandated warning labels. Proceedings, Human Factors and Ergonomics Society Annual Meeting, pp. 838–842, 2001.

Arndt S, Ayres TJ, Li L, Wood CT, Young D. Human factors in product recall planning. Proceedings, 6th Annual International Conference on Industrial Engineering, November 2001.

Murray J, Wood CT, Ayres TJ, Humphrey D. Mobile communications, driver distraction, and vehicle accidents. International Journal of Vehicle Design 2001; 26(1):70–84.

Wood CT, Ayres TJ, Schmidt R, Young D, Murray J. Affordance perception and safety intervention. Proceedings, Human Factors and Ergonomics Society Annual Meeting, Vol. 6, pp. 51–54, 2000.

Ayres TJ, Wood CT. Memory problems for survey-based estimates of population activity. International Journal of Cognitive Technology 1999; 4(1):4–10.

Wood CT, Arndt S, Kelkar R. Children's use of various internal automobile trunk release mechanisms intended to reduce child entrapment risk. Proceedings, Human Factors and Ergonomics Society Annual Meeting, pp. 912–915, 1999.

Ayres TJ, Wood CT, McCarthy RL, Arndt SR. Relative rollover risk estimates for pickup trucks. Proceedings, 7th International Conference on Product Safety Research, Washington, DC, 1999.

Arndt T, Ayres T, McCarthy R, Schmidt R, Wood CT, Young D. Warning labels and accident data. Proceedings, Human Factors and Ergonomics Society Annual Meeting, pp. 550–553, Chicago, IL, October 1998.

Humphrey DG, Murray JM, Wood CT, Ayres TJ. Human factors issues in the design of medical devices. Proceedings, Medical Design & Manufacturing Conference, pp. 116-1–116-6, January 1999.

Ayres TJ, Wood CT, Schmidt RA, McCarthy RL. Risk perception and behavioral choice. International Journal of Cognitive Ergonomics 1998; 2(1-2):35–52.

Ayres TJ, Wood CT, Schmidt R, Young D, Murray J. Effectiveness of warning labels and signs: An update on compliance research. Proceedings, Silicon Valley Ergonomics Conference & Exposition, pp. 199–205, May 1998.

Murray J, Ayres TJ, Kelsh M, Wood CT. Mobile telephones and road accidents: A review of some issues. Proceedings, Silicon Valley Ergonomics Conference and Exposition, pp. 194–198, 1998.

Wood CT, Arndt SR, McCarthy RL. Using risk analysis to reduce the hazards on playgrounds. Proceedings, National Manufacturing Week Conference, Chicago, IL, March 1998.

Wood CT. Design challenges to the use of child resistance as a safety strategy. Proceedings, Human Factors and Ergonomics Society Annual Meeting, pp 442–446, October 1997.

Ayres TJ, Wood CT, Schmidt RA, Bjelajac VM. Warning labels and the state of the art. Proceedings, Silicon Valley Ergonomics Conference and Exposition, Palo Alto, CA, May 1996.

McCarthy RL, Ayres, TJ, Wood CT. Risk and effectiveness criteria for using on-product warnings. Ergonomics 1995; 38, 11, 2164-2175.

Ayres TJ, Beyer R, Wood CT. Ergonomics and the treatment plant. Operations Forum 1995; 12.

Ayres TJ, Wood CT. The warning label development process. Proceedings, Silicon Valley Ergonomics Conference and Exposition, San Jose, CA, May 1995.

Beyer RR, McCarthy RL, Wood CT. Ergonomic analysis of extension ladders. Proceedings, Human Factors and Ergonomics Society Annual Meeting, 1994.

Wood CT, McCarthy RL, Padmanaban J, Beyer RR. Analysis of accident data and fatal risk for occupational use of extension ladders. Proceedings, Human Factors and Ergonomics Society Annual Meeting, 1994.

Wood CT, McCarthy RL, Fowler G, Robinson JN. A comparative analysis of the annual injury risk for motorized vehicular recreation. Proceedings, American Society of Mechanical Engineers Winter Annual Meeting, New Orleans, LA, November 1993.

Ayres TJ, Wood CT, et al. Applications of risk analysis to off-road vehicles. Proceedings, Society of Automotive Engineers Off-Highway and Powerplant Congress, September 1992.

Ayres TJ, Gross, MM, Horst DP, Wood CT, Beyer, RR, Acomb, DB, Bjelajac, VM. Do subjective ratings predict warning effectiveness? Proceedings, Human Factors Society Annual Meeting, 1990.

McCarthy RL, Taylor RK, Kost G, Robinson JN, Wood CT. A comparative analysis of industrial lift truck (forklift) accidents. Proceedings, American Society of Mechanical Engineers, Winter Annual Meeting, Dallas, TX, November, 1990.

Ayres TJ, Gross MM, Wood CT, Horst DP, Beyer RR, Robinson JN. What is a warning and when will it work? Proceedings, Human Factors Society Annual Meeting, 1989.

Wood CT. Policy analysis of California's program for gifted and talented students. Educational Evaluation and Policy Analysis 1985; 7(3):281–287.

Ball FM, Wood CT, Smith EE. When are semantic targets detected faster than visual and acoustic ones? Perception & Psychophysics 1975; 17(1):1–8.

Wood CT. Processing units in reading. Ph.D. Dissertation, Stanford University, 1974.

Juola JF, Fischler I, Wood CT, Atkinson RC. Recognition time for information stored in long-term memory. Perception & Psychophysics 1971; 10:8–14, 1971.

Reports

Wood CT, Gamel NN, Roberts SJ. Evaluation of the Pacific World Telecourse Prototype. RMC Research Corporation, June 1988.

Millsap M, Jastrzab J, Wood CT. State and local response to the Perkins Act: A conceptual framework. Abt Associates, December 1987.

Wood CT, Gabriel R. A study of targeting practices used in the Chapter 1 Program. SRA Technologies, Inc., 1986.

Tallmadge GK, Wood CT, Roberts SJ. Availability and utility of existing databases for addressing issues related to the impact of ECIA Chapter 1 Legislation and Regulations. SRA Technologies, Inc., 1984.

Wood CT. Final report of the evaluation of the Gifted and Talented Education Program. RMC Research Corporation, February 1983.

Tallmadge GK, Wood CT. Comparability of gains from the Three Models in the Title I Evaluation System. RMC Research Corporation, April 1980.

Tallmadge GK, Horst DP, Wood CT. The adequacy of the Equipercentile assumption in the Norm-Referenced Evaluation Model. RMC Research Corporation, April 1980.

Tallmadge GK, Wood CT. A comparison of lock-step and self-paced instruction strategies for training tracked vehicle mechanics. MOS-63C, RMC Research Corporation, 1978.

Wood CT, Fagan BM, Tallmadge GK. Hawaii State Title I Evaluation Report 1977–1978. RMC Research Corporation, August 1978.

Tallmadge GK, Wood CT. User's Guide, ESEA Title I Evaluation and Reporting System. RMC Research Corporation, January 1978.

Wood CT. Test norming practices and the Norm-Referenced Evaluation Model. Further Documentation of State ESEA Title I Reporting Models and Their Technical Assistance Requirements—Phase II, Vol. 2. Bessey BL (ed), RMC Research Corporation, 1978.

Tallmadge GK, Wood CT. Local norms. RMC Research Corporation, January 1978

Horst DP, Wood CT. Collecting achievement test data. RMC Research Corporation, January 1978.

Wood CT, Cannara AB, Tallmadge GK, Fagan BM. Further documentation of State ESEA Title I Reporting Models and their technical assistance requirements: Phase I, Part 2. RMC Research Corporation, August 1976.

Wood CT, Gamel NN, Tallmadge GK, Binkley JL. State ESEA Title I Reports: Review and analysis of past reports, and development of a model reporting system and format. RMC Research Corporation, October 1975.

Horst DP, Tallmadge GK, Wood CT. Measuring achievement gains in educational projects. RMC Research Corporation, October 1974; also published as "A Practical Guide for Measuring Project Impact on Student Achievement," Stock No. 1780–01460, U.S. Government Printing Office, Washington, DC.

Presentations

Beyer RR, Ayres TJ, Wood CT. Applying basic principles of human factors and ergonomics. 67th Annual Conference and Exposition of the Water Environment Federation, No. 947801, Chicago, IL, October 1994.

Ayres TJ, Wood CT. Memory problems for survey-based estimates of population activity. 3rd Practical Aspects of Memory Conference, College Park, MD, August 1994

McCarthy RL, Ayres TJ, Wood CT, Robinson JN. Risk-based warning design. American Bar Association National Institute, Product Warnings, Instructions and User Information. Washington, DC, January 1994.

Wood CT, McCarthy RL, Ayres TJ. Human subject testing in the development of warning labels. American Bar Association National Institute, Product Warnings, Instructions and User Information, Washington, DC, January 1994.

Editorial Boards

- Member of Editorial Board for *Journal of Children's Health*, 2003–2005

Professional Affiliations

- Human Factors and Ergonomics Society (member)
- Society for Risk Analysis (member)
- American Educational Research Association (member)

Previous Four Years of Deposition and Trial Testimony by Christine T. Wood

May 31, 2016

Deposition Date	Trial Date	Case Name	Case Client	Court	Case #
06/2012	06/2012	State Farm General Insurance Company (Haroutounyan) v Electrolux, et al.	Cathy M. Diehl - Prindle, Amaro, Goetz, Hillyard, Barnes & Reinholtz - Long Beach, CA	Superior Court of the State of California for the County of Los Angeles - North Central District	EC 053578
	06/2012	Barnes v Breg	Barry Koopmann - Bowman and Brooke LLP - Minneapolis, MN	United States Court of Western District of Washington	11-00402 JCC
07/2012		Ismail v GE	Clement L. Glynn - Glynn & Finley, LLC - Walnut Creek, CA	Superior Court of California County of Stanislaus	648595
08/2012		Robinson v Newell Window Furnishings	Holly Podulka - Schiff Hardin - Chicago, IL	United States District Court Eastern District of Missouri Eastern Division	4:10-CV-01176 JCH
08/2012		Hack v Daisy Manufacturing	William M. Griffin - Friday, Eldredge & Clark - Little Rock, AR	United States District Court Western District of Kentucky Bowling Green Division	1:09CV-172-R
08/2012		Prats v Graco Children's Products	Holly Podulka - Schiff Hardin - Chicago, IL	United States District Court Eastern District of Louisiana	2:11-CV-01765-CJB-DEK
08/2012		Robinson v ICON	John Halstead - Querrey & Harrow, Ltd. - Merrilville, IN	State of Indiana Lake Co. Superior Court #11	45D11-0809-CT-00118
09/2012		Kirkland v Scripto and Winn Dixie	Paul S. Jones - Luks, Santaniello, Petrillo & Jones - Orlando, FL	In the Circuit Court, Fourth Judicial Circuit, In and For Duval County, Florida	16-2009-CA-010915
10/2012		Neale v Volvo	John Thomas - Dykema Gossett PLLC - Ann Arbor, MI	In the United States District Court for the District of New Jersey Newark Division	2:10-cv-04407-DMC-JAD
10/2012		Novak v Walter Kidde Portable Equipment	Christina M. Jones - McGuire Woods LLP - Richmond, VA	In the District Court of Brazoria County, TX 23rd Judicial District Court	64729
10/2012	11/2012 & 02/13	Ibanez v Six Flags	Michael L. Amaro - Prindle, Amaro, Goetz, Hillyard, Barnes & Reinholtz - Long Beach, CA	Superior Court of the State of California For the County of Los Angeles - North Valley District Chatsworth Courthouse	PC045095
11/2012		Perko v Ford	John Thomas - Dykema Gossett PLLC - Ann Arbor, MI	United States District Court for the Northern District of Ohio Eastern Division	5:10cv-514
11/2012		Sunbeam DiSilvestro Investigation (Bookhamer)	Tom Vitu - Moffet, Vitu, Lascoe & Packus - Birmingham, AL	United States District Court Northern District of California	09-CV-06027 EMC (DMR)
11/2012	05/2014	American National Property and Casualty Company (Huezo) v Electrolux Home Products, Inc.	Michael L. Amaro - Prindle, Amaro, Goetz, Hillyard, Barnes & Reinholtz - Long Beach, CA	United States District Court Southern District of California	11cv1340 JLS (NLS)
11/2012 and 03/2014		Panico v Miles Industries	Greg Jones - Jones & Dyer, P.C. - Sacramento, CA	United States District Court Northern District of California (Oakland Division)	3:11-cv-02146-EDL
12/2012		Amica Mutual Insurance (Jervis) v Valspar	Anthony B. Corleto - Wilson Elser Moskowitz Edelman & Dicker LLP - Stamford, CT	State of Connecticut Superior Court Judicial District of Stamford/Norwalk Held at Stamford	FST-CV-10-6003636-S
	12/2012	Dowdy v Coleman	Kenneth R. Lang - Cozen O'Connor - Wichita, KS	In the United States District Court for the District of Utah, Central Division	1:11-CV-00045-DAK
03/2013 & 12/2013		Thiel v Baby Matters	Jerome A. Galante - Plunkett Cooney - Bloomfield Hills, MI	United States District Court Eastern District of Michigan Southern Division	11-cv-15112
03/2013		Peet v Sunbeam	James W. Ozog - Wiedner & McAuliffe - Chicago, IL	State of Michigan In the Court for the County of Wayne	11-007862-NI
04/2013		Daniel v Ford	John Thomas - Dykema Gossett PLLC - Ann Arbor, MI	United States District Court Eastern District of California Sacramento Division	2:11-cv-02890-WBS-EFB
04/2013		Tao v Victoria's Secret	David Osterman - Goldberg Segalla LLP - Princeton, NJ	United States District Court Eastern District of New York	CV11-419 (JBW) (SMG)
05/2013		Bard Avaulta Consulting	Lori Cohen - Greenberg Traurig LLP - Atlanta, GA	In the United States District Court for the Southern District of West Virginia Charleston Division	MDL: 2187
05/2013	07/2013	Travelers (Anderson) v Electrolux	Melissa L. Yemma - Nicolson Associates LLC - Media, PA	United States District Court Central District of California	2:12-CV-05112-DMG (Ex)
05/2013		Deasey v Newell Window Furnishings	Heidi Oertle- Schiff Hardin - Chicago, IL	In the Superior Court of the State of Arizona in and for the County of Pima	C2011-5784

Deposition Date	Trial Date	Case Name	Case Client	Court	Case #
06/2013		Coleman v Matrixx	Krista Cosner - Drinker Biddle & Reath LLP - SF, CA	In the Circuit Court of Cook County, Illinois County Department, Law Division	09 L 1580
07/2013		Sisk v Abbott Laboratories	Melissa B. Hirst - Jones Day - Chicago, IL	In the United States District Court for the Western District of North Carolina	1:11-cv-00159
08/2013		Adams v P & G and Blanner v P & G	Neil Goldberg - Goldberg Segalla LLP - Buffalo, NY	In the Court of Common Pleas Hamilton County, OH	A-12-04223 and A-12-04225
	08/2013	Roanoke v Aerofil Technology	Michael Turiello - Pretzel & Stouffer - Chicago, IL	American Arbitration Association	69-155-Y-000080-12
09/2013		Christian v W.M. Barr, et al	Brian Triplett - Sinunu Bruni LLP - San Francisco, CA	United States District Court Central District of California, Western Division	2:12-CV-09326-FMO-CW
10/2013		Coplin v Enerco	Kevin P. Etzhorn - Sandberg, Phoenix & Von Gontard - St. Louis, MO	In the Circuit Court of Crawford County State of Missouri	12CF-CC00003
10/2013		Landis & Nelson v Jarden	Robert W. Hayes - Cozen O'Connor - Philadelphia, PA	In the United States District Court for the Northern District of West Virginia Elkins Division	2:11-cv-00101-JPB
11/2013		DeSousa v Dental EZ	Jeffrey Walker - Walker & Mann - Rancho Cucamonga, CA	Superior Court of the State of California in and for the County of Riverside	INC 1105145
11/2013		Lunde v Kwik Trip	John P. Gatto - Murnane Brandt - Saint Paul, MN	State of Wisconsin Circuit Court, St. Croix County	07 CV 179
05/2014		Depuy Hip Implants	Steven W. Quattlebaum - Quattlebaum Grooms Tull & Burrow PLLC - Little Rock, AR	In the United States Court Northern District of Texas Dallas Division	3:11-MD-2244-K
05/2014		State Farm (Smith) v Electrolux	Melissa L. Yemma - Nicolson Associates LLC - Media, PA	United States District Court Western District of Louisiana Lake Charles Division	2:12-CV-2702
09/2014		Davis v Isuzu	Paul Cereghini - Bowman and Brooke LLP - Phoenix, AZ	Superior Court of Arizona, County of Navajo	CV201000098
10/2014		Knutson v Daisy	William M. Griffin - Friday, Eldredge & Clark - Little Rock, AR	In the Circuit Court of Jackson County, Missouri at Independence	1116-CV29712
11/2014	03/2015	Coterel v Dorel	Jonathan Judge - Schiff Hardin - Chicago, IL	In the United States District Court for the Western District of Missouri in Springfield	2:13-cv-4218
11/2014		Rivera v Volvo	Todd Rinner - Rodey Law Firm - Albuquerque, NM	In the United States District Court for the District of New Mexico	1:13-CV-00397-KG/KBM
12/2014		CR Bard MDL 200	Lori Cohen - Greenberg Traurig LLP - Atlanta, GA	In the United States District Court for the Southern District of West Virginia Charleston Division	MDL No. 2187
01/2015		Town of Lexington v Monsanto	Richard Campbell - Campbell Campbell Edwards & Conroy PC - Boston, MA	United States District Court District of Massachusetts	12-CV-11645
01/2015		Swanke v GM	Michael Cooney - Dykema Gossett PLLC - Detroit, MI	United States District Court for the District of North Dakota Southwestern Division	1:13-CV-00069-CSM
02/2015		Blair v Cannery Row	Edward Baldwin - Wood Smith Henning & Berman, LLP - Concord, CA	Superior Court of California County of San Mateo	CVI519951
03/2015		Doll v Target, Bell Sports	Mark A. Prost - Sandberg, Phoenix & Von Gontard P.C. - St. Louis, MO	In the Circuit Court of Platte County, Missouri	13AE-CV02129
03/2015		Loiotile v Electrolux Home Products	Rebecca Biernat - Tucker Ellis LLP - San Francisco, CA	In the United States District Court for the Northern District of Illinois, Eastern Division	1:13-cv-4097
03/2015		Deboch v Seattle Hospitality, Inc.	Thomas Merrick - Merrick Hofstedt & Lindsey PS - Seattle, WA	In the Superior Court of the State of Washington in and for King County	14-2-01606-9-SEA
05/2015		Harman v Target, Bell Sports	Linet Bidrossian - Yukevich Cavanaugh - Los Angeles, CA	Superior Court of the State of California for the County of Los Angeles - Central District	BC489100
06/2015		Nettleton v Ford	Eric Tew - Dykema Gossett PLLC - Washington, DC	United States District Court Northern District of California - San Francisco Division	11-CV-2953-RS
06/2015		White v American Signature	Brian DeGailer - Quintairos, Prieto, Wood & Boyer, P.A. - Orlando, FL	United States District Court Middle District of Florida Orlando Division	6:14-cv-1638-Orl-40GJK
06/2015		Lozano v ERG International	Charlotte M. Konczal - Harris & Yempuku - Sacramento, CA	Superior Court of California - County of Fresno	13 CE CG 03325 JH

Deposition Date	Trial Date	Case Name	Case Client	Court	Case #
07/2015	01/2016	Arce v Associated Students Children's Center	Michael L. Amaro - Prindle, Amaro, Goetz, Hillyard, Barnes & Reinholtz - Long Beach, CA	Superior Court of the State of California County of Los Angeles, Northwest District Courthouse	BC427228
	07/2015	Serby v First Alert	Barry Negrin - Kane Kessler PC - New York, NY	United States District Court Eastern District of New York	09-CV-4229
09/2015		Fox,et al. v Nissan	Paul Riehle - Sedgwick, LLP - San Francisco, CA	Superior Court of the State of California in and for the County of San Francisco	CGC-09-490470
09/2015		Tang v L.A. Arena Co.	Michael Moss - Lewis Brisbois Bisgaard & Smith LLP - Los Angeles, CA	Superior Court of the State of California for the County of Los Angeles	BC462188
10/2015		Sifuentes v Walter Kidde Portable Equipment	Christina M. Jones - McGuire Woods LLP - Richmond, VA	In the 327th Judicial Distric Court El Paso County, Texas	2010-4168
10/2015		Chavez v Glock	Christopher Renzulli - Renzulli Law Firm - White Plains, NY	Superior Court of the State of California for the County of Los Angeles- Central	BC384135
10/2015		Marshall v Lowe's	Rebecca Laffitte - Sowell Gray Stepp & Laffitte - Columbia, SC	In the United States District Court for the District of South Carolina Florence Division	4:14-cv-04585-RBH
11/2015		Sherrer v Bard	Sean P. Jessee - Greenberg Traurig - Atlanta, GA	In the Circuit Court of Jackson County, Missouri at Kansas City	1216-CV27829
12/2015	02/2016	ERC v Aloe Vera	Caol Brophy - Sedgwick LLP - San Francisco, CA	Superior Court of the State of California, County of San Francisco	CGC-11-515588
12/2015		Depuy Hip Implants-Bellwether	Steven W. Quattlebaum - Quattlebaum Grooms Tull & Burrow PLLC - Little Rock, AR	United States District Court Northern District of Texas Dallas Division	MDL:2344
02/2016		Dawood v Mercedes Benz	Garrett Sanderson - Carroll Burdick & McDonough LLP - San Francisco, CA	United States District Court Western District of Washington at Tacoma	3:14-CV-05179 RBL
04/2016		MyFord Touch	Randall Edwards - O'Melveny & Myers LLP - San Francisco, CA	United States District Court Northern District of California San Francisco Division	13-cv-3072-EMC
05/2016		Lumber Liquidators MDL Warning	Diane Flannery - McGuire Woods, LLP - Richmond, VA	In the United States District Court Eastern Distict of Virginia Alexandria Division	1:15-md-02627 (AJT/TRJ)
05/2016		Sachs & Chodos v Toyota	David Schrader - Morgan Lewis & Bockius LLP - Los Angeles, CA	Superior Court of the State of California County of Los Angeles, Northwest District Courthouse	BC443701
05/2016		Vuksic v Walt Disney Parks	Gary Wolensky - Buchalter Nemer, P.C. - Orange County, CA	Superior Court of the State of California County of Orange - Central Justice Center	30-2013-00692154-CU-PO-CJC

EXHIBIT 26

SPECIFICATION

FOR

WESTPORT MIDDLE SCHOOL

WESTPORT, MASSACHUSETTS

5-27-92

TEL 1-617-964-1700

EXHIBIT 21
PENGAD 800-631-6989
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4-22-16 RD

11 December 1968

DRUMMEY ROSANE ANDERSON

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SECTION 7A

WATERPROOFING, DAMPPROOFING & CAULKING

(Filed Sub-Bid Required)

1. General Requirements

(a) The General Conditions, Supplementary General Conditions, and applicable portions of Division I of the Specifications are a part of this Section.

(b) Equality of material or articles other than those named or described in this Section will be determined in accordance with the provisions of Supplementary General Conditions.

2. Scope of Work

(a) Furnish labor, materials, equipment and services necessary for the installation of waterproofing, dampproofing and caulking where shown on the Drawings and/or as herein specified which shall include, but not be limited to, the following:

(1) Dampproofing of all exterior surfaces of concrete walls coming in contact with earth on one side and rooms and pits on the other.

(2) Dampproofing of exterior face of concrete parapets spandrel beams, and exterior foundation walls above grade where faced with brick.

(3) Exterior and interior caulking of all items of disimilar material adjacent to building construction such as door and window frames, entrance systems, louvers, thresholds, vents, etc.

(4) Caulking of masonry to masonry and masonry to concrete.

(5) Caulking of hollow metal frames in masonry construction.

(6) In addition to the above noted areas to receive caulking, any and all miscellaneous caulking as indicated on the Drawings.

(7) Provide and install concealed thru-wall flashing where indicated on the Drawings and where required above openings in exterior walls.

(8) Provide and install 20 oz. copper waterstop in vertical masonry expansion joints where located on drawings. See detail.

(b) The work to be done under this Section is shown on Drawings numbered: L-1 through L-10, A-1 through A-34, S-1 through S-17, SD-1 through SD-3, P-1 through P-9, H-1 through H-20, E-1 through E-18.

3. Work Specified Under Other Sections

(a) Metal to metal caulking of windows: SECTION 8D
(b) Caulking required by roofing & flashing sub-contractor: SECTION 7F
(c) Caulking of spaces around pipe, conduit, ducts, pipe sleeves, etc. shall be done by trades installing utility lines.

4. Materials

(a) Caulking: one-part, non-sag, polysulfide base sealant conforming to Federal Specification TT-S-00230. Caulking shall be "Hornflex One-Component" by Grace Construction Materials", 1178 Srucsureseal" by Presstite Products or Synthacaulk GC-9, by Pecora Chemical Corp.

(b) Sealant Backer Rod: white, non-absorbent closed cell foam polyethylene. Density 1.8 to 2.2 lb. per cubic foot. Capilarity, nil. Resiliency, 30% to 35% rebound. Tensile strength, 20 to 39 lbs. per sq. in. Select a size that will cause a minimum of 30% compression. Example, if joint is 1/4", select 3/8" backing. Joint backing shall be Tremco joint backing by Tremco, "Ethafoam SB" by Dow, or approved equal.

(c) Primer: "P-53 Primer" by Pecora Chemical Corp., "Hornflex - 1C Primer", by Grace Construction Materials, or "No. 211 Primer" by Presstite Products. Primers shall be from manufacturer of caulking. Use of primer as well as mixing and application shall be in strict accordance with manufacturer's recommendation for each type of surface. Use primer only on Masonry surfaces.

(d) Non-Fibrated Dampproofing: Asbestos free solvent base asphalt compound for application by brush or spray conforming to Federal Specification SS-A-701. similar to Dehydratine 4 by Grace Construction Materials, Hydrocide 648 by Sonneborn Building Products, or RIW Marine Mastic by Toch Brothers, Kamak 100 by Karnak Chemical Corp., or approvel equal.

(e) Fibrated Dampproofing: a heavy bodied non-sag solvent base asphalt compound reinforced with long asbestos fibers for trowel application conforming to Federal Specification SS-C-153, Type I similar to Dehydrative 6 Mastic by Grace Construction Materials, Hydrocide Mastic by Sonneborn Building Products, RIW Marine Mastic by Toch Brothers, Karnak 220 Fibrated, or approved equal.

(f) Thru-Wall Flashing: A full sheet of copper coated on both sides with asphalt mastic, bonded under pressure between two layers of asphalt-saturated woven cotton fabric into a single sheet. The copper weight shall not be less than 3 oz. per square foot of uncoated copper. Flashing shall be similar to "Copper Fabric Flashing" by Sandell, AFCO Products, Inc., Wasco, or approved equal.

(g) Furnish affidavits certifying that all materials conform to the requirements of these specifications.

5. Installation of Caulking

(a) Preparation:

(1) Joints shall be examined prior to application and any conditions detrimental to achieving a positive, weathertight seal shall be reported to the General Contractor and the Architect.

(2) All openings, joints, or channels to be sealed shall be thoroughly clean, dry and free from dust, oil, grease, loose mortar or any other foreign matter.

(3) Surfaces with protective coatings with which the sealant will come in contact, such as new aluminum or bronze shall be wiped with xylol, or a methyl ethyl ketone solvent to remove the protective coating and any oil deposit that may be left on the metal surfaces.

(4) Where joints are deeper than 1/2" and/or where indicated on drawings, polyethylene joint backing shall be used and packed into the joint to within 1/2" of the surface. A size shall be selected so as to allow for a minimum of 30% compression of the backing when inserted into the joint. Where joints are 3/4" wide, the backing shall be placed so that the depth of joint to receive the sealant does not exceed 1/4".

(5) Precast or masonry joint surfaces shall be wire brushed, then air blown clean.

(6) Sealant shall not be applied to masonry joints treated with a water repellent or masonry preservative.

(b) Application

(1) Sealant shall be gun-applied through a nozzle opening of such diameter so that the full bead of sealant is gunned into the joint, filling the joint completely. A superficial or skin bead will not be acceptable.

(2) All beads shall be tooled immediately after application to insure firm, full contact with the inner faces of the joint. Excess material shall be struck off with a tooling stick or knife.

(3) The finished bead shall be flush with the surface, or as otherwise indicated.

(4) Remove all excess materials and smears adjacent to the joint as work progresses.

(5) All materials shall be used in accordance with the manufacturer's printed instructions.

5. Installation of Caulking (Continued)

(c) Guarantee

Caulking shall be completely watertight and guaranteed against leakage for a period of one year after acceptance of the installation.

6. Installation of Dampproofing

(a) General:

(1) All surfaces to receive dampproofing shall be dampproofed with a two-coat application.

(2) Dampproofing shall not be applied when temperature is below 40 degrees F.

(3) Surfaces to receive dampproofing shall be clean and free of all foreign matter. Do not apply over a frost-covered surface. All cracks, voids, honey-combs, etc. shall be filled and repaired with mortar to provide a strong structural surface. Use material as it comes from container. Thinning shall not be permitted.

(b) Application for Exterior Perimeter Walls, Spandrels & Parapets:

(1) Exterior perimeter walls, spandrels and parapets shall receive two coats of unfibered dampproofing.

(2) Apply first and second coats by brush or power spray in a continuous unbroken film, free from pinholes or other surface breaks. Coverage shall be in accordance with manufacturer's printed instructions. Allow first coat to dry thoroughly, a minimum of 20-24 hours before applying second coat.

(3) Fill all cracks, crevices and grooves. Make sure each coating is continuous and free from breaks or pinholes. Carry dampproofing over exposed tops and outside edges of footing, forming a cove at junction of wall and footing. Spread around all joints, grooves, and slots and into all chases, corners, reveals, and soffits. Bring the coating from bottom of footing to brick ledge, across brick ledge up to top of foundation wall.

(4) Thoroughly coat steel supporting angles between angle and concrete. Apply one coat of unfibered dampproofing and one coat of fibered dampproofing over angle and between concrete and angle leaving no voids between the two surfaces.

6. Installation of Dampproofing (Continued)

(c) Application for Boiler Room and Elevator Pit:

(1) Boiler Rooms and Elevator Pit walls shall receive one coat of unfibered dampproofing as a primer and a second coat of fibered dampproofing as a finish.

(2) Apply first coat by brush or power spray in a continuous unbroken film, free from pinholes or other surface breaks. Coverage shall be in accordance with manufacturer's printed instructions. Allow first coat to dry thoroughly a minimum of 20-24 hours before applying second coat.

(3) Apply second coat 1/8 inch thick by trowel. Coverage shall be in accordance with manufacturer's printed instructions.

(4) Fill all cracks, crevices and grooves. Make sure each coating is continuous and free from breaks or pinholes. Carry dampproofing over exposed tops and outside edges of footing, forming a cove at junction of wall and footing. Spread around all joints, grooves, and slots and into all chases, corners, reveals, and soffits. Bring the coating from bottom of footing to underside of floor slab above.

7. Installation of Thru-Wall Flashing

(a) The Waterproofing, Dampproofing and Caulking Sub-Contractor shall cooperate with the Masonry Sub-Contractor with regard to the installation of thru-wall flashing so that progress of the work will not be impeded.

(b) The flashing for horizontal masonry surfaces shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. The flashing shall start 1/2" from the outside face of the wall and shall be carried thru the masonry veneer turning up at concrete wall to facilitate flow thru weep holes to outside. Flashing shall be turned up on back of wall to a height of 6" above top of foundation and secured in place and moppedl in. Refer to drawings for details and location.

8. Guarantee

The Contractor shall guarantee that if at any time within one year from the date of completion, it should happen that leakage develops in the surfaces treated by him, due to defective work on his part, he will upon request promptly make repairs thereto at his own expense. Defects in the structure or other causes beyond his control resulting in fracture are not to be covered by this guarantee.

9. Time, Manner, and Requirements for Submitting Sub-Bids

The sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Superintendent of Schools, Town Hall, Westport, Massachusetts, before twelve o'clock noon on January 15, 1969.

The following should appear on the upper left-hand corner of the envelope:

Name of Sub-Bidder

Westport Middle School

Sub-Bid for Section 7A, WATERPROOFING, DAMPPROOFING & CAULKING

Every sub-bid submitted for work under this Section shall be on form furnished by the office of the Architect, as required by Section 44G of Chapter 149 of the General Laws, as amended.

Sub-bids filed at the office of the Superintendent of Schools shall be accompanied by cash or certified check on, or a treasurer's or cashier's check issued by a responsible bank or trust company, payable to the Town of Westport in the amount stipulated in the Instructions to Bidders. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.

See Sections 44H to 44K of Chapter 149 of the General Laws (as amended) for statutory procedures regarding sub-bids.

SECTION 81

GLASS AND GLAZING

(Filed Sub-Bid Required)

1. General Requirements

(a) The General Conditions, Supplementary General Conditions, and applicable portions of Division I of the Specifications are a part of this Section.

(b) Equality of material or articles other than those named or described in this Section will be determined in accordance with the provisions of Supplementary General Conditions.

2. Scope of Work

(a) The scope of work under this Section consists of furnishing all labor, tools, equipment and materials to install all glass and glazing as shown on drawings and/or as herein specified and shall include but not be limited to the following:

1. Exterior Windows
2. Interior Glazed Partitions
3. Vision Panels in Doors
4. Aluminum Entrances
5. Glazing Materials and Accessories

(b) The work to be done under this Section is shown on drawings numbered: A-1 through A-34.

3. Work Specified Under Other Sections

(a) Glazing beads and stops shall be furnished under other appropriate sections of the specifications, but shall be installed under this Section.

4. Samples

(a) The following samples shall be submitted to the Architect for approval:

Glass - each type, 4 x 4 inches.
Glazing Compound - One quarter pint can and manufacturer's description.

5. General

(a) All glass shall meet or exceed the requirements of Federal Specification DD-G-0045 lb. Each piece of glass shall bear the manufacturer's label stating name of manufacturer and quality of the glass, including weight and thickness. Absence of label shall be cause for rejection. Wire glass shall conform to requirements of Underwriters Laboratories, Inc.

(b) All glass hereinafter specified shall be as manufactured by Pittsburgh Plate Glass, Libby-Owen-Ford, Mississippi Glass, or approved equal.

(c) The size of glass indicated on the drawings are approximately only, and the actual sizes required shall be determined by measuring the frames to receive the glass.

(d) Refer to drawings for type and location of all glass to be installed.

(e) Materials shall be delivered when and as required and stored in a safe location, as directed. Material shall not be unpacked until it is to be set, unless unpacking is required for inspection by the Architect.

6. Materials

(a) Environmental Glass: "Greylite 56" as manufactured by Pittsburgh Plate Glass Industries, or approved equal; 7/32 inches thick; maximum heat gain: 190 BTU/hr./sq. ft.; visible transmittance: 56%; "U" Factor: 1.

(b) Spandrel Glass: "Vitrolux" spandrel glass as manufactured by Libby-Owen-Ford Co. or approved equal. Glass shall be "black pearl" in color. Provide at all exterior entrances where shown on drawings. Glaze in the same manner as the rest of the entrances.

(c) Sheet glass: Heavy sheet "B" quality, 3/16" thick.

(d) Obscure Glass: 7/32" thick, light transmittance 88.2% similar to "Industrex" as manufactured by American Saint Gobain Corp. or approved equal. Noted as A' on the drawings.

(e) Double insulating glass: Double glazed units shall be Twindow-Metal Edge as manufactured by Pittsburgh Plate Glass Co. or approved equal and shall consist of two pieces of 1/4" clear polished plate glass. The lites of glass shall be separated by a 1/4" dessiccant-filled metal spacer forming a dehydrated air space hermetically sealed at the periphery with a flexible sealer. The entire assembly shall be encased in a metal channel. Use where indicated on drawings.

(f) Plate and Float Glass: Polished, 1/4" thick unless noted otherwise, Type 1 glazing quality. Use where indicated on drawings.

(g) Wire Glass: 1/4" thick polished both sides, similar to "Crossweld" Polished Wire Glass as manufactured by Libby-Owen-Ford. Use where indicated on drawings.

(h) Clear Tempered Glass: 1/4" thick unless otherwise noted. Fully tempered polished plate. Use where indicated on drawings.

6. Materials (Cont'd)

(i) Obscure Tempered Glass: 9/32 inch rough plate glass, fully tempered. Use where indicated on drawings.

(j) Preformed Sealant: Based on Butyl or Polyisobutylene Polymer similar to "440 Tape" by Tremco, "Extru-Seal PB-22" by Pecora Chemical Corp. or "579 Series" by Presstite Products.

(k) Sealant: One-part polysulfide base sealant conforming to Federal Specification TT-S-00230. Caulking shall be "Hornflex One-Component" by Grace Construction Materials, "1178 Strucsureseal" by Presstite Products, or "Synthacaulk GC-9" by Pecora Chemical Corp., or approved equal.

(l) Accessories:

Setting blocks: neoprene 80-90 durometer
Center shims: neoprene 40-50 durometer

(m) Glazing Compound: Elastic type conforming to Federal Specification TT-P-781a. Type similar to "M251" by Pecora Chemical Corp., or approved equal.

(n) Cleaning Solvent: Cleaning solvent for aluminum shall be xylene, toulene, or other suitable oil-free cleaning solvent.

7. Workmanship

(a) All glazing labor shall be performed in accordance with the standards of the F.G.J.A. Glazing Manual, dated 1965. Unless specifically excepted hereinafter, all general conditions shall apply.

(b) Glass clearance dimensions shall be based on the type and thickness of the glass as determined by the F.G.J.A. Glazing Manual and as hereinafter specified.

(c) Surfaces shall be dry and free from protective coatings, dust, or other foreign materials before glazing. Clean all surfaces with cleaning solvent before glazing. All glass shall be set with the wave parallel to the sill, without springing and proper clearance at all edges.

(d) All sash shall be checked prior to glazing to make certain the opening is square, plumb and secure in order that uniform face and edge clearances are maintained. Inspect all butt and miter joints. If these joints are open, they shall be sealed with sealant, as specified herein, prior to glazing.

(e) No glass shall be installed where it may be damaged unless it is properly protected at all times.

8. Window Glazing

(a) Edge clearance of glass shall be 5/16 inch minimum all around frame.

(b) Minimum face clearance of glass from sash rabbet shall be 1/8 inch all around.

(c) Glass shall be cut at factory or shop to exact size.

(d) Bow shall be glazed convex to outside.

(e) Finished glazing shall be such that no strain is imposed upon the glass.

(f) Rest glass on two setting blocks at quarter points from each corner.

(g) Apply extruded elastic tape to rabbet, allowing it to lap sight line with 1/2 inch minimum bearing. Iron out wrinkles in tape with thumbs..

(h) Starting at quarter points, place spacers not more than 48 inches o.c. Place no less than two spacers for each edge.

(i) Cut tape around spacers.

(j) When setting glass on setting blocks, take care to center in opening with equal clearances at all edges between glass and frame.

(k) Press glass firmly into tape with a slight lateral movement to assure proper adhesion.

(l) Lay polysulfide bead into space between glass and sash. Apply sufficient compound so that, when the stop is put in place, the polysulfide will be forced between sash, glass and stop. Place stop side spacers opposite previously set spacers. Butter stop with polysulfide compound so that, when the stop is in place, the compound will extend from outside edge of stop contact surface to a depth of approximately 3/8 inch. Compound shall make contact with glass as stop is put in place, forcing contact with polysulfide bed and completely sealing joint. Remove excess compound on stop side with glazing knife at a slight angle (not undercut) at sight line. Trim excess tape at slight angle over sight line. Tool neatly to assure positive contact.

9. Hollow Metal Glazing

(a) Allow edge clearance of glass of 1/4 inch minimum all around.

(b) Allow minimum face clearance of glass from sash rabbet of 1/8 inch all around.

(c) Rest glass on two setting blocks at quarter points from each corner.

(d) Center glass in rabbet. Apply sufficient glazing compound to rabbet in order to rise above the sight line after pressing glass into it; cover the embedded portion of glass completely with compound.

9. Hollow Metal Glazing (Cont'd)

(e) Maintain equal recommended clearances at perimeter, inside and out, and press glass into place.

(f) Bed bead against glass and bottom of rabbet with compound. Press bead into place. Leave full bed of compound between glass and bead. Secure bead to sash or frame as specified or as recommended by frame manufacturer. Strip surplus compound from both sides of glass at an angle (not undercut).

10. Vision Panel in Doors

(a) Vision panels shall be glazed in accordance with recommendations of hollow metal door manufacturer. All sizes for glass shall be taken for the actual openings. The Contractor shall assume all responsibility for proper sizes as those indicated on drawings are approximate and shall be used for estimating only.

11. Aluminum Entrances

(a) Aluminum entrance systems shall be glazed with vinyl snap-in glazing beads. Material and installation shall be in accordance with the recommendations of the aluminum entrance system manufacturer.

12. Cleaning and Replacement

(a) After final acceptance, all labels and excess glazing compound shall be removed and glass shall be washed and left clean.

(b) All damaged and/or defective glass shall be removed and replaced with perfect glass at no additional expense to the Owner. The Architect reserves the right to determine whether glass or glazing installation is defective.

13. Guarantee

(a) The Contractor shall guarantee the glazing installation against leakage of air or water for a period of one year from the date of acceptance of the building.

Time, Manner, and Requirements for Submitting Sub-Bids

The sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Superintendent of Schools, Town Hall, Westport, Massachusetts, before twelve o'clock noon on January 15, 1969 .

The following should appear on the upper left-hand corner of the envelope:

Name of Sub-Bidder

Westport Middle School

Sub-Bid for Section 81, GLASS AND GLAZING

Every sub-bid submitted for work under this Section shall be on form furnished by the office of the Architect, as required by Section 44G of Chapter 149 of the General Laws, as amended.

Sub-bids filed at the office of the Superintendent of Schools shall be accompanied by cash or certified check on, or a treasurer's or cashier's check issued by a responsible bank or trust company, payable to the Town of Westport in the amount stipulated in the Instructions to Bidders. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.

See Sections 44H to 44K of Chapter 149 of the General Laws (as amended) for statutory procedures regarding sub-bids.

EXHIBIT 27

TEL: HIGHLANDS 5-5130
GARRISON 7-7620

NATIONAL WATERPROOFING CO.

KENNELLY'S METHODS AND MATERIALS

ENGINEERS AND CONTRACTORS

ESTABLISHED 1912

1077-1081 COLUMBUS AVENUE
BOSTON 20, MASS.

March 24, 1969

Westcott Construction Corporation
1[illegible]5 West Washington Street
North Attleboro, Massachusetts 02761

Re: Section 7A Waterproofing, Dampproofing and Caulking
Middle School
Westport, Massachusetts
Brummer, Rosane, Anderson Inc. Architects.

Gentlemen:

Please forward to the Architect for his approval the following list of materials which we propose to use at the above captioned job site.

(1) Dampproofing Below Grade and Above Grade
Sonotex's SS-A-701 - #340 Asphalt Dampproofing
Brochure enclosed.

(2) Mastic on steel supporting angles
Sonotex's #350.
Brochure enclosed.

(3) Thru Wall Flashing
AFCo #300 copper fabric as specified. — 3 oz.

(4) Caulking (Exterior and interior)
PRC 5000 - one part polysulfide, sealant.
Brochure enclosed - also color card for selection of color

(5) Filler - Ethafoam SB ~~"Shok Foam"~~ (polyethylene filler)
Sample enclosed - a product of Dow Chemical Co.
Distributed by Whitney Building Products, Inc.

(6) Primer - PRC Primer #16 for use with PRC #5000.

Very truly yours,

NATIONAL WATERPROOFING CO.

William H. Davin

WHD:s
Enclosures

EXHIBIT 28

For – Clerk

NATIONAL WATERPROOFING CO.

ESTABLISHED 1912

WATERPROOFING ENGINEERS AND CONTRACTORS

195 BROADWAY
ARLINGTON, MASS. 02174
TEL. 646-2500

May 9,1969

Westcott Construction Corporation
135 East Washington Street
North Attleboro, Massachusetts 02761

Attention: Mr. Donald Carter

Re: Section #7A Waterproofing, Dampproofing and Caulking
Middle School
Westport, Massachusetts
Drummey, Rosane, Anderson, Inc. Architects

Gentlemen:

This is to certify that the materials listed in our letter of March 24,1969 conform with the specification, Section #7A, Waterproofing, Dampproofing and Caulking.

Very truly yours,

NATIONAL WATERPROOFING CO.

William J. Sheils

William J. Sheils
President

Sworn to and subscribed before me this 9th day

of May, 1969

Robert A. Bowers

Notary Public

DRUMMEY-ROSANE-ANDERSON
RECEIVED
MAY 15 1969
NEWTON, MASS.

EXHIBIT 29

1. PRC RUBBER CALK® 5000 Sealant: a one-part, nonsagging, polysulfide, sealing compound.

PRC Rubber Calk 5000 Sealant is protected by U. S. Patent No. 3,225,-017.

"PRC" and "PRC Rubber Calk" are trademarks of Products Research & Chemical Corporation, registered with the U.S. Patent Office.

2. MANUFACTURER

Products Research & Chemical Corporation
2919 Empire Avenue
Burbank, California 91504
Phone: (213) 849-3992

410 Jersey Avenue
Gloucester City, New Jersey 08030
Phone: (609) 456-5700

95 Rivalda Road
Weston, Ontario, Canada
Phone: (416) 742-6941

3. PRODUCT DESCRIPTION

Composition: Polysulfide base.

Basic Use: For calking and sealing all joints subject to structural movement to provide a firm, flexible, weather-tight seal. Ideal for glazing and metal setting. Bonds to masonry, metal, glass, and wood.

Limitations: Although the surface cures and becomes tack-free quickly, the material should not be used in areas where time does not allow a complete cure before subjection to pedestrian and vehicular traffic. Nor should it be applied in joints in floating slabs which have asphaltic or tar membranes.

PRC® Primer #2 will discolor to a deep brown when subjected to sunlight; and, therefore, care should be taken to prevent excess material from being applied outside of joints where appearance is important. PRC primers will deteriorate polystyrene foam. Therefore, do not use polystyrene foam as joint fillers in areas where it may come in contact with primers. Foams and sponges other than those recommended should be used only when the compatibility with PRC primers has been tested to the customer's satisfaction.

Sizes: PRC Rubber Calk 5000 Sealant is packaged in spouted cartridges, one-gallon cans, and 5-gallon pails. PRC Primer #2 is packaged in ½ pint, pint, quart, and gallon kits. PRC Primer #16 is packaged in bottles of the following sizes: ½ pint, pint, quart, and gallon.

Storage Life: Storage life of sealant and primers, when stored below 80°F in original, unopened containers, is as shown in Table 1.

NOTES:

1. PRC Rubber Calk 5000 Sealant will begin to cure once the container is opened and contact is made with atmospheric moisture. This will reduce the storage life; however, if a thin skin forms, it may be removed and the material may still be used.

2. Primer #16 is moisture sensitive; containers must be kept tightly closed when not in use.

Color: Standard colors are aluminum-gray, black, gray, ivory, limestone, and white. Other colors are available on special order.

Standards: Meets the requirements of Federal Specification TT-S-230a; and, also meets the cured physical property requirements of USASI Specification A116.1-1967 and Federal Specification TT-S-227b(1).

4. TECHNICAL DATA

Consistency: Gun Grade

Tack Free Time: 24 hrs. @ 75°F, 50% RH

Cure Time:

For ⅛" thickness: 10 days @ 75°F, 50% RH

For ¼" thickness: 20 days @ 75°F, 50% RH

This Spec-Data Sheet conforms to editorial style prescribed by The Construction Specifications Institute. The manufacturer is responsible for technical accuracy.

Hardness: 25 Shore A (ASTM D2240)

Shrinkage: Negligible

Temperature Range: −40°F to 200°F

See Tables 2 and 3 for adhesive strength, tensile strength, and ultimate elongation data.

5. INSTALLATION

Joint Dimensions: It is recommended that dimensions be established for each joint in conformance with service conditions. Width of joint may be determined by calculating expansion and contraction limits of the structure in the temperature extremes of the locale and multiplying this figure by a factor of 4. For example, if it is calculated that a joint will open and close ¼" under temperature extremes, the joint should then be designed ¼" times

TABLE 2

ADHESIVE STRENGTH IN TENSION AND ULTIMATE ELONGATION

This nonstandard test was comprised of cured test specimens consisting of two small concrete blocks primed with PRC Primer #16, sealed with a seam of PRC Rubber Calk 5000 Sealant ½" x ½" x 2".

	TENSILE ADHESION	ULTIMATE ELONGATION
At 75°F	80 psi	200%
At 75°F after 9 days at 160°F	70 psi	150%
At 75°F after 21 days in water	50 psi	150%

TABLE 3

TENSILE STRENGTH AND ULTIMATE ELONGATION

Tensile strength and ultimate elongation were determined in accordance with ASTM D412.

	TENSILE STRENGTH	ULTIMATE ELONGATION
At 75°F	170 psi	500%
At 75°F after 12 days at 160°F	190 psi	350%
Twin-Arc Weather-Ometer (ASTM E-42)		
For 500 hours	180 psi	400%
For 1100 hours	100 psi	220%

NOTE: All of the above property values are typical for the material, but are not for use in specifications or for acceptance inspection criteria because of variations in testing methods, conditions, and configurations.

TABLE 1.

PRODUCT	STORAGE LIFE
PRC Rubber Calk 5000 Sealant (NOTE 1)	One year (minimum)
PRC Primer #2	One year (approximately)
PRC Primer #16 (NOTE 2)	Six months (approximately)

4 or 1" wide. No joint should be less than ¼" wide. The depth of the sealant in a joint should be not greater than the width and not less than ¼". For joints an inch wide or greater, the depth of the sealant should be ½ the width. Where necessary, joints should be packed with expansion joint fillers, such as PRC/Minicel* backer rod, flexible tubing, or closed-cell sponge of vinyl or rubber, to obtain the desired depth for the sealant. Fillers which contain or have been treated with oil, grease, or bituminous materials must not be used.

*Minicel is a registered trademark of Haveg Industries.

Surface Preparation: All surfaces must be clean and dry, and must be free of loose aggregate, paint, corrosion, oil, grease, tar, asphalt, mastic compounds, wax, waterproofing agents, and form release agents. Joints should be protected from contamination of bituminous or resinous materials sometimes sprayed on new concrete to aid in curing.

NOTE: Joints must not be contaminated by bituminous materials.

Primer: For normal conditions, primer is not required. However, for extreme moisture exposure, refer to Table 4.

TABLE 4

SURFACE	RECOMMENDATIONS
Unglazed vitrified clay, polished marble, glazed ceramic tile, granite, glazed terrazzo tile, aluminum, copper, brass, chrome plate, stainless steel, porcelain enamel.	None
Wood.	PRC Primer #2 (two-part, staining)
Unpolished marble, limestone, concrete, unglazed ceramic tile, unglazed terrazzo tile, precast facings, brick, steel, glass.	PRC Primer #16 (one-part, nonstaining)

APPROVED
FOR DESIGN AND
GENERAL DIMENSIONS ONLY
SEE TRANSMITTAL FORM
MAY 8 1969
DRUMMEY-ROSANE-ANDERSON

Where primer is recommended, apply one coat to the surface (except apply two coats of PRC Primer #2 to wood) and allow to dry at least 30 minutes at temperatures above 70°F (allow second coat of PRC Primer #2 on wood to dry at least 16 hours at temperatures above 70°F). The drying time must be doubled for each 20°F decrease in temperature below 70°F. PRC Primer #2 must be used within 72 hours after mixing.

Application: Apply with a hand or air-operated caulking gun, putty knife, or trowel. Firmly press sealant into joint to assure complete wetting of the bonding surface. The sealant should be applied within 8 hours after the primer has dried to reduce the chances of the primer becoming contaminated.

Safety Precautions: PRC Primers #2 and #16 contain flammable and volatile solvents. Keep away from heat, sparks, and flame. Proper safety precautions used with flammable material must be taken when applying this product. Comply with all local safety regulations.

Health Precautions: PRC Rubber Calk 5000 Sealant and PRC primers have been proven to be safe materials to handle when reasonable care is observed. Ordinary hygienic principles, such as washing hands before eating or smoking, should be observed. Avoid repeated or prolonged contact with the skin, open breaks in the skin, and ingestion. Keep out of reach of children. PRC Rubber Calk 5000 Sealant contains a barium compound and is harmful if swallowed. Obtain immediate medical attention in cases of ingestion. Wear gas-tight goggles when handling PRC Primer #2. If PRC Primer #2, Part B comes in contact with the skin or eyes, it should be washed off immediately with plenty of water. PRC Primer #2 contains xylene. PRC Primer #16 contains methanol and may be fatal or cause blindness if swallowed. It cannot be made non-poisonous. The maximum allowable concentration in air for methanol and xylene is 200 parts per million for safe working conditions. (Refer to DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS by N. Irving Sax.) Use adequate ventilation or air-supplied respirators during application. Avoid repeated or prolonged breathing of vapors. In case of extreme vapor exposure, remove affected personnel to fresh air immediately and obtain medical attention.

6. AVAILABILITY AND COST

Availability: Products are supplied through building materials dealers for the general contracting trade providing regional inventories for rapid delivery. Major waterproofing contractors are supplied direct from the eastern or western manufacturing plants. Factory warehouses are strategically located and direct technical service is available in all major metropolitan areas throughout the United States. Licensed manufacturing has been established in England, France, Denmark, and Japan.

Costs: Competitive prices and trade discounts applicable to the various classes of trade are available upon request.

7. GUARANTEES

PRC products are warranted under the following policy: All recommendations, statements, and technical data contained herein are based on tests we believe to be reliable and correct, but accuracy and completeness of said tests are not guaranteed and are not to be construed as a warranty, either expressed or implied. User shall rely on his own information and tests to determine suitability of the product for the intended use and user assumes all risk and liability resulting from his use of the product. Seller's and manufacturer's sole responsibility shall be to replace that portion of the product of this manufacturer which proves to be defective. Neither seller nor manufacturer shall be liable to the buyer or any third person for any injury, loss, or damage directly or indirectly resulting from use of, or inability to use, the product. Recommendations or statements other than those contained in a written agreement signed by an officer of the manufacturer shall not be binding upon the manufacturer or seller.

8. MAINTENANCE

Repair: If PRC Rubber Calk 5000 Sealant is damaged and the bond is still intact, it may be repaired simply by cutting out the damaged area and recalking. No primer is required. If the bond has been affected, remove the PRC Rubber Calk 5000 Sealant, clean and prepare the joints in accordance with the instructions outlined under "Surface Preparation."

9. TECHNICAL SERVICES

Trained, experienced, area salesmen are available throughout the U.S.A. and Canada. Laboratory facilities and technical services are available on both coasts (See Section 2 for addresses and phone numbers.)

10. FILING SYSTEMS

Sweets' Catalog—20c/Prd
A.I.A. File No. 7-D†

†The familiar AIA filing system in use for many years has recently been replaced by the filing designations of the Uniform System. The new designation appears on page 1 of this Spec Data sheet. It will supersede the former AIA file number on all future publications.

EXHIBIT 30

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
_______________________________/

RULE 30(b)(6) DEPOSITION OF
CGKV, JASON KNUTSON, DESIGNEE
JASON KNUTSON, INDIVIDUALLY
Boston, Massachusetts
Friday, April 22, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 105854

JASON KNUTSON

Pinck; is that correct?

A. I would say that we would take direction from Pinck as the agent of the client.

Q. We briefly discussed Fuss. Can you describe what CGKV's role was with Fuss?

A. My partner and I worked with Fuss & O'Neill, dating back to our time at Cole. So we worked on many projects.

We hired them as our hazardous materials consultant to examine an existing building with regard to the proposed scope of work at that building, and they helped determine what might be appropriate to test for, and then they do the sampling of materials that they've identified.

Q. When you stated they determine what's appropriate to test for, do you mean the physical sampling, or do you mean the hazardous materials to test for?

A. Both.

Q. We also mentioned AM Fogarty?

A. Yes.

Q. That was your cost estimator?

JASON KNUTSON

A. Yes.

Q. On the last page, or on Page 37, we see again the Westport interview questions, correct?

A. Uh-huh, yes.

Q. These are the actual -- in red we have the answers that CGKV provided, the official answers, I suppose?

A. Correct.

Q. They differ slightly from the answers on Exhibit 5, correct?

A. Yes.

Q. Did you go through all these answers with Westport?

A. My memory is yes.

Q. Was there a dialogue regarding these questions?

A. Yes.

Q. And so one of the questions that you discussed with Westport was your experience with hazardous materials in window replacements, correct?

A. Correct.

Q. Again you mentioned you should also

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test for PCBs, correct?
A. That's what this says.
Q. Did you tell that to Westport that day?
A. I'm sure we did. I'm sure we discussed PCBs. I can't say for sure that we directed them that they need to. It's written that way.
Q. So you discussed that PCBs could exist in their school?
A. Correct.
Q. Do you recall if they had any questions about that?
A. I don't recall.
Q. Did you explain why you believe PCBs might be in their schools?
A. I don't recall specifically. It might have been part of the discussion.
Q. And did you explain where PCBs might be found within their schools?
A. It may have been part of the discussion. I don't recall the discussion.
Q. But you recall telling them in some terms that there may be PCBs in their

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building products?

A. That's what this says.

MS. GODDIN: Objection.

Go ahead.

A. That's what this suggests (indicating).

Q. Do you have any recollection contrary to what this states?

A. I don't.

Q. So after this presentation, at some point you were hired for the green repair program, correct?

A. Yes.

Q. And how did you come to learn that you were hired?

A. I don't recall.

MS. CHANG: Can you mark this as the next exhibit.

(Exhibit 7 was marked for identification.)

Q. Do you recognize Exhibit 7?

A. Is it appears to be an email from me to Larry Borins at Pinck & Company.

Q. In the email you're announcing to

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information?

A. I don't know specifically, but I can surmise.

Q. Do you have a specific idea where he got that?

MR. McCREA: Objection. Form.

A. My best memory is that what to test for at each of those three schools would have been a matter of discussion between Westport Community Schools, CGKV, the OPM Fuss & O'Neill.

Q. So Fuss & O'Neill was present at those conversations?

A. Whether physically present or through communications, I can't remember.

Q. And Pinck had conversations with Fuss & O'Neill?

A. I don't remember if it would have been through us or if there was any direct communication, and I don't remember the timing of this document (indicating) compared to the results of Fuss & O'Neill's initial investigations.

Q. What do you mean by that?

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inspection and sampling, to facilitate the green repair program. This is for Westport Middle School.

Q. And the proposal is directed to you, correct?

A. It is.

Q. And was it directed to you as the designer on the green repair program?

A. Correct.

Q. Why did the -- what were the circumstances leading up to this proposal?

MR. McCREA: Objection.

MS. GODDIN: Objection.

Q. Let me rephrase.

Do you know why Fuss & O'Neill drafted this proposal?

A. It was at our request.

Q. At CGKV's request?

A. Correct.

Q. So CGKV requested Fuss & O'Neill to draft a proposal specifically for asbestos, lead and PCBs?

A. We did. My best recollection is that would be also based on discussions with the

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OPM and the owner as to what would be appropriate to test for.

Q. Because CGKV wouldn't make that decision by itself, correct?

A. We tend not to. We don't.

Q. So at some point prior to May 6th, CGKV, Pinck & Company and Westport decided to test for asbestos, lead and PCBs?

A. That is my best recollection.

Q. In this proposal, Fuss & O'Neill explains that sampling for PCBs is not mandated by the U.S. EPA; is that correct?

A. That's what Page 1 says.

Q. Was this proposal ever shared with the Town of Westport or the Westport Community Schools?

A. It was. It was at least intended to be a part of the contract. The fee proposal references this.

Q. Which fee proposal are you referring to?

A. CGKV's designer services fee proposal to the Westport Community Schools.

Q. Do you know when that was submitted

is cost savings or a time savings, but we definitely, you know, make that decision with the owner.

Q. And then you give written approval to the subcontractor to go forward?

A. Typically.

(Exhibit 21, 22 and 23 were marked for identification.)

(A recess was taken from 2:31 to 2:40 p.m.)

BY MR. McCREA:

Q. Mr. Knutson, what's been marked as Exhibit 21 are the specifications for Westport Middle School dated December 11, 1968. Do you see that?

A. Okay.

Q. And if you look at the section -- and I didn't print the whole specification. I was honing in on Section 7A with regard to waterproofing, damp-proofing and caulking.

A. Yes.

Q. If you turn to the third page of the exhibit --

A. Of the exhibit or the section?

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Q. The third page of the exhibit.

A. Okay.

Q. And it says, "No. 4, Materials."

A. Okay.

Q. You see that? It says, "(a), Caulking: One-part, nonsag, polysulfide base sealant conforming to Federal Specification TT-S-00230. Caulking shall be Hornflex One-Component by Grace Construction Materials, 1178 Srucsureseal by Presstite Products or Synthacaulk CG-9 by Pecara Chemical Corp." Did I read that correctly?

A. Almost.

Q. Without the correct pronunciations.

Set that aside and go to Exhibit 22, which is the waterproofing folder from the original construction, and National Waterproofing, which was the subcontractor, a subcontractor, and the first page is -- well skip to the fourth page of the exhibit. Go in chronological order.

It's a letter from National Waterproofing Company to Westcott

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Construction Corporation dated March 4, 1969.

A. Okay.

Q. Are you there?

A. Yep.

Q. And it says, "Please forward to the architect for his approval the following list of materials which we propose to use at the above-captioned job site."

And if you go down to No. 4, "Caulking (exterior and interior)," it says "PRC-5000." Do you see that?

A. Yes.

Q. Okay. So this March 24, 1969 letter comes after the specifications, which are in Exhibit 21.

A. Okay.

Q. And this letter is asking for approval to use PRC-5000 correct?

A. It appears to.

Q. Okay. And so then go to the second page of the exhibit, and that's dated May 9, 1969, which is after March 24, 1969. This is from National Waterproofing Company to

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Westcott Construction Corporation.

It says, "This is to certify that the materials listed in our letter of March 24, 1969 conform with the specification Section No. 7A" -- which if you look at 21, 7A is the section on waterproofing damp-proofing and caulking.

A. Yep.

Q. "Very truly yours, National Waterproofing Co.," and then it is signed and notarized.

So then if you go to the very back two pages of the exhibit?

A. 22?

Q. 22. It's a data sheet on PRC rubber caulk 5000. Do you see that?

A. Yes.

Q. On the last page it says -- there's a stamp. "Approved for design" --

A. "General dimensions only."

Q. "See transmittal form May 8, 1969 Drummey Rosane Anderson." That's the architect?

A. Yes.

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Q. They're giving approval to the use of this PRC-5000?

MS. GODDIN: Objection.

A. That's what this looks like, but I don't have any firsthand evidence.

Q. If you go to the final exhibit, it's the daily construction reports.

A. Where did you find this great stuff, by the way? Because I would have loved to have this for our work down there.

Q. In the files.

You see the daily construction report of Drummey Rosane Anderson, and you'll see the subcontractors are listed. I didn't print all 846 pages of these.

If you go through, you'll see that National Waterproofing is one of the subcontractors that did the caulking. Do you see those?

A. I see their name listed, yes.

MS. CHANG: Mitchell, he may have gotten your highlighted copy.

MS. GODDIN: I have a highlighted copy, too.

EXHIBIT 31

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
_____________________________/

DEPOSITION OF MAUREEN T.F. REITMAN, ScD
Boston, Massachusetts
Friday, September 23, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 112694

MAUREEN REITMAN

Q. Okay. What kind of caulk was it?

A. To the extent that such a material was present, I believe the documents indicate that it would have been a polysulfide type caulk, and I believe the information that's available indicates that it was likely from the Products Research Corporation.

Q. Okay. When you say to the extent it was present, you're not talking about present at the time of your inspection? You're talking about present at the Westport school back in the day?

MR. GOUTMAN: Objection. Vague. Overly broad. Ambiguous.

A. What I'm saying is, to the extent that a PCB-containing caulk, intentionally PCB-containing caulk was present in the school at some point, my understanding is that it was likely to have been a polysulfide, and it was likely to have been from the Products Research Corporation.

Q. Okay. What company would have -- explain the process to me of the formulation of this product, the polysulfide caulk

EXHIBIT 32

Town of Westport
ANNUAL REPORTS
1970

BOARD OF SELECTMEN
and
OTHER BOARDS OF OFFICERS

Including a Statement of the Receipts and Expenditures of the Fiscal Year Ending December 31, 1970.

R. E. SMITH PRINTING CO., INC.

REPORT OF PRINCIPAL OF WESTPORT MIDDLE SCHOOL

Mr. Nicholas F. Cariglia
Superintendent of Schools
Westport, Massachusetts

Dear Mr. Cariglia:

As Principal of the Westport Middle School I hereby submit my annual report.

The Westport Middle School opened its doors on September 14th, 1970, three days later than the other Westport Schools and with an enlarged student population. When the Westport schools closed on June 19th, 1970, the student population scheduled for the Middle School was 572 and when we took inventory of our students on the first full day of classes we had 655 students, an increase of 83 students. This situation became very evident during the summer months and two additional teachers were hired.

We are now four months into our first school year and gradually overcoming the inevitable problems of a new building. This required considerable patience and cooperation from everyone involved.

Our experiences to date indicate that continued revision and updating of our curriculum and materials has highest priority. This is urgent in the immediate future. Improvements in these very crucial areas will be reflected in budget requests. This cannot occur simultaneously across all grades and all subjects because of costs; therefore, we will be concentrating our efforts in the areas of reading and mathematics.

The relative smoothness of the Middle School opening was due to the outstanding cooperation of many people.

I extend my sincere thanks to the Superintendent of Schools, and his staff, to Miss Audrey Tripp, Principal of the Milton E. Earle School, Miss Irene Boodry, Principal of the Alice A. Macomber School and Mr. Harold Wood, Principal of Westport High School, to my entire staff, to Mr. John Machado and all of his staff who so capably carried out the "Big Move", and to the very dedicated members of the School Committee and Middle School Building Committee.

Respectfully submitted,

Paul Wilber, Principal

EXHIBIT 33

United States Environmental Protection Agency
EPA-747-F-09-005
September 2009

Office of Pollution Prevention and Toxics (7404)

Preventing Exposure to PCBs in Caulking Material






PCBs are found in high levels in building caulk

Caulk containing high levels of PCBs (polychlorinated biphenyls) has been found in many schools and other buildings built or remodeled before 1978. Because PCBs can migrate from the caulk into air, dust, surrounding building materials, and soil, EPA is concerned about potential PCB exposure to building occupants.

Health impacts of PCB exposure

PCBs are man-made toxic chemicals that persist in the environment and bioaccumulate in animals and humans. PCBs were manufactured in the United States between 1950 and 1978, before their manufacture was banned by Congress due to concerns about their potential for adverse effects on human health and the environment. Exposure to PCBs can affect the immune system, reproductive system, nervous system, and endocrine system. In humans, PCBs are potentially cancer-causing.

Protect children and other building occupants

The preventive steps described below can help reduce exposure to PCBs in caulk until it can be removed.

- Improve ventilation and add exhaust fans. Clean air ducts.
- Clean frequently to reduce dust and residue inside buildings.
- Use a wet or damp cloth or mop to clean surfaces.
- Use vacuums with high-efficiency particulate air (HEPA) filters.
- Do not sweep with dry brooms and minimize the use of dusters.
- Wash hands with soap and water after cleaning and before eating or drinking, and wash children's toys often.

Test for PCBs in buildings built between 1950 and 1978

If school administrators and building owners are concerned about exposure to PCBs and wish to supplement these steps, EPA recommends testing to determine if PCB levels in the air exceed EPA's suggested public health levels. If testing reveals PCB levels above these levels, schools should be especially vigilant in implementing and monitoring practices to minimize exposures.

Caulk that is peeling or deteriorating may be tested to determine its PCB content. If PCBs are found in the air, EPA will assist in developing a plan to reduce exposure and manage the caulk. Your EPA regional PCB coordinator can direct you to a PCB testing lab; see the back cover for more information.

PCBs were not added to caulk after 1978. Therefore, in general, schools built after 1978 do not contain PCBs in caulk.

Avoid exposure to PCBs in building caulk

Caulk that is peeling, brittle, cracking, or deteriorating visibly in some way may have the highest potential for creating dust. In addition to inhalation from PCBs in the air or dust, exposure may occur when a person comes in contact with the caulk and any surrounding porous materials into which the PCBs may have been released (e.g., brick, concrete, wood). Exposure may also occur through contact with PCB-contaminated soil adjacent to buildings. Soil may become contaminated with PCBs when caulk weathers.

Protections during removals, renovations

Schools, building owners, and daycare providers in public and commercial buildings need to follow PCB-safe renovation practices to minimize potential exposures resulting from renovations to workers, teachers, and children.

It is important to manage the removal in a way that minimizes workers' exposure to the PCBs (e.g., use protective clothing such as facemasks, gloves, etc.) and prevents the release of PCBs into the environment. The work practices described below can help reduce exposure to PCBs in caulk until it can be removed.

In addition to the safeguards mentioned above:

- Wear appropriate protective clothing when conducting cleanup activities.
- Dispose of all cleanup materials (mops, rags, filters, water, etc.) in accordance with all federal, state, and county regulations.
- For caulk used on windows, walls, columns, and other vertical structures that people may come into contact with, use heavy-duty plastic and tape to contain the area so that caulk or dust and debris from the surrounding masonry do not escape. The plastic should cover the caulk and surrounding areas of masonry.

EPA is helping to address the issue of PCBs in caulk

EPA is conducting research on how the public is exposed to PCBs in caulk and on the best approaches for reducing exposure and potential risks associated with PCBs in caulk. Where PCBs have been found in caulk, EPA is committed to helping schools and communities enact plans to reduce exposure. Please contact your regional PCB coordinator at 888-835-5372 for help with assessing contamination and exposure and developing cleanup plans.

Summary

EPA is particularly concerned when PCBs are present during renovation or remodeling activities because these activities increase the potential likelihood of exposure.

- Keep people out of areas where cracked or peeling caulk is evident such as in playgrounds and near steps.
- Promote safe work practices during renovation activities.
- Take actions to safely remove caulk during PCB removal or renovation projects and undertake and complete the work in a timely fashion.

Reducing Potential Exposures to PCBs from Caulk in Schools and Other Buildings

Points to Remember

1 EPA is concerned about potential exposure to PCBs (polychlorinated biphenyls) in caulk found in older schools and buildings. Consider testing for PCBs by having your air monitored or test the caulk if it is peeling or visibly deteriorating. Call EPA's PCBs in Caulk Hotline at 888-835-5372 to find a PCB testing lab.

2 Call 888-835-5372 or visit http://www.epa.gov/pcbsincaulk to find your EPA regional PCB coordinator.

3 Talk to your EPA regional PCB coordinator who will provide you with simple actions to take today, and longer term actions for removing the sources of PCBs including developing a cleanup plan.

4 Prioritize where you should first concentrate work.

5 Implement the plan.

6 Retest and monitor for PCBs in the air once removal is complete.

For more information

http://www.epa.gov/pcbsincaulk/
EPA's PCBs in Caulk Hotline: 888-835-5372

This fact sheet is intended solely for guidance. It does not replace or supplant the requirements of the Toxic Substances Control Act or the PCB regulations at 40 C.F.R. part 761, and it is not binding on the U.S. Environmental Protection Agency or individuals. Please refer to the regulations at 40 C.F.R. part 761 for specific requirements relating to PCBs and PCB-containing materials.






For more information:

http://www.epa.gov/pcbsincaulk/
EPA's PCBs in Caulk Hotline: 888-835-5372

EPA-747-F-09-005

EXHIBIT 34

Public Health Levels for PCBs in Indoor School Air

The U.S. EPA has calculated prudent public health levels that maintain PCB exposures below the "reference dose" - the amount of PCB exposure that EPA does not believe will cause harm. EPA's reference dose (RfD) is 20 ng PCB/kg body weight per day. Indoor air levels are based upon EPA's understanding of average exposure to PCBs from all other major sources, and were calculated for all ages of children from toddlers in day-care to adolescents in high school as well as for adult school employees.

In calculating these indoor air levels, EPA considered potential sources of PCB exposure from both school and non-school environments. Non-school sources of PCB exposure include both indoor and outdoor air, indoor dust, outside soils, and diet. Although the concentrations of PCBs in environmental media are not well characterized, mean or median values from the scientific literature, and average contact rates, were used to estimate exposure. For non-school sources, the largest single source of PCB exposure for most individuals in uncontaminated buildings is diet, which contributes roughly 50 to 60% to total PCB exposure. Typical indoor and outdoor air contains a small amount of PCBs, and inhalation exposure accounts for another 25 to 35% of total exposure. Together, these non-school sources of PCBs generally result in exposures that are significantly below the reference dose. In addition, it is worth noting that the PCB concentrations in food have been decreasing and this trend would further decrease exposure.

School sources of PCBs that were considered include school indoor and outdoor air, indoor dust, and nearby outside soils. In calculating these public health levels for indoor air in schools, EPA assumed that the PCB concentrations in dusts and soils in and around schools were the same as in average homes or other buildings without elevated PCBs. EPA also assumed an 8-hour school day for adults and children less than 3 years old, and a 6.5 hour school for all other children. EPA also assumed children would be in school 180 days per year. Using estimates of exposure for sources except indoor air in schools, EPA calculated the school indoor air PCB concentration that would result in a total exposure equal to the reference dose. These calculated indoor air concentrations are the air concentration values provided in the table below.

EPA recommends that the concentrations of PCBs in indoor air be kept as low as is reasonably achievable and that total PCB exposure be kept below the reference dose level. The concentration values provided in the table below are based upon average situations. Spending less time in schools would decrease school exposure and cause the values to be higher. Spending more time in schools would have the opposite effect and would decrease the values. PCB concentrations in outdoor soils, indoor dusts, or indoor surfaces greater than those in background, non-school environments would suggest that exposure sources other than air in schools increase total exposure and, therefore, would decrease these air concentration values.

Building owners and school administrators wishing to make similar calculations based on their own specific circumstances should contact their regional PCB coordinator.

Public Health Levels of PCBs in School Indoor Air (ng/m3)

Assuming a background scenario of no significant PCB contamination in building materials and average exposure from other sources, these concentrations should keep total exposure below the reference dose of 20 ng PCB/kg-day.						
Age 1-<2 yr	Age 2-<3 yr	Age 3-<6 yr	Age 6-<12 yr Elementary School	Age 12-<15 yr Middle School	Age 15-<19 yr High School	Age 19+ yr Adult
70	70	100	300	450	600	450

EXHIBIT 35

PCBs in Building Materials—Questions & Answers

July 28, 2015

Introduction

Based on the information available, the EPA believes that there was potentially widespread use of PCB-containing building materials in schools and other buildings built or renovated between about 1950 and 1979. This is an important issue because PCBs have been identified as probable human carcinogens and may cause a variety of non-cancer health effects.[1] Although the presence of PCBs in schools and other buildings may be a concern, the presence of PCBs alone is not necessarily a cause for immediate alarm. If PCBs are present or suspected of being present, EPA recommends the actions outlined in this document be taken by school administrators, building owners and building managers to reduce PCB exposures.

The specific questions and answers (Q&As) provided in this document are meant to help school administrators, building owners, managers and occupants better understand the types of building materials that may contain PCBs, the potential for building occupant exposure to PCBs, and how exposure to PCBs can be assessed and reduced. Information presented in this document is broadly applicable and serves as practical guidance meant to reduce potential exposure of building occupants to PCBs within a reasonable time frame and under exposure conditions expected in schools and other buildings.

School administrators, building owners and managers can take practical actions to reduce potential PCB exposures in buildings built or renovated between about 1950 and 1979. These include best management practices (BMPs) such as removing all PCB-containing fluorescent light ballasts (FLBs) from schools and other buildings since they can be a significant source of PCBs, improving ventilation, keeping surfaces clean to reduce dust that may contain PCBs, and improving building occupant hygiene (see Q&A #16). Due to building-specific factors, these practical actions may not always adequately reduce PCB exposure (see Q&A #25). Additional or more frequent cleaning, or other actions to identify and address PCB sources, may be warranted to reduce total PCB exposures. In such cases, the EPA recommends that school officials, building owners and managers consult with their EPA Regional PCB Coordinator and make decisions about appropriate action after thoughtful consideration of all available information and all legal requirements. After implementing BMPs or taking other actions in schools to address sources of PCBs, school administrators may want to consider conducting indoor air testing and comparing test results to the Exposure Levels for Evaluating PCBs in Indoor School Air (See Q&A #25 & 26) to assess PCB levels in indoor air. Only air testing can determine if PCBs are present in indoor air after BMPs and other actions have been implemented.

[1] http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/effects.htm

The Exposure Levels for Evaluating PCBs in Indoor School Air provided in this Q&A document are based on potential exposure of school occupants over the course of a typical school year and are meant to keep total daily PCB exposure below the EPA life-time reference dose level for PCBs. These levels for indoor school air are not meant to be interpreted or applied as “bright line” or “not-to-exceed” criteria. Rather, measurements above these levels are intended to suggest the need for the further investigation of PCB sources in the school building and other actions to reduce exposure. If indoor air PCB concentrations persist above these levels in school buildings, school administrators should work in consultation with their EPA Regional PCB Coordinator to develop a plan to minimize exposures, including, as appropriate, plans to remove PCB-containing building materials. Note the Exposure Levels for Evaluating PCBs in Indoor School Air discussed in Section IV of this document were developed specifically for schools and cannot be directly applied to other buildings without adjustment of the underlying exposure assumptions (see Q&A #27, 28, 30 and 31).

This document is intended to be used as an informal reference and is not intended to be a summary of applicable PCB requirements. This document does not replace nor supplant the requirements of the Toxic Substances Control Act (TSCA) PCB regulations. Please refer to the regulations at 40 CFR part 761 for specific regulatory and legal requirements. You can also contact the appropriate EPA Regional PCB Coordinator if you have more questions concerning PCBs in building materials.

I. Potential Sources of PCB Exposure in Schools and Other Buildings

A. Overview

1. What are potential sources of PCBs in schools and other buildings?

Potential sources of PCBs in schools and other buildings built or renovated between about 1950 and 1979 include caulking used around windows, door frames, building joints, masonry columns and other masonry building materials. PCB-containing caulk may be present inside and on the exterior of the building as well as in surrounding surfaces. PCBs have been used in paints, mastics and other adhesives, fireproofing materials, and in the manufacture of some ceiling tiles and acoustic boards, among other products. PCBs may also be present in high intensity discharge (HID) lamp ballast capacitors and the capacitors of fluorescent light ballasts (FLBs) manufactured before 1979. The capacitors within the light ballasts in HID and fluorescent lighting fixtures serve to limit the amount of electrical current going to the lamp (e.g., tube or bulb). PCBs can emit into the air during normal use of these fixtures and if the ballast fails or ruptures. Building materials where PCBs were intentionally added during manufacture or application (called manufactured sources or also primary sources, such as the examples above) can lead to PCBs in indoor air. PCBs in the indoor air can then adsorb onto other surfaces and dust, which become secondary sources of PCBs (sources of PCBs where PCBs were not intentionally added to the material). These secondary sources may, in some cases, contribute to PCB concentrations in indoor air even after the manufactured sources are removed. PCBs from manufactured sources such as caulk may also contaminate adjoining materials, such as masonry or wood, through direct contact and create secondary sources.

2 . How are building occupants exposed to PCBs in schools or other buildings?

PCB exposure to building occupants may occur through inhalation of PCBs that have off-gassed into the air from both manufactured sources and secondary sources. Building occupants may also be exposed to PCBs through the ingestion of PCB-containing dust and residues present on building surfaces transferred from hand to mouth. Building occupants may also experience direct dermal exposure to PCBs.

3. What are additional sources of PCB exposure to the general population?

Dietary intake and inhalation are the greatest sources of exposures to PCBs in the general population, although PCB concentrations in food have decreased. Together, these sources of PCBs generally result in background exposures that are significantly below the “reference dose” – or the amount of PCB exposure that EPA does not believe will cause harm (see Q&A #25 and #27). Indoor and outdoor air typically contain small amounts of PCBs. Most of the dietary intake comes from consumption of fish/seafood, meat, and dairy products. Some population groups or individuals with high fish/seafood consumption may experience higher dietary intake of PCBs than the general public.

B. Manufactured Sources of PCBs in School and Other Buildings

PCBs in Fluorescent Light Ballasts (FLBs)

4. Why are PCB-containing FLBs a concern?

PCBs are contained within the FLB capacitors and in the FLB interior potting material of old magnetic T12 lighting fixtures (see Q&A #5). The capacitor regulates the amount of electricity coming into the lighting fixture and the potting material serves to insulate the FLB and reduce the "humming" noise. Because all PCB-containing FLBs currently in use have exceeded their designed life span, it makes them susceptible to leaking or rupturing at any time which may lead to increased exposures to building occupants. Residues from these sources are difficult and costly to clean up. Additionally, intact PCB-containing FLBs may emit small amounts of PCBs into the air during normal use of the lighting fixture. For these reasons, EPA recommends all PCB-containing FLBs be removed from lighting fixtures. Note that EPA has limited data suggesting older HID ballast capacitors may be a source of PCB exposure. EPA recommends that school administrators and building owners consider removing and replacing HID ballasts that contain PCBs.

5. How do I know if my building has PCB-containing FLBs?

Any building built or renovated before 1979 (most uses of PCBs were banned in 1979) is likely to have PCB-containing FLBs if it has not undergone a complete lighting retrofit after 1979 (i.e., all light fixtures in the building are replaced with those manufactured after 1979). In some cases, PCB-containing FLBs that were manufactured before 1979 were stored and later used in some fluorescent light fixtures installed or repaired after 1979. Thus, some schools and other buildings built after 1979 that have not undergone a complete lighting retrofit could have PCB-containing FLBs. To determine whether your building has PCB-containing FLBs, conduct a visual inspection of the FLBs in a representative number (see http://www.epa.gov/wastes/hazard/tsd/pcbs/pubs/ballasts.htm#05) of light fixtures (not just the tubes). Examining any available date of manufacture information is recommended.

The following criteria are provided to help identify FLBs that may contain PCBs:

- FLBs manufactured before July 1, 1979 may contain PCBs.
- FLBs manufactured between July 1, 1978 and July 1, 1998 that do not contain PCBs must be labeled "**No PCBs**" by the manufacturer.
- If an FLB is not labeled "**No PCBs**", it is best to assume it contains PCBs unless it is known to be manufactured after 1979.
- FLBs manufactured after 1998 are not required to be labeled but should not contain PCBs.

Note that PCBs are contained within magnetic T12 FLB capacitors and in the FLB interior potting material. Only the T12 magnetic FLBs (not T8 or T5 FLBs) may contain PCBs. The "T" designates the lamp that goes with the FLB as a "tubular" shape. The number after the "T" represents the lamp diameter in eighths of an inch.

6. What should I do if my building has PCB-containing FLBs?

EPA recommends removing all PCB-containing FLBs from schools and other buildings because these FLBs have exceeded their designed life span and are susceptible to leaking or rupturing in the future. Leaking PCB-containing FLBs left in place are a violation of the PCB regulations and must be removed. If there is staining or residues on light fixtures and/or on building surfaces that are attributable to prior PCB releases from the FLBs, the fixtures and surfaces must be cleaned or disposed of in accordance with 40 CFR part 761, subpart D. Consult with your EPA Regional PCB Coordinator to ensure that all relevant clean-up procedures are followed; see http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/coordin.htm. Replacing old lighting systems with new, energy efficient systems will eliminate this potential source of PCBs. For more information on PCBs in FLBs, see http://www.epa.gov/wastes/hazard/tsd/pcbs/pubs/ballasts.htm. (see also Q&A #17).

PCBs in Caulk

7. What is known about the use of PCBs in caulk?

PCBs were widely used in caulking and elastic sealant materials, particularly between about the 1950s through the 1970s. These materials were primarily used in or around windows, door frames, stairways, building joints, masonry columns, and other masonry building materials. PCBs were used in these building materials because of their properties as a plasticizer. PCBs have been detected in caulk in buildings, including schools, with concentrations ranging from below 50 parts per million (ppm) to greater than 440,000 ppm.

8. Why is caulk a potential source of PCB exposure?

If caulk contains PCBs, the PCBs may be released into the air through off-gassing. This may occur when the caulk is intact and undisturbed or if it is deteriorating. PCBs in the air originating from caulk can then be absorbed into other building materials, creating secondary sources which can then re-emit PCBs into the air (see Q&A # 13). PCBs in manufactured materials such as caulk may also move directly into adjoining materials, particularly porous materials such as wood, concrete, and other types of masonry. PCBs from exterior caulks may also leach into surrounding building materials and soil from precipitation and deterioration of the caulk, and from disturbances during renovations or construction.

9. How many schools and other buildings built or renovated between about 1950 and 1979 contain PCB-containing caulk?

EPA does not have much information on the prevalence of PCB-containing caulk in schools and other buildings. Based on the limited number of test samples gathered from different parts of the country, EPA believes that there was potentially widespread use of PCB-containing caulk in schools and other buildings built or renovated between about 1950 and 1979.

10. Is PCB-containing caulk present in housing structures?

In some instances, EPA found PCBs in large scale apartment complex buildings. However, the use of PCBs in residential building materials is not well documented.

PCBs in Paint and Coatings

11. Are PCBs present in paint used in schools and other buildings built or renovated between about 1950 and 1979?

PCBs may have been intentionally added to some specialty paints and coatings to improve their performance for use primarily in industrial and/or military applications (e.g., paints manufactured to endure thermal stress, vibration or corrosivity) but such specialty paints or coatings could have been used in some schools and other buildings built or renovated between about 1950 and 1979. PCBs intentionally added to specialty paints and coatings may occur in high concentrations. Although specialty paints or coatings were not typically used for interior or exterior decorative architectural uses, PCBs have been found in paint on walls in some schools and other buildings, so all interior and exterior decorative uses of PCB-containing paint cannot always be ruled out. PCBs in manufactured materials such as specialty paint may move directly into adjoining materials, particularly porous materials such as wood, concrete, and other types of masonry. PCBs, if present in exterior paints, may also leach into surrounding building materials and soil from precipitation and deterioration of the paint, and from disturbances during renovations or construction.

Other Potential Manufactured Sources

12. What are other manufactured sources of PCBs in building materials?

Besides caulk, paint and FLBs, other building materials or components may have been manufactured with PCBs. For example, window glazing, ceiling tiles, spray-on fireproofing, and floor finish containing PCBs have been found in some schools and other buildings. These other potential sources of PCBs and the extent of their use in schools and other buildings are not well characterized.

<u>C. Secondary Sources of PCBs</u>

13. What are examples of secondary sources of PCBs?

Secondary sources of PCBs are created when PCBs in manufactured sources move into other materials in schools and other buildings. Examples of secondary sources of PCBs include dust, paint, laminates, wood products, masonry, furniture foam, ceiling tiles, floor tiles, and carpet. There are two primary mechanisms for the movement of PCBs in schools and other buildings. First, PCBs are emitted from manufactured materials into the air inside schools and other buildings. PCBs in the air are then absorbed into other building materials, components, furnishings and dust. Second, PCBs in manufactured materials such as caulk may move directly into adjoining materials, particularly porous materials such as wood, concrete, and other types of masonry. In schools with manufactured PCB sources, many different kinds of building materials have been found to have measurable levels of PCBs and are potential secondary PCB sources.

14. What do we know about PCB concentrations on interior building surfaces for schools and other buildings constructed or renovated using PCB-containing building materials?

Interior building surfaces (through residues and dust) are a potential source of non-dietary ingestion, dermal and inhalation exposure to PCBs. Available data indicate that when present, PCB concentrations on interior building surfaces can be variable from building to building and from room to room within the same building. Indoor dust is composed of multiple types of materials, potentially including deteriorating building materials, outside soils tracked into schools and buildings, and various kinds of organic matter. Measured values of PCBs in dust have ranged from less than 1 to 6,800 micrograms (one microgram is equal to one millionth of a gram) of PCBs per gram of dust. EPA recommends that interior building surface concentrations of PCBs be minimized through appropriate and frequent cleaning (see Q&A #16).

15. What do we know about PCB concentrations in the soils surrounding schools and other buildings constructed or renovated using PCB-containing building materials?

The soils surrounding schools and other buildings can be contaminated with PCBs originating from PCB-containing building materials, particularly from exterior caulks and sealants. In general, although not in all cases, measurements have indicated that higher concentrations of PCB-contaminated soils are found closest to the schools and other buildings.

II. Actions to Reduce PCB Exposure in Schools and Other Buildings

A. Best Management Practices (BMPs)

16. What are the BMPs to reduce PCB exposures in schools and other buildings?

Regardless of whether PCBs are known to be present, EPA recommends that all schools and other buildings built or renovated between about 1950 and 1979 implement the following practical actions to minimize potential building occupant exposure to PCBs:

- **Remove all PCB-containing fluorescent light ballasts (FLBs).** EPA recommends that non-leaking PCB FLBs be removed and retrofitted as part of lighting upgrades or as a stand-alone project. Leaking PCB FLBs must be removed as required under 40 CFR part 761, subpart D. The EPA recommends that an experienced contractor or properly trained facilities maintenance staff perform the removal, cleanup, and disposal of PCB-containing FLBs, light fixtures, and building surfaces. Consult with your EPA Regional PCB

Coordinator to ensure that all relevant cleanup procedures are followed; see http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/coordin.htm. The EPA's recommended procedures for the proper removal and disposal of PCB FLBs are listed at: http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/ballasts.htm.

- **Conduct the following best management practices listed below on a frequent ongoing basis to minimize potential exposures to PCBs**:
  - ✓ Ensure that ventilation systems are operating properly and are regularly inspected and maintained according to system manufacturer instructions and guidelines or ANSI/ASHRAE/ACCA Standard 180-2012—Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems. If system cleaning is needed, follow ANSI/ACCA Standard 6 – Restoring the Cleanliness of HVAC Systems (2007).
  - ✓ Clean inside schools and other buildings frequently to reduce dust and residue.
  - ✓ Use a wet or damp cloth or mop to clean surfaces.
  - ✓ Use vacuums with high efficiency particulate air (HEPA) filters.
  - ✓ Do not sweep with dry brooms or use dry cloths for dusting.
  - ✓ Wash hands with soap and water, particularly before eating.
  - ✓ Wash children's toys.

For EPA's general school cleaning recommendations visit: http://www.epa.gov/iaq/schools/clean_maintenance.html

Due to building-specific factors, these BMPs may not always adequately reduce PCB exposure. In some cases, additional and more frequent cleaning or other actions to identify and address PCB sources may be warranted.

B. PCB Source Removal and Repair

17. What recommendations does EPA provide to school administrators or building owners on the proper removal and disposal of PCB fluorescent light ballasts (FLBs)?

EPA recommends that an experienced contractor or properly trained facilities maintenance staff perform the removal, cleanup and disposal of PCB-containing FLBs. Leaking PCB FLBs must be properly disposed of pursuant to the PCB regulations at 40 CFR part 761. Staining or residues on light fixtures and/or on building surfaces that are attributable to prior PCB releases from the FLBs must be cleaned (40 CFR section 761.61 or 761.79) or the contaminated building materials disposed of in accordance with 40 CFR part 761, subpart D. Consult with your EPA Regional PCB Coordinator to ensure that all relevant cleanup procedures are followed; see http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/coordin.htm. EPA's recommended procedures for the proper removal of PCB FLBs are listed at: http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/ballasts.htm.

18. Should PCB-containing building materials be removed during building repair and renovation activities?

Yes, EPA recommends that PCB-containing caulk and other PCB-containing building materials be removed during planned renovations and repairs (when replacing windows, doors, roofs, ventilation, etc.). Prior to removal, EPA recommends PCB testing for caulk and other building materials that are going to be removed to determine what protections are needed during removal and to determine proper disposal requirements. Where testing confirms the presence of PCBs at regulated levels in building materials, they must be disposed of in accordance with the PCB regulations at 40 CFR part 761, subpart D. In lieu of testing, caulk and other potentially PCB-containing building materials that are part of building repair and renovation activities may be assumed to contain PCBs at regulated levels and disposed of in accordance with 40 CFR part 761, subpart D.

19. What special procedures are needed when doing repairs or renovations that may disturb PCB-containing building material?

To ensure that PCB-containing building material does not contaminate surrounding surfaces when it is removed and disposed of, repairs that disturb PCB-containing building material, such as window removal and replacement, should be conducted by trained workers who use safe work practices to minimize dust and contain contaminated waste. EPA has developed guidance for minimizing exposures when conducting repairs and renovation activities, including cleaning the work area once the work is completed; see http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/caulk/caulkcontractors.htm.

Actions contractors should take include:

- Ensure workers are properly trained and are using gloves, eye goggles, skin protection and approved particulate breathing masks.
- In dusty work areas, have showers available and separate changing areas so that dust on clothing is not brought home.
- If working with solvents, provide respirators.
- Use heavy plastic sheeting to cover floors and other fixed surfaces like large appliances in the work area.
- Close and seal vents in the work area and turn off forced-air heating and air-conditioning systems.
- Regularly clean the work area using a HEPA vacuum and wet mopping.
- Properly dispose of personal protective equipment and cleaning material.

Building occupants should be notified of the PCB repair and renovation activities and be completely isolated from the parts of the building undergoing PCB repair and renovation activities to prevent exposure to PCBs. Additional steps, including physically isolating the work space with physical barriers and negatively pressurizing work areas may be necessary (see http://www.epa.gov/iaq/schooldesign/renovation.html). If complete isolation of the work space cannot be assured, school administrators and building owners should temporarily remove occupants from the area of the building while the work is underway.

For additional guidance on protecting occupants during renovations or other construction activities, see ANSI/SMACNA 008-2008: IAQ Guidelines for Occupied Buildings Under Construction. The guidelines are available from the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) at www.smacna.org.

20. Can PCB-containing building materials be encapsulated to prevent the release of PCBs?

EPA has looked at the effectiveness of encapsulation (or sealing) techniques to prevent the release of PCBs. Based on laboratory research by EPA's Office of Research and Development, encapsulation was found to be most effective for interior surfaces that contain low levels of PCBs (i.e., up to several hundred parts per million). Encapsulation was not found to be effective for more than a short period of time in reducing air emissions from sources that have a high PCB content. Depending on the PCB reduction goal, the performance of the encapsulant and the conditions of the building, the upper limit of the PCB concentration for successful encapsulation may vary. Therefore, post-encapsulation monitoring may be an essential part of the encapsulation process. Building owners should consult EPA's research on this issue for more specifics (see http://nepis.epa.gov/Adobe/PDF/P100FA5L.pdf).

Encapsulation may be useful for the reduction of air emissions from secondary sources such as contaminated building materials under and around PCB-containing caulk or paint that has been removed. Because each site will present unique circumstances, please consult your EPA Regional PCB Coordinator regarding the application of encapsulation measures on a case-by-case basis. Additional details about EPA's research findings may be found at: http://www.epa.gov/pcbsincaulk/caulkresearch.htm

III. Assessment of PCBs in Schools and Other Buildings

A. Air Testing for PCBs

21. What should a school administrator do if there are concerns about possible exposure to PCBs in school indoor air?

As noted in Q&A #16, EPA recommends that all schools and other buildings built or renovated between about 1950 and 1979 implement Best Management Practices (BMPs) to minimize potential building occupant exposure to PCBs. After implementing BMPs, school administrators should consult with their EPA Regional PCB Coordinator to assess if there still may be the potential for PCB releases in their school and whether to consider testing indoor air for PCBs. If air testing is conducted, the test results should be evaluated using the Exposure Levels for Evaluating PCBs in Indoor School Air (see Q&A #25 & 26).

Each school is unique, which means that many factors should be considered when deciding whether and how to test the indoor air at a school. This decision should be made in consultation with the EPA Regional PCB Coordinator and the decision makers should thoughtfully consider all available information, such as: school-specific conditions (e.g., building age, types of materials used in construction, layout, maintenance or renovation history), BMPs already implemented to address PCB sources (see Q&A #16), and available technical resources, costs, and public concerns.

While there are accepted analytical methods to measure PCBs in indoor air samples, there is no broadly accepted sampling protocol for testing PCBs in indoor air. Accordingly, EPA is unable to provide a generic recommendation on indoor air testing due to the many different school-specific situations encountered in designing a sampling plan. Development of an air testing plan should endeavor to be as representative as circumstances in the school allow and factor in school-specific conditions, which EPA believes school administrators are best positioned to identify in consultation with their EPA Regional PCB Coordinator. Only air testing can determine if PCBs are present in indoor air after BMPs and other actions have been implemented.

If school administrators decide to test school indoor air and find that PCB levels exceed the Exposure Levels for Evaluating PCBs in Indoor School Air (see Q&A #25), they should consult with their EPA Regional PCB Coordinator on appropriate next steps, such as the implementation of BMPs and whether manufactured sources (e.g., FLBs, caulk, paint) or secondary sources (e.g., paint, ceiling tiles) of PCBs should be investigated.

Furthermore, if PCB indoor air level exceedances persist, school administrators should work with their EPA Regional PCB Coordinators to develop a plan to minimize exposures (e.g., continue following the best management practices as indicated in Q&A #16, such as further cleaning of affected areas and optimizing ventilation) and investigate additional potential sources of PCB-containing building materials or expand air testing to identify the extent of the areas with air level exceedances.

See also Q&A #25 for additional information on the Exposure Levels for Evaluating PCBs in Indoor School Air.

22. Are there air sampling methods for determining the presence of PCBs in indoor air of schools and other buildings?

For determining the presence of PCBs in indoor air of schools and other buildings, EPA has two approved air sampling methods: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Compendium Method TO-4A (high air volume) and Compendium Method TO-10A (low air volume). These two methods can be found respectively at:

http://www.epa.gov/ttnamti1/files/ambient/airtox/to-4ar2r.pdf and
http://www.epa.gov/ttnamti1/files/ambient/airtox/to-10ar.pdf

There are a number of factors to be considered when developing a building-specific sampling plan for testing the air. These include but are not limited to:

- Potential seasonal variations in the air concentrations due to changes in ventilation and temperature (e.g., windows may be open in the summer and closed in the winter);
- Whether the intent is to study worst-case or normal operating conditions within the building;
- The number of samples to be collected and their locations; and
- Whether the samples will be analyzed for individual types of PCBs: aroclors, homologues or congeners. Congeners are individual PCB chemicals; aroclors are specific mixtures of PCB congeners and homologues are a way of grouping PCB congeners by the number of chlorine atoms they have.
- To ensure that PCBs are accurately quantified, the type of PCB must be measured against the same type of PCB (Aroclors must be measured against a standard for that Aroclor, and an individual PCB congener must be measured against a standard for that congener).

For more information see:
http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/caulk/caulktesting.htm

B. Interior Building Surfaces Testing for PCBs

23. How do I determine PCB levels on interior building surfaces?

There is currently no EPA method that is specific to sampling for PCBs in dust and residues on interior building surfaces. The most common approach for measuring PCBs on building interior surfaces is to sample a 100 cm^2 area by wiping with a solvent-wetted gauze material and analyze the gauze for PCBs. The surface wipe approach is specified for certain situations in the PCB spill clean-up regulations. Surface wipes collect PCBs bound to dust particles on surfaces and may also collect PCBs adhering to the material surface (residues). Hexane is the solvent specified in the PCB spill clean-up regulations (40 CFR section 761.123). In addition to collecting dust, hexane on the wipes is likely to extract PCBs adhering to materials. ASTM Method D6661-01 (2006) *Standard Practice for Field Collection of Organic Compounds from Surfaces Using Wipe Sampling* is also an available method for sampling surfaces for organics.

Bulk dust collection using a vacuum equipped with a filter is another approach for sampling indoor surfaces. A key challenge for bulk dust measurements is that surfaces often do not contain enough dust for accurate weighing or achieving adequate PCB analytical limits of detection.

C. Testing Building Materials for PCBs

24. How do I determine PCB levels in non-liquid building materials?

There are several laboratory methods for determining the presence of PCBs in non-liquid building materials such as caulk and paint. The laboratory should follow the recommended approach referenced in EPA's PCB regulations at 40 CFR part 761, such as method 3500B/3540C from EPA's SW-846, Test Methods for Evaluating Solid Waste for chemical extraction of PCBs and Method 8082 from SW-846 for chemical analysis. An alternative method to those specified methods may be validated under 40 CFR part 761 subpart Q. To ensure that PCBs are accurately quantified, Aroclors must be measured against a standard for that specific Aroclor and an individual PCB congener must be measured against a standard for that specific congener.

IV. Exposure Levels for Evaluating PCBs in Indoor School Air

25. What are the Exposure Levels for Evaluating PCBs in Indoor School Air?

EPA calculated the Exposure Levels for Evaluating PCBs in Indoor School Air so that if children and adults breathed PCBs at or below those levels for the hours per day and days per year in which school is in session, those PCB exposures would not lead to risks of suffering adverse health effects. These calculations are based on the oral reference dose (RfD) of 20 ng PCB/kg body weight per day and are adjusted to reflect a typical school year (See Q&A #30). The Exposure Levels for Evaluating PCBs in Indoor School Air are based upon EPA's understanding of average exposure to PCBs from all other major pathways. These air levels were developed for all ages of children from toddlers in day-care to adolescents in high school, as well as for adult school employees. For background information on the potential health effects of PCB exposure, see http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/effects.htm. These exposure levels should not be interpreted nor applied as "bright line" or "not-to-exceed" criteria, and may be used to guide thoughtful evaluation of indoor air quality in schools. Isolated or infrequent indoor air PCB measurements that exceed the exposure levels would not signal unsafe exposure to PCBs.

EPA advises that total exposure to PCBs from all sources be kept below the oral reference dose (RfD) of 20 ng PCB/kg body weight per day. This RfD is an estimate of a daily, lifelong, oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime. The Exposure Levels for Evaluating PCBs in Indoor School Air maintain total PCB exposure below the RfD, considering other major pathways of PCB exposure. The level of PCBs that adults and children might be exposed to through pathways other than school indoor air was set equal to what is estimated to be average background PCB exposure for those pathways. Therefore, the values in the following table are only applicable to a school when one assumes that exposure to PCBs through pathways other than school indoor air are equal to average PCB background levels. School-specific exposure levels can be calculated if specific PCB data are available for one or more of the exposure pathways other than school indoor air. As shown in the table, for a typical school day, the Exposure Levels for Evaluating PCBs in Indoor School Air range from a low of 100 ng/m^3 for toddlers age 1 to <2 years and children 2 to <3 years, to a high of 600 ng/ m^3 for high school students, age 15 to <19 years. Values for each age group are provided in the table below.

Exposure Levels for Evaluating PCBs in Indoor School Air (ng/m^3)*

Assuming that PCB exposures through pathways other than school indoor air are equal to average background PCB exposures for those pathways, these indoor school-air concentrations should keep total PCB exposure below the oral reference dose of 20 ng PCB/kg-day.

Age 1 to <2 yr	Age 2 to <3 yr	Age 3 to <6 yr	Age 6 to <12 yr Elementary School	Age 12 to <15 yr Middle School	Age 15 to <19 yr High School	Age 19+ yr Adult
100	**100**	**200**	**300**	**500**	**600**	**500**

* **Note**: These exposure levels were derived to serve as health protective values intended for evaluation purposes. These levels should not be interpreted nor applied as “bright line” or “not-to-exceed” criteria. For further explanation, see Q&A #26 & #27. Exposure levels have been revised to reflect more recent data on dietary exposure and have been rounded to the nearest hundred ng/m^3.

26. How should the “Exposure Levels for Evaluating PCBs in Indoor School Air” be used?

After the implementation of the recommended BMPs or conducting other actions to reduce exposure, these exposure levels may be used to guide thoughtful evaluation of indoor air quality in schools. These exposure levels should not be interpreted nor applied as “bright line” or “not-to-exceed” criteria. Isolated or infrequent indoor air PCB measurements that exceed the exposure levels would not necessarily signal unsafe exposure to PCBs. When measured indoor school air PCB concentrations are above these exposure levels, the EPA suggests that school building administrators take further steps to reduce PCB exposure such as reviewing, reevaluating and adjusting BMPs or taking other actions to identify and address PCB sources.

Note, the earlier version of this document used the terminology “Recommended Public Health Levels for PCBs in Indoor School Air.” The EPA revised that terminology to “Exposure Levels for Evaluating PCBs in Indoor School Air” because the Agency believes the revised terminology better reflects the intended purpose of these levels. For more information about the exposure assumptions used to calculate the Exposure Levels for Evaluating PCBs in Indoor School Air and how they might affect potential risk, see Q&As #27-31.

27. What pathways of exposure were considered when developing Exposure Levels for Evaluating PCBs in Indoor School Air?

The exposure pathways considered when developing the exposure estimates underlying the derivation of the Exposure Levels for Evaluating PCBs in Indoor School Air included several that can occur away from school: inhalation (indoor and outdoor), indoor dust ingestion, outdoor soil ingestion, indoor dust contact, and total dietary ingestion. EPA also considered several kinds of exposures that can occur at a school: school building inhalation (indoor and outdoor), indoor dust ingestion, outdoor soil ingestion, and indoor dust contact. Average PCB concentrations in these media were used in developing the exposure estimates for each of the pathways other than school indoor air. Additionally, the underlying exposure estimates did not include direct ingestion of, nor direct contact with, potentially contaminated building materials because these are expected to happen infrequently and exposure estimates were developed to represent average PCB exposures over the course of a school year.

28. What are the limitations of EPA's exposure estimates used to derive the Exposure Levels for Evaluating PCBs in Indoor School Air?

The exposure estimates underlying the derivation of the exposure levels assume that 1) the PCB concentrations in environmental media (i.e., outdoor air, dust, soils) relevant to each exposure pathway are equal to the background concentrations of PCBs for those media and 2) children's and adults' contact rates for those media are what are expected to occur on average while in a school. Because PCB levels in environmental media are not well understood and may be variable depending upon school-specific conditions, the exposure levels should be used with consideration of the uncertainty in the underlying exposure estimates. School-specific exposure levels can be calculated if specific PCB data are available for one or more of the exposure pathways other than school indoor air. The Exposure Levels for Evaluating PCBs in Indoor School Air should not be used to estimate occupational exposure associated with non-school buildings or site clean-ups or for residential use.

29. Why are the Exposure Levels for Evaluating PCBs in Indoor School Air different for different age groups?

The Exposure Levels for Evaluating PCBs in Indoor School Air are estimated using different exposure assumptions and factors for different age groups. Children at different age levels and adults have different rates for the amount of air they breathe, foods they eat, and amount of dust and soil they contact and ingest. Some of these factors differ because of behavioral differences between age groups. For example, children have higher soil and dust ingestion rates than adults. Others factors differ because of physiological differences between children and adults. For example, the average body weight is lower for younger children than for older children and adults. Because the exposure levels are divided by body weight, younger children have higher dietary and inhalation exposures per unit body weight than older children and adults.

30. For exposure estimates, what assumptions is EPA making about the amount of time children spend in school?

EPA estimated exposure to PCBs in schools using established values for the number of days per year and the number of hours per day children and adults spend at school. Depending upon age, these values were 180 to 185 days per year, and 6.5 to 8 hours per day at school. However, exposure assessments can also be made with other values that reflect activities specific for a given school or other type of building. Note, since the number of days per year for non-school buildings may be higher (e.g., 220 – 250 days per year), the Exposure Levels for Evaluating PCBs in Indoor School Air presented in Q&A # 25 cannot be directly applied to non-school buildings.

31. Are the Exposure Levels for Evaluating PCBs in Indoor School Air applicable to other types of buildings?

The Exposure Levels for Evaluating PCBs in Indoor School Air were developed specifically for schools and cannot be directly applied to other buildings without adjustment of the underlying exposure assumptions. For example, the assumptions were based on 180 to 185 days per year, and 6.5 to 8 hours per day spent in the school which are likely not applicable to an office or residential setting.

V. Research Studies

32. What research has EPA conducted?

EPA's research on PCBs in schools was designed to identify and evaluate potential sources of PCBs in order to better understand exposures to children, teachers, other school workers and other building occupants and to improve risk management decisions. EPA has investigated PCB-containing caulk and paint, as well as other potential sources of PCBs in schools. The results of this research could also be applied to buildings other than schools. Specifically, EPA's Office of Research and Development research results have:

- characterized potential sources of PCBs in schools (e.g., caulk, coatings, FLBs);
- showed that both intact (non-leaking) and leaking FLBs can emit PCBs into indoor air;
- characterized potential secondary sources of PCBs in school buildings;
- investigated the relationship of manufactured (primary) sources to PCB concentrations in air, dust, and soil;
- used models to estimate PCB exposures and exposure pathways in school buildings; and,
- evaluated methods for encapsulation and on-site treatment to reduce exposures to PCBs in caulk and other sources.

Read about the results of this research at http://www.epa.gov/pcbsincaulk/caulkresearch.htm

VI. EPA's Enforcement Approach for PCB-Containing Building Materials

33. Does EPA intend to enforce the requirement that caulk ≥ 50 ppm and other PCB materials unauthorized for use be removed?

EPA regulations implementing the Toxic Substances Control Act (TSCA) prohibit the use of PCBs in caulk and other building materials manufactured with PCBs at levels greater than or equal to 50 ppm, including the continued use of such materials that are already in place. EPA regulations also generally prohibit the continued use of other materials that are contaminated with PCBs by such manufactured sources. Although EPA does have enforcement tools that it can use as appropriate where the PCB concentration in the caulk or other materials is above the regulatory limit, EPA is most interested in ensuring that school districts and other building owners undertake the recommended actions to limit exposures to PCBs (see Q&A #16). EPA believes that enforcement may not be the most effective tool to reduce health risks when school districts and other building owners follow these recommendations. Thus, such buildings will in most cases be a low priority for enforcement. Nonetheless, EPA will not hesitate to act in situations where there are significant risks to public health that are not being addressed.

EXHIBIT 36

An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings

Prepared by

Bureau of Environmental Health
Massachusetts Department of Public Health

December 2009

INTRODUCTION

The purpose of this information booklet is to provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere. Recently, the U.S. Environmental Protection Agency (EPA) provided broad guidance relative to the presence of PCBs in building materials, notably PCBs in caulking materials. The most common building materials that may contain PCBs in facilities constructed or significantly renovated during the 1950s through the 1970s are fluorescent light ballasts, caulking, and mastic used in tile/carpet as well as other adhesives and paints.

This information booklet, developed by the Massachusetts Department of Public Health's Bureau of Environmental Health (MDPH/BEH), is designed to supplement guidance offered by EPA relative to potential health impacts and environmental testing. It also addresses managing building materials, such as light ballasts and caulking, containing PCBs that are likely to be present in many schools and public buildings across the Commonwealth. This is because the Northeastern part of the country, and notably Massachusetts, has a higher proportion of schools and public buildings built during the 1950s through 1970s than many other parts of the U.S. according to a 2002 U.S. General Accounting Office report. The Massachusetts School Building Authority noted in a 2006 report that 53 percent of over 1,800 Massachusetts school buildings surveyed were built during the 1950s through 1970s. This information booklet contains important questions and answers relative to PCBs in the indoor environment and is based on the available scientific literature and MDPH/BEH's experience evaluating the indoor environment of schools and public buildings for a range of variables, including for PCBs as well as environmental data reviewed from a variety of sources.

1. What are PCBs?

Polychlorinated biphenyl (PCB) compounds are stable organic chemicals used in products from the 1930s through the late 1970s. Their popularity and wide-spread use were related to several factors, including desirable features such as non-flammability and electrical insulating properties. Although the original use of PCBs was exclusive to closed system electrical applications for transformers and capacitors (e.g., fluorescent light ballasts), their use in other applications, such as using PCB oils to control road dust or caulking in buildings, began in the 1950s.

2. When were PCBs banned from production?

Pursuant to the Toxic Substance Control Act (TSCA) of 1976 (effective in 1979), manufacturing, processing, and distribution of PCBs was banned. While the ban prevented production of PCB-containing products, it did not prohibit the use of products already manufactured that contained PCBs, such as building materials or electrical transformers.

3. Are PCBs still found in building materials today?

Yes. Products made with PCBs prior to the ban may still be present today in older buildings. In buildings constructed during the 1950s through 1970s, PCBs may be present in caulking, floor mastic, and in fluorescent light ballasts. Available data reviewed by MDPH suggests that caulking manufactured in the 1950s through 1970s will likely contain some levels of PCBs. Without testing it is unclear whether caulking in a given building may exceed EPA's definition of PCB bulk product waste of 50 parts per million (ppm) or greater. If it does, removal and disposal of the caulk is required in accordance with EPA's TSCA regulations (40 CFR § 761).

4. Are health concerns associated with PCB exposure opportunities?

Although the epidemiological evidence is sometimes conflicting, most health agencies have concluded that PCBs may reasonably be anticipated to be a carcinogen, i.e., to cause cancer.

PCBs can have a number of non-cancer effects, including those on the immune, reproductive, neurological and endocrine systems. Exposure to high levels of PCB can have effects on the liver, which may result in damage to the liver. Acne and rashes are symptoms typical in those that are exposed to high PCB levels for a short period of time (e.g., in industry / occupational settings).

5. If PCBs are present in caulking material, does that mean exposure and health impacts are likely?

No. MDPH/BEH's review of available data suggests that if caulking is intact, no appreciable exposures to PCBs are likely and hence health effects would not be expected. MDPH has conducted indoor tests and reviewed available data generated through the efforts of many others in forming this opinion.

6. How can I tell if caulking or light ballasts in my building may contain PCBs?

If the building was built sometime during the 1950s through 1970s, then it is likely that the caulking in the building and/or light ballasts may contain some level of PCBs. Light ballasts manufactured after 1980 have the words "No PCBs" printed on them. If the light ballast does not have this wording or was manufactured before 1980, it should be assumed that it contains PCBs.

7. What are light ballasts?

A light ballast is a piece of equipment that controls the starting and operating voltages of fluorescent lights. A small capacitor within older ballasts contains about one ounce of PCB oil. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air.

8. Does the presence of properly functioning fluorescent light ballasts in a building present an environmental exposure concern?

No appreciable exposure to PCBs is expected if fluorescent light ballasts that contain PCBs are intact and not leaking or damaged (i.e., no visible staining of the light lenses), and do not have burned-out bulbs in them.

9. Should I be concerned about health effects associated with exposure to PCBs as a result of PCB-containing light ballasts?

While MDPH has found higher PCB levels in indoor air where light bulbs have burned-out, the levels are still relatively low and don't present imminent health threats. A risk assessment conducted recently at one school did not suggest unusual cancer risks when considering a worst case exposure period of 35 years for teachers in that school. Having said this, MDPH believes that facility operators and building occupants should take prompt action to replace bulbs and/or ballasts as indicated to reduce/eliminate any opportunities for exposure to PCBs associated with PCB-containing light ballasts.

10. When should PCB-containing light ballasts be replaced?

If ballasts appear to be in disrepair, they should be replaced immediately and disposed of in accordance with environmental regulatory guidelines and requirements. However, if light bulbs burn out, the best remedy is to change them as soon as possible. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air. Thus, burned-out bulbs should be replaced promptly to reduce overheating and stress on the ballast. As mentioned, ballasts that are leaking or in any state of disrepair should be replaced as soon as possible.

It should be noted that although older light ballasts may still be in use today, the manufacturers' intended lifespan of these ballasts was 12 years. Thus, to the extent feasible or in connection with repair/renovation projects, the older light ballasts should be replaced consistent with the intended lifespan specified by the manufacturers.

11. Does MDPH recommend testing of caulking in buildings built during the 1950s - 1980?

Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning. Results should be compared with similar testing done in an area without deteriorating caulking. In this way, a determination can be made regarding the relative contribution of caulking materials to PCBs in the general indoor environment.

12. What if we determine that caulking in our building is intact and not deteriorating?

Based on a review of available data collected by MDPH and others, the MDPH does not believe that intact caulking presents appreciable exposure opportunities and hence should not be disturbed for testing. As with any building, regular operations and maintenance should include a routine evaluation of the integrity of caulking material. If its condition deteriorates then the steps noted above should be followed. Consistent with EPA advice, if buildings may have materials that contain PCBs, facility operators should ensure thorough cleaning is routinely conducted.

13. Should building facilities managers include information about PCB-containing building materials in their Operations and Maintenance (O&M) plans?

Yes. All buildings should have an O&M plan that includes regular inspection and maintenance of PCB building materials, as well as thorough cleaning of surfaces not routinely used. Other measures to prevent potential exposure to PCBs include increasing ventilation, use of HEPA filter vacuums, and wet wiping. These O&M plans should be available to interested parties.

14. Are there other sources of PCBs in the environment?

Yes. The most common exposure source of PCBs is through consumption of foods, particularly contaminated fish. Because PCBs are persistent in the environment, most residents of the U.S. have some level of PCBs in their bodies.

15. Where can I obtain more information?

For guidance on replacing and disposing of PCB building materials, visit the US EPA website: http://www.epa.gov/pcbsincaulk/. For information on health concerns related to PCBs in building materials, please contact MDPH/BEH at 617-624-5757.

EXHIBIT 37

MICHAEL DUARTE

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
______________________________/

DEPOSITION OF MICHAEL DUARTE

Boston, Massachusetts

Thursday, April 21, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 105352

MICHAEL DUARTE

A. Right.

Q. -- and I assume if some kid threw a baseball through a window.

A. We did stuff like that.

Q. Leave those kind of idiosyncratic events out.

As a general proposition, the jury can conclude that the sealant around the window and door assembles and the caulking where the glass light was assembled into, I guess a metal frame?

A. It's a metal frame.

Q. So caulking within the frame and caulking of sealant around the frame, where it's placed into the building, that was original?

A. For the most part.

Q. So 41-year-old caulking and sealant. That's a pretty accurate statement?

A. I would think so.

Q. Okay. And if you go down towards the bottom of the "General Description" page, there is a reference to the boilers being 21 years of age. Those were replacement

MICHAEL DUARTE

"What is your MSBA previous experience?"

A. Yes.

Q. I invite you, if you want to go through this, you'll see the questions on this document have been typed on this document and made part of the presentation to your green project subcommittee.

A. They match?

Q. Yes. They match. Does that make sense to you?

A. It does.

Q. The interview question 1C is "What is your experience with hazardous materials and roof and window replacement projects?" Do you see that?

A. I do.

Q. And you'll find that on Exhibit 8, too. 1C "What is your experience" --

A. Yeah. I see it. I do.

Q. So the town on or actually before April 6th, 2011, sent a request off to the architects who were interviewing for the job and asked them to define for the green project subcommittee what the experience of

MICHAEL DUARTE

the architectural firm was with hazardous materials in roofing and window emplacement projects. Makes sense?

A. Yeah.

Q. You remember that?

A. Yeah, I think I do.

Q. Go back to the larger document or the one in your hand.

A. This one (indicating).

Q. Yes. 1C, the question again is "What is your experience with hazardous materials in roof and window replacement projects?" Have I read that correctly?

A. Yes, you did.

Q. The response CGKV delivered at the meeting on April 6th, at least at the meeting and maybe earlier, if a document was sent in earlier, the response was, "We have worked with Fuss & O'Neill and EnviroScience for many years on several projects with hazardous materials. It is common to find asbestos in sealants for windows and roofs and lead paint in the wood, but we must be sure to test for PCBs. Do you see that?

MICHAEL DUARTE

A. I do.

Q. Is it fair for us to conclude that the town, through its green project repair committee, was asking the architects, who wanted work, to inform them, the town, about their experience with hazardous materials?

MR. McCREA: Objection. Form.

A. I feel more comfortable with the premise of the asbestos part than the PCB part. That's my -- the way I look at this.

Q. My question is, the town --

A. Yeah.

Q. -- you, you and your colleagues at the town on this green project subcommittee --

A. Right.

Q. -- were reaching out to the architects who wanted the work and saying to the architects who wanted the work, wanted to earn the fees, tell us about your experience with hazardous materials, correct?

A. That's what I'm reading here.

Q. And that would be hazardous materials

MICHAEL DUARTE

in conjunction with the window replacement project?

A. Yes.

Q. Because that's what the middle school project was all about, right?

A. Windows and doors.

Q. So the town before April 6th, 2011, recognized the relationship between a renovation project for windows and doors in building that was built in 1969 and hazardous materials, correct?

MR. McCREA: Objection. Form.

A. I believe that's exactly what I'm looking at.

Q. And the response given to the town by the architect in response to that question "tell us about your experience with hazardous materials," referenced Fuss & O'Neill, referenced asbestos and sealant and caulk, lead paint in windows and PCBs, correct?

A. Right.

Q. So if you turn to the next page.

A. This (indicating)?

EXHIBIT 38

Massachusetts School Building Authority

RECEIVED
NOV 30 2010
BY:

November 17, 2010

Steven Ouellette, Chair
Westport Board of Selectmen
816 Main Road
Westport, MA 02790

Re: Westport Public Schools, Alice A. Macomber Elementary School
Westport Middle School
Westport High School

Dear Mr. Ouellette:

I am pleased to report that the Board of the Massachusetts School Building Authority ("MSBA") voted to invite the Town of Westport into the Green Repair Program to collaborate with the MSBA in conducting a Feasibility Study on the Alice A. Macomber Elementary School for a potential roof repair/replacement; Westport Middle School for a potential window repair/replacement; and, Westport High School for a potential roof and/or window repair/replacement project.

I do want to emphasize that this invitation to collaborate on a Feasibility Study is ***not*** approval of a project, but is strictly an invitation to the Town of Westport to work with the MSBA to explore potential solutions to the problems that have been identified. Moving forward in the MSBA's Green Repair Program process requires collaboration with the MSBA, and communities that "get ahead" of the MSBA without MSBA approval will not be eligible for grant funding. To qualify for any funding from the MSBA, local communities must follow the MSBA's statute, regulations and Green Repair Program requirements, which require MSBA collaboration and approval at each step of the process.

During the Feasibility Study phase, the Town of Westport and the MSBA will collaborate to find the most fiscally responsible and sustainable solution to the problems identified at the Alice A. Macomber Elementary School, Westport Middle School and Westport High School. The Feasibility Study, which will be conducted pursuant to the MSBA's regulations, will require the Town of Westport to complete a number of pre-requisites before the MSBA and the District can finalize the procurement of consultants which will help bring the Town of Westport's feasibility study to fruition. These pre-requisites, which must be completed within 60 days of this letter, require the Town of Westport to submit the following information to the MSBA for its review, within the timeframes noted below*:

- a preliminary overview of available or projected local funding for any proposed project (within 30 days);
- a current routine and capital maintenance plan for the Town's school facilities (within 60 days);
- an Initial Compliance Certificate executed by the Town, to ensure that the Town understands and will comply with the MSBA's requirements and regulations (within 30 days); and
- certified votes of the local funding appropriation (within 60 days).

* *All timeframes noted above are based on the date of this letter.*

If you have any concerns about meeting any of the above timeframes, please let us know as soon as possible.

We have attached the program description, eligibility requirements and project requirements for the Green Repair Program for your review. Once the Town of Westport has completed the pre-requisites listed above, the MSBA and the Town of Westport will discuss procuring the project management and design professionals utilizing the MSBA's list of pre-qualified consultants for the Green Repair Program. In the meantime, however, I wanted to share with you the Board's decision and provide a brief overview of what this means for the Town of Westport.

I look forward to continuing to work with you as the MSBA's Green Repair Program progresses. As always, feel free to contact me or my staff at (617) 720-4466 should you have any questions.

Sincerely yours,

Katherine Craven

Katherine Craven
Executive Director

Cc: Senator Joan M. Menard
Representative Michael Rodrigues
James Bernard, Chair, Westport School Committee
Carlos Colley, Superintendent, Westport Public Schools
File Letters 10.2

EXHIBIT 39

Karen L. Augusto

From: Michael McGurl [mmcgurl@keville.com]
Sent: Friday, December 10, 2010 9:46 AM
To: Carlos Colley
Cc: Karen L. Augusto
Subject: [Scanned] MSBA/Green Repair Program - Westport
Attachments: Owner's Project Manager Selection Criteria Form 12.7.10.doc; Selection and Assignment of Owner's Project Managers - Green Repair Program 12.7.10.pdf; Designer Selection Criteria Form 12.7.10.doc; Selection and Assignment of Designers - Green Repair Program 12.7.10.pdf

Dear Superintendent Colley,

In order to begin the process for selecting an Owner's Project Manager and a Designer for the Alice A. Macomber Elementary School, Westport Middle School, and the Westport High School Green Repair Projects, I have attached the Owner's Project Manager and the Designer Selection Criteria Forms, on which the District will state how each OPM and Designer candidate will be ranked. The MSBA asks that the Selection Criteria Forms be returned on District letterhead. Also, please see the attached Selection and Assignment of Owner Project Managers and Selection and Assignment of Designers, which guides you through the selection of your consultants. The MSBA encourages the District to submit the Selection Criteria Forms together, but the District will be asked to select its OPM prior to a Designer. If you have any questions regarding the attached documents or the Green Repair Program, please let me know.

Thank you,
Mike McGurl

Michael McGurl
Project Assistant
Keville Enterprises, Inc. (WBE/DBE)
www.keville.com
mmcgurl@keville.com

Massachusetts School Building Authority
40 Broad Street, Suite 500
Boston, MA 02109
617-960-3066

[Letterhead of City/Town/Regional School District]

Selection Criteria Form
Owner's Project Manager
Green Repair Program

1) District Selection Committee

In accordance with "Selection and Assignment of Owner's Project Managers – Green Repair Program," assembled for your review and approval is the membership of the Selection Committee for (NAME OF DISTRICT). Committee Members include the following:

(Please provide name, title, address and phone number of each member.)

Designation	**Name and Title**	**E-Mail Address and Phone Number**
School Committee Member*		
Superintendent of schools or his/her designee*		
Local Chief Executive Officer or his/her designee*		
Other members (Please add lines, if necessary, to indicate additional members of selection committee)		

*Required members

2) District Selection Criteria

In accordance with "Selection and Assignment of Owner's Project Manager – Green Repair Program," assembled for your review and approval is the Selection Criteria that the District intends to use (as noted by a check below) for selecting an Owner's Project Manager from the applicants pre-selected through the Green Repair Program for (NAME OF SCHOOL). Selection Criteria include the following:

a.) Selection Criteria	Criteria selected
Prior Similar Experience	X
Personnel Qualifications	X
Current Workload and Capacity	X

Experience with Stretch Energy Code	
Knowledge of Energy Efficiency Programs	
Knowledge of Construction Procurement Law	
Additional Criteria	

(Bold selection criteria must be utilized by the District in its evaluation.)

b) Description of rating system to be used for the Selection Criteria:
(NOTE: The MSBA recommends use of a numerical rating rather than least/advantageous and highly advantageous.)

3) District Interviews

If the District chooses to conduct interviews after review of the applications, the District will notify the MSBA of the time and submit the interview questions for acceptance by the MSBA. The MSBA may choose to participate in the interview process.

The (NAME OF DISTRICT) recommends as outlined in steps 1 and 2 above the District Selection Committee Members and the Selection Criteria and agrees to notify the MSBA before conducting interviews, if any.

Sincerely,

By: ______________________________
Authorized signature for District

Title: ______________________________

Date: ______________________________

____
Accepted by MSBA Date

EXHIBIT 40

CGKV Architects, Inc.

97 Marion Street
Somerville, MA 02143
Tel. 617-504-8196
Fax. 617-812-6364

Presentation to:

WESTPORT, MA

MSBA GREEN REPAIR PROGRAM

April 6, 2011

CGKV Architects, Inc.

97 Marion Street
Somerville, MA 02143
Tel. 617-504-8196
Fax. 617-812-6364

FIRM BACKGROUND

CGKV Architects, Inc., located in Somerville, Massachusetts, was founded by Ernesto Vazquez, AIA, NCARB, LEED AP and Jason Knutson, AIA. After working together for a decade at Cole and Goyette Architects and Planners Inc. on multiple and varied projects, they formed a new corporation that continues the same quality architectural services. Our firm continues to provide architectural, planning, and interior design services to public and private clients, including individuals, corporations, institutions, and governmental agencies.

CGKV's architectural services include building evaluation, design, agency reviews, code analysis, construction documents, engineering coordination, cost estimating, and construction management. Planning services include facilities evaluation and programming, site analysis, master planning, and project management.

Our diversified practice includes large and medium sized projects for new buildings, additions, and renovations for residential and educational facilities. The firm Principals have extensive experience with educational facilities and especially with public construction in Massachusetts, per Chapter 149. These projects were successfully bid, including filed sub-bids, within budget constraints and without contest from any contractors. In addition to our responsibility for the Technical Specifications, we have worked with clients to assure that the front end specifications reflect the specific regulations and ordinances of the Municipality or Agency.

In our continued effort to continue our firm's knowledge and expertise, Jason Knutson has been certified by MCPPO and completed the Certification for School Project Designers and Owner's Project Managers course. Ernesto Vazquez is a LEED Accredited Professional and is capable of guiding a project through the complicated LEED process for project certification.

CGKV is a minority owned firm and has been certified by SOMWBA as an MBE.

CGKV Architects, Inc.

97 Marion Street
Somerville, MA 02143
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Fax. 617-812-6364

PUBLIC PROJECTS (Chapter 149)




- Parker School Renovations, Quincy, MA*
- Harris School Renovations, Springfield, MA*
- Andover Town Offices, Andover, MA*
- Andover Doherty School Veteran's Memorial Hall Auditorium, Andover, MA*
- Boston School Programs, Boston, MA*
- Memorial Hall Library Renovations, Andover, MA*
- Wilmington High School Classroom Renovations, Wilmington, MA*
- Burke High School Renovation & Addition, Boston, MA*
- West Elementary School Renovations, Andover, MA
- The Bigelow Square Condominium Renovations, South Boston, MA*
- The Foundry Condominium Renovations, South Boston, MA*
- Massport Noise Mitigation Program MPA L451-C14, Chelsea, MA
- Massport Noise Mitigation Program MPA L451-C12, Chelsea & East Boston, MA
- Hemenway School Renovations, Hyde Park, MA*
- Norwell Gardens Elderly Housing Renovations , Norwell, MA*
- Massport Noise Mitigation Program MPA L451-C6, Chelsea, MA*
- Massport Residential Sound Insulation Program MPA L676-C11, South Boston, MA*
- Massport Noise Mitigation Program MPA L451-C2, Chelsea, MA*
- Highland Heights Family Housing Renovations, Taunton, MA*
- Massport Residential Sound Insulation Program MPA L676-C7, Winthrop, E. Boston, S. Boston, MA*
- Massport Residential Sound Insulation Program MPA L676-C6, Winthrop, MA*
- Quincy Middle School Study, Quincy, MA*
- Massport Residential Sound Insulation Program MPA L676-C3, South Boston, MA*
- Massport Residential Sound Insulation Program
- Massport Residential Sound Insulation Program MPA L676-C1, Winthrop, E. Boston, S. Boston, MA*
- Burke High School Study and Design, Boston, MA*
- New Quincy High School Program and Design, Quincy, MA*

CGKV Architects, Inc.

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List of Public Projects (Chapter 149)

- Massport Residential Sound Insulation Program MPA L605-C5, Winthrop, Revere, E. Boston, MA*
- Massport Residential Sound Insulation Program MPA L605-C4, East Boston, MA*
- Massport Residential Sound Insulation Program MPA L605-C1, East Boston, MA*
- Point Webster Middle School Renovations, Quincy, MA*
- Clifford Marshall School Renovations, Quincy, MA*
- Beechwood-Knoll School Renovations, Quincy, MA*
- Cutler Elementary School Renovations, Hamilton, MA
- Somerville Ice Rink, Somerville, MA
- South Shore Charter P.S., Norwell, MA
- Masconomet School, Topsfield, MA
- F. H. Freedman School, Springfield, MA
- Warner School, Springfield, MA
- Washington School, Springfield, MA
- White School, Springfield, MA

(Note: Project executed by CGKV Principals as Project Managers/ Captains at Cole and Goyette.)*

CGKV Architects, Inc.

97 Marion Street
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WINDOW & DOOR REPLACEMENT PROJECTS (Chapter 149)

- F. H. Freedman School, Springfield, MA
- Warner School, Springfield, MA
- Washington School, Springfield, MA
- White School, Springfield, MA
- Masconomet School, Topsfield, MA
- Massport Noise Mitigation MPA L451-C17, Chelsea, MA
- Massport Noise Mitigation MPA L451-C16, Chelsea, MA
- Massport Noise Mitigation MPA L451-C14, Chelsea, MA
- Massport Noise Mitigation Program MPA L451-C12, Chelsea & East Boston, MA
- Hemenway School Renovations, Hyde Park, MA*
- Norwell Gardens Elderly Housing, Norwell, MA*
- Massport Noise Mitigation Program MPA L451-C6, Chelsea, MA*
- Massport Residential Sound Insulation Program MPA L676-C11, South Boston, MA*
- Massport Noise Mitigation Program MPA L451-C2, Chelsea, MA*
- Highland Heights Family Housing, Taunton, MA*
- Massport Residential Sound Insulation Program MPA L676-C7, Winthrop, E. Boston, S. Boston, MA*
- Massport Residential Sound Insulation Program MPA L676-C6, Winthrop, MA*
- Quincy Middle School Study, Quincy, MA*
- Massport Residential Sound Insulation Program MPA L676-C3, South Boston, MA*
- Massport Residential Sound Insulation Program MPA L676-C2, Winthrop, E. Boston, S. Boston, MA*
- Massport Residential Sound Insulation Program MPA L676-C1, Winthrop, E. Boston, S. Boston, MA*
- Burke High School Study and Design, Boston, MA*
- New Quincy High School Program and Design (new construction), Quincy, MA*
- Massport Residential Sound Insulation Program MPA L605-C5, Winthrop, Revere, East Boston, MA*
- Massport Residential Sound Insulation Program MPA L605-C4, East Boston, MA*
- Massport Residential Sound Insulation Program MPA L605-C1, East Boston, MA*
- Point Webster Middle School, Quincy, MA*
- Clifford Marshall School, Quincy, MA*
- 249 A Street Cooperative, South Boston, MA*
- Jamaicaway Tower and Townhouses Window Study, Boston, MA*
- Beechwood-Knoll School, Quincy, MA*
- Parker School, Quincy, MA*
- Harris School Window Replacement, Springfield, MA*

(Note: Project executed by CGKV Principals as Project Managers or Project Captains at Cole and Goyette.)*

CGKV Architects, Inc.

97 Marion Street
Somerville, MA 02143
Tel. 617-504-8196
Fax. 617-812-6364

WINDOW & DOOR REPLACEMENT PROJECTS (Chapter 149)

CGKV Architects, Inc. has extensive experience with window and door replacement in educational facilities. For example, the pictures below depict the window and door replacement at the Hemenway School in Hyde Park, MA. The following projects were completed while with Cole and Goyette, Architects and Planners Inc.

Above Left:
Beechwood Knoll School
Quincy, MA
photo: Nick Wheeler

Above Middle:
437 D Street
South Boston, MA
photo: Jason Knutson

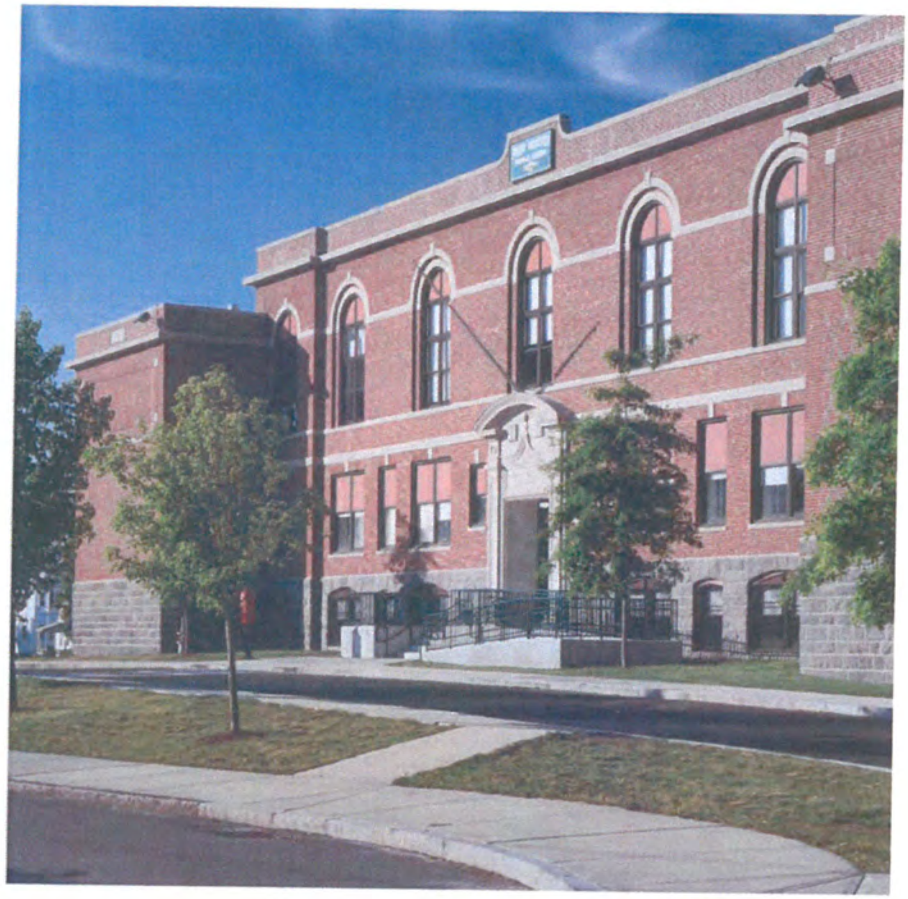
Above Right:
Bigelow Square
South Boston, MA
photo: Jason Knutson

Below Right:
Pt. Webster Middle School
Quincy, MA
photo: Nick Wheeler

Opposite Page:
Hemenway School
Hyde Park, MA
Photos: Ernie Vazquez

ROOFING AND WATERPROOFING

CGKV Architects, Inc. has practical experience with many different types of roof systems including, standing seam metal, asphalt & fiberglass shingles, SBS, PVC, and EPDM. We also have experience with detailed investigation of existing roofs and wall systems. For example, the pictures below depict an investigation of existing water infiltration issues that were subsequently resolved with a new SBS roof and masonry wall repair. The following projects were completed while with Cole and Goyette, Architects and Planners Inc.



Fiberglass Shingles
Above Left:
The Villas at Eagle's Nest Condos
Franklin, MA
photo: Ernie Vazquez

PVC Membrane
Above Middle:
Memorial Hall Library
Andover, MA
photo: Ernie Vazquez

EPDM
Above Right:
Pt. Webster Middle School
Quincy, MA
photo: Nick Wheeler

Metal Roof
Below Right:
Clifford Marshall School
Quincy, MA
photo: Nick Wheeler

SBS Membrane
Opposite Page:
Hemenway School
Hyde Park, MA
Photo: Ernie Vazquez

CGKV Architects, Inc.

EDUCATION

CGKV Architects, Inc. designs new buildings and renovations of older buildings for preschools, elementary schools, middle schools, high schools, colleges, and universities. Our professional services include architecture, planning, and interior design. Our designs for educational institutions have been honored with awards and featured in publications. The following projects were completed while with Cole and Goyette, Architects and Planners Inc.

Above:
Parker School
Quincy, MA
photo: Nick Wheeler

Above Right:
Clifford Marshall School
Quincy, MA
photo: Nick Wheeler

Below Right:
Central Middle School
Quincy, MA
photo: David DesRoches

Right:
Beechwood Knoll School
Quincy, MA
photo: Nick Wheeler

Below Right:
Hemenway School
Hyde Park, MA
photo: Ernesto Vazquez

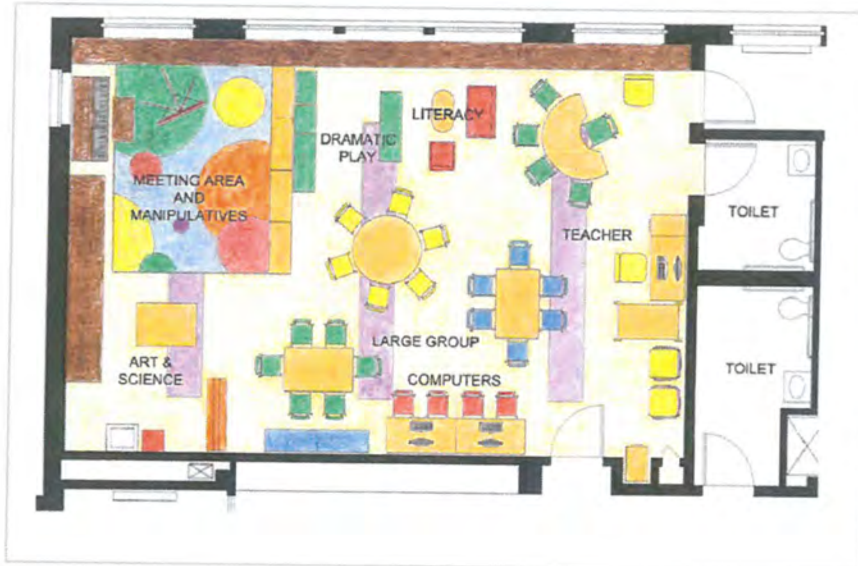
Below:
Judge Rotenberg Education Center
Canton, MA
photo: Nick Wheeler

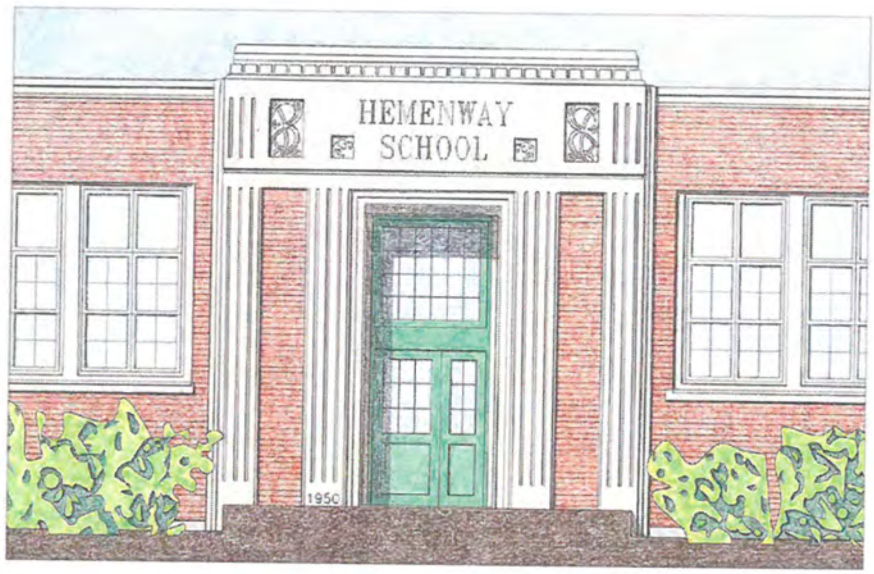
CGKV Architects, Inc.

HEMENWAY SCHOOL
Hyde Park, Massachusetts

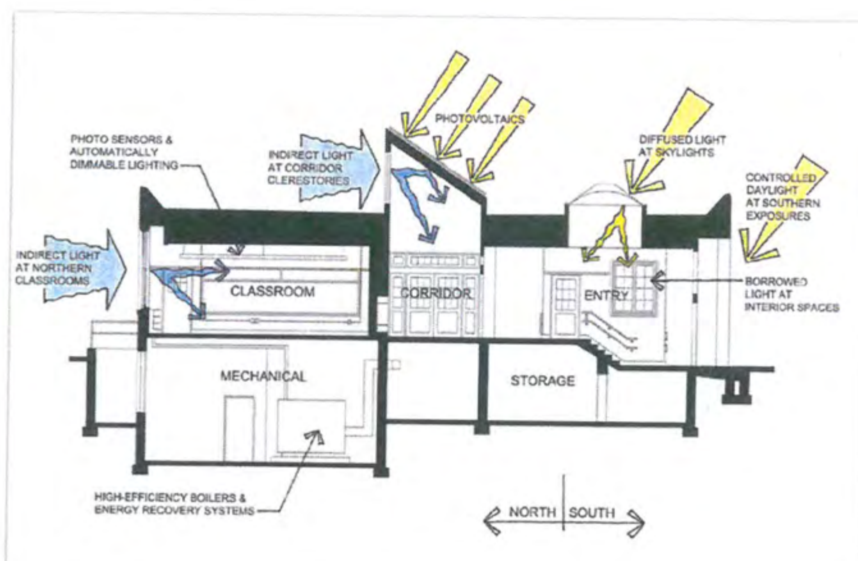
The Hemenway School in the Hyde Park neighborhood of Boston was renovated to facilitate Boston Public Schools' goal of expanding its early education program. The renovations included asbestos remediation, building envelope repair, mechanical, electrical, plumbing, fire protection upgrades, acessibility upgrades, and window replacement. The Principals of CGKV Architects, Inc., while with Cole and Goyette, Architects and Planners Inc., led the design, construction documents, and construction administration.

This 1950s art moderne building was among the first schools constructed in Boston after World War II, and its renovation is a part of the city's plan to preserve and maintain its historic schools. Environmental sustainability was a key goal of the renovation of this 18,000 square foot building. The design featured new clerestories with north-facing glazing and south-facing photovoltaic panels along the central corridor. New interior and exterior ramps provide accessibility at the three main building entrances and throughout the entire first floor. The front entry was redesigned to create a new protected interior ramp encircling a light-filled resource room. The school site underwent a major transformation to become a green and lively recreation and learning space.





Project: *Hemenway School*
Client: *Boston Public Facilities Department*
Location: *Hyde Park, MA*



CGKV Architects, Inc.

97 Marion Street
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SOUTH SHORE CHARTER PUBLIC SCHOOL
Norwell, Massachusetts

The existing roof at the South Shore Charter Public School was studied to determine the possible type of new roofing system. EPDM, PVC, TPO, Built-up Roofing, and Modified Bitumen were all studied along with new skylights and masonry repairs. After a feasibility study was conducted, CGKV proceeded with construction documents to replace the roof with a new PVC system. Currently the project is at the 95% Construction Document Phase and will be bid shortly.

Above Left:
Mechanical Equipment

Above Middle:
Existing Roof Overview

Above Right:
Existing Skylights at Roof

Below Right:
Existing Skylights at Interior

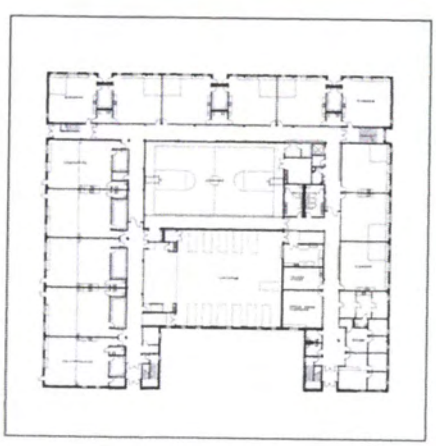
Opposite Page:
Existing Front Elevation

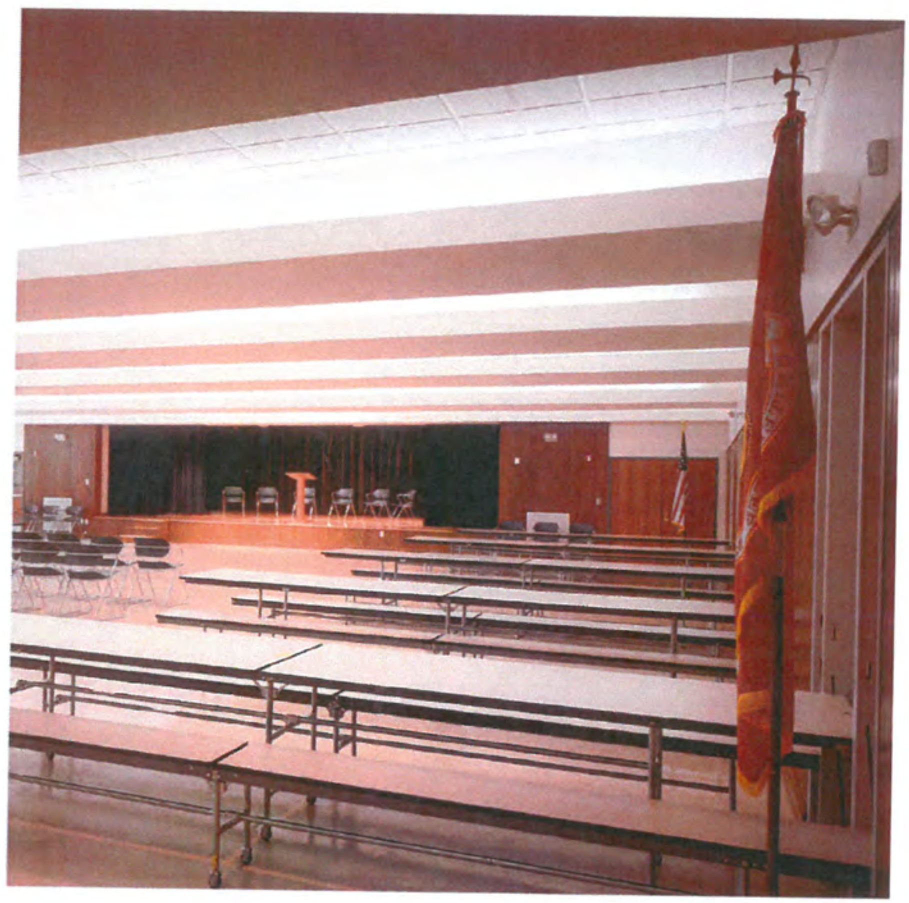
CLIFFORD MARSHALL SCHOOL
Quincy, Massachusetts

This new school for 600 students, Pre-K through 5th grade, includes 72,000 square feet with classrooms, library/media center, cafetorium, gymnasium, and related spaces. The two story brick and steel framed building is located on a six acre site developed for playfields, bus drop-off, and some parking. This project was completed while with Cole and Goyette, Architects and Planners Inc.

Designed to meet the needs of the Quincy School System into the next century, many programmatic and technological issues were addressed. State of the art computer data, voice and video technology are provided to each classroom to meet developing teaching methods. By surrounding communal areas with classrooms on two floors, well defined functional spaces are created. To meet a limited budget, efficient and effective architectural and engineering systems are utilized in the design. The building's surfaces, geometry and shapes provide a lively and nurturing environment for its young students.

Project: *Clifford Marshall School*
Location: *Quincy, Massachusetts*
Client: *Quincy Department of Public Works*
Contractor: *A. Bonfatti & Company, Inc.*
Photographer: *Nick Wheeler*





CGKV Architects, Inc.

POINT WEBSTER MIDDLE SCHOOL
Quincy, Massachusetts

The renovation of this 1921 school building provided improved and modernized facilities for 600 middle school students. The renovations included interior and exterior renovations, asbestos remediation, building envelope repair, mechanical upgrades, and window replacement. The Principals of CGKV Architects, Inc., while with Cole and Goyette, Architects and Planners Inc., led the project from the design to construction administration phases.

The building was made accessible through the addition of a new elevator, construction of a set of new interior stairs, and installation of a chair lift and ramps. Major interior alterations were required to provide new spaces for physical education, industrial arts, family and consumer science, music, and computer technology instruction. The school's spacious auditorium was carefully renovated to restore its original character and use. The lower level was transformed into a fully equipped library / media center In addition to the many interior improvements, all plumbing, HVAC, electrical, and data/communications systems were replaced, resulting in a complete upgrade of the building to meet the demands of evolving educational programs.

Project: *Point Webster Middle School*
Client: *City of Quincy*
Location: *Quincy, Massachusetts*
Contractor: *Boston Building and Bridge Corp.*
Photographer: *Nick Wheeler*

CGKV Architects, Inc.

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MASCONOMET SCHOOL
Topsfield, Massachusetts

The existing fixed windows at the Masconomet School are inaccessible from the ground level and do not provide adequate ventilation during special events like graduation. CGKV Architects, Inc. provided architectural services to study possible window replacement at the Masconomet School's Field House with projected windows operated remotely with electric motors. Various options were studied in conjunction with mechanical upgrades.

Masconomet School
Topsfield, MA
photo: E. Vazquez

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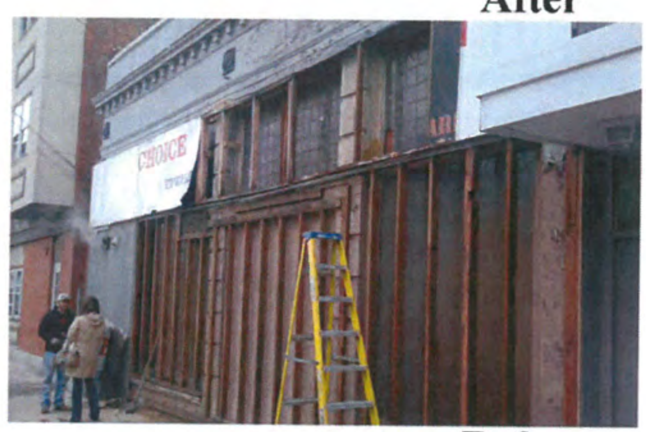
CHOICE THRU EDUCATION
Chelsea, Massachusetts

Choice Thru Education operates in Chelsea, MA as a community based nonprofit agency to provide and develop educational opportunities for the City's youth. The building received improvements to fenestration and building envelope components that addressed the impact of aircraft noise associated with Logan Airport. The main entrance and two ancillary entrances were reconfigured to create interior vestibule spaces and improve noise and thermal properties.

After

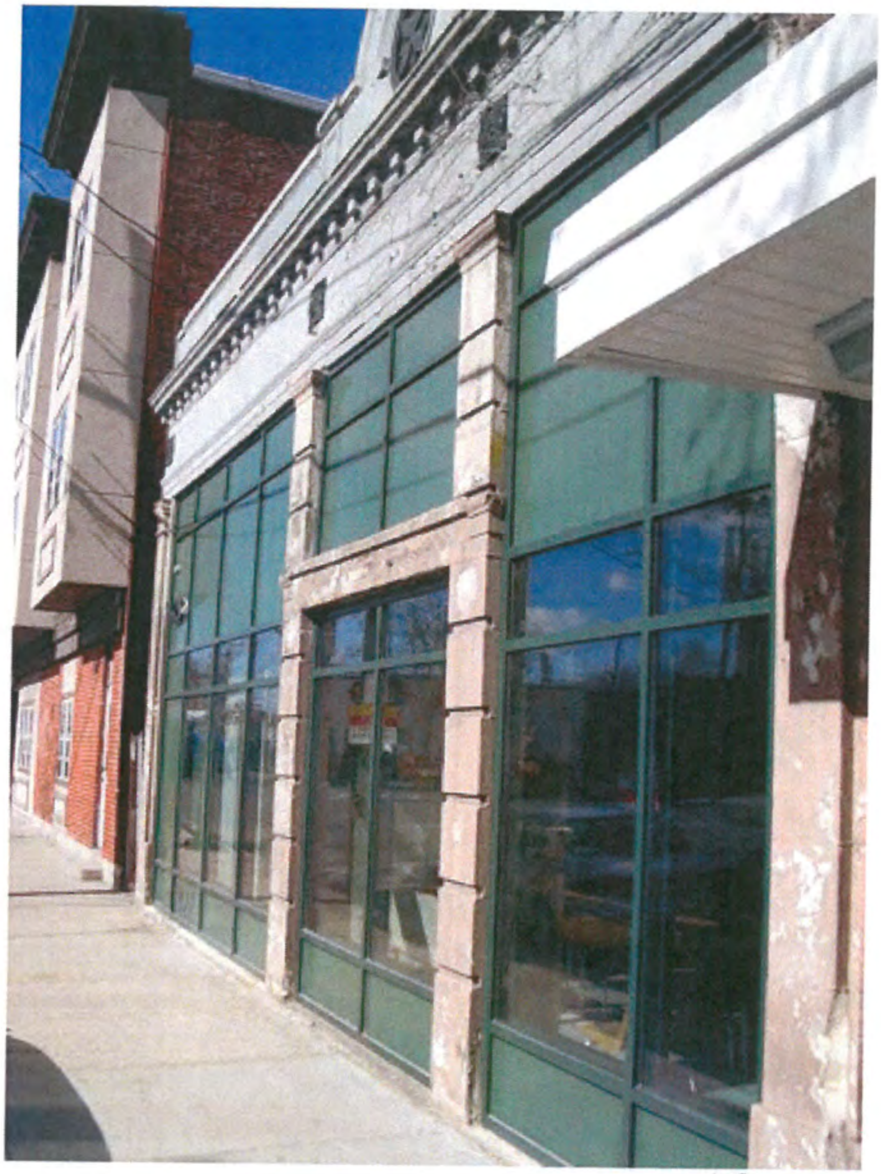
Before



Before

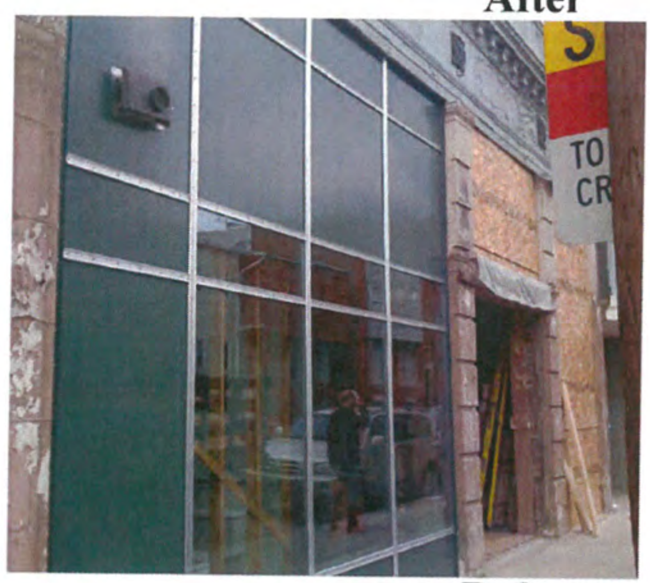
CGKV's intervention at Choice Thru Education achieved the project's goals for improved acoustical and thermal properties, but also transformed the interior environment into one filled with natural light, openness, and fresh air. The building's original steel-framed, single glazed, windows were replaced with new aluminum acoustical windows that, in addition to blocking out exterior noise, provide increased opportunities for natural ventilation during temperate months and improved thermal performance during the winter. The front elevation storefront was replaced with a new curtain wall system comprised of thermally-broken aluminum framing members, dual glazing for enhanced acoustical performance, and 3.5 inch thick insulated metal acoustical wall panels.

Project: *Choice Thru Education*
Client: *Massport*
Location: *Chelsea, MA*



After

Before



Before

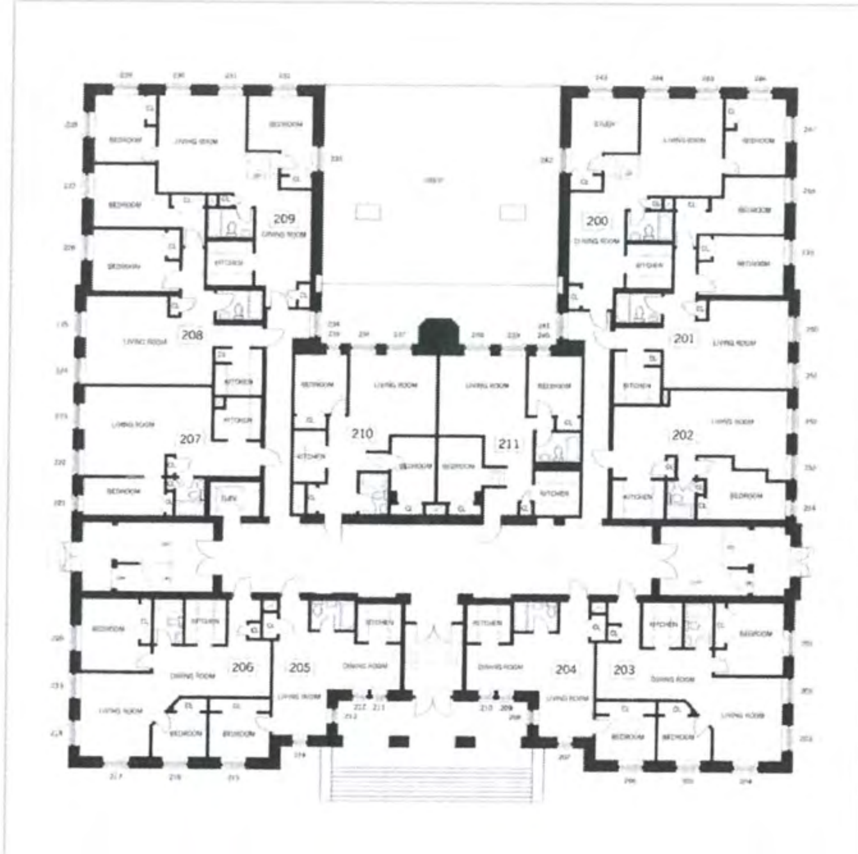
CGKV Architects, Inc.

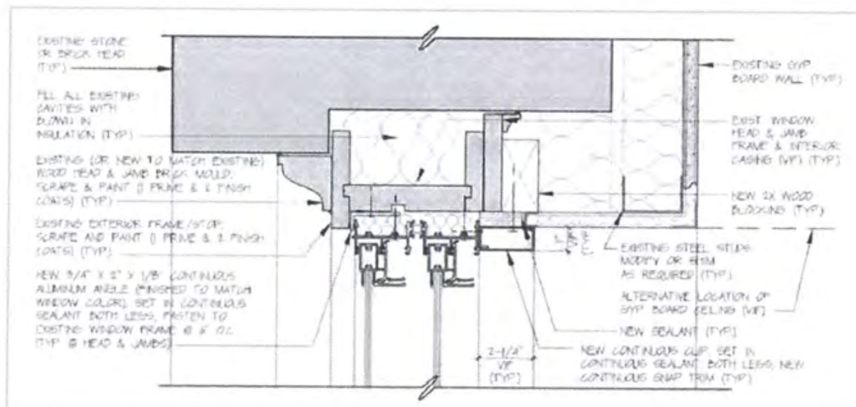
THE BIGELOW SQUARE CONDOMINIUMS
South Boston, Massachusetts

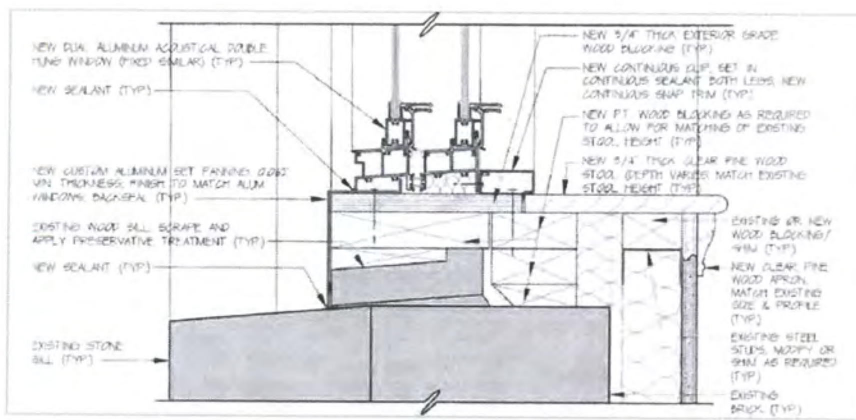
The Bigelow Square Condominiums in South Boston, in a former public school building constructed in the mid-nineteenth century, is comprised of 47 residential units. The goal of this renovation was to mitigate airplane noise associated with Logan International Airport and provide the residents of this historic building with quieter living environments through sound insulation. The historic windows and doors were replaced with great care to maintain the historic nature of the building. The Principals of CGKV Architects, Inc., while with Cole and Goyette Architects and Planners Inc., led the design and construction administration phases.

The building was assessed to determine appropriate acoustical treatments to meet State and Federal requirements. Acoustical testing was conducted of the exterior envelope, and windows and doors were found to be the most significant noise paths. The building is listed on the State and National Registers of Historic Places, so one significant challenge was to design treatments that satisfied the concerns of the Massachusetts Historical Commission and the Boston Landmarks Commission. The historic character of the building was maintained through restoration of existing exterior wood trim and installation of new dual aluminum acoustical windows with true muntins replicating the existing glazing patterns. These specialized windows work together with ancillary treatments to provide an upgrade to the acoustical integrity of the entire building envelope.

Project: *The Bigelow Square Condominiums*
Client: *Massachusetts Port Authority*
Location: *South Boston, Massachusetts*
Contractor: *Lambrian Construction Corp.*







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MASSPORT NOISE MITIGATION PROGRAM
Chelsea, Massachusetts

Over the past twenty years, the Massachusetts Port Authority has acoustically insulated thousands of dwellings throughout East Boston, South Boston, Winthrop, Revere, and Chelsea. Airplane noise is abated primarily by the replacement of windows and doors. The following examples illustrate a small sample of the recent work by CGKV involving the replacement of doors and windows at varied building and construction types in Chelsea, MA.

Above Photos:
Residential Buildings
Chelsea, MA
photo: E. Vazquez

CGKV Architects, Inc.

VILLAS AT EAGLE'S NEST
Franklin, Massachusetts

Design, construction documents, and construction administration were provided for five new 30,000 square foot multi-family buildings at Eagle's Nest in Franklin, Massachusetts. This residential development houses an adult community in 36 dwelling units spread across a 90 acre wooded site. The Principals of CGKV Architects, Inc., while with Cole and Goyette Architects and Planners Inc., led the design and construction administration phases.

The condominiums at Eagle's Nest feature a master suite, second bedroom, two and a half baths, living room, dining room, kitchen, library/media room, private underground parking, and elevator. Each unit features an open floor plan with patios to provide continuous space to the exterior. The buildings are designed in the shingle style and are wood frame construction with an emphasis on durable and low maintenance materials. The spacious units range in size from 2,300 square feet to 3,200 square feet, allowing for ample storage and modern amenities. The wooded lot is carefully designed to house all five buildings and a scenic nature trail while respecting the existing landscape.

Project: *Eagle's Nest*
Location: *Franklin, Massachusetts*
Client: *Eastern Management & Development, LLC*

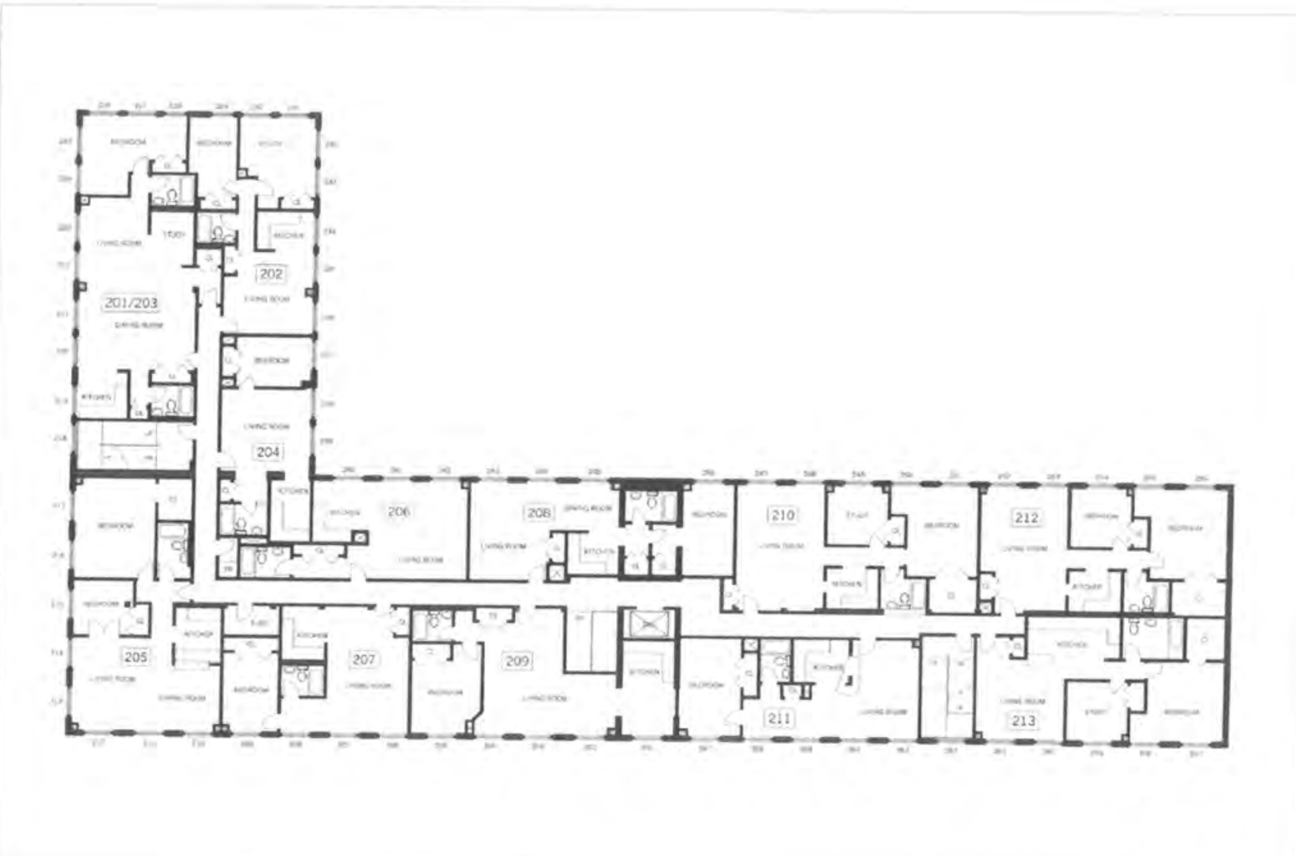
CGKV Architects, Inc.

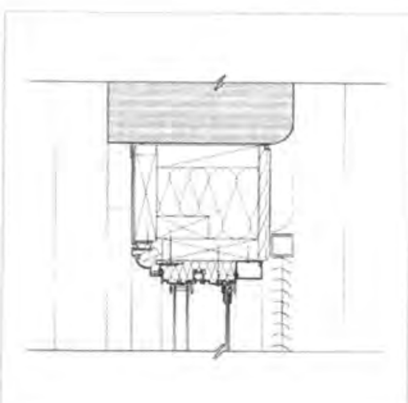
THE FOUNDRY CONDOMINIUMS
South Boston, Massachusetts

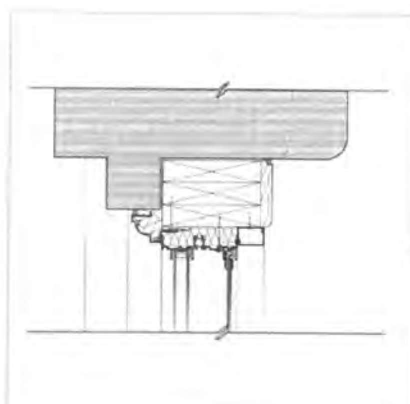
The Foundry Condominiums contain 52 residential units. Located in South Boston, the building is directly affected by the noise of planes taking off and landing at Logan International Airport. The goal of this renovation was to provide a sound insulated living environment for the residents of the Foundry. The Principals of CGKV Architects, Inc., while with Cole and Goyette Architects and Planners Inc., led the design and construction administration phases.

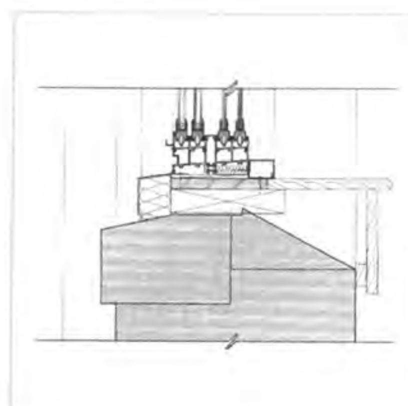
The building was assessed and the exterior envelope was acoustically tested to determine appropriate acoustical treatments. The Foundry's solid brick bearing walls block most outside noise from entering the building, but the existing windows were found to be a significantly weaker sound barrier. All existing windows on the Second through Fifth Floors will be replaced with new dual aluminum acoustical fixed and gliding units. The window installation also includes custom exterior aluminum panning, all new structural framing, and new interior wood trim. A special acoustical treatment was also designed to augment the performance of areas of the building's existing wood plank roof structure.

Project: *The Foundry Condominiums*
Client: *Massachusetts Port Authority*
Location: *South Boston, Massachusetts*
Contractor: *Lambrian Construction Corp.*





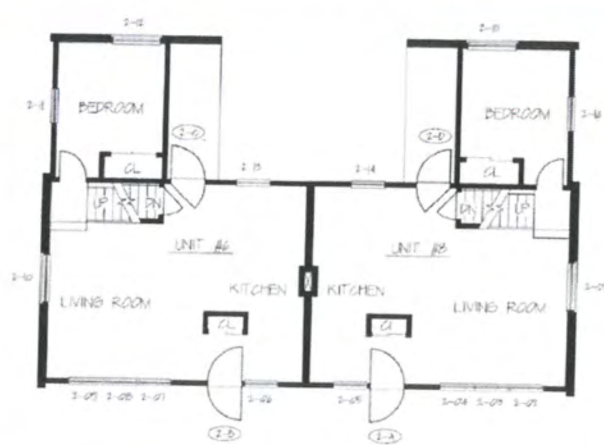




CGKV Architects, Inc.

HIGHLAND HEIGHTS FAMILY HOUSING
Taunton, Massachusetts

The goal of the renovation of the Highland Heights Development was to modernize the existing building exteriors through replacement of all windows and storm doors and selective replacement of exterior siding materials. Highland Heights, originally constructed in the 1950s, consists of twenty two-story buildings with two dwellings per building. The Principals of CGKV Architects, Inc, while with Cole and Goyette, Architects and Planners Inc., led the design, construction documents, and construction administration.



The exterior building envelope improvements focus on new windows, storm doors, and siding. The improvement of window openings was achieved through the replacement of the existing aluminum windows with new energy-efficient vinyl windows and the application of aluminum panning over the trim. The new storm doors create more consistent installations and weather tight openings. Replacement of the existing deteriorated siding also aided in eliminating existing water penetration issues. All of this work provides not only a tighter building envelope but also improved thermal and sound insulation. A strong emphasis was placed on construction administration and scheduling in order to accommodate tenants in the occupied units.

Project: *Highland Heights Family Housing*
Location: *Taunton, MA*
Client: *Taunton Housing Authority; Massachusetts Department of Housing & Community Development*

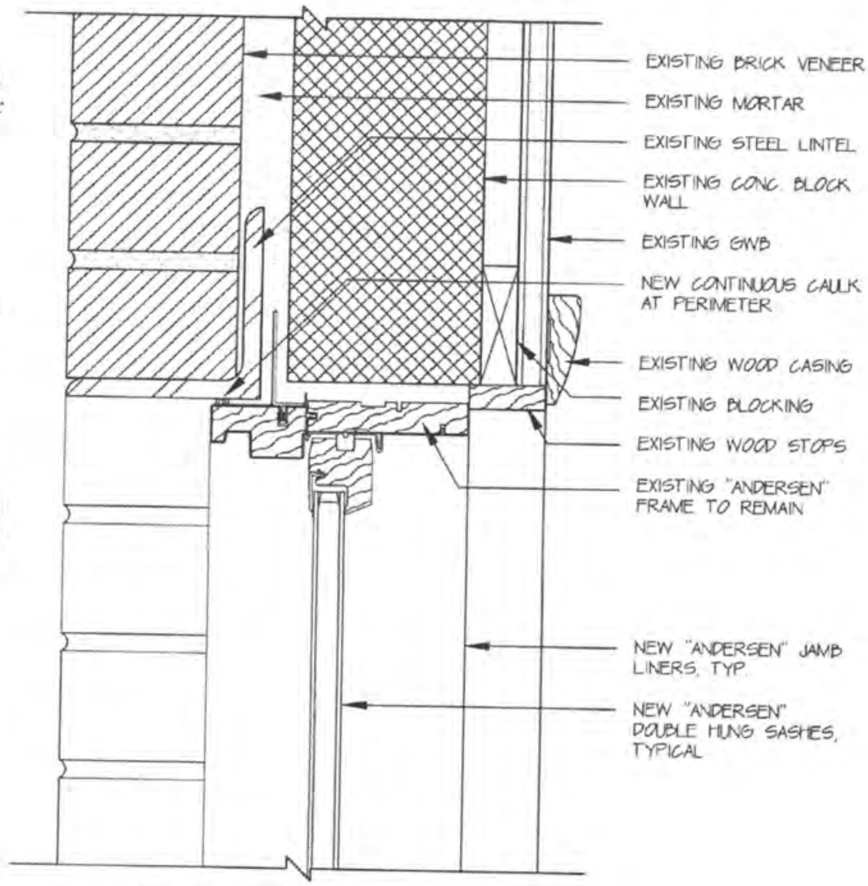
CGKV Architects, Inc.

NORWELL GARDENS ELDERLY HOUSING
Norwell, MA

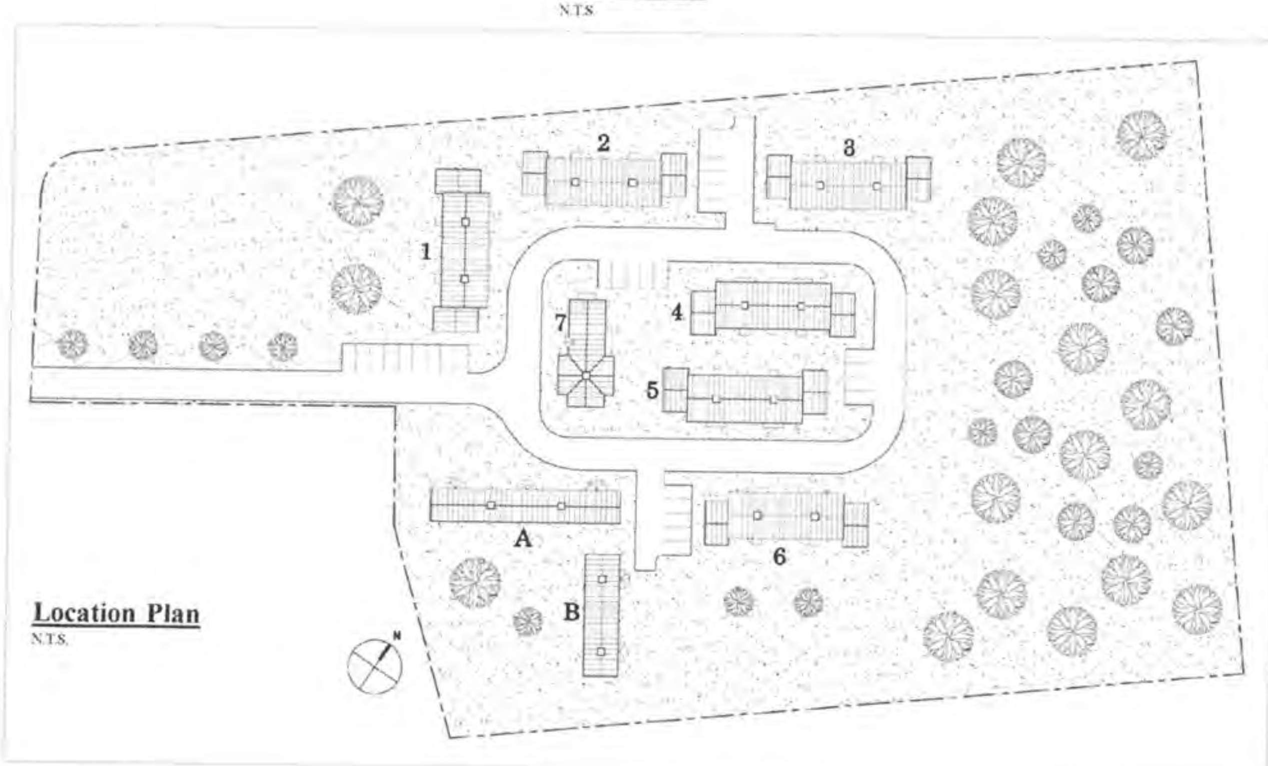
The scope of work at the Norwell Gardens Elderly Housing development included window replacement and masonry waterproofing in nine individual buildings. Roughly 400 double hung windows were replaced with "Andersen" vinyl clad wood window conversion kits. Water infiltration issues were also addressed at the exterior masonry walls. The Principals of CGKV Architects, Inc., while with Cole and Goyette Architects and Planners Inc., led the design and construction administration phases.

The Norwell Gardens Elderly Housing development consists of nine individual buildings on seven acres in Norwell, MA. The original masonry construction lacked proper waterproofing and therefore was prone to water infiltration at the North East elevation from wind driven rain. We studied the problem and provided several options for repair that ranged from masonry sealers to rebuilding of the masonry veneer walls with an appropriate cavity, weep hole, and flashing system. The existing window sashes at the development were in serious disrepair and were therefore replaced with original manufacturer sashes with insulated low E glass. The sashes are painted wood by "Andersen Windows." The existing vinyl frames were in good condition and required only minor repair.

Project: *Norwell Gardens Elderly Housing*
Location: *Norwell, MA*
Client: *Norwell Housing Authority; Massachusetts Department of Housing & Community Development*



Head Detail
N.T.S.



Location Plan
N.T.S.

CGKV Architects, Inc.

Westport Community Schools

Interview Questions

1a. What is your MSBA previous experience?
Cutler Elementary School Renovations
F.H. Freedman School Renovations (Window and Door Replacement)
Warner School Renovations (Window and Door Replacement)
Washington School Renovations (Door Replacement)
White St. School Renovations (Window Replacement)
Mary Walsh Renovations (Roofing – Schematic Design)
Milton Bradley Renovations (Roofing – Schematic Design)
F.H. Freedman School Renovations (Roof Replacement – 60% CDs)
Warner School Renovations (Roof Replacement – 60% CDs)

1b. What is your roof & window project replacement experience?
Please see enclosed examples of previous experience.

1c. What is your experience with hazardous materials in roof & window replacement projects?
We have worked with Fuss & O'Neill / EnviroScience for many years on several projects with hazardous materials. It is common to find asbestos in sealants for windows and roofs and lead paint at windows, but we must also be sure to test for PCBs.

2. What do you see as the biggest challenge to this project being completed on time?
Many cities and towns are off to a late start to complete construction in the summer of 2011. We will need to identify issues and determine solutions early. The multiple submissions, bidding process, and the manufacturing of building products usually take longer than many municipalities anticipate.
Roofing projects will include 3 weeks for shop drawings, 4 weeks lead time, and 4 weeks construction.
Window projects will include 3 weeks for shop drawings, 12-16 weeks lead time, and 6-8 weeks construction depending on scope.

3. Can the actual engineer/architect that would perform the services in our district be available at the interview and throughout the project?
The Principals of CGKV, here with you today, will be personally involved throughout the project.

4. If issues arise 6 months to a year later (leaks, damage or the like) what would be your commitment to Westport to help fix the problem with the builders?
The MSBA Contract calls for an inspection by the Architect 10 months after completion to review for any warranty issues. We are committed to establishing a long term working relationship with the Town of Westport.

CGKV Architects, Inc.

5. Describe the construction management services you will provide:
   a. Are you there for all inspections and major completion milestones for approval?
      CGKV Principals will conduct inspections and attend all completion milestones.

   b. How often do you check up on contractors?
      Site visits are dependent upon project scope and duration. During a fast paced roof replacement project, we might be on site 2 or 3 times per week. At minimum, we will conduct weekly construction meetings with the Contractor, Town and OPM.

   c. What is your experience in working with construction managers during projects?
      We are accustomed to working with very experienced and highly qualified project managers on projects with State agencies and larger cities and towns. We have a good working relationship with the outside OPM hired by the City of Springfield.

   d. What is your experience with submitting paperwork for MSBA and payments / reimbursements on time?
      We have experience submitting milestone submissions to MSBA in their requested formats.

6. What will you do to reduce the number of change orders needed during the construction phase?
   Complete and accurate drawings and specifications are critical. It is important to perform a thorough investigation early in the process.

7. How will you determine the existing conditions?
   It is extremely helpful when a city or town has original construction documents for their facilities. However, we are experienced in evaluating and documenting existing conditions as required. We will perform test cuts in roof assemblies to both determine the specifics of construction and test for hazardous materials.

8. How will you determine project costs and timeline?
   CGKV Principals have worked with AM Fogarty as our third-party, independent cost estimator for many years on similar public construction projects. We also review cost and schedule factors with trusted representatives of manufacturers and contractors.

9. What is your opinion on the option of solar panels on the roof or retrofitting them to an existing roof?
   Solar panels should be coordinated with new roofing work to the greatest extent possible. The costs and benefits should be closely evaluated.

10. What will you do to ensure a successful project? (What do you see as your role?)
    The Principals of CGKV will be personally involved in all phases of the project. We do not have a cookie-cutter process. We recognize that all projects are unique and have specific challenges and goals to be addressed.

EXHIBIT 41

PINCK & CO

Westport Community Schools - MSBA Green Repair Project

Macomber Elementary / Middle School / High School

Feasibility Cost Estimate

5/4/2011

Const Cost - Labor & Materials -

Item	Quantity		Low Unit Cost	Low Total	High Unit Cost	High Total
High School Roof						
Install PVC Membrane Roof	90,000	SF	$13.00	$1,170,000	$16.00	$1,440,000
Demo/Install included above						
Macomber School Roof						
Install PVC Memb Roof @ flat	14,100	SF	$13.00	$183,300	$16.00	$225,600
Install Asphalt shingle @ slope	22,000	SF	$9.25	$203,500	$11.00	$242,000
Demo/Install included above						
Middle School Windows						
Type A: 133 @ 18.25 SF	2,427	SF	$78.00	$189,326	$83.00	$201,462
Type A1: 9 @ 18.25 SF	164	SF	$78.00	$12,812	$83.00	$13,633
Type B: 94 @ 34 SF	3,196	SF	$75.00	$239,700	$80.00	$255,680
	5,788	SF				
High School Windows						
All windows North & South Addition - Many types	2,050	SF	$75.00	$153,750	$80.00	$164,000
Total Project Construction Cost Estimate no Hazardous Materials				**$2,152,387**		**$2,542,375**

Hazardous Material Removal / Disposal

Windows: Caulk'g/Glaz'g ONLY positive for Asbestos

	Quantity		Unit Cost	Total
Middle School Abatement	5,788	SF	$15.00	$86,820
Environmental Engineering				$20,000
Total				$106,820
High School Abatement	2,050	SF	$15.00	$30,750
Environmental Engineering				$10,000
Total				$40,750

Hazardous Material Removal / Disposal (cont.)

Windows: Caulk'g/Glaz'g ONLY positive for PCBs

Middle School Abatement		5,788 SF	p	#VALUE!
Environmental Engineering				$40,000
	Total			#VALUE!
High School Abatement		2,050 SF	$20.00	$41,000
Environmental Engineering				$30,000
	Total			$71,000

Other Potential Hazardous Materials:

Windows PCB: If exterior glazing, may be in soil (remove 6" deep approx 5' all directions from window) If in caulking may be in adjacent masonry (remove 1 course of adjacent masonry)

Roof Asbestos: Roofing felts & adhesives and Asphalt shingles – For buildings of this era, about 25% of the time test positive for asbestos (remove & dispose @ $3/SF) Flashings & caulking at roof penetrations and perimeter - about 75% of the time test positive for asbestos.

Roof PCB: Flashings & caulking at roof penetrations and perimeter - about 5% of the time test positive for PCB

Lead Paint: Paint often tests positive for lead in buildings of this era. (Standard contractor training except where children under 6 exposed for long period of time)

OPM and Architect/Engineer Fees: Typical Ranges MSBA Green Repair Projects

OPM Fee	$2,540,000	5.50%	$139,700	7.50%	$190,500
AE Fee	$2,540,000	8.50%	$215,900	10.00%	$254,000

EXHIBIT 42

FUSS & O'NEILL
EnviroScience, LLC

Disciplines to Deliver

May 6, 2011

Mr. Jason Knutson, AIA
Principal
CGKV Architects, Inc
97 Marion Street
Somerville, MA 02143

RE: Hazardous Materials Consulting Services
Westport Green Repairs Project – Westport Middle School
Fuss & O'Neill EnviroScience, LLC No. 20080788.A2E

Dear Mr. Knutson:

Fuss & O'Neill, EnviroScience LLC (EnviroScience) is pleased to provide the following proposal to conduct a hazardous building materials inspection and sampling to facilitate the proposed Green Repairs project work necessary for the above referenced site. We understand the intent of the project is to conduct work under the MSBA's Green Building Repair Program. Work shall include a review of exterior envelope to include windows and doors only at one school building.

We have prepared this scope of services for the project based on reviewed information provided by CGKV only. We have not visited the sites or reviewed any prior inspection data at this time. We understand the project is MSBA funded.

We have included a scope and fee associated with sampling of building materials such as roofing, caulking and glazing compounds for polychlorinated biphenyls (PCBs). Sampling for PCB's in the above matrices is presently not mandated by the U.S. Environmental Protection Agency (EPA), however significant liability risk for disposing of PCB containing wastes exist. Recent knowledge of PCBs within these matrices has become more prevalent especially with remediation contractors, waste haulers and disposal facilities. Many property owners have become subject to large changes in schedule, scope and costs as a result of failure to identify this possible contaminant prior to renovation or demolition.

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www.FandO.com

Connecticut
Massachusetts
New York
Rhode Island
South Carolina

FUSS & O'NEILL

The Project Site and Scope:

1. Westport Middle School – 400 Old County Road – Replacement of windows and doors. Building was built in 1969 with no additions and no replacement of original doors or widows.

We propose testing for hazardous building materials as the site based on the limits of proposed work noted above. We shall provide testing of hazardous building materials to include asbestos, lead paint, and PCBs.

A. Hazardous Materials Inspection

1. Asbestos Testing

EnviroScience will conduct inspection and sampling as necessary for asbestos-containing materials at each building in areas where proposed renovation work is to be performed. During the inspection, EnviroScience will evaluate and quantify the materials which will be impacted by the proposed work. .

We will collect samples of suspect bulk materials for analysis by polarized light microscopy (PLM) using approved EPA protocol in accordance with accreditation of the National Institute of Standards and Technology (NIST).

The EPA considers a homogeneous material to be non asbestos containing upon receipt of three to seven negative sample analysis results by PLM. EnviroScience will collect a set of three to seven samples of each suspect material, and we will stop analysis on the set upon receipt of the first positive analysis. EPA suggests that Transmission Electron Microscopy (TEM) laboratory analysis be conducted on materials such as mastics and other non-organically bound materials to confirm asbestos content if results of initial PLM results do not identify asbestos.

We shall include testing of the following materials.

1. Interior Window Caulking, Exterior Window Caulking and Glazing compound from windows – 9 samples

2. Door Interior and Exterior Caulking. – 6 samples

3. We will review other areas of potential impact at sites to ensure no other suspect materials present. Propose inclusion of additional budget of 6 samples in total budget for analysis.

FUSS & O'NEILL

Mr. Jason Knutson, AIA
May, 6, 2011
Page 3

We shall include an estimated budget of **21 samples** for PLM analysis. *Analysis of samples shall be at unit rates on a per sample basis.* We also recommend including analysis of at least one sample of each set of three samples of the above materials for TEM analysis. – 7 samples.

2. Testing of Surfaces for Lead Based Paint

It is our understanding that previous testing has not been performed. EnviroScience recommends a lead based paint screening program using X-Ray Fluorescence direct read instrumentation or representative paint chip samples to test representative surfaces that could cause exposure to workers during renovation work. This work would be done in consultation with OSHA Regulation 29CFR 1926.62 and Commonwealth of Massachusetts regulations. During this process a lead inspector would test the representative paint surfaces and components to screen for lead content. The inspection for lead paint would not be a comprehensive inspection for compliance with Commonwealth of Massachusetts regulations. Paint chip samples if collected shall be analyzed by Atomic Absorption Spectrometry (AAS)

It is necessary to ascertain the lead content of the paints so that the contractor will know his responsibilities under OSHA regulation 29 CFR 1926.62, Lead Exposure in Construction.

3. PCB Building Material Sampling

EnviroScience recommends that the roofing, caulking and glazing compound from each homogenous sampling area where renovations will occur be collected to determine PCB content. We shall conduct testing for PCBs by collecting representative samples for PCB analysis of source materials only. We suggest collecting three representative samples of each material type noted below.

Samples shall be collected from materials including but not limited to:

- Exterior Window Caulking (3 samples)
- Window Glazing Compound (3 samples)
- Interior Window Caulking (3 samples)
- Interior Door Caulking (3 samples)
- Exterior Door Caulking (3 samples)

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Discreet samples shall be collected of source materials. If additional homogenous caulking types are identified, with differing substrates, different appearance or other distinguishing characteristics which indicate a different source, we shall collect samples while on site. If additional samples are collected we shall inform you prior to sending additional samples for analysis. We have allowed for an additional **3 samples** in the budget.

Care shall be exercised to ensure sampling equipment is decontaminated between sample collection using hexane wash and rinse to avoid cross contamination of samples. Samples shall be placed in glass jars for transport to laboratory using proper chain of custody. Samples will be analyzed using EPA Method 3500B/3540C (Soxhlet Region 1) for extraction and analysis of samples using EPA Method 8082.

We have included a total of **18 samples** in the budget for PCB analysis.

Exclusions: The above testing for PCBs is for source materials only and does not include an evaluation of adjacent substrates such as brick, concrete or soil. These adjacent materials may require testing to determine PCB content if original source materials are determined to contain regulated concentrations of PCBs.

Report Preparation and Deliverables

We shall prepare an inspection report which identifies the materials sampled and results of testing. We shall provide scope and cost impact for the proposed project with regard to hazardous materials impact.

B. Develop Hazardous Materials Abatement Design/Specification

EnviroScience will prepare a set of technical specifications, in an agreed upon format, to address removal of asbestos-containing and other hazardous building materials from the areas which will be impacted by this renovation project. EnviroScience will include sections to address the required work practices, existing site conditions, project phasing, and a detailed schedule to be met by the abatement contractor.

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Specifications will be in sufficient details so that they will form the basis for the submittal of bids by hazardous materials abatement contractors and will include AutoCAD drawings showing the locations of asbestos-containing materials based on existing conditions; drawings provided by CGKV Architects, Inc.

The specifications shall be prepared as technical section 02080 for asbestos, 02090 for de-leading and 02091 for lead paint for inclusion in the overall bid package being prepared for the renovation project. Work shall include review meetings noted with CGKV Architects, Inc., during schematic design, design development and during Contract Documents as necessary to discuss scope and impact based on required renovation work.

We shall also assist in the bid process as noted including attending the pre-bid meeting with prospective bidders and preparing addenda items as necessary.

Exclusions: The proposed scope of services excludes development of required plan to EPA and technical specifications for PCB remediation in building matrices. Upon discovery of PCBs above regulated concentrations we can conduct additional testing and preparation of required plans for PCB remediation will be required in accordance with 40 CFR Part 761.

C. Construction Administration/ Project Monitoring - Hazardous Materials

1. Pre-Abatement Services

EnviroScience shall attend a pre-construction meeting with the selected general trades and contractor and sub-contractors for abatement.

EnviroScience will observe pre-cleaning, safety procedures, and setup of total containment, three stage decontamination unit, waste load-out and, air pressure differential systems. EnviroScience will also conduct a pre-abatement, visual inspection/certification of the total containment work area.

EnviroScience can provide the necessary advice and support to evaluate submittals by abatement contractors.

To accomplish this task, EnviroScience will review the abatement contractor submittals including:

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- Abatement plans: These plans will be based on abatement drawings of the decontamination facilities and their locations, work area isolation plan with layout of engineering controls (e.g. HEPA filter, etc.), and will describe how the contractor will manage aspects of the project such as a security plan, a routing plan for removal of contaminated materials from the building, and a listing of all tools, equipment and supplies proposed for use during the abatement project.
- Description of protective clothing and approved respiratory protection systems to be used.
- Explanation of decontamination sequence to be used.
- Description of asbestos stripping, removal and disposal methods to be used.
- Description of the final clean up procedures to be used.
- Proposed landfill for disposal of waste materials and procedures for disposal and hauling to disposal sites.
- Emergency procedures plan in the event an abatement worker is injured and/or becomes ill during the course of performing work.
- Notification to regulatory agencies regarding the abatement schedule and other pertinent information necessary to assure that the contractor has obtained all necessary permits and approvals.

2. Project Monitoring and Daily Documentation

EnviroScience will provide trained, experienced and licensed asbestos Project Monitors to monitor exposure levels and to verify adherence to project specifications during the performance of abatement activities. If problems arise, EnviroScience's Project Monitor will notify the Construction Manager/Owner, who will have the authority to stop the abatement work at any time it is determined that conditions are not within the specification, or that a health hazard might exist for other employees or building occupants, or that the potential exists for contamination of the environment. The Project Monitor's specific duties on-site will include:

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- Document that the asbestos abatement contractor is adhering to standard procedures identified in the project specification during abatement work to ensure maximum protection and safeguard from asbestos exposure of the workers, visitors, building occupants, and the environment.
- Periodically collect and analyze air samples by phase contrast microscopy (PCM) on-site to evaluate airborne fiber levels in the work area as well as areas adjacent to abatement activities, to assure proper engineering controls are in place and/or to document airborne fiber levels.

- On a routine basis, check containment barriers for separation, ensure adherence to standard operating procedures, implementation of proper engineering control systems and HEPA exhaust system, respiratory protection system, and any other aspects of the abatement process that may impact the health and safety of the people and the pollution of the environment. The monitoring frequency will be determined by a CIH and our Project Manager based on good professional judgment.

3. Post Abatement and Re-occupancy Clearance Air Testing

- In conjunction with the abatement contractor's superintendent, complete a visual inspection after final cleaning of each abatement work area to ensure that ACM has been effectively removed as required in the project specifications. After inspecting a number of locations, a decision will be made whether to complete a detailed inspection. If the presence of asbestos is determined during the random inspection, the contractor will be informed that complete re-cleaning is necessary before any further inspection can occur. Once a detailed inspection is initiated, then spot cleaning by the contractor will be in order. Once certified as clean, the asbestos abatement contractor will be allowed to begin a "lockdown" procedure in the work area.
- After completion of visual inspection and lockdown procedures, the Project Monitor will perform aggressive air sampling using clean leaf blowers or fans to certify that the work area meets clearance airborne fiber levels as required by the project specifications. Samples will be collected on a 25-millimeter filter cassette and will be 1,200 liter minimum with a maximum flow rate of 12 liters per minute. The work area will be certified as clean when total airborne fiber concentrations are not greater than 0.01 fibers/cubic centimeter of air (f/cc) using Phase Contrast Microscopy (PCM). For interior work areas where AHERA will require clearance samples by Transmission Electron Microscopy (TEM) we shall send to EMSL Analytical, Inc for 48 hour turnaround.

- After clearance is obtained, our Project Monitor will observe the removal of barriers and disposal of same in sealed plastic bags designated as asbestos waste and cleaned as specified. Once the area is clear for re-occupancy, a final check will be conducted in conjunction with Town representatives to assure completion of abatement work.

4. Project Documentation

A Documentation of Records report will be prepared by EnviroScience at the completion of the project. This report will include the following:

- Introduction and summary of the project
- Methods, findings and conclusions
- Air sample data sheets
- Sample analysis laboratory reports
- Daily log sheets
- Pre abatement, daily and final checklists and inspection reports
- Abatement contractor certifications, licenses, medical and training records
- Contractor abatement plan and material specifications
- Permits, notifications and disposal records

PROJECT SCHEDULE AND COST

EnviroScience is prepared to initiate work on the above project at a mutually agreeable time following receipt of a signed agreement.

A – Hazardous Materials Inspection

Labor and Report	$750
PLM Analysis (21 samples @ $18/each)	$378
TEM Analysis (7 samples @ $65/each)	$455
PCB Sampling Labor and Report	$750
PCB Source Analysis (18 samples @ $90/each)	$1,620
Sub-total	**$3,953**

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Item B - Design Services (excluding PCBs)

Prepare technical specifications and drawings	$1,800
Attend Pre-bid Meeting if requested	$550
Sub-total	**$2,350**

Item C - Construction Administration services

Assume 20 days of monitoring.

Project Monitoring 15 days @ $480/day	$7,200
PCM Air samples assume 10 samples per day (150 @$8/each)	$1,200
Project Management, assume 1 hour per monitoring day (15 hours @ $110/hour)	$1,650
Final Report	$300
Sub-total	**$10,350**
PROJECT TOTAL:	**$16,653**

TERMS AND CONDITIONS

The attached Terms and Conditions shall govern the services listed herein and are an integral part of this agreement.

AGREEMENT FOR SERVICES

If you are in agreement with this proposal and the Terms and Conditions, please indicate by signing this letter and returning it to our office via fax or mail.

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INITIATION OF SERVICES

Services have commenced based on your verbal authorization. Receipt of your signed agreement will indicate your authorization to proceed with the work.

Please contact us immediately if you have any questions related to this proposal. We look forward to working with you on this project.

Sincerely,

Robert L. May Jr.
Vice President

Stephen W. Connelly
Senior Vice President

RLM:adw

Attachment: General Terms & Conditions

AUTHORIZATION TO PROCEED

I hereby authorize Fuss & O'Neill EnviroScience, LLC to proceed with the above-referenced project in accordance with the aforementioned Terms and Conditions and proposal herein.

Printed Name ______________________ Date ______________________

Signature ______________________ Title ______________________

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GENERAL TERMS AND CONDITIONS

Attached to and incorporated into the Proposal that, as executed, shall serve as an agreement between CGKV Architects, Inc (Client) and Fuss & O'Neill EnviroScience, LLC (Consultant) dated May 6, 2011 in respect of the Project described therein.

1.0 GENERAL

The Consultant shall perform for the Client professional consulting services in all phases of the Project to which this Agreement applies as hereinafter provided. These services will include serving as the Client's professional consulting representative for the Project.

Any provisions of this Agreement held in violation of any law or ordinance shall be deemed stricken, and all remaining provisions shall continue valid and binding upon the parties. Client and Consultant shall attempt in good faith to replace any invalid or unenforceable provisions of this Agreement with provisions which are valid and enforceable and which come as close as possible to expressing the intention of the original provisions.

Client shall reimburse Consultant for all costs of modifications and any additional services required to comply with laws, rules or regulations first coming into effect after the signing of this agreement, charges for which will be based on the Consultant's fee schedule at the time the additional services are performed. It is understood that various codes and regulations are subject to varying and sometimes contradictory interpretation. Consultant will exercise its professional skill and care consistent with the generally accepted standard of care to provide a work product that complies with such regulations and codes. Consultant cannot warrant that all documents issued by it shall comply with said regulations and codes.

2.0 MEANING OF TERMS

As used herein the term "Agreement" refers to the Proposal Letter or Agreement to which these General Terms and Conditions are attached as if they were part of one and the same document.

3.0 CLIENT'S RESPONSIBILITIES

Client shall:

- Provide all criteria and full information as to Client's requirements for the Project,
- Designate a person to act with authority on the Client's behalf in respect to all aspects of the Project,
- Examine and respond promptly to the Consultant's submissions,
- Give prompt written notice to the Consultant whenever the Client observes or otherwise becomes aware of any perceived defect in the work,
- Guarantee access to and make all provisions for the Consultant to enter upon public and private property,
- As appropriate and required by law be responsible for reporting certain significant environmental hazards of contaminated property.

Unless otherwise specifically indicated in writing, Consultant shall be entitled to rely, without liability, on the accuracy and completeness of information provided by Client, Client's consultants and contractors, and information from public records, without the need for independent verification.

Client acknowledges that if Consultant's professional services involve the use of vehicles or other equipment as part of Project, some damage to the project site could occur. Client understands that unless specifically stated in the Agreement, and provided Consultant uses reasonable care, correction of such damage is not the responsibility of Consultant.

4.0 REUSE OF DOCUMENTS

All documents, including reports, electronic media, drawings and specifications, prepared or furnished by Consultant and its subsidiaries, independent professional associates, subconsultants and subcontractors pursuant to this Agreement are instruments of service in respect of a particular Project and the Consultant shall retain an ownership and property interest therein whether or not the Project is completed. Client may make and retain copies of such documents for information and reference in connection with the Project; however, such documents are not intended or represented to be suitable for reuse by Client, including extensions of the Project or on any other project, nor are they to be relied upon by anyone other than Client.

Copies of documents that may be relied upon by Client are limited to printed copies (also known as hard copies) that are signed or sealed by Consultant. Files in electronic media format or text, data, graphic or other types that are furnished by Consultant to Client are only for convenience of Client. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. When transferring documents in electronic media format, Consultant makes no representations as to long-term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems or computer hardware differing from those in use by Consultant at the beginning of this Project.

Any reuse, modification or disbursement of documents to third parties without written consent and project-specific adaptation by the Consultant will be at the Client's sole risk and without liability or legal exposure to Consultant or its subsidiaries, independent professional associates, subconsultants, and subcontractors. Accordingly, Client shall, to the fullest extent by law, defend, indemnify and hold harmless the Consultant from and against any and all costs, expenses, fees, losses, claims, demands, liabilities, suits, actions and damages whatsoever arising out of or resulting from such unauthorized reuse, modification or disbursement. If it is necessary to distribute any documents to an unrelated third party, the Client agrees and will insure that:

1. The third party is bound by all of the conditions and limitations of this Agreement and related documents;
2. The third party is bound by all limitations of liability or indemnity provisions; and,
3. The limitation of liability set forth in Section 12 is an aggregate limit and the Client does not have the right or duty to apportion the limitation amount between itself and the third party.

Any or Project-specific adaptation by Consultant will entitle the Consultant to further compensation at rates to be agreed upon by Client and the Consultant.

5.0 OPINIONS OF COST

Since the Consultant has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor's methods of determining prices, or over competitive bidding or market conditions, the Consultant's opinions of probable total project costs and construction cost are to be made on the basis of the Consultant's experience and qualifications and represent the Consultant's best judgment as an experienced and qualified professional familiar with the construction industry; but the Consultant cannot and does not guarantee that proposals, bids or actual total project or construction costs will not vary from opinions of probable cost prepared by the Consultant. If prior to the bidding or negotiating phase the Client wishes greater assurance as to total project or construction costs, the Client shall employ an independent cost estimator.

6.0 SUCCESSORS AND ASSIGNS

6.1 Neither the Client nor the Consultant shall assign, sublet or transfer any rights under or interest in (including, but without limitation, moneys that may become due or moneys that are due) this Agreement without the written consent of the other, except to the extent that any assignment, subletting or transfer is mandated by law or the effect of this limitation may be restricted by law. Unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under this Agreement. Nothing contained in this paragraph shall prevent the Consultant from employing such independent professional associates and consultants, as the Consultant may deem appropriate to assist in the performance of services hereunder.

6.2 Nothing under this Agreement shall be construed to give any rights or benefits in this Agreement to anyone other than the Client and the Consultant, and all duties and responsibilities undertaken pursuant to this Agreement will be for the sole and exclusive benefit of the Client and the Consultant and not for the benefit of any other party.

7.0 MEDIATION

Prior to the initiation of any legal proceedings, the parties to this Agreement agree to submit all claims, disputes or controversies arising out of or in relation to the interpretation, application or enforcement of this Agreement to non-binding mediation. Such mediation shall be conducted under the auspices of the American Arbitration Association or such other mediation service or mediator upon which the parties agree. The party seeking to initiate mediation shall do so by submitting a formal, written request to the other party to this Agreement. This section shall survive completion or termination of this Agreement, but under no circumstances shall either party call for mediation of any claim or dispute arising out of this Agreement after such period of time as would normally bar the initiation of legal proceedings to litigate such claim or dispute under the laws of the State of Massachusetts.

8.0 PURCHASE ORDERS

In the event the Client issues a purchase order or other instrument related to the Consultant's services, it is understood and agreed that such document is for the Client's internal accounting purposes only and shall in no way modify, add to, or delete any of the terms and conditions of this Agreement. If the Client does issue a purchase order or other similar instrument, it is understood and agreed that the Consultant shall indicate the purchase order number on the invoices sent to the Client.

9.0 SUBCONSULTANTS

Except as expressly agreed, the Client will directly retain other consultants whose services are required in connection with the Project. As a service, the Consultant will advise the Client with respect to selecting other consultants and will assist the Client in coordinating and monitoring the performance of other consultants. In no event will the Consultant assume any liability or responsibility for the work performed by other consultants, or for their failure to perform any work, regardless of whether the Consultant hires them directly or as subconsultants, or only coordinates and monitors their work. When the Consultant does engage a subconsultant on behalf of the Client, the expenses incurred, including rental of special equipment necessary for the work, will be billed as they are incurred, subject to an administrative markup of 15 percent or as specified in the rate table or billing terms in effect at the time the services are provided. By engaging the Consultant to perform services, the Client agrees to hold the Consultant, its directors, officers, employees, and other agents harmless against any claims, demands, costs, or judgments relating in any way to the performance or non-performance of work by another consultant or subconsultant, except claims for personal injury, death, or personal property damage caused by the negligence of the Consultant's employees.

10.0 INDEMNIFICATION

10.1 Client and Consultant each agree to indemnify and hold the other harmless, and their respective officers, employees, agents, and representatives from and against liability for all claims, losses, damages, and expenses, including reasonable attorneys' fees, to the extent such claims, losses, damages or expenses are caused by the indemnifying party's negligent acts, errors, or omissions. In the event claims, losses, damages, or expenses are caused by the joint or concurrent negligence of the Client and Consultant, they shall be borne by each party in proportion to its negligence.

10.2 The Consultant shall under no circumstances be considered the generator of any hazardous substances, pollutants or contaminants encountered or handled in the performance of the Consultant's services. In the event that the Consultant or any other party encounters asbestos or toxic materials at the job site which was previously unknown or had not been disclosed to Consultant, or should it become known that certain materials may be present at the job site or any adjacent areas that may affect the performance of the consultant's services, the Consultant may, at it's option and without liability for consequential or any other damages, suspend performance of service on the Project until the Client retains appropriate specialist consultants to identify, abate and/or remove the asbestos or hazardous or toxic material, and warrant that the job site is in full compliance with applicable laws and regulations with regard to said substances.

10.3 Neither party shall have liability for loss of product, loss of profit, loss of use, or any other indirect, incidental, special, or consequential damages incurred by the other party, whether brought as an action for breach of contract, breach of warranty, tort, or strict liability, and irrespective of whether caused or allegedly caused by either party's negligence and the Client agrees to defend, indemnify and hold the Consultant harmless with respect to any such claim. The Client and Consultant agree to require a similar provision in all contracts with contractors, subcontractors, subconsultants, vendors, and other entities involved in this Project to carry out the intent of this provision.

10.4 The Consultant and the Client agree that should the Consultant's services not include construction phase services, the Client shall be solely responsible for interpreting any contract documents and observing the work of the Contractor to discover, correct or mitigate errors, inconsistencies or omissions. If the Client authorizes deviations, recorded or unrecorded, from the documents prepared by the Consultant, the Client shall not bring any claim against the Consultant and shall indemnify and hold the Consultant, its agents and employees harmless from and against claims, losses, damages and expenses, including but not limited to defense costs and the time of the Consultant, to the extent such claim, loss, damage or expense arises out of or results in whole or in part from such deviations, regardless of whether or not such claim, loss, damage or expense is caused in part by a party indemnified under this provision.

10.5 In no event shall the indemnification obligation extend beyond the date when the institution of legal or equitable proceedings for professional negligence would be barred by an applicable statute of repose or statute of limitations.

11.0 LIMITATION OF LIABILITY

Notwithstanding any other provision of these General Terms and Conditions, and unless otherwise subject to a greater limitation, the Consultant's liability to the Client for any loss or damage, including, but not limited to, special and consequential damages, arising out of or in connection with the accompanying Proposal or any related Agreement from any cause, including the Consultant's professional negligent errors or omissions shall not exceed the greater of $50,000 or the total compensation received by the Consultant hereunder, and the Client hereby releases the Consultant from any liability above such amount.

12.0 STANDARD OF CARE

All services of the Consultant and its independent professional associates, consultants and subcontractors will be performed in a manner consistent with that degree of skill and care ordinarily exercised by practicing professionals performing similar services in the same locality, at the same site and under the same or similar circumstances and conditions. The Consultant makes no other warranties, express or implied, with respect to the services rendered hereunder.

If Consultants services include Connecticut Licensed Environmental Professional (LEP) verification or Massachusetts Licensed Site Professional (LSP) opinion, Client acknowledges that such services are subject to regulatory audit. In rendering an LEP verification or LSP opinion the Consultant is providing a professional opinion consistent with the standard of care for LEPs/LSPs in the industry; however, regulatory agencies may require response actions beyond those that were the basis for the LEP verification or LSP opinion. Services associated with such audits or response actions can be provided by consultant at an additional cost not included in the Agreement to be mutually agreed upon between Client and Consultant.

If LSP services are provided they will be rendered consistent with 309 CMR, the "Regulations of the Board of Registration of Hazardous Waste Site Cleanup Professionals." LSP Opinions will be provided with consideration of the assumptions, limitations and qualifications of the MCP (310 CMR 40.0000) and relevant final guidance and interpretation published by the Commonwealth of Massachusetts.

13.0 CHANGES OR DELAYS

Unless the accompanying Agreement/Proposal provides otherwise, the proposed fees constitute the Consultant's estimate to perform the services required to complete the Project, as the Consultant understands it to be defined. For those projects involving conceptual or process development work, activities often are not fully definable in the initial planning. In any event, as the project progresses, the facts developed may dictate a change in the services to be performed, which may alter the scope. The Consultant will inform the Client of such situations so that negotiation of change in scope and adjustment to the time of performance can be accomplished as required. If such change, additional services, or suspension of services results in an increase or decrease in the cost of or time required for performance of the services, whether or not changed by any order, an equitable adjustment shall be made and the Agreement modified accordingly.

Costs and schedule commitments shall be subject to renegotiation for unreasonable delays caused by the Client's failure to provide specified facilities or information, Client's failure to make payment in accordance with it's obligations under this contract, or for delays caused by unpredictable occurrences or force majeure, including but not limited to fires, floods, riots, strikes, unavailability of labor or materials, delays or defaults by suppliers of materials or services, process shutdown, acts of God or of the public enemy, or acts or regulations of any governmental agency. Temporary work stoppage caused by any of the above will result in additional cost (reflecting a change in scope) beyond that outlined the Agreement.

14.0 PAYMENT

Consultant shall typically invoice Client for services performed under this agreement on a monthly basis, and Client shall pay Consultant's invoices within thirty (30) days of receipt. Client agrees to bring to Consultant's attention in writing any questions regarding Consultant's invoice within ten (10) days of receipt. In the event that Client does not provide Consultant with written questions within ten (10) days, the invoice shall be deemed accurate and acceptable to Client. If Client fails to make any payment due the Consultant for services, expenses or other charges within thirty (30) days after receipt of the Consultant's statement therefore, the amounts due the Consultant will be increased at the rate of one and one half (1.5) percent per month from said thirtieth day, and in addition, the Consultant may, after giving a minimum of seven (7) days written notice to the Client, suspend services under this Agreement until the Consultant has been paid in full all amounts due for services, expenses and charges. Consultant may at its sole discretion also suspend services on any or all other projects being performed by Consultant for Client under any other agreements until Consultant has been paid in full for all amounts due for services, expenses and any other charges. The Client shall be responsible for the reasonable cost of collection including reasonable attorney's fees.

15.0 TERMINATION

The obligation to provide further services under this Agreement may be terminated by either party upon seven (7) days written notice in the event either party fails to substantially perform in accordance with the terms to this Agreement through no fault of the terminating party. In the event of any termination, the Consultant will be paid for all services rendered to the date of termination, all reimbursable expenses and termination expenses. Failure to make payments in accordance herewith shall constitute substantial nonperformance. This Agreement shall automatically terminate if payments are not brought current within seven (7) days of notice of termination.

16.0 CONTROLLING LAW

This Agreement is to be governed by the law of the State of Massachusetts.

17.0 SUBSURFACE INVESTIGATIONS

Client recognizes that special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing program, implemented with appropriate equipment and experienced personnel under the direction of a trained professional who functions in accordance with a professional standard of practice may fail to detect certain hidden conditions. The passage of time also must be considered, and the Client recognizes that due to natural occurrences or direct or indirect human intervention at the Site or distance from it, actual conditions may quickly change. Provided the Consultant uses reasonable care, the Consultant shall not be liable for such alteration or damage or for damage to, or interference with any subterranean structure, pipe, tank, cable, or other element or condition whose nature and location are not called to the Consultant's attention in writing before exploration commences.

18.0 LITIGATION AND ADDITIONAL WORK

In the event the Consultant is to prepare for or appear in any litigation on behalf of the Client or is to make investigations of reports on matters not covered by this Agreement, or is to perform other services not included herein, additional compensation shall be paid the Consultant, charges for which will be based upon Consultant's fee schedule at the time the additional services are performed.

19.0 INSURANCE

The Consultant will secure and maintain such insurance as will protect him from claims under the Workmen's Compensation Act and from claims for bodily injury, death or property damage which may arise from the performance of Consultant's services under this Agreement.

The Consultant will secure and maintain professional liability insurance for protection against claims arising out of the performance of professional services under this Agreement caused by negligent errors or omissions for which the Consultant is legally liable.

20.0 SALES TAX EXEMPTION CERTIFICATE

Client must provide the Consultant an exemption certificate within fifteen (15) days after the effective date of this Agreement for any exemptions claimed by the Client from the sales tax for any services performed or for any tangible personal property purchased under this Agreement. In the event that the Client fails to timely provide the Consultant with such an exemption certificate within such time, the Client shall be solely responsible for obtaining a refund for any and all sales tax collected or paid by the Consultant in connection with the performance of this Agreement before the Client provides the Consultant with such exemption certificate, including any sales tax paid by the Consultant to subcontractors, engineers, suppliers or any other individual entity.

21.0 PERIOD OF SERVICE

The Consultant shall proceed with the services under this Agreement promptly and will diligently and faithfully prosecute the work to completion.

22.0 NOTICE REQUIREMENTS

If Client alledges that it has discovered a negligent defect, fault, error, non-compliance or omission in Consultant's services, it shall give written notice to the Consultant within thirty (30) days. Notice shall include a detailed description of the nature of the alleged negligent defect, fault, error, non-compliance or omission. Client agrees that failure to give such notice shall result in Client's waiver of the claim. Additionally, Client agrees that failure to give such notice from the time it reasonably should have discovered any alleged defect, fault, error, non-compliance or omission in Consultant's services, and failed to give proper notice, shall result in Client's waiver of the claim.

23.0 PROPRIETARY RIGHTS OF CONSULTANT

Client acknowledges that Consultant has developed systems, processes, apparatus, analytical tools and methods which are proprietary to Consultant and which are used in its business. Such systems, processes, apparatus, analytical tools and methods (including software, patents, copyrights and other intellectual property), and all derivations, enhancements or modifications thereof made by Consultant including those as a result of work performed by Consultant hereunder, shall be and remain the property of Consultant.

EXHIBIT 43

Limited Hazardous Building Materials Inspection

Westport Middle School
400 Old County Road
Westport, MA

CGKV Architects, Inc.

Somerville, Massachusetts

May 25, 2011

FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill EnviroScience, LLC
50 Redfield Street, Suite 100
Boston, Massachusetts 02122

Project No. 20080788.A2E

FUSS & O'NEILL
EnviroScience, LLC

Disciplines to Deliver

May 25, 2011

Mr. Jason Knutson, AIA
Principal
CGKV Architects, Inc
97 Marion Street
Somerville, MA 02143

RE: Hazardous Materials Consulting Services
Westport Green Repairs Project – Westport Middle School
Fuss & O'Neill EnviroScience, LLC No. 20080788.A2E

Dear Mr. Knutson:

Enclosed is the report for the hazardous building materials inspection conducted at the Westport Middle School located at 400 Old County Road in Westport, Massachusetts.

The services were performed on May 11, 2011 by Fuss & O'Neill EnviroScience, LLC licensed inspectors and included asbestos and lead paint inspections and sampling for PCB's in caulking and sealants associated with window and door systems to be replaced. The information summarized in this document is for the above-mentioned materials only. The work was performed in accordance with our written proposal dated May 5, 2011.

If you have any questions regarding the contents of this report, please do not hesitate to contact Bob May at (617) 282-4675, extension 4701. Thank you for this opportunity to have served your environmental needs.

Sincerely,

Robert L. May, Jr.
Vice President

Stephen W. Connelly
Senior Vice President

RLM:adw

Enclosure

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South Carolina
Vermont

G:\P2008\0788\A2E\Deliverables\Reports\RLM_WestportMiddle_HazMatRpt_20110524.doc

CGKV12366

FUSS & O'NEILL
EnviroScience, LLC

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Hazardous Building Materials Inspection Report
Westport Middle School
CGKV Architects, Inc.

Appendices

FUSS & O'NEILL
EnviroScience, LLC

1 Introduction

Fuss & O'Neill EnviroScience, LLC (EnviroScience) representative, Jonathan Hand, performed a hazardous building material inspection at the Westport Middle School located at 400 Old County Road in Westport, Massachusetts. The inspection was performed on May 11, 2011. Refer to *Appendix A* for a copy of licenses.

The work was performed for CGKV Architects, Inc. in accordance with our written scope of services dated May5, 2011. Note the work included an inspection for asbestos containing materials (ACM), lead paint and PCB containing caulking and sealants associated with window and door systems scheduled for replacement. The building was constructed in 1969 and has no additions and windows and doors are original to the building and have not been replaced.

Samples to confirm results were sent for analysis of various substrates and confirmatory analysis was also performed utilizing Transmission Electron Microscopy (TEM) for results having no asbestos detected by Polarized Light Microscopy(PLM).

2 Asbestos Inspection

A property Owner must ensure that performance of a thorough inspection for Asbestos Containing Materials (ACM) prior to possible disturbance of materials containing asbestos during renovation or demolition is conducted. This is a requirement of the U.S. Environmental Protection Agency (USEPA), National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation 40 CFR Part 61, Sub-part M.

This includes friable, non-friable Category I and non-friable Category II ACM.

- A friable material is defined as material that contains greater than 1 percent asbestos, that when dry **can** be crumbled, pulverized or reduced to powder by hand pressure.
- A Category I Non-friable material refers to material that contains greater than 1 percent asbestos specifically packings, gaskets, resilient floor coverings and asphalt roofing products that when dry **can not** be crumbled, pulverized or reduced to powder by hand pressure.
- A Category II Non-friable material refers to any non-friable material excluding Category I materials that contains greater than 1 percent asbestos that when dry **can not** be crumbled, pulverized or reduced to powder by hand pressure.

Massachusetts Department of Environmental Protection (MADEP) further defines the definition of asbestos containing materials as any material containing 1 percent or more asbestos to be an ACM.

During this inspection, suspect Asbestos-Containing Materials (ACM) were separated into three USEPA categories. These categories are Thermal System Insulation (TSI), SURF ACM, and MISC ACM. TSI includes all materials used to prevent heat loss or gain or water condensation on mechanical systems. Examples of TSI are pipe insulation, boiler insulation, duct insulation, and mudded insulation on pipe fittings. Surfacing ACM includes all ACM that is sprayed, troweled, or otherwise applied to an existing surface. Surfacing ACM is commonly used for fireproofing, decorative, and acoustical applications. Miscellaneous materials include all ACM not listed as thermal or surfacing, such as linoleum, vinyl asbestos flooring, and ceiling tiles.

Samples are recommended to be collected in a manner sufficient to determine asbestos content and include homogenous building materials. The USEPA, NESHAP regulation does not specifically identify a minimum number of samples to be collected, however recommends the use of sampling protocols included in 40 CFR Part 763, Sub-Part E -Asbestos Containing Materials in Schools.

Samples of suspect asbestos containing materials were collected in accordance with United States Environmental Protection Agency (USEPA) recommendations and Asbestos Hazard Emergency Response Act (AHERA) protocols. The protocols included the following:

1. Surfacing Materials (SURF) such as plaster, spray-on fireproofing, etc. were collected in a randomly distributed manner representing each homogenous area based on the overall quantity represented by the sampling as follows:

    a. Three (3) samples collected from each homogenous area that is less than or equal to 1,000 square feet.
    b. Five (5) samples collected from each homogenous area that is greater than 1,000 square feet but less than or equal to 5,000 square feet.
    c. Seven (7) samples collected from each homogenous area that is greater than 5,000 square feet.

2. Thermal System Insulation (TSI) such as pipe insulation, tank insulation, etc. were collected in a randomly distributed manner representing each homogenous area. Three (3) samples collected from each material. Also, a minimum of one (1) sample of any patching materials applied to TSI presuming the patched area is less than 6 linear or square feet should be collected.

Miscellaneous Materials (MISC) such as floor tile, gaskets, construction mastics, etc. had a minimum of two (2) samples of each homogenous material type. Sampling was conducted in a manner sufficient to determine asbestos content of the homogenous material as determined by the inspector.

The Inspector collected samples and prepared proper chain of custody for transmission of samples to an accredited laboratory for analysis by Polarized Light Microscopy (PLM). Samples of all suspect ACM to be impacted by the renovations were collected. The EnviroScience sampling locations, material type, sample identification and asbestos content are identified by bulk sample analysis in Tables 1 and 2 of the "Results" section. Any materials on the site not listed in the following tables should be considered suspect ACM until sample results prove otherwise.

2.1 Results

Utilizing the USEPA protocol and criteria, the following materials were determined to be **ACM**:

TABLE 1
Positive Analytical Results for Suspect ACM

SAMPLE LOCATION	MATERIAL TYPE	SAMPLE NO.	ASBESTOS CONTENT
Room 264, Cafeteria and Room 124	Interior Window glazing Compound	0511JH-M-01A	2% Chrysotile
Doors to exterior near Room 122, Main Entrance and Door near Room 166	Interior Door caulking	0511JH-M-02A	2% Chrysotile

Utilizing the USEPA protocol and criteria, the following materials were determined not to contain asbestos for the representative samples collected.

TABLE 2
Negative Analytical Results for Suspect ACM

Sample Location	Material Type	Sample Number
Doors to exterior near Room 122, Main Entrance and Door near Room 166	Exterior Door Caulking	0511JH-M-03A-C*
Exterior Side C1 Window, Side A4 Window and B4 Window	Exterior Window Caulking	0511JH-M-04A-C*

*These samples are recommended to TEM analysis.

Refer to *Appendix B* for PLM Laboratory Analysis Results.

2.2 Discussion

The USEPA, Occupational Safety and Health Administration (OSHA), and the Commonwealth of Massachusetts Division of Occupational Safety (DOS) defines any material that contains greater than one percent (>1%) asbestos, utilizing PLM, as being an ACM. The Commonwealth of Massachusetts Department of Environmental Protection (DEP) defines any material that contain equal to or greater than one percent (1%) asbestos as being an ACM. Materials that are identified as "none detected" are specified as not containing asbestos. Friable materials that are identified as containing less than ten percent (<10%) asbestos, are recommended to be analyzed further utilizing the EPA 400 point-counting technique to verify asbestos content by the USEPA. A property owner may elect to presume the results are asbestos containing based on the initial PLM results without the additional analysis by the EPA 400 point-counting technique.

Additionally, the USEPA has suggested that materials that are non-friable organically bound materials such as mastic adhesives, etc are recommended for further confirmatory analysis utilizing Transmission Electron Microscopy (TEM). Two (2) of the collected samples were recommended to be analyzed by TEM. The results of TEM analysis are provided below in Table 3.

Table 3
Materials Analyzed By TEM

Sample Location	Material Type	SAMPLE NO.	ASBESTOS CONTENT
Doors to exterior near Room 122, Main Entrance and Door near Room 166	Exterior Door Caulking	0511JH-M-03A-C	None Detected
Exterior Side C1 Window, Side A4 Window and B4 Window	Exterior Window Caulking	0511JH-M-04A-C	1.3% Chrysotile

The results of confirmatory analysis by TEM did not identify asbestos at 1% or greater for one of the analyzed materials. The results confirm the prior PLM results and no further action is required associated with these materials. The result of sample analyzed of Exterior Window Caulking was determined to contain greater than 1% asbestos utilizing TEM. Refer to *Appendix C* for TEM Laboratory Analysis results.

Window systems associated with the building were sampled and the glazing compound associated with interior and exterior caulking of the windows were determined to contain asbestos. The interior caulking materials associated with metal door frames was also determined to contain asbestos.

Table 4 identifies the location, materials type and quantity of ACM identified during this inspection. Any suspect material not identified in this inspection should be presumed to contain asbestos. We have utilized the previous results and confirmatory sampling to generate the following scope and quantities of work associated with roofs. For consistency we have included the roofing systems based on the numbering of roofs by others.

TABLE 4
Materials Present Containing Asbestos

Location	Material	Estimated Quantity
All Windows	Interior Window glazing Compound	240
All doors to exterior	Interior Door caulking	9 double-door units, with transoms
All Windows	Exterior Window Caulking	240

LF = Linear Feet, SF = Square Feet, EA = Each

2.3 Conclusion

The materials determined to contain asbestos that will be impacted by any proposed renovation and selective demolition work must be abated by a licensed asbestos abatement contractor prior to disturbance in building demolition or renovation. This is a requirement of the Commonwealth of Massachusetts DOS, DEP and USEPA NESHAP standards for asbestos abatement. The window systems contain both glazing compound and exterior caulking which contains asbestos and will be impacted by the proposed window replacement project. In addition, the door caulking on interior side of door systems to the exterior contains asbestos. The window systems can be isolated to the building exterior and removed for proper disposal. Entrance door systems scheduled to be replaced can also be isolated to the exterior and caulking removed from the interior side of frame for proper disposal.

<u>Any suspect material encountered during renovation/demolition that is not identified in this report, as being non-ACM should be assumed to be ACM unless sample results prove otherwise.</u>

3 Lead-Based Paint Determination

A lead based paint determination was performed associated with window and door systems at the Westport Middle School located at 400 Old County Road in Westport, Massachusetts by Fuss & O'Neill EnviroScience, LLC representative, Jonathan Hand, on May 11 2011. An X-ray fluorescence (XRF) analyzer was used to perform the lead based paint determination. The testing was conducted in accordance with the protocol outlined in the attached document: "Testing Procedures and Equipment" in *Appendix D*.

A SciTec Map 4 Spectrum Analyzer, serial number 1275 was utilized for the lead based paint determination. The instrument was checked for proper calibration prior to each use as detailed by the manufacturer and the Performance Characteristic Sheet (PCS) developed for the instrument.

For the purpose of this lead based paint determination, only limited interior and exterior components representing the initial painting history of the building in the 1970's section where proposed work is to occur were tested. Of course, individual repainting efforts are not discoverable in such a limited program. Lead based paint issues involving properties that are not residential are regulated to a limited degree to worker protection involving paint disturbing work activities and waste disposal. Additionally, recent regulations involving Child Occupied Facilities where children under age 6 frequents, are required to follow Lead Safe Renovation requirements of the USEPA as adopted by the DOS in Massachusetts.

Worker protection is regulated by OSHA regulations. Lead safe work practices and required training, certification and licensure of Lead-Safe Renovation Contractors and Lead-Safe Renovator- Supervisors are regulated by DOS regulations 453 CMR 22.00. For worker protection, OSHA regulations involve air monitoring of workers to determine exposure levels when disturbing lead containing paint. A lead based paint determination can not determine a safe level of lead but is intended to provide guidance as to the locations of what are considered industry standards for lead in paint. Contractors may then better determine exposure of workers to air borne lead by understanding the different concentrations of lead paint on representative components and surfaces. Air monitoring can then be performed during activities that disturb paint on representative surfaces.

Lead safe work practices require use of specific containment and work procedures to be followed in residential and child occupied facilities built prior to 1978. Contractors must be licensed as Lead-Safe Renovation Contractor in accordance with DOS requirements and have a trained and certified Lead-Safe Renovator Supervisor (Supervisor) on the project at all times who has trained staff performing work disturbing lead paint. The Supervisor must ensure that the work practice requirements, cleaning and verification are performed for child occupied facilities in accordance with regulation 453 CMR 22.00. It should be noted that renovation work is not considered a de-leading activity for compliance purposes with the Lead Law. Compliance with the Lead Law for licensed day cares or residential properties in order to achieve compliance letters in accordance with Department of Health regulation 105 CMR 460.00 must be performed in strict conformance with the regulations. Since this site at Westport Middle School is NOT a child occupied facility, the above regulation with the exception of work protection & waste disposal does not apply.

The USEPA Resource Conservation and Recovery Act (RCRA) as well as DEP regulate disposal of lead containing waste. Waste materials containing lead that will be impacted during renovation or demolition and result in waste for disposal must be tested using the Toxicity Characteristic Leachate Procedure (TCLP) analysis if lead is determined to be present in non-residential buildings. A TCLP sample is a representative sample of the intended waste stream. The results are compared to the level of greater than 5.0 mg/L that is considered hazardous lead waste. If the result is below the established level the material is not considered hazardous and may be disposed of as normal construction debris. Samples of the matrix materials were not collected during this inspection based on findings of very low levels of lead paint, and fact that all tested matrices were metal.

A level of lead paint exceeding 1.0 milligrams of lead per square centimeter (mg/cm^2) is considered toxic or dangerous for compliance with standards. For purpose of this lead based paint determination the level of 1.0 mg/cm^2 has been utilized as a threshold for areas where possible worker exposures may occur and to determine necessary adherence during disturbance with Lead Safe Renovation requirements. The complete results of lead based paint determination are included in *Appendix E*.

3.1 Results

The lead based paint determination indicated consistent painting trends associated with representative window and door systems tested. No exterior painted components were determined to contain levels of lead (greater than 1.0 mg/cm^2).

No materials were found to contain lead paint at the time of this inspection.

3.2 Discussion

OSHA published a Lead in Construction Standard (OSHA Lead Standard) 29 CFR 1926.62 in May 1993. The OSHA Lead Standard has no set limit for the content of lead in paint below which the standards do not apply. The OSHA Lead Standards are task-based and are based on airborne exposure and blood lead levels.

The results of this survey are intended to provide guidance to contractors for occupational exposure control to lead. Building components containing lead levels above industry standards may cause exposures to lead above OSHA standards during proposed demolition and renovation activities.

3.3 Conclusion

Lead paint was not found on the representative surfaces tested during the determination. We understand that a current plan for the site will involve replacement of the window and door systems and no further action is required.

Disclaimer: *The information contained in the survey report concerning the presence or absence of lead paint does not constitute a comprehensive lead inspection in accordance with Commonwealth of Massachusetts regulations 105 CMR 460. The surfaces tested represent only a portion of those surfaces that would be tested to determine whether the premises are in compliance with the aforementioned regulations which are specific to a child occupied residence only and not applicable to a building of this type and use.*

4 Bulk Sample Analysis – Polychlorinated Biphenyls (PCBs)

4.1 Background

Sampling of building materials for polychlorinated biphenyls (PCBs) is presently not mandated by the USEPA. However, significant liability risk for improperly disposing of a PCB containing waste material exists. Recent knowledge and awareness of PCBs within matrices such as caulking, glazing compounds, paints, adhesives, and ceiling tiles has become more prevalent especially amongst remediation contractors, waste haulers, and disposal facilities.

Many property Owners have become subject to large changes in schedule, scope, and costs as a result of failure to identify these possible contaminants prior to renovation or demolition. We recommended this testing be performed based on plans for renovation at the site. This was due to the significant impact and potential requirements for planning required by the USEPA, which must be implemented if PCBs are identified at a project site.

The USEPA requirements apply, and require removal of PCB's once identified regardless of project intent as an unauthorized use of PCBs. In other words if buildings are to remain for re-use and PCBs are identified the USEPA still requires removal of PCB materials once it is determined that PCBs are present. In addition to identification of source materials containing

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PCBs, if PCBs are present at certain concentrations, additional testing of adjacent surfaces in contact with PCB sources, or which may have been contaminated from a source of PCBs such as soil, must also be performed or remediated.

USEPA requirements apply only if PCBs are present in concentrations above a specified level. Presently materials containing PCBs at concentrations equal to or greater than (≥) 50 parts per million (ppm) or equivalent units of milligrams per kilogram (mg/kg) are regulated. Note materials containing less than (<) 50 ppm may also be regulated unless proven to be an "Excluded PCB Product". The definition of an Excluded PCB Product includes those products or source of the products containing <50 ppm concentration PCBs that were legally manufactured, processed, distributed in commerce, or used before October 1, 1984.

4.2 Bulk Sampling of Source Materials

On May 11, 2011, EnviroScience's representative, Jonathan Hand, collected twelve (12) bulk samples of building materials to be analyzed for PCBs. Sampling involved removal of bulk product materials (source materials), such as window and door caulking and glazing compounds, using hand tools to submit in bulk form to determine PCB content. Tools utilized to collect samples were disposable items and discarded after each individual sample was collected to avoid cross contamination of samples. Each sample was placed in an individual container, labeled, and delivered to laboratory using proper chain of custody. Samples were analyzed at Con-Test Analytical Laboratories located in East Longmeadow, MA. Samples were analyzed using EPA Method 3500B/3540C (Soxhlet Region 1) for extraction and analysis of samples using EPA Method 8082. Refer to Table 5 for analytical results of all PCB bulk samples.

The USEPA regulates materials containing ≥ 50 ppm. However, if PCBs greater than 1 ppm are present in a material, it must be demonstrated (proven) that the materials containing < 50 ppm PCBs are an "Excluded PCB Product", which for this circumstance would be a product legally manufactured or used prior to October 1, 1984.

4.3 Results

The following table identifies the collected samples by location, material type, and sample number, results are pending.

TABLE 5
Sampling and Analysis Results Table for PCB Bulk Samples

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Room 264 (C1, C2),	Interior Window glazing Compound	511JH-C1A	76 (Aroclor 1254)
Cafeteria (B7, C3, C7)	Interior Window glazing Compound	511JH-C1B	80 (Aroclor 1254)
Room 124 (B2, B3)	Interior Window glazing Compound	511JH-C1C	16 (Aroclor 1254)

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SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Doors to exterior near Room 122	Interior Door caulking	0511JH-C2A	1,500 (Aroclor 1254)
Doors to exterior Main Entrance	Interior Door caulking	0511JH-C2B	19 (Aroclor 1254)
Doors to exterior near Room 166	Interior Door caulking	0511JH-C2C	1,200 (Aroclor 1254)
Doors to exterior near Room 122	Exterior Door caulking	0511JH-C3A	180,000 (Aroclor 1254)
Doors to exterior Main Entrance	Exterior Door caulking	0511JH-C3B	110 (Aroclor 1254)
Doors to exterior near Room 166	Exterior Door caulking	0511JH-C3C	240,000 (Aroclor 1254)
Exterior Side C1, C4 Window	Exterior Window Caulking	0511JH-C4A	270,000 (Aroclor 1254)
Exterior Side A1, A4 Window	Exterior Window Caulking	0511JH-C4B	190,000 (Aroclor 1254)
Exterior Side B4, B7 Window	Exterior Window Caulking	0511JH-C4C	270,000 (Aroclor 1254)

The materials sampled were determined to contain PCBs at regulated concentrations based on the limited representative samples collected. Refer to *Appendix F* for Laboratory analysis results.

4.4 Conclusions

EnviroScience performed testing for PCBs and the results did identify PCBs at concentrations above EPA threshold of 50 ppm. The results with the exception of two of the twelve samples collected exceeded 50 ppm. It should be noted that the two results containing less than 50 ppm are likely a result of maintenance activity which could have removed original caulking or glazing compound containing greater than 50 ppm as PCBs were present in both materials but < 50 ppm. Therefore an "exclusion" is not likely to exist for these materials and all window and door systems should be included in proposed remediation plan.

The results indicate both interior and exterior materials associated with windows and door systems contain PCBs. The firs step prior to development of a scope of required remediation work is to characterize adjacent surfaces. This will include conducting sampling of adjacent masonry, soil and dust associated with the site.

Since a present regulated source of PCBs exists based on results for interior window glazing compounds, interior door caulking, exterior door caulking and exterior window caulking, EPA requires a determination of potential contamination as an evaluation of potential remediation wastes. The present results require sampling of the following surfaces to determine extent of PCB contamination of adjacent surfaces:

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- adjacent masonry surfaces at interior side of door systems
- adjacent masonry surfaces at exterior side of door systems
- adjacent masonry surfaces at exterior side of window systems
- asphalt and concrete sidewalks adjacent to doors
- exterior soil
- collection of wipe samples on interior window sills and floors

A schedule and sequence of sampling will be determined with the school that best supports decision making for the project as well as health and safety of staff and students. We understand that the intent is to potentially begin work in 2011 and we are not presently anticipating performance of air sampling at this time. If air sampling is requested or the schedule of work will go beyond 2011 we may recommend air sampling to be consistent with current EPA suggested guidance for schools

The costs for conducting the above mentioned testing and development of plans for submission to EPA will be required and are beyond the scope of the current proposal for services. We can provide supplemental scope and fee in a proposal for work.

Reviewed by:

Robert L. May, Jr.
Vice President

Stephen W. Connelly
Senior Vice President

RLM:adw

FUSS & O'NEILL EnviroScience, LLC

Appendix A

Inspector Licenses and Certifications

Commonwealth of Massachusetts

Division of Occupational Safety

Heather E. Rowe, Acting Commissioner

Asbestos Inspector

JONATHAN L. HAND

Eff. Date 03/09/11

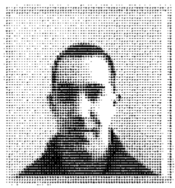
Exp. Date 03/07/12

AI041945

Member of C.O.N.E.S.

HV

12



HV - RENEW

Fuss & O'Neill EnviroScience, LLC.

146 Hartford Road, Manchester, CT 06040 – (860) 646-2469

This is to certify that

Jonathan Hand

xxx-xx-8836

has successfully completed the

4 Hr. Asbestos Inspector Refresher

Asbestos Accreditation under TSCA Title II

40 CFR Part 763

Robert L. May, Jr., Principal Instructor

Kevin Miller, Training Manager

January 4, 2011
Date of Course

AI-R-01/11-9
Certificate Number

January 4, 2011; A+
Examination Date & Grade

January 4, 2012
Expiration Date

CERTIFICATE OF ACHIEVEMENT

This certifies that

Jonathan Hand

has successfully completed the

24 Hour Asbestos Site Inspector Training
Asbestos Accreditation Under TSCA Title II
40 CFR Part 763
conducted by

ATC Associates Inc.
73 William Franks Drive
West Springfield, MA 01089
(413) 781-0070

Official record of successful completion of this Course is the DOH2832 Certificate issued on January 9, 2008.

Principal Instructor

January 7-9, 2008
Date of Course

January 9, 2009
Expiration Date

Regional Manager

SI-1359
Certificate Number

January 9, 2008
Examination Date

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Appendix B

Asbestos PLM Sample Results and Chain of Custody

EMSL Analytical, Inc.
307 West 38th Street, New York, NY 10018
Phone: (212) 290-0051 Fax: (212) 290-0058 Email: manhattanlab@emsl.com

Attn: **Bob May**
Fuss & O' Neill EnviroScience, LLC
146 Hartford Road
Manchester, CT 06040

Fax: (860) 812-2228 Phone: (860) 646-2469
Project: **20080788.A2E/ WESTPORT MIDDLE SCHOOL-CGKV/ WESTPORT MIDDLE SCHOOL**

Customer ID: ENVI54
Customer PO:
Received: 05/16/11 9:21 AM
EMSL Order: 031114076
EMSL Proj:
Analysis Date: 5/17/2011

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos % Fibrous	Non-Asbestos % Non-Fibrous	Asbestos % Type
511JH-M-01A *031114076-0001*	ROOM 264 - WINDOW GLAZING COMPOUND	Gray Non-Fibrous Heterogeneous		98% Non-fibrous (other)	**2% Chrysotile**
511JH-M-01B *031114076-0002*	CAFETERIA - WINDOW GLAZING COMPOUND				**Stop Positive (Not Analyzed)**
511JH-M-01C *031114076-0003*	ROOM 124 - WINDOW GLAZING COMPOUND				**Stop Positive (Not Analyzed)**
511JH-M-02A *031114076-0004*	EXTERIOR DOOR NEAR 122 - INTERIOR DOOR CAULK	Black Non-Fibrous Heterogeneous	5% Fibrous (other) 10% Cellulose	83% Non-fibrous (other)	**2% Chrysotile**
511JH-M-02B *031114076-0005*	MAIN ENTRANCE - INTERIOR DOOR CAULK				**Stop Positive (Not Analyzed)**
511JH-M-02C *031114076-0006*	EXTERIOR DOOR NEAR 166 - INTERIOR DOOR CAULK				**Stop Positive (Not Analyzed)**

Initial report from 05/18/2011 00:11:03

Analyst(s)

Jessica Cox (8)

James Hall, Laboratory Manager
or other approved signatory

EMSL Analytical, Inc.
307 West 38th Street, New York, NY 10018
Phone: (212) 290-0051 Fax: (212) 290-0058 Email: manhattanlab@emsl.com

Attn: **Bob May**
Fuss & O' Neill EnviroScience, LLC
146 Hartford Road
Manchester, CT 06040

Fax: (860) 812-2228 Phone: (860) 646-2469
Project: **20080788.A2E/ WESTPORT MIDDLE SCHOOL-CGKV/ WESTPORT MIDDLE SCHOOL**

Customer ID: ENVI54
Customer PO:
Received: 05/16/11 9:21 AM
EMSL Order: 031114076
EMSL Proj:
Analysis Date: 5/17/2011

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos % Fibrous	Non-Asbestos % Non-Fibrous	Asbestos % Type
511JH-M-03A *031114076-0007*	EXTERIOR DOOR NEAR 122 - EXTERIOR DOOR CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
511JH-M-03B *031114076-0008*	MAIN ENTRANCE - EXTERIOR DOOR CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
511JH-M-03C *031114076-0009*	EXTERIOR DOOR NEAR 166 - EXTERIOR DOOR CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
511JH-M-04A *031114076-0010*	C1 WINDOW - EXTERIOR WINDOW CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
511JH-M-04B *031114076-0011*	A4 WINDOW - EXTERIOR WINDOW CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
511JH-M-04C *031114076-0012*	B4 WINDOW - EXTERIOR WINDOW CAULK	Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**

Initial report from 05/18/2011 00:11:03

Analyst(s)

Jessica Cox (8)

James Hall, Laboratory Manager
or other approved signatory

031114076

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EnviroScience, LLC

031114076

www.fando.com

50 Redfield Street, Suite 100 Boston, MA 02122 (617) 282-4675 Fax: (617) 282-8253

SAMPLE LOG FOR ASBESTOS BULKS

Sheet 1 of 2

Project Name: Westport Middle School - CGKV Project No. 20080788.42E

Building: Westport Middle School Project Manager: Bob May

Sample ID	Sample Location	Material	Result (%)
511 JH-M-01A	Room 264	window glazing compound	2% Chrysotile
-01B	Cafeteria		—
-01C	Room 124	↓	—
-02A	Exterior Door near 122	Interior Door caulk	2% chrysotile
-02B	Main Entrance		—
-02C	Exterior Door near 166	↓	—
-03A	Exterior Door near 122	Exterior Door Caulk	none
-03B	Main Entrance		
-03C	Exterior Door near 166	↓	↓
-04A	C1 window	Exterior window caulk	none
-04B	A4 window	↓	↓

TCM Reported 5/20

Analysis Method: ☒ PLM ☐ Other ______ Turnaround Time 48 hr

Based on the turnaround time indicated above, analyses are due to EnviroScience on or before this date: ______ Please call the EnviroScience Laboratory at (860) 953-2700 if analyses will be late.

Fax Results To: EnviroScience Consultants, Inc. Laboratory at 413-647-0018

Special Instructions: Stop at first positive in each set. Do not point count.

Samples Collected By: JH Date: 5/11/11 Time: PM

Samples [Rec'd][Sent By]: [ ] [ ] Date: [ ] [5/13/11] Time: [ ] [ ]

Samples Received By: [signature] Date: 5/16/11 Time: 9:21am

Shipped To: ☒ EMSL (State) NY ☐ Other ______

Method of Shipment: ☒ Fed Ex ☐ UPS Overnight ☐ UPS Ground ☐ Other ______

Y:\Admin\FORMS\Asbestos Bulks Chain of Custody-Boston rev 0407.doc

031114076

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EnviroScience, LLC

03114076

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SAMPLE LOG FOR ASBESTOS BULKS

Sheet 2 of 2

Project Name: Westport Middle School -CGKV Project No. 20080788.A2E

Building: Westport Middle School Project Manager: Bob May

Sample ID	Sample Location	Material	Result (%)
-04C	B4 window	↓	none

Analysis Method: ☒ PLM ☐ Other ____ Turnaround Time 48 hr

Based on the turnaround time indicated above, analyses are due to EnviroScience on or before this date: ____. Please call the EnviroScience Laboratory at (860) 953-2700 if analyses will be late.

Fax Results To: EnviroScience Consultants, Inc. Laboratory at 413-647-0018

Special Instructions: Stop at first positive in each set. Do not point count.

Samples Collected By: JH Date: 5/11/11 Time: PM

Samples [Rec'd][Sent By]: [ ][ ] Date: [ ][5/13/11] Time: [ ][ ]

Samples Received By: [signature] Date: 5/16/11 Time: 9:21am

Shipped To: ☒ EMSL (State) NY ☐ Other ____

Method of Shipment: ☒ Fed Ex ☐ UPS Overnight ☐ UPS Ground ☐ Other ____

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Appendix C

Asbestos TEM Sample Results and Chain of Custody

EMSL Analytical, Inc.
307 West 38th Street, New York, NY 10018
Phone: (212) 290-0051 Fax: (212) 290-0058 Email: manhattanlab@emsl.com

Attn: **Bob May**
Fuss & O' Neill EnviroScience, LLC
146 Hartford Road
Manchester, CT 06040

Fax: (860) 812-2228 Phone: (860) 646-2469
Project: **20080788.A2E/ WESTPORT MIDDLE SCHOOL-CGKV/ WESTPORT MIDDLE SCHOOL**

Customer ID: ENVI54
Customer PO:
Received: 05/16/11 9:21 AM
EMSL Order: 031114076
EMSL Proj:
Analysis Date: 5/22/2011

Test Report: Asbestos Analysis of Bulk Materials via Transmission Electron Microscopy. Chatfield Method (rev 2)

SAMPLE ID	COLOR	APPROX. MATRIX MATERIAL	NON-ASBESTOS FIBERS	RANGE	ASBESTOS TYPE	AVG
511JH-M-03A *031114076-0007*	Black	100.0%	ND		ND	
511JH-M-04A *031114076-0010*	Black	98.7%		1.2-1.5%	Chrysotile	1.3%

Initial report from 05/18/2011 00:11:03

Analyst(s)
David Z. Chen (2)

James Hall, Laboratory Manager
or other approved signatory

THIS IS THE LAST PAGE OF THE REPORT.

03114076

As per Bob please analyze samples 3A ? 4A Tem chatfield 03114076 48hr TAT 5/20 @ 2pm (8)

FUSS & O'NEILL EnviroScience, LLC

www.fando.com

50 Redfield Street, Suite 100 Boston, MA 02122 (617) 282-4675 Fax: (617) 282-8253

SAMPLE LOG FOR ASBESTOS BULKS

Sheet 1 of 2

Project Name: Westport Middle School - CGKV Project No. 20080788.42E

Building: Westport Middle School Project Manager: Bob May

Sample ID	Sample Location	Material	Result (%)
511 JH-M-01A	Room 264	window glazing compound	
-01B	Cafeteria	↓	
-01C	Room 124		
-02A	Exterior Door near 122	Interior Door caulk	
-02B	Main Entrance	↓	
-02C	Exterior Door near 166		
-03A	Exterior Door near 122	Exterior Door Caulk	
-03B	Main Entrance	↓	
-03C	Exterior Door near 166		
-04A	C1 window	Exterior window caulk	
-04B	A4 window	↓	

Analysis Method: ☒ PLM ☐ Other ____ Turnaround Time 48 hr

Based on the turnaround time indicated above, analyses are due to EnviroScience on or before this date: ____ Please call the EnviroScience Laboratory at (860) 953-2700 if analyses will be late.

Fax Results To: EnviroScience Consultants, Inc. Laboratory at 413-647-0018

Special Instructions: Stop at first positive in each set. Do not point count.

Samples Collected By: JH Date: 5/11/11 Time: PM

Samples [Rec'd][Sent By]: [ ][ ] Date: [ ][5/13/11] Time: [ ][ ]

Samples Received By: [signature] Date: 5/16/11 Time: 9:21 am

Shipped To: ☒ EMSL (State) NY ☐ Other

Method of Shipment: ☒ Fed Ex ☐ UPS Overnight ☐ UPS Ground ☐ Other

Y:\Admin\FORMS\Asbestos Bulks Chain of Custody-Boston rev 0407.doc

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Appendix D

Lead Testing Equipment and Procedures

STANDARD OPERATING PROCEDURES
TESTING PROCEDURES AND EQUIPMENT
(Commonwealth of Massachusetts)

Massachusetts General Laws (M.G.L.) c. III, §190-199A 105CMR 460 with reference to lead based paint testing were consulted for this inspection. This regulation is administered by the Massachusetts Department of Public Health's Lead Poisoning Prevention Program. EnviroScience inspectors are licensed by the Commonwealth under this regulation.

This lead evaluation was either comprehensive or a determination. Both the proposed scope of work and the final report will note which type of evaluation was done. A comprehensive inspection means that representative painted surfaces were systematically evaluated on a room by room basis in accordance with the above referenced Massachusetts regulations.

A lead determination, means that only a few surfaces were tested and that conclusions about untested areas cannot be reliably determined based on the limited testing that was done. A disclaimer will be employed in the report to note that the lead evaluation done is not in complete accordance with the testing protocol in the Massachusetts lead regulations.

Lead-based paint surfaces and components were identified by utilizing on-site x-ray fluorescence (XRF) instruments. EnviroScience Consultants, Inc. owns and maintains two different types of XRFs for testing for lead-based paint. These instruments are four (4) Radiation Monitoring Device LPA-1s (RMD) and a Scitec MAP 4 analyzer. Each of these instruments is operated in accordance with state and federal and manufacturer standards on the use of the instruments.

The federal government has developed Performance Characteristic Sheets (PCS) for each of the types of instruments cited above. Each instrument must be calibrated in accordance with these PCSs on a 1.0 milligram lead standard. Each of EnviroScience's instruments has one of these standards assigned to it. Some of the standards were purchased directly from the government and the others from the manufacturers of the instruments.

Readings (corrected for a substrate contribution, if applicable) of 1.0 mg/cm^2 or greater are considered to be dangerous levels of lead which must be abated (or in the case of certain metal components, just rendered intact) if a child under the age of six years has access to them and they are either on a defective surface, a chewable surface or a movable/impact surface on window components.

Prior to the start of any testing, a sketch of the building is drawn, and side designations are given to help identify exactly where readings were taken. Drawings depicting the room numbering scheme are located on the cover page(s) for the building(s) inspected. Each side of the building was labeled A, B, C or D. The "A" side of the unit is the side of primary entrance into a dwelling, and this room is always Room 1. Areas in the units include rooms, hallways and closets. Areas are numbered in a clockwise fashion as building construction allows. This allows the inspector to indicate which substrate surface was tested. The type of hazard (if present) is described by circling the acronym on the testing form.

When more than one surface type was present on a side, the component tested was indicated with a number. If two windows were present on a building side, they were numbered left to right. Closet shelves and shelf supports were numbered top to bottom.

It is understood that the room layouts presented in the report are in conformance with the conditions that exist at the time the testing is performed. EnviroScience avoids labeling a room solely by its current functional use (i.e., living room, bedroom, etc.) since this use can change over time. Similarly, room layouts can change dramatically as dwellings are renovated and additions are built, incorporating existing rooms, or existing interior walls are moved or eliminated altogether.

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September 2002

FUSS & O'NEILL
EnviroScience, LLC

Appendix E

Lead Testing Data Sheets

FUSS & O'NEILL EnviroScience, LLC

Project # __________ Address Westport Middle School Date 5/11/11

Room	Side	Surface	Pb by XRF	Defective	Substrate*
Main Door	A	Door	-.07		M
		+ Frame	-.25		M
	ABCD	window components	-.28		M
	BCD	Door + Frame	-.10		M

*P=Plaster S=Gypsum Wallboard (sheetrock) L=Lead Containing Alloy (No Coating) M=Metal A=Alumimum W=Wood V=Vinyl

Page ____ of ____

FUSS & O'NEILL EnviroScience, LLC

Appendix F

PCB Sample Results and Chain of Custody

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ANALYTICAL LABORATORY

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

May 20, 2011

Bob May
Fuss & O'Neill EnviroScience, LLC - MA
50 Redfield Street, Suite 100
Boston, MA 02122

Project Location: Westport Middle School, Westport, MA
Client Job Number:
Project Number: 20080788.A2E
Laboratory Work Order Number: 11E0454

Enclosed are results of analyses for samples received by the laboratory on May 13, 2011. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Holly L. Folsom

Holly L. Folsom
Project Manager

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ANALYTICAL LABORATORY

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

REPORT DATE: 5/20/2011

Fuss & O'Neill EnviroScience, LLC - MA
50 Redfield Street, Suite 100
Boston, MA 02122
ATTN: Bob May

PURCHASE ORDER NUMBER: 20080788.A2E

PROJECT NUMBER: 20080788.A2E

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 11E0454

The results of analyses performed on the following samples submitted to the CON-TEST Analytical Laboratory are found in this report.

PROJECT LOCATION: Westport Middle School, Westport, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
512JH-C1A	11E0454-01	Caulk	Int win glaze 264 C1 & 2	SW-846 8082	
512JH-C1B	11E0454-02	Caulk	cafe B7, C3 & 7	SW-846 8082	
512JH-C1C	11E0454-03	Caulk	124 B2 & 3	SW-846 8082	
512JH-C2A	11E0454-04	Caulk	Int door caulk near 122	SW-846 8082	
512JH-C2B	11E0454-05	Caulk	Main	SW-846 8082	
512JH-C2C	11E0454-06	Caulk	Near 166	SW-846 8082	
512JH-C3A	11E0454-07	Caulk	Ext door caulk near 122	SW-846 8082	
512JH-C3B	11E0454-08	Caulk	Main	SW-846 8082	
512JH-C3C	11E0454-09	Caulk	Near 166	SW-846 8082	
512JH-C4A	11E0454-10	Caulk	Ext win caulk C1 & C4	SW-846 8082	
512JH-C4B	11E0454-11	Caulk	Ext win caulk A1 & A4	SW-846 8082	
512JH-C4C	11E0454-12	Caulk	B4 & B7	SW-846 8082	

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

SW-846 8082

Qualifications:

The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.

Analyte & Samples(s) Qualified:

Decachlorobiphenyl, Decachlorobiphenyl [2C], Tetrachloro-m-xylene, Tetrachloro-m-xylene [2C]

11E0454-04[512JH-C2A], 11E0454-06[512JH-C2C], 11E0454-07[512JH-C3A], 11E0454-08[512JH-C3B], 11E0454-09[512JH-C3C], 11E0454-10[512JH-C4A], 11E0454-11[512JH-C4B], 11E0454-12[512JH-C4C]

The results of analyses reported only relate to samples submitted to the Con-Test Analytical Laboratory for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Daren J. Damboragian
Laboratory Manager

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ANALYTICAL LABORATORY

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: Int win glaze 264 C1 & 2   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C1A   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-01

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1221 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1232 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1242 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1248 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1254 [2]	76	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1260 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1262 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB
Aroclor-1268 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 5:53	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	122	30-150		5/20/11 5:53
Decachlorobiphenyl [2]	103	30-150		5/20/11 5:53
Tetrachloro-m-xylene [1]	106	30-150		5/20/11 5:53
Tetrachloro-m-xylene [2]	98.9	30-150		5/20/11 5:53

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: cafe B7, C3 & 7   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C1B   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-02

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1221 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1232 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1242 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1248 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1254 [2]	80	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1260 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1262 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB
Aroclor-1268 [1]	ND	3.5	mg/Kg	20		SW-846 8082	5/13/11	5/20/11 6:07	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	125	30-150		5/20/11 6:07
Decachlorobiphenyl [2]	105	30-150		5/20/11 6:07
Tetrachloro-m-xylene [1]	111	30-150		5/20/11 6:07
Tetrachloro-m-xylene [2]	105	30-150		5/20/11 6:07

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: 124 B2 & 3   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C1C   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-03

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1221 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1232 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1242 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1248 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1254 [2]	16	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1260 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1262 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB
Aroclor-1268 [1]	ND	1.9	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:04	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	93.0	30-150		5/19/11 23:04
Decachlorobiphenyl [2]	90.6	30-150		5/19/11 23:04
Tetrachloro-m-xylene [1]	107	30-150		5/19/11 23:04
Tetrachloro-m-xylene [2]	97.5	30-150		5/19/11 23:04

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: Int door caulk near 122   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C2A   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-04

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1221 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1232 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1242 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1248 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1254 [2]	1500	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1260 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1262 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB
Aroclor-1268 [1]	ND	190	mg/Kg	1000		SW-846 8082	5/13/11	5/19/11 23:19	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/19/11 23:19
Decachlorobiphenyl [2]	*	30-150	S-01	5/19/11 23:19
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/19/11 23:19
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/19/11 23:19

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor Sample Description: Main Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C2B Sampled: 5/11/2011 00:00

Sample ID: 11E0454-05

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1221 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1232 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1242 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1248 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1254 [1]	19	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1260 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1262 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB
Aroclor-1268 [1]	ND	1.8	mg/Kg	10		SW-846 8082	5/13/11	5/19/11 23:33	JMB

Surrogates	% Recovery	Recovery Limits	Flag	
Decachlorobiphenyl [1]	97.4	30-150		5/19/11 23:33
Decachlorobiphenyl [2]	89.5	30-150		5/19/11 23:33
Tetrachloro-m-xylene [1]	93.7	30-150		5/19/11 23:33
Tetrachloro-m-xylene [2]	82.3	30-150		5/19/11 23:33

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: Near 166   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C2C   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-06

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1221 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1232 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1242 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1248 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1254 [2]	1200	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1260 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1262 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB
Aroclor-1268 [1]	ND	91	mg/Kg	500		SW-846 8082	5/13/11	5/20/11 6:22	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 6:22
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 6:22
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 6:22
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 6:22

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: Ext door caulk near 122   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C3A   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-07

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1221 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1232 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1242 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1248 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1254 [2]	180000	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1260 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1262 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB
Aroclor-1268 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:02	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 0:02
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 0:02
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 0:02
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 0:02

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor Sample Description: Main Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C3B Sampled: 5/11/2011 00:00

Sample ID: 11E0454-08

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1221 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1232 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1242 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1248 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1254 [2]	110	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1260 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1262 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB
Aroclor-1268 [1]	ND	9.9	mg/Kg	50		SW-846 8082	5/13/11	5/20/11 0:16	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 0:16
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 0:16
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 0:16
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 0:16

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor | Sample Description: Near 166 | Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C3C | Sampled: 5/11/2011 00:00

Sample ID: 11E0454-09

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1221 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1232 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1242 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1248 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1254 [2]	240000	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1260 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1262 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB
Aroclor-1268 [1]	ND	17000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:30	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 0:30
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 0:30
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 0:30
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 0:30

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor Sample Description: Ext win caulk C1 & C4 Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C4A Sampled: 5/11/2011 00:00

Sample ID: 11E0454-10

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1221 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1232 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1242 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1248 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1254 [2]	270000	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1260 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1262 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB
Aroclor-1268 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:45	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 0:45
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 0:45
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 0:45
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 0:45

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: Ext win caulk A1 & A4   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C4B   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-11

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1221 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1232 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1242 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1248 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59.	JMB
Aroclor-1254 [2]	190000	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1260 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1262 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB
Aroclor-1268 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 0:59	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 0:59
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 0:59
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 0:59
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 0:59

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Westport Middle School, Westpor   Sample Description: B4 & B7   Work Order: 11E0454

Date Received: 5/13/2011

Field Sample #: 512JH-C4C   Sampled: 5/11/2011 00:00

Sample ID: 11E0454-12

Sample Matrix: Caulk

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1221 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1232 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1242 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1248 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1254 [2]	230000	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1260 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1262 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB
Aroclor-1268 [1]	ND	18000	mg/Kg	100000		SW-846 8082	5/13/11	5/20/11 1:13	JMB

Surrogates	% Recovery	Recovery Limits	Flag	Date/Time Analyzed
Decachlorobiphenyl [1]	*	30-150	S-01	5/20/11 1:13
Decachlorobiphenyl [2]	*	30-150	S-01	5/20/11 1:13
Tetrachloro-m-xylene [1]	*	30-150	S-01	5/20/11 1:13
Tetrachloro-m-xylene [2]	*	30-150	S-01	5/20/11 1:13

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Sample Extraction Data

Prep Method: SW-846 3540C-SW-846 8082

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
11E0454-01 [512JH-C1A]	B030498	0.572	10.0	05/13/11
11E0454-02 [512JH-C1B]	B030498	0.574	10.0	05/13/11
11E0454-03 [512JH-C1C]	B030498	0.537	10.0	05/13/11
11E0454-04 [512JH-C2A]	B030498	0.535	10.0	05/13/11
11E0454-05 [512JH-C2B]	B030498	0.544	10.0	05/13/11
11E0454-06 [512JH-C2C]	B030498	0.550	10.0	05/13/11
11E0454-07 [512JH-C3A]	B030498	0.565	10.0	05/13/11
11E0454-08 [512JH-C3B]	B030498	0.507	10.0	05/13/11
11E0454-09 [512JH-C3C]	B030498	0.597	10.0	05/13/11
11E0454-10 [512JH-C4A]	B030498	0.559	10.0	05/13/11
11E0454-11 [512JH-C4B]	B030498	0.554	10.0	05/13/11
11E0454-12 [512JH-C4C]	B030498	0.541	10.0	05/13/11

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B030498 - SW-846 3540C										
Blank (B030498-BLK1)				Prepared: 05/13/11 Analyzed: 05/19/11						
Aroclor-1016	ND	0.20	mg/Kg							
Aroclor-1016 [2C]	ND	0.20	mg/Kg							
Aroclor-1221	ND	0.20	mg/Kg							
Aroclor-1221 [2C]	ND	0.20	mg/Kg							
Aroclor-1232	ND	0.20	mg/Kg							
Aroclor-1232 [2C]	ND	0.20	mg/Kg							
Aroclor-1242	ND	0.20	mg/Kg							
Aroclor-1242 [2C]	ND	0.20	mg/Kg							
Aroclor-1248	ND	0.20	mg/Kg							
Aroclor-1248 [2C]	ND	0.20	mg/Kg							
Aroclor-1254	ND	0.20	mg/Kg							
Aroclor-1254 [2C]	ND	0.20	mg/Kg							
Aroclor-1260	ND	0.20	mg/Kg							
Aroclor-1260 [2C]	ND	0.20	mg/Kg							
Aroclor-1262	ND	0.20	mg/Kg							
Aroclor-1262 [2C]	ND	0.20	mg/Kg							
Aroclor-1268	ND	0.20	mg/Kg							
Aroclor-1268 [2C]	ND	0.20	mg/Kg							
Surrogate: Decachlorobiphenyl	*3.68*		mg/Kg	4.00		92.1	30-150			
Surrogate: Decachlorobiphenyl [2C]	*3.64*		mg/Kg	4.00		91.1	30-150			
Surrogate: Tetrachloro-m-xylene	*3.93*		mg/Kg	4.00		98.4	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*3.78*		mg/Kg	4.00		94.5	30-150			
LCS (B030498-BS1)				Prepared: 05/13/11 Analyzed: 05/19/11						
Aroclor-1016	1.0	0.20	mg/Kg	1.00		105	40-140			
Aroclor-1016 [2C]	1.3	0.20	mg/Kg	1.00		127	40-140			
Aroclor-1260	1.2	0.20	mg/Kg	1.00		117	40-140			
Aroclor-1260 [2C]	1.2	0.20	mg/Kg	1.00		117	40-140			
Surrogate: Decachlorobiphenyl	*3.77*		mg/Kg	4.00		94.3	30-150			
Surrogate: Decachlorobiphenyl [2C]	*3.72*		mg/Kg	4.00		93.0	30-150			
Surrogate: Tetrachloro-m-xylene	*3.98*		mg/Kg	4.00		99.4	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*3.83*		mg/Kg	4.00		95.8	30-150			
LCS Dup (B030498-BSD1)				Prepared: 05/13/11 Analyzed: 05/19/11						
Aroclor-1016	1.0	0.20	mg/Kg	1.00		105	40-140	0.399	30	
Aroclor-1016 [2C]	1.2	0.20	mg/Kg	1.00		123	40-140	3.03	30	
Aroclor-1260	1.1	0.20	mg/Kg	1.00		111	40-140	5.81	30	
Aroclor-1260 [2C]	1.2	0.20	mg/Kg	1.00		122	40-140	3.80	30	
Surrogate: Decachlorobiphenyl	*3.71*		mg/Kg	4.00		92.6	30-150			
Surrogate: Decachlorobiphenyl [2C]	*3.63*		mg/Kg	4.00		90.8	30-150			
Surrogate: Tetrachloro-m-xylene	*4.00*		mg/Kg	4.00		100	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*3.84*		mg/Kg	4.00		95.9	30-150			

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
S-01	The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
No certified Analyses included in this Report	

The CON-TEST Environmental Laboratory operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	American Industrial Hygiene Association	100033	01/1/2012
MA	Massachusetts DEP	M-MA100	06/30/2011
CT	Connecticut Department of Publilc Health	PH-0567	09/30/2011
NY	New York State Department of Health	10899 NELAP	04/1/2012
NH	New Hampshire Environmental Lab	2516 NELAP	02/5/2012
RI	Rhode Island Department of Health	LAO00112	12/30/2011
NC	North Carolina Div. of Water Quality	652	12/31/2011
NJ	New Jersey DEP	MA007 NELAP	06/30/2011
FL	Florida Department of Health	E871027 NELAP	06/30/2011
VT	Vermont Department of Health Lead Laboratory	LL015036	07/30/2011
WA	State of Washington Department of Ecology	C2065	02/23/2012

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☐ 80 Washington Street, Suite 301, Poughkeepsie, NY 12601

11E0454

CHAIN-OF-CUSTODY RECORD 22248

Turnaround
☐ 1 Day* ☐ 2 Days* ☐ 3 Days* ☒ Standard (5 days) ☐ Other ______ (days)
*Surcharge Applies

PROJECT NAME: Westport Middle School
PROJECT LOCATION: Westport, MA
PROJECT NUMBER: 20080788.A2E
LABORATORY: Con-Test

REPORT TO: Bob May
INVOICE TO: Bob May
P.O. NO.: 20080788.A2E
Sampler's Signature: Jon Hand   Date: 5/12/11

Source Codes:
MW=Monitoring Well PW=Potable Water S=Soil W=Waste
SW=Surface Water T=Treatment Facility B=Sediment A=Air
X=Other Solid

Analysis Request: PCB Soxhlet Method 8082 Total PCB

Containers: Soil VOA Vial, [ ] methanol; Soil VOA Vial, [ ] water; Glass Soil Container ( ) oz [ ] Na_2SO_4; Glass Soil Container ( ) oz; Other: Glass 4oz Food; Water VOA Vial, [ ] As is [ ] HCl; Glass Amber ( ) ml, [ ] As is [ ] H_2SO_4; Plastic - As is, [ ] 250 ml [ ] 500 [ ] 1000 ml; Plastic - H_2SO_4, [ ] 250 ml [ ] 500 ml; Plastic - HNO_3, 250 ml [ ] Filtered [ ] Unfiltered; Plastic - NaOH, 250 ml

	Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	PCB Soxhlet Method 8082 Total PCB	Other: Glass 4oz Food	Comments
-1		✓	✓	✓		512JH-C1A	X	5/11/11		X	X	Int win glaze 264 C1-2
-2		✓	✓	✓		-C1B	X	↓		X	X	cafe B7,C3-7
-3		✓	✓	✓		-C1C	X	↓		X	X	124 B2-3
-4		✓	✓	✓		-C2A	X	↓		X	X	Int Door Caulk Near 122
-5		✓	✓	✓		-C2B	X	↓		X	X	Main
-6		✓	✓	✓		-C2C	X	↓		X	X	Near 166
-7		✓	✓	✓		-C3A	X	↓		X	X	Ext Door caulk Near 122
-8		✓	✓	✓		-C3B	X	↓		X	X	Main
-9		✓	✓	✓		-C3C	X	↓		X	X	Near 166
-10		✓	✓	✓		-C4A	X	↓		X	X	Ext win Caulk C1-C4

Transfer Number	Relinquished By	Accepted By	Date	Time
1	JH	Boston Fridge	5/12/11	0800
2	Boston Fridge	[signature]	5-13-11	2:30
3	[signature]	[signature] 5.8	5/13/11	1927
4				

Reporting and Detection Limit Requirements:

Additional Comments:

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11E0454

- ☐ 146 Hartford Road, Manchester, CT 06040
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- ☐ 1419 Richland Street, Columbia, SC 29201
- ☐ 78 Interstate Drive, West Springfield, MA 01089
- ☒ 50 Redfield Street, Suite 100, Boston, MA 02122
- ☐ 275 Promenade Street, Suite 350, Providence, RI 02908
- ☐ 80 Washington Street, Suite 301, Poughkeepsie, NY 12601

CHAIN-OF-CUSTODY RECORD 22249

Turnaround
☐ 1 Day* ☐ 2 Days* ☐ 3 Days* ☒ Standard (5 days) ☐ Other ______ (days)
*Surcharge Applies

PROJECT NAME: Westport Middle School
PROJECT LOCATION: Westport, MA
PROJECT NUMBER: 20080788.A2E
LABORATORY: Con-Test

REPORT TO: Bob May
INVOICE TO: Bob May
P.O. NO.: 20080788.A2E
Sampler's Signature: Jon Hand Date: 5/12/11

Source Codes:
MW=Monitoring Well PW=Potable Water S=Soil W=Waste
SW=Surface Water T=Treatment Facility B=Sediment A=Air
X=Other Solid

Analysis Request: PCB Soxhlet Method 8082 total PCB

Containers: Soil VOA Vial, [ ] methanol; Soil VOA Vial, [ ] water; Glass Soil Container ( ) oz; Glass Soil Container ( ) oz; Other: Glass 4oz Iced; Water VOA Vial, [ ] As is [ ] HCl; Glass Amber ( ) ml, [ ] As is [ ] H₂SO₄; Plastic - As is, [ ] 250 ml [ ] 500 [ ] 1000 ml; Plastic - H₂SO₄, [ ] 250 ml [ ] 500 ml; Plastic - HNO₃, 250 ml [ ] Filtered [ ] Unfiltered; Plastic - NaOH, 250 ml

	Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	PCB Soxhlet Method 8082 total PCB	Other: Glass 4oz Iced	Comments
-11		✓	✓	✓		512JH-C4B	X	5/12/11		X	X	Ext wire caulk A1-A4
-12		✓	✓	✓		-C4C	X	↓		X	X	B4-B7

Transfer Number	Relinquished By	Accepted By	Date	Time
1	JH	Bos Fridge	5/12/11	
2	Boston Fridge	W R Whittington	5-13-11	2:30
3	W R Whittington	Stacey Hylbert S.S	5-13-11	1923
4				

Reporting and Detection Limit Requirements:

Additional Comments:

39 Spruce St.
East Longmeadow, MA. 01028
P: 413-525-2332
F: 413-525-6405
www.contestlabs.com

con-test® ANALYTICAL LABORATORY

Sample Receipt Checklist

CLIENT NAME: Fuss + O'Neill RECEIVED BY: SD DATE: 5/13/11

1) Was the chain(s) of custody relinquished and signed? Yes No
2) Does the chain agree with the samples? Yes No
If not, explain:
3) Are all the samples in good condition? Yes No
If not, explain:
4) How were the samples received:
On Ice ☑ Direct from Sampling ☐ Ambient ☐ In Cooler(s) ☑
Were the samples received in Temperature Compliance of (2-6°C)? Yes No N/A
Temperature °C by Temp blank: ______ Temperature °C by Temp gun: 5.8
5) Are there Dissolved samples for the lab to filter? Yes No
Who was notified ______ Date ______ Time ______
6) Are there any samples "On Hold"? Yes No Stored where:
7) Are there any RUSH or SHORT HOLDING TIME samples? Yes No
Who was notified ______ Date ______ Time ______
8) Location where samples are stored: 19

Permission to subcontract samples? Yes No
(Walk-in clients only) if not already approved
Client Signature:

Containers received at Con-Test

	# of containers		# of containers
1 Liter Amber		8 oz amber/clear jar	
500 mL Amber		4 oz amber/clear jar	12
250 mL Amber (8oz amber)		2 oz amber/clear jar	
1 Liter Plastic		Other glass jar	
500 mL Plastic		Plastic Bag / Ziploc	
250 mL plastic		Air Cassette	
40 mL Vial - type listed below		SOC Kit	
Colisure / bacteria bottle		Tubes	
Dissolved Oxygen bottle		Non-ConTest Container	
Flashpoint bottle		Other	
Encore		PM 2.5 / PM 10	
Perchlorate Kit		PUF Cartridge	

Laboratory Comments:

40 mL vials: # HCl ______ # Methanol ______
Bisulfate ______ # DI Water ______
Thiosulfate ______ Unpreserved ______

Time and Date Frozen:

Do all samples have the proper Acid pH: Yes No N/A
Do all samples have the proper Base pH: Yes No N/A

March 2011

CGKV12417

EXHIBIT 44

Polychlorinated Biphenyls (PCBS) Source Removal Project Report and Management Plan

Westport Middle School
400 Old Colony Road, Westport, Massachusetts

Westport Community Schools

17 Main Road, Westport, MA

April 1, 2013

FUSS & O'NEILL
EnviroScience, LLC

Fuss & O'Neill EnviroScience, LLC
50 Redfield Street, Suite 100
Boston, MA 02122

Project No. 20080788.A6E

FUSS & O'NEILL
EnviroScience, LLC

April 1, 2013

Dr. Carlos Colley
Superintendent
Westport Community Schools
17 Main Road
Westport, Massachusetts 02790

RE: **Polychlorinated Biphenyls (PCBS) Source Removal Project**
Report and Management Plan for Westport Middle School
400 Old Colony Road, Westport, Massachusetts
Fuss & O'Neill EnviroScience, LLC No. 20080788.A6E

Dear Dr. Colley:

Enclosed please find the final report for Polychlorinated Biphenyls (PCBS) Source Removal Project Report and Management Plan for the Westport Middle School located in Westport, Massachusetts. The Waste Shipment Record (WSR) documents have been included with the report. This documentation should be placed at the central location where the school asbestos management plans are stored. In addition, the report should be transmitted to the EPA Region 1 coordinator to fulfill request for information in reference for the work performed between May and December 2011.

This report is the requested submittal and shall be submitted upon your review and acceptance to the following:

Ms. Kimberly N. Tisa, PCB Coordinator
Remediation and Restoration II Branch
United States Environmental Protection Agency, Region 1
5 Post Office Square, Suite 100-(OSRR07-2)
Boston, MA 02109-3912
Telephone (617) 918-1527

If you have any questions regarding the enclosed report, please do not hesitate to contact me at (617-282-4675), extension 4701. Thank you for this opportunity to have served your environmental needs.

Sincerely,

Robert L. May, Jr.
Vice President

Kevin W. Miller, Ph.D.
President/Data Verification Coordinator

RLM/ftc
Enclosure

50 Redfield Street
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f 617.282.8253
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Massachusetts
Rhode Island
South Carolina

G:\P2008\0788\A6E\March 2013 Final Deliverable\rlm_WestportMiddleSchool_PCB_SourceRemoval_RPT_20130401.docx

FUSS & O'NEILL
EnviroScience, LLC

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1 Executive Summary

Fuss & O'Neill EnviroScience, LLC (EnviroScience) was retained to provide inspection, testing, planning, and on-site project monitoring for work involving the removal of Polychlorinated Biphenyls (PCBs) in source building materials.

Westport Community Schools was selected as the recipient of funds from the Massachusetts School Building Authority (MSBA) for a Green Repairs Project at the Westport Middle School. The Green Repair Project was to include replacement of existing metal window systems and exterior door systems.

During the planning portion of the project, a due diligence inspection involving the testing of building materials for potential hazardous materials was conducted in May 2011. A summary report was prepared which identified building materials associated with the window systems and door systems to contain PCBs as source PCB Bulk Product Waste exceeding U.S. Environmental Protection Agency (EPA) concentrations of 50 ppm. In addition to PCBs the materials also contained asbestos.

The discovery of PCBs which exceed EPA maximum allowable of 50 ppm is considered a prohibited or an "unauthorized use" of PCBs according to the Toxic Substance Control Act (TSCA) and therefore subject to the requirements that the materials be immediately removed in accordance with EPA regulation 40 CFR 761.

The Green Repair project could not occur until the summer of 2012 due to required planning and length of time to manufacture and receive replacement window systems which would not allow for immediate response to replace the windows and doors and address the PCBs identified in the caulking and glazing compounds. Additional testing of adjacent substrates, soil, indoor air, and wipe sampling was performed in June 2011. Intent of adjacent porous surface sampling and soil sampling was to determine additional remediation work that would be required during replacement of window and door systems to be included in an overall project budget.

Indoor air sampling and wipe sampling was required due to the delay in performance of any work until 2012 and proposed occupancy of the school building in September 2011. Also, the structure of the building is concrete frame and removal of framework if contaminated by a source of PCBs would require potential use of encapsulation techniques under a Risk Based Disposal Plan in accordance with 40 CFR 761.61 (c).

Adjacent substrates including porous brick and adjacent concrete were sampled in June 2011. Adjacent materials were determined to contain PCBs within a range of 0.12 ppm to a high of 39 ppm up to 1 inch depth into substrate at caulking joints. A total of 21 samples of surface soil were collected along the building perimeter on all four sides of the structure and limited location determined to contain PCB concentrations above 1 ppm. A total of 20 wipe samples were collected adjacent to windows and doors on non-porous floor surfaces and porous window sill surfaces. Non-porous floor surfaces ranged from a low of 0.21 micrograms per wipe to a high of 110 micrograms per wipe. Porous brick window sills ranged from a low of none detected (ND) to a high of 2.5 micrograms per wipe.

Indoor air sampling was performed utilizing Method TO-10A homolog analysis for PCBs. In total 14 locations were sampled. The results were compared to EPA Public Health Levels of PCBs in School

Indoor Air for school age children 6<12 years of age which is 300 ng/m^3. The results identified 8 of the 14 samples exceeded this Public Health Level with a range of None Detected to a High of 990 ng/m^3 and average was 432 ng/m^3. School had been dismissed for the summer recess at the time sample results were received and teachers and custodial staff were removed from the building at that time and not permitted to occupy the building.

The information was transmitted to the EPA Region 1 coordinator via telephone call on June 24, 2011 after presented to the Westport Permanent School Committee meeting on June 23, 2011. EPA Region 1 coordinatorecommended proceeding with attempts to identify additional PCB Bulk Product material inside the building due to elevated concentrations of PCBs in indoor air.

On June 27 and 29, 2011 limited additional potential sources of interior PCB Bulk Product Waste were sampled. Inspection involved a review of unit ventilator units at walls, ceilingand roofs for potential caulking, sealants or other suspect PCB items or materials. Identified suspect materials included locations of interior caulking at columns, a foam filler at concrete beams and columns, mastic/felt above "tectum" ceiling panels, white plaster material at air intake at unit ventilators, and homasote insulation at roof air intake ducts. Of the sampled materials regulated concentrations of PCBs above 50 ppm were identified associated with interior caulking at columns, the foam filler at concrete beams and columns, mastic/felt above "tectum" ceiling panels. The significant sources of PCB Bulk Product included more than 70,000 square feet of ceiling mastic and 6,000 LF of caulking both interior and exterior to the building.

The discovery of interior sources of PCBs prompted a site meeting with EPA Region 1 Coordinator to discuss next steps in planning process and potential occupancy of school in September 2011. The site meeting occurred on July 14, 2011. The significant sources of PCBs at Westport Middle School prompted several challenges to occupy the building in September 2011 and the Westport Community Schools Superintendent began identification of alternative space options which included split schedules at Westport schools, use of other School districts, abandoned buildings, and portable classrooms as alternatives to occupancy of the Westport Middle School.

A pilot project was planned and work was conducted by Triumvirate Environmental Inc. (Triumvirate). The pilot project included an action plan in several representative rooms of the building to physically remove materials to better understand the feasibility of conducting the work, associated time and cost to complete, and identify, with post removal air samples, the effectiveness of reducing indoor air quality to acceptable ranges.

Results of the pilot project determined the effectiveness of reducing indoor air concentrations by removing most of the identified interior sources of PCBs and limited removal of exterior caulking materials around windows beneath unit ventilator intake points. Indoor air sample results identified post removal indoor air concentrations to be close to or lower than 300 ng/m^3.

A special meeting of the Westport Permanent School Committee was held to identify the results of the pilot project and to discuss anticipated costs for replication of process throughout the school building on August 2, 2011. Budget costs were prepared by Triumvirate. A meeting was held with EPA Region 1 Coordinator to discuss the plans to move forward with source removal of identified PCB Bulk Product materials. EPA Region 1 Coordinator confirmed no formal submission of a plan was required. Caution was offered by EPA Region 1 Coordinator that this process is only the first step with the only goal of potentially occupying the building in September 2011 and that long range plans and goals for continued monitoring and eventual elimination of all PCB Bulk Product Materials and addressing adjacent PCB Remediation Wastes must be developed by Westport Community Schools

The project to begin removal of interior and exterior identified PCB source materials as PCB Bulk Product Waste began on August 11, 2011. The Contractor was Triumvirate. Triumvirate utilized as sub-contractors Dec-Tam Corporation (Dec-tam) as well as LVI Services (LVI) to assist with the project and maintain the goal of opening school on September 6, 2011. The scope of work included the complete removal of all accessible interior "tectum" ceiling panels and the majority of the associated asbestos and PCB containing mastic/felt on concrete ceiling deck. Work also included complete removal of all PCB Containing interior caulking, all interior PCB containing foam filler, and removal of all exterior PCB Containing window caulking. PCB Containing caulking was removed from interior and exterior door systems to the height of the doors. Interior PCB Containing window glazing compound could not be removed and will need to be part of a future window replacement project; so as an interim measure work included encapsulation of the caulking. Initial phases of work included a thorough cleaning of exterior of all room furnishings utilizing HEPA vacuums and wet wiping to clean potentially PCB laden dust. Once clean wipe samples from representative locations were collected, the furniture was tagged and moved to the gymnasium or exterior storage trailers by a moving company. Locations of carpeting were removed where present with the exception of Office areas and media center offices. Once rooms were emptied, a full negative pressure enclosure was established in accordance with requirements of 453 CMR 6.00 for asbestos removal. Tectum and associated mastic adhesives were removed from all classrooms as well as program spaces such as the cafeteria and media center. Once completed, areas were final cleaned and the ceilings encapsulated with an asbestos encapsulant. Final air clearance samples by Transmission Electron Microscopy (TEM) were collected on rush turnaround to clear the containments. Once final air clearance was achieved for asbestos the work area barriers (wall polyethylene sheeting) were partially removed to facilitate access to interior PCB materials which did not contain asbestos. These materials included interior foam filler, interior caulking and interior window glazing compound. These materials were then removed with the exception of interior window glazing which was encapsulated as an interim measure with a new layer of caulking to conceal the glazing compound.

While interior work was occurring workers removed all of the exterior PCB containing caulking at windows and lower accessible portions of door systems. Containment barriers included use of polyethylene sheeting on interior side of windows and door systems, covering of ground surfaces, and sealing of the unit vents. Workers wore appropriate personal protective equipment. Exterior caulking materials also contained asbestos and required acceptable visual inspection by licensed asbestos project monitors prior to re-caulking of joints.

Upon completion of work to remove or encapsulate source materials, work areas were thoroughly cleaned and representative wipe samples for PCBs were collected within each room on non-porous floors and porous window sills. HVAC systems were cleaned, balanced and run for a period of 12 hours in addition to continued ventilation with HEPA equipped negative air filtration devices. Post removal indoor air samples were collected for analysis using Method TO-10A Homolog. Samples were collected in all classrooms and function spaces. Work was conducted in phases as each work area was completed.

Results of indoor air samples in general were initially below EPA guidance of 300 ng/m^3. If a room or group of rooms were above the guidance criteria, the rooms were re-cleaned and ventilated for a period before being re-sampled. On September 6, 2011, all classrooms and the Media Center, with a few exceptions, were below the EPA guidance and school opening was allowed on September 8, 2011 after a two day delay to allow maintenance staff and teachers time to prepare rooms for use. Areas which did not initially fall below EPA guidance included Cafeteria, Kitchen area, Office area and a few isolated rooms off the media center, and Room 24. These areas were subjected to additional cleaning and ventilation for several weeks resulting in opening of the Cafeteria, Kitchen and most offices.

Included in this report and management plan is information on some alternatives that Westport Community Schools is considering for long term future plans for the school building. It is recognized by Westport Community Schools that the project undertaken is a first step to eliminate much of the identified sources of PCBs to reduce indoor air concentrations and that full abatement and remediation of PCBs has not been achieved. The first charge of the project was to safely occupy the school in September 2011 in order to begin process of long range plans.

On-going routine cleaning by the school system is occurring with purchased HEPA vacuums and quarterly monitoring of indoor air has been conducted through the school year. The goal of the project, though a significant cost to Westport Community Schools and the Town of Westport, were met to safely occupy the building to conduct required educational programs during school year 2011/2012.

2 Introduction

Fuss & O'Neill EnviroScience, LLC (EnviroScience) was retained to provide inspection, testing, planning and on-site project monitoring for work involving the removal of Polychlorinated Biphenyls (PCBs) and asbestos identified in building materials.

Westport Community Schools was selected as the recipient of funds from the Massachusetts School Building Authority (MSBA) for a Green Repairs Project at the Westport Middle School. The Green Repair Project was to include replacement of existing metal window systems and exterior door systems.

The project team included the following:

EPA Region 1 Coordinator
Westport Community Schools (WCS)
Westport Permanent School Committee (WPSC)
Owner's Project Manager: Pinck & Company, Inc. of Boston, MA (Pinck)
Architect: CGKV Architects of Cambridge, MA (CGKV)
Environmental Consultant: Fuss & O'Neill EnviroScience, LLC of Boston, MA (EnviroScience)

2.1 Background

In May 2011, during preparation for a window replacement project being performed for the Green Repair Program administered under the MSBA, samples of window caulking, window glazing, and door caulking were collected and analyzed for asbestos and polychlorinated biphenyls to determine if these compounds were present in the building materials. The samples were collected by EnviroScience on behalf of the project architect, CGKV.

A summary report for the initial sampling was prepared, dated May 25, 2011 ,which identified building materials associated with the window systems and door systems to contain PCBs as source PCB Bulk Product Waste exceeding U.S. Environmental Protection Agency (EPA) concentrations of 50 parts per million (ppm). In addition to PCBs, the materials also were determined to be asbestos-containing materials (ACM). The identified concentrations of PCBs, as Aroclor 1254, were present in caulking materials associated with windows and door systems. A total of 12 samples of potential PCB Bulk Product Waste materials were collected. Concentrations of PCBs for window caulking reached significant concentrations of between 190,000 ppm and 270,000 ppm. Exterior Door caulking ranged from 110 ppm to 240,000 ppm. Interior door caulking ranged from 19 ppm to 1,500 ppm and interior window glazing compound ranged from 16 ppm to 80 ppm.

The discovery of PCBs which exceed EPA maximum allowable concentration of $\leq$50 ppm is considered a prohibited or an "unauthorized use" of PCBs according to the Toxic Substance Control Act (TSCA) and therefore subject to the requirements that the materials be immediately removed in accordance with EPA regulation 40 CFR 761. TSCA is a strict liability statute, and there is no requirement that a violator's conduct be willful of knowing for it to be found in violation of TSCA or its implementing regulation. PCBs are a synthetic chemical that were applied to products due to their resistive, insulating, and softening properties including low flammability, fire resistance, chemical stability, electrical insulation, durability, resistance to degradation and use as a softener and plasticizer. They were widely used in dielectric fluids (i.e. for transformers, capacitors, fluorescent light ballasts), plasticizers, caulking, adhesives/mastic, sealants, paints, inks, dyes, PVC coating for electrical wire and components, floor finishers, lubricating and cutting oils, and many other products. Due to concerns about the toxicity and persistence of PCBs, in 1979 PCBs were essentially banned for use in the United States.

2.2 Building Description

The Westport Middle School is located at 400 Old County Road in Westport, Massachusetts 02790. The school was originally constructed in 1969 and is approximately 116,000 SF. Last renovation to the school building was in 2003. The building is two stories plus a basement level where mechanical room and boilers are located. The gymnasium and auditorium are two stories in height. The following are some general details on the construction of the school:

- The building is cast-in place reinforced concrete frame consisting of concrete columns and beams with poured in place concrete floor and roof slabs.
- The exterior finish materials include brick veneer and exposed concrete framing.
- Window systems are metal frames with interior sills of brick, wood, or plastic.
- Door systems are metal frames and metal doors, many with transom windows and sidelights.
- Interior walls are plaster or sheetrock with exposed concrete columns and beams and some areas of exposed interior brick including cafeteria, media center, auditorium, gymnasium and office areas.
- The floor finishes within the building are primarily vinyl floor tile, with carpet present in the office areas, media center, teacher's lounge and few classrooms.
- The hallways, offices and portions of the media center, cafeteria and kitchen, have dropped ceilings which are "tectum" lay-in panels.

- The majority of the remaining building has exposed "tectum" panels which are at the ceiling directly beneath the concrete slab of floor or roof above. These panels were installed during forming of the concrete floor slabs and have a water-proofing mastic between the panels and concrete slab above.
- The lighting is primarily overhead florescent lights located within dropped ceilings or hanging beneath "tectum" ceilings.
- Air heating and ventilation within each classroom is provided by individual unit ventilators original to the building which have a shared air intake typically between lower and upper level floors of the building.
- Separate HVAC systems are present in each of the cafeteria, media center, gymnasium, auditorium and select second floor classrooms.
- Hallways and office areas are provided with fresh air ventilation only.
- The building has six internal stairwells for circulation, five of which lead directly to the building exterior. Ceilings within the stairwells at upper level are "tectum" panels.
- The building is accessed from multiple levels based on topography of the land around the building.
- The exterior has concrete paving, sidewalks, and plaza. Many areas have exposed grass and soil with minimal plantings around the building.

A locus map, showing the geographical location of the school, is presented in **Figure 1**.

2.3 PCB Actions Time-Line

The Westport Middle School project started with the initial site characterization in May 2011. The time line and key events involved in the project are itemized herein. It should be noted that many meetings with EPA Region 1 coordinator were held including two on site visits to review conditions during the initial planning stage of the project.

May 25, 2011 Hazardous Material Report Initial Test Results

Fuss & O'Neill EnviroScience (EnviroScience) issues their hazardous material inspection reports for the proposed replacement work at the three school buildings that are part of the Green Repair Program. Window replacement proposed at the Middle School therefore window caulk & glazing compound was tested for Hazardous materials. PCB's in concentrations higher than EPA regulation found in:

- Interior door caulking*
- Interior window glazing*
- Exterior door caulking*
- Exterior window caulking*

**Materials also contain asbestos.*

June 2, 2011: Meeting with Westport Community Schools (WCS)

Pinck & Co & EnviroScience meet with WCS to review 5/25 PCB report and discuss next steps. EnviroScience authorized to proceed to next round of testing EnviroScience outlines necessary steps to test adjacent substrates to determine remediation wastes for materials in contract or potentially contaminated by PCBs. These include masonry, concrete, soil, interior dust and air. EnviroScience is authorized to process to next round of testing.

June 6 to June 14, 2011 Sampling of Adjacent Materials and Surfaces and Interior Air

EnviroScience takes samples of exterior materials adjacent to window caulking, soils and concrete below the windows & doors, Interior Wipe samples adjacent to windows and doors and interior air samples at random locations around the building. Sampling work takes several days and test results take 5 days to a week to come back from Laboratory.

June 14, 2011 Ext Bulk Substrate Materials and In Wipe Test Results

Tests show PCB concentration in adjacent masonry and concrete, and soil and concrete paving below windows above EPA threshold for high occupancy building. PCB contamination also discovered in wipe samples at interior sills and interior floors.

June 17, 2011 Interior Air Sample Results

Lab analysis of interior air samples show PCB concentrations above EPA guidelines for children 6 to 12 years old at 8 of 13 locations tested.

June 23, 2011: Meeting with Westport Community Schools Building Committee

Pinck & Co & EnviroScience meet with School Building Committee to discuss latest round of PCB test results and discuss next steps. EnviroScience authorized to proceed with Interior material sampling to try to determine the additional sources of interior PCB contamination and to take additional interior wipe tests in random locations on horizontal surfaces with accumulations of dust.

June 27 to July 5, 2011 Sampling of Possible Interior Source Materials and Wipe Tests.

EnviroScience takes additional 24 wipe samples and identifies 3 additional source materials containing PCBs higher than EPA regulation. Sampling takes several days and test results take 5 days to come back from the laboratory.

July 6, 2011 Interior Bulk Substrate Materials and Interior Wipe Test Results

Wipe samples at many locations in interior test positive for PCB contamination. PCB's in concentrations higher than EPA guidelines found in:

- Mastic above "tectum" ceiling panels*
- Interior caulking between concrete columns & masonry
- Infill (compressible foam like) material between concrete columns and adjacent wall finishes.

**Materials also contain asbestos*

July 14, 2011 Site Visit with EPA to Review Conditions and Findings

Conduct site walkthrough to establish suggested nest steps for addressing PCB source materials and elevated air sample results in order to attempt occupancy.

- EPA suggests pilot project to isolate building materials

July 21-29, 2011 Pilot Project to Remove Select Source PCB Materials

Conduct pilot project to physically remove rather than isolate materials in concurrence with EPA and conduct post remediation air sampling. Resulting air samples below EPA guidance.

August 1-5, 2011 Pricing Development from Two Contractors.

Develop specification and plan for obtaining competitive quotes for conducting removal in entire building prior to September 6, 2011.

August 10, 2011 Bid Awarded to Triumvirate for Work

August 11, 2011 Obtain MassDEP Asbestos Waivers to Allow Start of Project

August 11 to September 6, 2011 Perform PCB Remediation

Work Crews including movers clean and begin preparations to remove 70,000 sf of asbestos and PCB ceiling mastic and over 6,000 LF of PCB caulking. Work involves two shifts 6 days per week with over 100 men and two project monitors. Expedited turnaround times for all samples both Asbestos TEM air samples and PCB samples.

September 8, 2011 School Opens

School opens with a 2 day delay to allow receipt of air samples and maintenance and teachers to prepare classrooms before school start. School opens with 90% usage with air samples meeting EPA guidance.

3 Site Characterization

3.1 Initial Bulk Product Sampling

On May 11, 2011, EnviroScience's representative, Jonathan Hand, collected twelve (12) bulk samples of suspect PCB Bulk Product building materials to be analyzed for PCBs. Sampling involved removal of bulk product materials (source materials), such as window and door caulking and glazing compounds, using hand tools to submit in bulk form to determine PCB content. Tools utilized to collect samples were disposable items and discarded after each individual sample was collected to avoid cross contamination of samples. Each sample was placed in an individual container, labeled, and delivered to laboratory using proper chain of custody. Samples were analyzed at Con-Test Analytical Laboratories located in East Longmeadow, MA. Samples were analyzed using EPA Method 3500B/3540C (Soxhlet Region 1) for extraction and analysis of samples using EPA Method 8082.

The USEPA regulates materials containing $\geq$ 50 ppm. However, if PCBs greater than 1 ppm are present in a material, it must be demonstrated (proven) that the materials containing < 50 ppm PCBs are an "Excluded PCB Product", which for this circumstance would be a product legally manufactured or used prior to October 1, 1984.

The following table identifies the collected samples on May 11, 2011 by location, material type, and sample number.

TABLE 1
Sampling and Analysis Results for PCB Bulk Products Samples
May 11, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Room 264 (C1, C2),	Interior Window Glazing Compound	511JH-C1A	76 (Aroclor 1254)
Cafeteria (B7, C3, C7)	Interior Window Glazing Compound	511JH-C1B	80 (Aroclor 1254)

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Room 124 (B2, B3)	Interior Window Glazing Compound	511JH-C1C	16 (Aroclor 1254)
Doors to exterior near Room 122	Interior Door Caulking	0511JH-C2A	1,500 (Aroclor 1254)
Doors to exterior Main Entrance	Interior Door Caulking	0511JH-C2B	19 (Aroclor 1254)
Doors to exterior near Room 166	Interior Door Caulking	0511JH-C2C	1,200 (Aroclor 1254)
Doors to exterior near Room 122	Exterior Door Caulking	0511JH-C3A	180,000 (Aroclor 1254)
Doors to exterior Main Entrance	Exterior Door Caulking	0511JH-C3B	110 (Aroclor 1254)
Doors to exterior near Room 166	Exterior Door Caulking	0511JH-C3C	240,000 (Aroclor 1254)
Exterior Side C1, C4 Window	Exterior Window Caulking	0511JH-C4A	270,000 (Aroclor 1254)
Exterior Side A1, A4 Window	Exterior Window Caulking	0511JH-C4B	190,000 (Aroclor 1254)
Exterior Side B4, B7 Window	Exterior Window Caulking	0511JH-C4C	230,000 (Aroclor 1254)

The materials sampled were determined to contain PCBs at regulated concentrations based on the limited representative samples collected. Refer to full inspection report for laboratory analysis results included in **Appendix A**.

EnviroScience performed testing for PCBs and the results identified PCBs at concentrations above EPA threshold of 50 ppm. The results with the exception of two of the twelve samples collected exceeded 50 ppm. It should be noted that the two results containing less than 50 ppm were likely a result of maintenance activity which could have removed original caulking or glazing compound containing greater than 50 ppm as PCBs were present in both materials but < 50 ppm. Therefore an "exclusion" for these materials was not sought and all window and door systems were included in proposed remediation.

The results indicated both interior and exterior materials associated with windows and door systems contain PCBs. The next step prior to development of a scope of required remediation work was to characterize adjacent surfaces. This included conducting sampling of adjacent masonry, soil and dust associated with the site.

Since a regulated source of PCBs was identified, based on results for interior window glazing compounds, interior door caulking, exterior door caulking, and exterior window caulking; a determination of potential contamination as an evaluation of potential remediation wastes was required.

The following surfaces were evaluated to determine extent of PCB contamination of adjacent surfaces:

- adjacent masonry surfaces at interior side of door systems
- adjacent masonry surfaces at exterior side of door systems
- adjacent masonry surfaces at exterior side of window systems
- asphalt and concrete sidewalks adjacent to doors
- exterior soil
- collection of wipe samples on interior window sills and floors

3.2 Sampling of Adjacent Substrate Materials

On June 7 and 8, 2011, EnviroScience's representative, Jonathan Hand and Dustin Diedricksen, collected twenty six (26) bulk samples of building materials adjacent to identified PCB Bulk Product Waste. The sampling of potential PCB Remediation Waste was conducted in support of proposed window and door replacement project in preparation for development of a Risk Based Disposal Plan to be filed with EPA. EnviroScience collected samples of substrate building materials that were in direct contact with identified PCB Bulk Product Waste materials (e.g. brick and concrete) to satisfy the EPA testing requirements. We collected samples of substrate materials at specified depths for each substrate material. Substrate materials associated with exterior window caulking included brick masonry and concrete columns and beams. Substrate materials associated with door systems for both interior and exterior caulking included brick masonry, interior brick, concrete columns, concrete beams, and concrete sidewalks beneath door systems.

Each of the identified substrates was sampled from 0"- ½" depths at each representative location. In addition, at brick substrates an additional sample was collected at a depth of ½"-1" for the representative locations totaling 26 samples. Samples were collected utilizing a coring drill to sample substrate adjacent to existing caulking joints. The core drilling procedure utilized was modeled after EPA Guidance for field sampling of concrete.

Discreet samples were collected of substrate building materials. Care was exercised to ensure sampling equipment was decontaminated between sample collection using hexane wash and rinse to avoid cross contamination of samples. Samples were placed in containers for transport to laboratory using proper chain of custody. Samples were analyzed using EPA Method 3500B/3540C (Soxhlet Region 1) for extraction and analysis of samples using EPA Method 8082.

TABLE 2
Sampling and Analysis Results
for Potential PCB Remediation Waste Substrate Materials
June 7, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Exterior Window at Room 121	Exterior Window Jamb – Brick 0 – ½" Depth	607JH-C-01A	3.4 (Aroclor 1254)
Exterior Window at Room 121	Exterior Window Jamb – Brick ½ - 1" Depth	607JH-C-01B	3.4 (Aroclor 1254)

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SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Exterior Window at Room 121	Exterior Window sill – Brick 0 – ½" depth	607JH-C-01C	0.13 (Aroclor 1254)
Exterior Window at Room 121	Exterior Window Sill– Brick ½ - 1" Depth	607JH-C-01D	0.17 (Aroclor 1254)
Exterior Window at Room 121	Exterior window Header – Concrete Beam 0 – ½" Depth	607JH-C-01E	0.38 (Aroclor 1248) 0.57 (Aroclor 1254)
Exterior Window at Girls' Locker Room	**Exterior Window Jamb – Brick 0 – ½" depth**	**607JH-C-02A**	**4.3 (Aroclor 1254)**
Exterior Window at Girls' Locker Room	Exterior Window Jamb – Brick ½ - 1" Depth	607JH-C-02B	0.47 (Aroclor 1248) 0.67 (Aroclor 1254)
Exterior Window at Girls' Locker Room	**Exterior Window Sill – Brick 0 – ½" Depth**	**607JH-C-02C**	**17 (Aroclor 1254)**
Exterior Window at Girls' Locker Room	Exterior Window Sill– Brick ½ - 1" depth	607JH-C-02D	0.33 (Aroclor 1254)
Exterior Window at Girls' Locker Room	Exterior Window Header – Concrete Beam 0 – ½" Depth	607JH-C-02E	0.22 (Aroclor 1248) 0.26 (Aroclor 1254)
Exterior Door at Gymnasium Ramp	**Exterior Door Header – Concrete Beam 0 - ½" Depth**	**607JH-C-03**	**4.1 (Aroclor 1254)**
Exterior Window at Room 166	**Exterior Window Jamb – Brick 0 – ½" Depth**	**607JH-C-04A**	**39 (Aroclor 1254)**
Exterior Window at Room 166	Exterior Window Jamb – Brick ½ - 1" Depth	607JH-C-04B	0.40 (Aroclor 1248) 0.73 (Aroclor 1254)
Exterior Window at Room 166	**Exterior Window Sill – Brick 0 – ½" Depth**	**607JH-C-04C**	**3.2 (Aroclor 1254)**
Exterior Window at Room 166	**Exterior Window Sill– Brick ½ - 1" Depth**	**607JH-C-04D**	**1.7 (Aroclor 1254)**
Exterior Window at Room 166	Exterior Window Header – Concrete Beam 0 – ½" Depth	607JH-C-04E	0.41 (Aroclor 1248) 0.63 (Aroclor 1254)
Exterior Window at Room 283 (2nd Floor)	Exterior Window Jamb – Brick 0 – ½" Depth	607JH-C-05A	0.20 (Aroclor 1254)
Exterior Window at Room 283 (2nd Floor)	Exterior Window Jamb – Brick ½ - 1" Depth	607JH-C-05B	0.33 (Aroclor 1254)
Exterior Window at Room 283 (2nd Floor)	**Exterior Window Sill – Brick 0 – ½" Depth**	**607JH-C-05C**	**28 (Aroclor 1254)**
Exterior Window at Room 283 (2nd Floor)	**Exterior Window Sill– Brick ½ - 1" Depth**	**607JH-C-05D**	**1.4 (Aroclor 1254)**
Exterior Window at Room 283 (2nd Floor)	**Exterior Window Header – Concrete Beam 0 – ½" Depth**	**607JH-C-05E**	**11 (Aroclor 1254)**
Exterior Door at Entrance near Room 166	Exterior Door Jamb – Brick 0 – ½" Depth	607JH-C-06A	0.12 (Aroclor 1254)

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Exterior Door at Entrance near Room 166	Exterior Door Jamb – Brick ½ - 1" Depth	607JH-C-06B	2.6 (Aroclor 1248) 2.3 (Aroclor 1254)
Exterior Concrete Walk (Below Door) at Entrance near Room 166	Exterior Walkway Concrete Beam 0 – ½" Depth	607JH-C-07	3.5 (Aroclor 1254)
Interior Door at Entrance near Room 166	Interior Door Jamb – Brick 0 – ½" Depth	607JH-C-08A	0.95 (Aroclor 1248) 0.97 (Aroclor 1254)
Interior Door at Entrance near Room 166	Interior Door Jamb – Brick ½ - 1" Depth	607JH-C-08B	2.9 (Aroclor 1248) 2.3 (Aroclor 1254)

Note: Results in bold text in Table 2 exceed proposed clean-up standard for "high occupancy" use building for soil as Bulk PCB Remediation Waste.

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The materials sampled were determined to contain PCBs within substrates. A proposed clean-up standard for the Westport Middle School was recommended at "high occupancy" use which would require adjacent substrates to be remediated to a clean-up standard of <u><</u>1 ppm for unrestricted use in accordance with requirements of 40 CFR Part 761.61 (a)(4)(i). Refer to **Appendix B** for the substrate laboratory analysis results and chains of custody.

EnviroScience performed testing for PCBs and the results identified PCBs at concentrations above EPA clean-up standard of ≤1 ppm for a "high occupancy" use building at many substrate locations. The determination of PCBs exceeding 1 ppm in adjacent concrete beams and columns would preclude from remediation methods of substrate removal due to engineers recommendations that substrates not be removed. Proposed remediation methods of encapsulation would be required by methods of a Risk-Based Disposal plan with EPA in accordance with 40 CFR Part 761.61 (c). In order to demonstrate no unreasonable risk, wipe, soil, and air samples were also collected.

A "high occupancy" use is defined by EPA in regulation 40 CFR Part 761.3 means any area where PCB remediation waste has been disposed of on-site and where occupancy for any individual not wearing dermal and respiratory protection for a calendar year is: 840 hours or more (an average of 16.8 hours or more per week) for non-porous surfaces and 335 hours or more (an average of 6.7 hours or more per week) for bulk PCB remediation waste. Examples could include a residence, school, day care center, sleeping quarters, a single or multiple occupancy 40 hours per week work station, a school class room, a cafeteria in an industrial facility, a control room, and a work station at an assembly line.

3.3 Sampling of Adjacent Soil

EnviroScience collected soil samples at the exterior perimeter of the building. Soil samples were collected adjacent to exterior masonry walls (i.e. at drip-line) at depths of 0" – ½" at 21 locations. Additional soil samples were collected at 4" depth at exact drip-line locations, and 5' from exterior masonry walls and perpendicular to the aforementioned drip-line samples (0" – ½" depth). Sample locations were approximately 10' apart (minimum 2 locations per building side) and three soil samples were collected at each of the 21 locations described herein.

A total of 63 soil samples were collected to appropriately identify extent of potential PCB contamination of soil. All (21) surficial samples collected at drip-line were analyzed at laboratory with instruction to hold additional two samples within set (i.e. 4" at drip-line; 0 – ½" at 5' distance). Those locations having surface samples with PCB content greater than 1.0 ppm are recommended for further analyses to determine extent of contamination.

TABLE 3
Sampling and Analysis Results for PCB Soil Samples
June 6, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Outside Room 104 (A Side)	Soil	606JH-S-01A	0.78 (Aroclor 1254)
Outside Room 105	Soil	606JH-S-02A	0.68 (Aroclor 1254)
Outside Room 110	Soil	606JH-S-03A	0.78 (Aroclor 1254)
Outside Room 112	Soil	606JH-S-04A	0.59 (Aroclor 1254)
Outside Room 116	**Soil**	**606JH-S-05A**	**1.0 (Aroclor 1254)**
Outside Room 121	Soil	606JH-S-06A	0.65 (Aroclor 1254)
Outside Room 122	Soil	606JH-S-07A	0.52 (Aroclor 1254)
Outside Room 125	Soil	606JH-S-08A	0.69 (Aroclor 1254)
Outside Girls' Locker Room (B Side)	Soil	606JH-S-09A	0.24 (Aroclor 1254)
Outside Girls' Locker Room (B Side)	Soil	606JH-S-10A	0.77 (Aroclor 1254)
Outside Girls' Locker Room (C Side)	Soil	606JH-S-11A	0.63 (Aroclor 1254)
Outside Boys' Locker Room	Soil	606JH-S-12A	0.32 (Aroclor 1254)
Outside Room 154	**Soil**	**606JH-S-13A**	**0.91 (Aroclor 1254)**
Outside Room 163	Soil	606JH-S-14A	0.82 (Aroclor 1254)
Outside Room 166 (C Side)	**Soil**	**606JH-S-15A**	**1.2 (Aroclor 1254)**
Outside Room 166 (D Side)	**Soil**	**606JH-S-16A**	**0.99 (Aroclor 1254)**
Outside Room 168	Soil	606JH-S-17A	0.35 (Aroclor 1254)
Outside Room 172	**Soil**	**606JH-S-18A**	**2.3 (Aroclor 1254)**
Outside Room 176	**Soil**	**606JH-S-19A**	**2.1 (Aroclor 1254)**
Outside Room 101	Soil	606JH-S-20A	0.38 (Aroclor 1254)
Outside Room 104 (D Side)	Soil	606JH-S-21A	0.18 (Aroclor 1254)

Note: Results in bold text in Table 3 exceed proposed clean-up standard for "high occupancy" use building for soil as Bulk PCB Remediation Waste.

A total of 21 samples of soil were analyzed as surficial soil samples at perimeter at depths of 0-1/2". A proposed clean-up standard for the Westport Middle School was recommended at "high occupancy" use which would require soil to be remediated to a clean-up standard of <u><</u>1 ppm for unrestricted use in accordance with requirements of 40 CFR Part 761.61 (a)(4)(i). Refer to **Appendix C** for soil laboratory analysis results.

EnviroScience performed testing for PCBs in soil and the results identified PCBs at concentrations above EPA clean-up standard of ≤1 ppm for a "high occupancy" use building at six soil locations. Additional soil sampling will be required at depth of 4 inches and a distance of five feet from building to determine extent of remediation required. This testing will be a future phase of work during plan preparations for remediation.

3.4 Wipe Sampling of Settled Dust

Hexane wipe samples were collected in accordance with methods in consultation with 40 CFR §761Sub-Part P. Sufficient sample size was collected to ensure a detection limit that allows quantification of the data relative to the EPA action concentration of ≤1 µg/100 cm^2.

Twenty (20) PCB wipe samples were collected on interior floors (non-porous) and interior window sills (porous) below window systems within the school building. Each wipe sample was sealed in 4 oz. glass jar, properly labeled, and chain of custody was filled out and sent to Con-test Analytical Laboratory in East Long Meadow, MA for analysis by a modified EPA method 8270C.

TABLE 4
Sampling and Analysis Results for PCB Wipe Samples
June 8, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (µg/wipe)
Non-porous Floor Surfaces			
Stair 123	**Surface Wipe at Floor**	**608JH-W-01**	**110 (Aroclor 1254)**
Room 124	Surface Wipe at Floor	608JH-W-04	0.21 (Aroclor 1254)
Girls' Locker Room	Surface Wipe at Floor	608JH-W-05	0.53 (Aroclor 1254)
Room 164	Surface Wipe at Floor	608JH-W-07	0.54 (Aroclor 1254)
Stair 165	**Surface Wipe at Floor**	**608JH-W-08**	**8.2 (Aroclor 1254)**
Room 101	Surface Wipe at Floor	608JH-W-10	0.71 (Aroclor 1254)
Stair 111	**Surface Wipe at Floor**	**608JH-W-11**	**55 (Aroclor 1254)**
Stair 215	**Surface Wipe at Floor**	**608JH-W-12**	**1.9 (Aroclor 1254)**
Room 268	**Surface Wipe at Floor**	**608JH-W-14**	**1.3 (Aroclor 1254)**
Room 277	Surface Wipe at Floor	608JH-W-16	0.85 (Aroclor 1254)
Cafeteria	**Surface Wipe at Floor**	**608JH-W-18**	**1.8 (Aroclor 1254)**
Room 241	**Surface Wipe at Floor**	**608JH-W-20**	**1.0 (Aroclor 1254)**
Porous Window Sills			
Room 124	Surface Wipe at Window Sill	608JH-W-02	0.76 (Aroclor 1254)
Girls' Locker Room	Surface Wipe at Window Sill	608JH-W-03	0.71 (Aroclor 1254)
Room 164	Surface Wipe at Window Sill	608JH-W-06	0.36 (Aroclor 1254)
Room 101	Surface Wipe at Window Sill	608JH-W-09	None Detected

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (µg/wipe)
Room 268	Surface Wipe at Window Sill	608JH-W-13	**1.7 (Aroclor 1254)**
Room 277	Surface Wipe at Window Sill	608JH-W-15	0.90 (Aroclor 1254)
Cafeteria	Surface Wipe at Window Sill	608JH-W-17	**2.5 (Aroclor 1254)**
Room 241	Surface Wipe at Window Sill	608JH-W-19	0.33 (Aroclor 1254)

Note: Results in bold text in Table 4 exceed proposed clean-up standard for "high occupancy" school use building for wipe $\leq$1 µg/100 cm².

Twelve PCB wipe samples were collected on interior floors (non-porous) and eight PCB wipes were collected on interior window sills (porous) below window systems within the school building. Seven of the twelve wipes (58%) on representative floors exceeded standard of $\leq$1 µg/100 cm² for floors. Two of the eight wipes (25%) on representative window sills exceeded standard of $\leq$1 µg/100 cm². Refer to **Appendix D** for initial wipe sample laboratory analysis results and chains of custody.

4 Initial Indoor Air Sampling for PCBs

Based on the detection of PCBs in the school window and door caulking and window glazing compounds at concentrations that were greater than 50 ppm and in response to concern for the public health of school students and staff, WCS and the WPSC for Westport in adherence with published recommendations of the EPA, requested that sampling/analysis of the indoor air for PCBs be performed.

To evaluate potential impact to indoor air from the detected PCBs, EnviroScience was requested to conduct indoor air sampling from representative locations within the school building. Sampling was performed at both upper and lower level rooms that were scheduled for window replacement.

4.1 Indoor Air Sampling and Results

Fourteen (14) PCB air samples were collected on June 7, 2011 in accordance with EPA Method TO-10A. Sufficient sample volume of 500 L of air was collected on sample media for homolog analysis. This use of homolog analysis allowed quantification of data relative to EPA advisory concentration of 300 ng/m³ for children ages 6 to 12 and 450 ng/m³ for faculty and staff at 19 plus years (adults) in the school. Quality assurance and quality control (QA/QC) samples, including one duplicate and one blank, were also obtained. The samples were collected following EPA Method TO-10A procedures using low flow air sampling pumps and polyurethane foam traps (PUF tubes), over a duration of approximately 100 minutes at flow rates of approximately 4-5 liters per minute (for a total volume of approximately 0.5 cubic meters).

Selection of PCB air sampling locations within school building included highly sensitive receptor locations (e.g. classroom locations) representative of each floor. Focus of selected locations also included rooms having windows where known PCB Bulk Product Waste materials were present. During the indoor air sampling, conditions that are typically present within the school when the students are present, (E.g. doors closed, unit ventilators and other HVAC systems in operation) were observed. The initial air sampling was performed immediately upon dismissal of students for the day. It should be noted that indoor air samples were collected prior to any sampling of adjacent substrates, soil, or wipe sampling which would impact potential PCB containing materials. The samples were submitted for PCB homolog analysis (modified 8270C) to Con-test Analytical Laboratory in East Long Meadow, MA.

Fourteen specific locations were sampled for indoor air. Eight of the fourteen indoor air samples (57%) from representative locations met or exceeded the standard of 300 ng/m³ for indoor air. All but two of the collected samples exceeded 50% of the maximum allowable standard. Refer to Table 5 for summary of results. Refer to **Appendix E** for initial air sample laboratory analysis results and chain of custody.

Based on the discovery of PCBs within indoor air which met or exceeded the EPA advisory concentrations for school age children ages 6 to <12 for indoor air, it was considered that additional sources within the building may contain PCBs. The EPA Region 1 Coordinator was immediately notified of the results of indoor air samples and was also of the opinion that additional likely sources of PCBs should be investigated.

The school Superintendent for WCS, also requested that additional random wipe samples be collected throughout the school on furniture etc., to determine if based on such elevated concentrations of PCBs within the indoor air, that surfaces within the building had PCB contamination. An investigation for additional PCB sources (PCB Bulk Products) and additional wipe sampling was performed per request on June 27th and June 29th.

TABLE 5
Sampling and Analysis Results for PCB Indoor Air Samples
June 7, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (ng/m³)
Cafeteria	**Indoor Air Sample**	**67DD-AIR-01**	**410**
Room 212	**Indoor Air Sample**	**67DD-AIR-02**	**940**
Room 227	**Indoor Air Sample**	**67DD-AIR-03**	**620**
Room 241	**Indoor Air Sample**	**67DD-AIR-04**	**300**
Room 252 (Library)	**Indoor Air Sample**	**67DD-AIR-05**	**890**
Room 264	**Indoor Air Sample**	**67DD-AIR-06**	**990**
Room 277	**Indoor Air Sample**	**67DD-AIR-07**	**360**
Room 154	Indoor Air Sample	67DD-AIR-08	230
Room 164	Indoor Air Sample	67DD-AIR-09	170
Room 164 (Duplicate)	Indoor Air Sample	67DD-AIR-10	240
Room 101	**Indoor Air Sample**	**67DD-AIR-11**	**520**
Girls' Locker Room	Indoor Air Sample	67DD-AIR-12	110
Room 124	Indoor Air Sample	67DD-AIR-13	ND
Room 110	Indoor Air Sample	67DD-AIR-14	220
Room 118	Indoor Air Sample	67DD-AIR-15	230
Blank Sample	Indoor Air Sample	67DD-AIR-16	ND

Note: Results in bold text in Table 5 meet or exceed EPA indoor air advisory concentration of 300 ng/m³ for ages 6 to <12years of age.
ND – None Detected

The school was not in session upon receipt of the indoor air sample analysis results and a re-location plan was not required for student population. The Superintendent for WCS, re-located all teacher and office staff from the building to other locations and did not allow any summer programming to occur within the building upon determination of indoor air results. The information for indoor air testing as well as identification of PCBs in bulk products was transmitted to the EPA Region 1 coordinator via telephone call and e-mail on June 24, 2011 after the information was presented to the WPSC Committee meeting on June 23, 2011. The EPA Region 1 coordinator recommended proceeding with attempts to identify interior source of PCB Bulk Product Materials due to elevated concentrations of PCBs in indoor air within the building.

5 Supplemental Wipe and Bulk Sampling

5.1 Wipe Sampling of Settled Dust

Sampling was performed on June 27, 2011 and a total of 24 additional hexane wipe samples were collected of visible settled dust on less actively cleaned surfaces within the building. These surfaces included the top of book shelves, top of lockers, fire alarm panels, behind concrete columns, and other horizontal surfaces.

Wipe samples were collected in accordance with methods in consultation with 40 CFR §761Sub-Part P. Sufficient sample size was collected to ensure a detection limit that allows quantification of the data relative to the EPA action concentration of ≤ 1 µg/100 cm^2 (0.01 µg/cm^2). Each wipe sample was sealed in 4 oz. glass jar, properly labeled, and chain of custody was filled out and sent to Con-test Analytical Laboratory in East Long Meadow, MA for analysis by a modified EPA method 8270C.

TABLE 6
Sampling and Analysis Results for Additional PCB Wipe Samples
June 27, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (µg/wipe)
Samples Collected by Inspector John Coletti			
Kitchen Area on Microwave Oven Top	Surface Wipe	627-JAC-11	0.71 (Aroclor 1254)
Kitchen Area on Paper Towel Dispenser Top	Surface Wipe	627-JAC-12	0.54 (Aroclor 1254)
Cafeteria Top of Black Fire Alarm Box	**Surface Wipe**	**627-JAC-13**	**1.6 (Aroclor 1254)**
Cafeteria Right Wall Ledge Near Office Area	**Surface Wipe**	**627-JAC-14**	**1.4 (Aroclor 1254)**
Guidance Office (Room 227) Black Book Shelf Top	Surface Wipe	627-JAC-15	0.46 (Aroclor 1254)
Guidance Office (Room 227) Tan File Cabinet Top	**Surface Wipe**	**627-JAC-16**	**2.4 (Aroclor 1254)**
Hallway Area Near Room 249 on Top of Black Fire Alarm Box	**Surface Wipe**	**627-JAC-17**	**1.6 (Aroclor 1254)**

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (µg/wipe)
Hallway Area Near Room 249 on Floor Behind Concrete Column	**Surface Wipe on floor**	**627-JAC-18**	**3.1 (Aroclor 1254)**
Media Center Book Shelf Top	**Surface Wipe**	**627-JAC-19**	**2.4 (Aroclor 1254)**
Media Center Book Shelf Top	**Surface Wipe**	**627-JAC-20**	**3.1 (Aroclor 1254)**
Hallway Area Near Room 274 on Top of Black Fire Alarm Box	Surface Wipe	627-JAC-21	0.22 (Aroclor 1254)
Hallway Floor Near Room 274	**Surface Wipe**	**627-JAC-22**	**2.8 (Aroclor 1254)**
Band Back Green Room on Top of Shelf	Surface Wipe	627-JAC-23	ND
Band Room – Wood Cabinet Top	Surface Wipe	627-JAC-24	0.62 (Aroclor 1254)
Boys Locker Room on Top of Shelf	Surface Wipe	627-JAC-25	ND
Boys Locker Room Rear Corner Floor	Surface Wipe	627-JAC-26	0.70 (Aroclor 1254)
Room 120 Top of Black Book Shelf	Surface Wipe	627-JAC-27	0.39 (Aroclor 1254)
Room 120 Back Floor Area	Surface Wipe	627-JAC-28	0.64 (Aroclor 1254)
Samples Collected by Inspector Robert May			
Lower Level Classroom 108, Counter Top	Surface Wipe	0627RM-24	ND
Lower Level Black Fire Box Top	Surface Wipe	0627RM-25	0.33 (Aroclor 1254)
Lower Level Classroom 171, Top of Storage Cabinet	Surface Wipe	0627RM-26	ND
Lower Level Hallway Outside of Classroom 171 on Top of Sloped Lockers	Surface Wipe	0627RM-27	ND
Lower Level Classroom 166, Storage Cabinet Top	Surface Wipe	0627RM-28	0.76 (Aroclor 1254)
Lower Level Classroom 167, File Cabinet Top	Surface Wipe	0627RM-29	0.39 (Aroclor 1254)

Note: Results in bold text in Table 6 exceed proposed clean-up standard for "high occupancy" school use building for wipe <u><</u>1 µg/100 cm².

A total of 8 of the 24 samples (33%) exceeded a concentration of ≤ 1 µg/100 cm^2. The range of samples was ND to a high of 3.1 microgram per wipe. This additional information identified that PCBs were present in the building and not just associated with windows and doors which also led to conclusion that additional interior sources of PCBs were present. Refer to **Appendix F** for additional wipe sample laboratory analysis results and chain of custody on June 27, 2011.

5.2 Bulk Sampling of Additional Bulk Products

On June 27 and 29, 2011, EnviroScience's representative, Robert May, collected nine (9) bulk samples of suspect PCB Bulk Product building materials to be analyzed for PCBs. Sampling involved removal of bulk product materials (source materials), using hand tools to submit in bulk form to determine PCB content. Tools utilized to collect samples were disposable items and discarded after each individual sample was collected to avoid cross contamination of samples. Each sample was placed in an individual container, labeled, and delivered to laboratory using proper chain of custody. Samples were analyzed at Con-Test Analytical Laboratories located in East Longmeadow, MA. Samples were analyzed using EPA Method 3500B/3540C (Soxhlet Region 1) for extraction and analysis of samples using EPA Method 8082. Refer to Table 7 for analytical results of all PCB bulk samples.

The following table identifies the collected samples by location, material type, and sample number.

TABLE 7
Additional Sampling and Analysis Results for PCB Bulk Product Samples
June 27 and June 29, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Room 104 Ceiling	**Mastic adhesive above "tectum" ceiling panels**	**0627RM-30**	**64 (Aroclor 1254)**
Room 104 Ceiling	**Mastic adhesive above "tectum" ceiling panels**	**0627RM-31**	**73 (Aroclor 1254)**
Exterior, unit ventilator	White joint filler, appears as caulking	0629RM-01	ND
Exterior, unit ventilator air intake on roof for Cafeteria	Homasote insulation inside air intake duct	0629RM-02	11 (Aroclor 1254)
Exterior, unit ventilator air intake on roof for Media Center	Homasote insulation inside air intake duct	0629RM-03	10 (Aroclor 1254)
Room 265 Closet Area	"tectum" ceiling panels	0629RM-04	ND
Room 265 Closet Area	Mastic adhesive above "tectum" ceiling panels	0629RM-05	15 (Aroclor 1248)
Cafeteria	**Caulking at concrete column interior**	**0629RM-06**	**2,900 (Aroclor 1254) 5,500 (Aroclor 1254)**

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SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (mg/kg or ppm)
Room 154 Concrete column	Filler foam between interior concrete column/beams and interior plaster walls	0629RM-07	56 (Aroclor 1254)

Identified suspect materials included locations of interior caulking at columns, a foam filler at concrete beams and columns, mastic/felt above tectum ceiling panels, white plaster material at air intake at unit ventilators, and homasote insulation at roof air intake ducts. Of the sampled materials regulated concentrations of PCBs above 50 ppm were identified associated with interior caulking at columns, the foam filler at concrete beams and columns, mastic/felt above "tectum" ceiling panels. The significant sources of PCB Bulk Product included more than 70,000 square feet of ceiling mastic and caulking both interior and exterior to the building. Refer to **Appendix G** for additional bulk sample laboratory analysis results and chain of custody on June 27 and 29, 2011.

Interior Caulking

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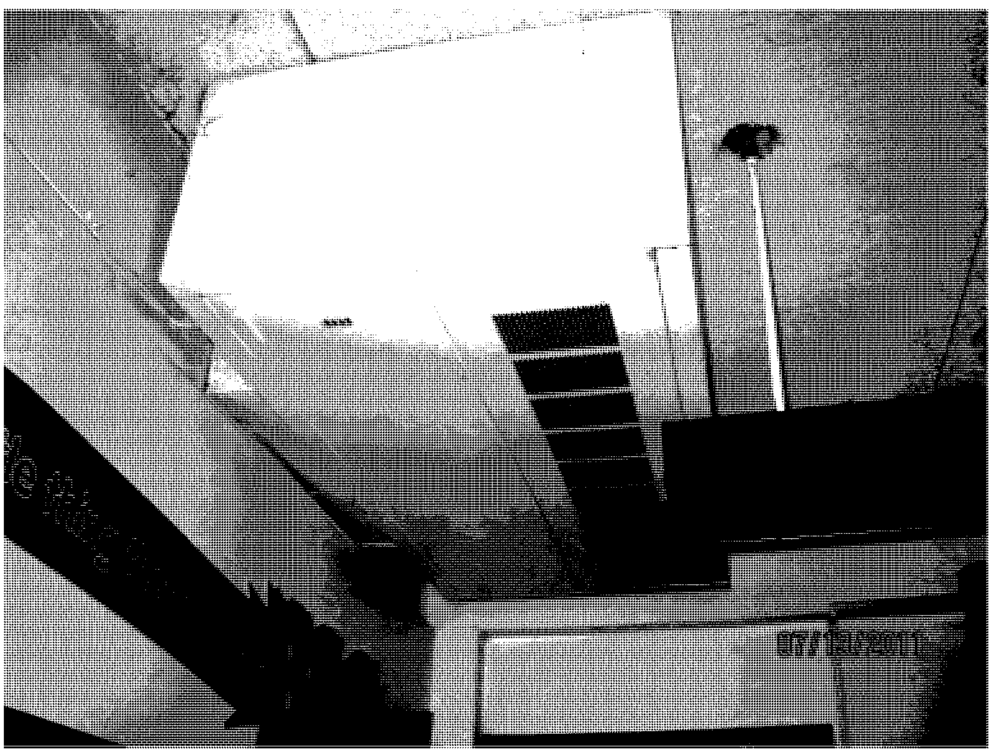
Interior Showing Tectum Ceilings and Overhead Unit Ventilators in Cafeteria



Interior Showing Tectum Ceilings and Overhead Unit Ventilators in Classroom

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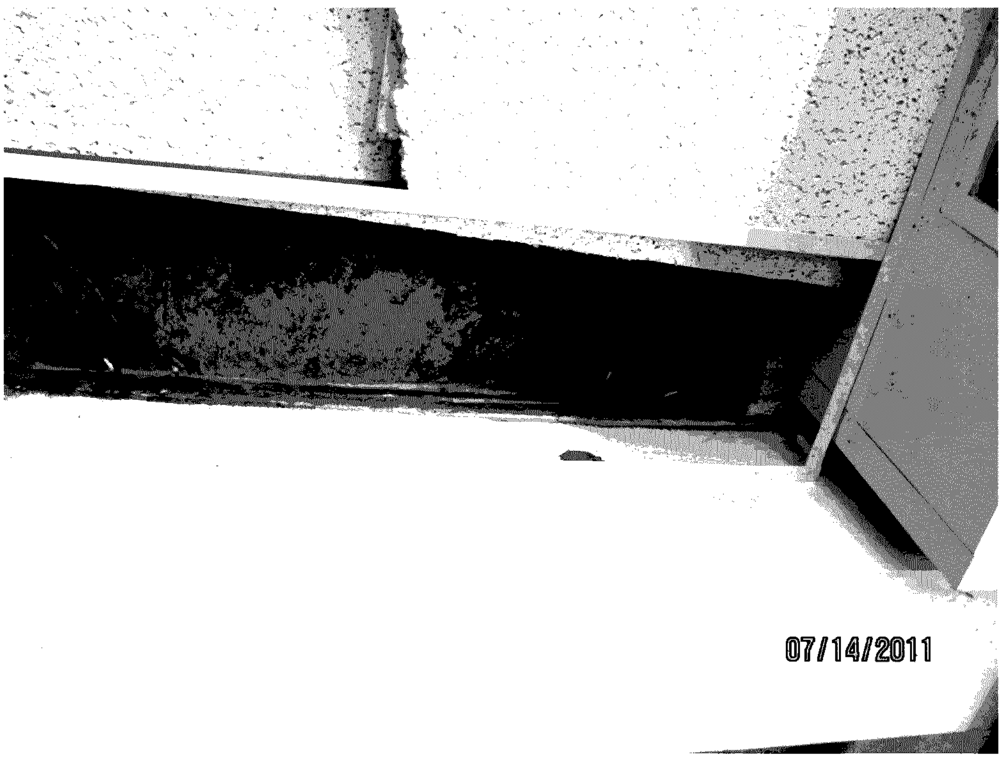
Interior Showing PCB Mastic above Tectum Ceilings (note location where tectum removed and drop ceiling present)



Interior Showing Tectum Ceilings at location of beam where removed in lower level

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Exterior Showing Roof and open roof top air intake

Exterior Showing close view of air intake at roof

6 Assessment and Mitigation Planning

6.1 Initial Planning

The discovery of interior sources of PCBs prompted a site meeting with EPA Region 1 Coordinator to discuss next steps in planning process and potential occupancy of school in September2011. The meeting on site was attended by EnviroScience, EPA, WCS Superintendent, WPSC representatives, and Pinck representatives to discuss potential mitigation efforts and develop a conceptual assessment and mitigation plan. The site meeting occurred on July 14, 2011.

EPA suggestions based on the identified sources was to conduct several tests of indoor air by isolating select PCB Bulk Product materials to determine which materials were producing indoor air concentrations. EPA was of the opinion that based on the concentrations identified and the magnitude of materials within the building occupancy in September 2011 was unlikely and alternative space should be identified by the WCS.

The target concentration for PCBs in indoor air in the building which contained PCB levels above EPA posted "Public Health Levels for PCBs in School Indoor Air" was reduction to levels below the guidelines applicable to the lowest student age group of 300 ng/m³ for indoor air that occupy the building.

The plan consisted of the following components:

- Identify alternative locations for student population and teachers for school year 2011/2012.
- Complete a comprehensive review of the ventilation system for the building and take measures to increase ventilation to optimal performance and clean existing ventilation systems.
- Inspect fluorescent light fixtures/ballast in the building. Upon inspection, any ballast's not labeled as "No PCB" were to be removed and replaced with new ballast's by a licensed electrician. In addition, any metal housings or plastic light covers with apparent staining from PCB ballast oil were removed and replaced with new components.
- Conduct a pilot project within select representative rooms having the conditions identified on both upper and lower levels of the building. The locations included rooms 212, 264, 110 and 164. Elements to be included in the pilot project were to include the following:
  - Conduct base-line sampling within each room to serve as a pilot room. Sampling included collection of indoor air samples and wipe samples.
  - Clean furniture and all room surfaces using HEPA vacuums and wet wipe cleaning methods.
  - Clean and balance existing unit ventilation systems within rooms to be used as pilot and run systems for a minimum period of 24 hours.
  - Upon completion conduct wipe sampling to confirm PCB concentrations have been reduced to below $\leq$1 μg/100 cm².
  - Repeat air sampling for indoor air to document any variation based on just cleaning and optimized ventilation of the rooms.
  - Conduct specific removal of identified PCB Bulk Product materials within specified locations to include complete removal of "tectum" ceilings, removal of mastic adhesives and felt to 90%, and removal of exterior caulking at window locations adjacent to unit ventilator intakes (typically) one or two windows only. Additional materials removed as appropriate based on presence included interior caulking at columns in room 264 and filler foam within room 164.

7 Conduct Pilot Project

The purpose of the pilot project was to evaluate various mitigation efforts that could effectively reduce the indoor air concentrations of PCBs within the classrooms to below the EPA guidance level of 300 ng/m³. The pilot test was designed to be implemented in a phased approach to determine which specific mitigation activities could be undertaken to achieve the project goal.

The pilot project work was conducted by Triumvirate Environmental Inc. (Triumvirate) utilizing Commonwealth of Massachusetts state contract through the Operational Services Division (OSD). The pilot project included an action plan in several representative rooms of the building to physically remove materials to better understand the feasibility of conducting the work, associated time and cost to complete and identify, with post removal air samples, the effectiveness of raising indoor air quality to acceptable ranges. Work began upon receipt of an e-mail notification on July 21, 2011 to EPA Region 1 Coordinator of planned PCB Bulk Product Removal which did not require a formal plan submission. The mastic/felt above "tectum" was also determined to contain asbestos and required a waiver from the Massachusetts Department of Environmental Protection (MassDEP) and the Department of Labor Standards (DLS) formerly known as the Division of Occupational Safety (DOS) to allow the removal of asbestos mastic. A waiver was granted by Mr. Andrew Cooney of MassDEP and subsequently from Gary Gaspar of DLS.

A detailed description of pilot process is provided and the time frame for completion included the following:

- 7-21 clean room contents and hard surfaces within rooms (Triumvirate)
- 7-22 HVAC contractor and balancer cleaned, reviewed and balanced unit ventilators (Triumvirate)
- 7-22 Take wipes on hard surfaces after cleaned (base-line) (EnviroScience)
- 7-22 to 7-23 run HVAC systems for a minimum of 24 hours
- 7-23 collect base-line post cleaning and balancing air and wipe samples (EnviroScience)
- 7-23 once initial samples collected begin set-up of containment (Triumvirate)
- 7-23 to 7-25 remove source materials (Triumvirate)
- 7-26 collect multiple post removal air samples (including variation of conditions such as some carpets were isolated and covered with poly sheeting and then run again uncovered). Samples collected by (EnviroScience)
- 7-28 to 8-2 air and wipe results received from lab (Con-test)

Results of pilot determined the effectiveness of reducing indoor air concentrations by removing the identified interior sources of PCBs and limited removal of exterior caulking materials around windows beneath unit ventilator intake points. Indoor air sample results identified post removal indoor air concentrations to be close to or lower than 300 ng/m3.

7.1 Pre-Cleaning

The furniture, exposed horizontal surfaces and other items within the open area of the classrooms were cleaned utilizing wet wipe wash (water and Simple Green™). If observable dust was present, the items were initially cleaned utilizing HEPA vacuum. Once cleaned, the items were moved from the room. The items were staged in separate areas identified by classroom number for ease in identification. Two surfaces within the rooms were sampled in accordance with EPA recommendations. Hexane was used as the organic solvent in this procedure.

The samples were analyzed for PCB utilizing EPA Method 3540C for extraction and EPA Method 8082 for sample analysis. The results were compared to the EPA guideline for the cleanup of PCBs on surfaces in schools of $\leq$1 ug/100 cm². Refer to Table 8 for a summary of pre-cleaning wipe sample results conducted as baseline for the pilot rooms. The laboratory analysis results are presented in **Appendix H**.

TABLE 8
Sampling and Analysis Results for Pre-Cleaning Pilot PCB Wipe Samples
July 22, 2011

SAMPLED LOCATION	OBJECT	SAMPLE NO.	PCB CONTENT (µg/wipe)
Room 212	Unit Vent	722RM-W-01	0.85 (Aroclor 1254)
Room 212	Counter	722RM-W-02	1.1 (Aroclor 1254)
Room 212	Unit Vent	722RM-W-03	0.66 (Aroclor 1254)
Room 264	Counter	722RM-W-04	1.6 (Aroclor 1254)
Room 264	Table	722RM-W-05	1.2 (Aroclor 1254)
Room 164	Table	722RM-W-06	0.23 (Aroclor 1254)
Room 164	Bookshelf	722RM-W-07	0.29 (Aroclor 1254)
Room 110	Counter	722RM-W-08	0.031 (Aroclor 1254)
Room 110	Counter	722RM-W-09	0.18 (Aroclor 1254)
Blank	Blank	722RM-W-10	0.0 (Aroclor 1254)

As the majority of the teaching materials, i.e. books, paper and other supplies, were stored in closed cabinets these items were boxed and made available to the respective teachers. Any visually observed dust was removed from these teaching materials via wet wipe or HEPA vacuum (in general, minimal dust was observed on these materials).

Following the cleaning and removal of furnishings, surfaces within the rooms were cleaned utilizing combination of HEPA vacuum and wet wiping methods. Rooms were thoroughly cleaned including cleaning of all horizontal surfaces within the room, working from the top portions of the room to the floor, using HEPA vacuum and wet wiping methods. The objective of the initial cleaning was to remove accumulated visible dust which remained in the room following furniture/teaching materials cleaning and removal.

7.2 HVAC Balance and Cleaning

Upon completion of pre-cleaning within the rooms to be used for pilot project, the unit ventilators were cleaned and balanced by an HVAC specialist, retained by Triumvirate, to ensure their proper operation and to optimize the amount of fresh air intake for the units. Three of the rooms for the pilot including rooms 110, 164 and 212 consisted of unit ventilators with shared direct exterior vents located in the soffit area between upper and lower levels of the building. The unit ventilators for rooms 110 and 164 were mounted on ceiling surfaces on perimeter wall. The unit ventilator in room 212 was floor mounted. The HVAC system in room 264 included an internal ceiling mounted unit ventilation system with fresh air intake located on the roof.

Once the HVAC specialist completed work it was determined that unit ventilators were providing approximately 50% fresh air make-up as the intake for the classrooms. The systems were operated for a period of 24 hours prior to conducting indoor air sampling.

7.3 Baseline Air and Wipe Samples

One indoor air sample was collected from each pilot room location as well as one in an adjacent room for a total of eight air samples after cleaning and balancing of HVAC systems and running for a period of 24 hours. The samples were to identify baseline concentrations prior to conducting removal of PCB Bulk Products during pilot project. PCB indoor air samples were collected on July 23, 2011 in accordance with EPA Method TO-10A. Sufficient sample volume of 1,000 L of air was collected on sample media to achieve a limit of detection of 0.01ng/m³ by homolog analysis. QA/QC samples, including one duplicate and one blank, were also obtained. The samples were collected following EPA Method TO-10A procedures using low flow air sampling pumps and polyurethane foam traps (PUF tubes), over a duration of approximately 200 minutes at flow rates of approximately 4-5 liters per minute.

During the indoor air sampling, conditions that are typically present within the school when the students are present, (E.g. doors closed, unit ventilators and other HVAC systems in operation) were observed. The samples were submitted for PCB homolog analysis (modified 8270C) to Con-test Analytical Laboratory in East Long Meadow, MA.

TABLE 9
Pilot Project Baseline Air Sampling and Analysis Results for PCB Indoor Air Samples
July 23, 2011

SAMPLED LOCATION	MATERIAL TYPE	SAMPLE NO.	PCB CONTENT (ng/m³)
Room 212	**Indoor Air Sample**	**723-JAC-A-01**	**840**
Room 212 (duplicate)	**Indoor Air Sample**	**723-JAC-A-02**	**780**
Cafeteria	**Indoor Air Sample**	**723-JAC-A-03**	**1,000**
Room 264	**Indoor Air Sample**	**723-JAC-A-04**	**1,000**
Room 268	**Indoor Air Sample**	**723-JAC-A-05**	**820**
Room 164	Indoor Air Sample	723-JAC-A-06	160
Room 163	**Indoor Air Sample**	**723-JAC-A-07**	**540**
Room 110	**Indoor Air Sample**	**723-JAC-A-08**	**540**
Room 108	**Indoor Air Sample**	**723-JAC-A-09**	**620**
Blank	Indoor Air Sample	723-JAC-A-10	ND

Note: Results in bold text in Table 9 meet or exceed EPA indoor air advisory concentration of 300 ng/m³ for ages 6 to <12years of age.ND –None Detected

Refer to **Appendix I** for laboratory analysis results.

Wipe samples were also taken again after the unit vents had been run for 24 hours after cleaning and after the air samples had been run as to not affect them.

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TABLE 10
Sampling and Analysis Results for Pre-Cleaning Pilot PCB Wipe Samples
July 23, 2011

SAMPLED LOCATION	OBJECT	SAMPLE NO.	PCB CONTENT (µg/wipe)
Room 212	Unit Vent	723JAC-W-01	0.91 (Aroclor 1254)
Room 212	Counter	723JAC-W-02	0.69 (Aroclor 1254)
Room 212	Unit Vent	723JAC-W-03	0.27 (Aroclor 1254)
Room 264	Counter	723JAC-W-04	0.88 (Aroclor 1254)
Room 264	Table	723JAC-W-05	0.29 (Aroclor 1254)
Room 164	Table	723JAC-W-06	0.27 (Aroclor 1254)
Room 164	Bookshelf	723JAC-W-07	0.13 (Aroclor 1254)
Room 110	Counter	723JAC-W-08	0.13 (Aroclor 1254)
Room 110	Counter	723JAC-W-09	0.063 (Aroclor 1254)
Blank	Blank	723JAC-W-10	0 (Aroclor 1254)

Refer to **Appendix J** for laboratory analysis results.

7.4 Conduct Pilot Removal Selective PCB Bulk Products

Upon collection of the baseline indoor air samples from the pilot room locations, Triumvirate crews began preparation of containment for the removal of the PCB Bulk Product materials within each location. The detailed work performed included the following:

- Prior to Testing, Unit Ventilators (UV) were cleaned in Rooms to be used as Pilot including Rooms 110, 164, 212 and 264 on July 22, 2011.
- Within the same locations, UVs were balanced by HVAC sub-contractor.
- Entire Rooms including Rooms 110, 164, 212 and 264 were cleaned by wet wiping and HEPA vacuuming.
- Once complete EnviroScience collected dust wipe samples from 2 representative surfaces. July 22, 2011.
- UVs were run continuously for 24 hours from July 22 to July 23, 2011.
- Wipe samples were collected again directly adjacent to initial tests after 24 hours on July 23, 2011.
- We began air samples using Method TO-10A within each room after the 24 hour period of running UV units. July 23, 2011.
- Upon completion of source removal or isolation work, we collected air samples for PCB analysis using Method TO-10A. Results are included in Table 1. Table 2 is a comparison of three sets of air data points from June 7, 2011, July 23, 2011 and June 27, 2011.

The pilot project included the following removal or isolation methods for various known or potential source materials:

Room 164 - Removal of an estimated 840 SF of "tectum" ceiling panels, removal of 95% of black mastic/felt from concrete ceiling, removal hampered due to condition of concrete ceiling and ceiling was encapsulated to allow asbestos clearance with Fiberlock bridging encapsulant.

Room 164 – Removal of 72 LF of caulking from first floor level window units (3 total) located on either side of air intake of Room 164 unit ventilator unit. Installation of Silicone sealant in place of old material.
Room 164 – Foam filler at columns and beams located in room were not removed.
Room 212 – Removal of 860 SF "tectum" ceiling panels, removal of 95% of black mastic/felt from concrete ceiling, removal hampered due to condition of concrete ceiling and ceiling was encapsulated to allow asbestos clearance with Fiberlock bridging encapsulant.
Room 212 – Removal of 24 LF of caulking from first floor level window unit located below air intake of Room 212 UV unit. Installation of Silicone sealant in place of old material.
Room 212 – Removal of 20 LF foam filler at 1 column located in room.
Room 264 – Removal of 40 LF of interior column caulking at 2 columns.
Room 264 – isolation of half the area of room where carpet was covered with 2 layers of 6-mil polyethylene sheeting. Room 264 is 980 SF. Air sample run on each half of the room divided by two layers of 4-mil polyethylene sheeting. Note each room included a column where caulking was removed. Note unit ventilator unit was not located on exterior perimeter wall and air intake is on roof so no window caulking was removed. The "tectum" ceiling panels were initially not removed from this location prior to air sampling.
Room 110 – No work performed due to difficulty in removing "tectum" ceiling mastic and plans for work were abandoned to focus on completion of three rooms.

7.5 Post Removal Air and Wipe Samples

Upon completion of pilot project removal work, an initial air test for asbestos was performed utilizing Transmission Electron Microscopy (TEM) due to the presence of asbestos in both ceiling mastic and caulking materials. Once completed air samples were also collected for PCB utilizing EPA Method TO-10A.

TABLE 11
Sampling and Analysis Results for Post Removal PCB Air Samples Collected During Pilot Project
July 27, 2011

SAMPLED LOCATION	SAMPLE TYPE	SAMPLE NO.	PCB CONTENT (ng/m^3)
Room 264 (Pilot Room) – uncovered carpet	Air Sample – TO-10A PCB Homologues	727JH-A-01	**480**
Room 264 (Pilot Room) – covered carpet	Air Sample – TO-10A PCB Homologues	727JH-A-02	**420**
Room 212 (Pilot Room)	Air Sample – TO-10A PCB Homologues	727JH-A-03	280
Room 164 (Pilot Room)	Air Sample – TO-10A PCB Homologues	727JH-A-04	61

Note: Results in bold text in Table 11 meet or exceed EPA indoor air advisory concentration of 300 ng/m^3 for ages 6 to <12years of age.

ND – None Detected

Average temperature range for samples was 84.9 degrees, and ambient pressure was 29.8 inches mercury.

Refer to **Appendix K** for laboratory analysis results.

Once the airs were run, additional wipe samples were taken on surfaces in the rooms.

TABLE 12
Sampling and Analysis Results for Post Removal Pilot PCB Wipe Samples
July 27, 2011

SAMPLED LOCATION	OBJECT	SAMPLE NO.	PCB CONTENT (µg/wipe)
Room 264	Counter	727JH-W-01	0.0 (Aroclor 1254)
Room 264	Desk	727JH-W-02	0.91 (Aroclor 1254)
Room 212	Unit Vent	727JH-W-03	0.37 (Aroclor 1254)
Room 212	Counter	727JH-W-04	0.71 (Aroclor 1254)
Room 164	**Sill**	**727JH-W-05**	**7.8 (Aroclor 1254)**
Room 164	Counter	727JH-W-06	0.0 (Aroclor 1254)

Note: Results in bold text in Table 12 exceed proposed clean-up standard for "high occupancy" school use building for wipe ≤1 µg/100 cm². This room was re-cleaned.

Refer to **Appendix L** for laboratory analysis results.

TABLE 13
Results Comparison for June 7, 2011 Initial Sampling to July 23, 2001 Base-line Sampling for Pilot Project, and Results post Pilot Project in select locations collected on July 27, 2011

SAMPLED LOCATION	SAMPLE TYPE	Results for June 7 (ng/m³)	Results for July 23 (ng/m³)	Results for July 27 (ng/m³)
Room 212 (Pilot Room)	Air Sample – TO-10A PCB Homologues	940	840	280
Room 212 (Pilot Room) – Duplicate Sample	Air Sample – TO-10A PCB Homologues	940	780	N/A
Room 264 (Pilot Room) – covered carpet	**Air Sample – TO-10A PCB Homologues**	**990**	**1,000**	**420**
Room 264 (Pilot Room) – uncovered carpet	**Air Sample – TO-10A PCB Homologues**	**990**	**1,000**	**480**
Room 164 (Pilot Room)	Air Sample – TO-10A PCB Homologues	170	160	61

SAMPLED LOCATION	SAMPLE TYPE	Results for June 7 (ng/m³)	Results for July 23 (ng/m³)	Results for July 27 (ng/m³)
Room 164 (Pilot Room)	Air Sample – TO-10A PCB Homologues	240 (prior duplicate sample)	160	61

Note: Results in bold text in Table 10 meet or exceed EPA indoor air advisory concentration of 300 ng/m³ for ages 6 to <12years of age.

ND – None Detected

The findings indicated most considerable change in room 212 from 840 ng/m³ to 280 ng/m³ as a difference of 560 ng/m³. The results in room 264 did not show a significant difference between carpeted floor being isolated or not isolated. The difference in the concentrations from July 23 to July 27th with the removal of the interior caulking at columns within Room 264 was also significant at a difference of 520 ng/m³. It should be noted that the result is still over 300 ng/m³ and in this location the "tectum" ceiling and mastic was not removed. It should also be noted that the samples were collected during the late evening to early morning hours when temperatures were lower in general both indoors and outdoors. To confirm the results observed in Room 212, Room 264 was placed under containment and the "tectum and mastic totaling 980 SF was removed and encapsulated similarly to work performed in rooms 212 and 164.

A single indoor air sample was collected in Room 264 on August 5, 2011 upon completion of "tectum" ceiling and mastic/felt. Result decreased further to 320 ng/m³.

Results of pilot determined the effectiveness of reducing indoor air concentrations by removing the identified interior sources of PCBs and limited removal of exterior caulking materials around windows beneath unit ventilator intake points. Indoor air sample results identified post removal indoor air concentrations to be close to or lower than 300 ng/m³.

A special meeting of the Permanent School Committee was held to identify the results of pilot project and discuss anticipated costs for replication of process throughout the school building on August 2, 2011. Budget costs were prepared by Triumvirate. The meeting prompted a request to obtain a second quote in order to ensure costs were competitive. A proposal package was prepared and site walk through planned to allow both Triumvirate as the original pilot project Contractor and a second vendor being LVI Environmental Services, Inc. (LVI) to provide comparative quote for the work. A copy of the document prepared to obtain quotes which serves as the scope of the project is included in Appendices.

8 Development of Plan for Replicating Pilot Project for Removal or Interim Measures Identified Bulk Product Material

8.1 Special Meetings

A special meeting of the WPSC was held to identify the results of pilot project and discuss anticipated costs for replication of process throughout the school building on August 2, 2011. Budget costs were prepared by Triumvirate. The meeting prompted a request to obtain a second quote in order to ensure costs were competitive. A proposal package was prepared and site walk through planned to allow both Triumvirate as the original pilot project Contractor and a second vendor being LVI Environmental Services, Inc. (LVI) to provide comparative quote for the work. A copy of the document prepared to obtain quotes which serves as the scope of the project is included in **Appendix M**.

A meeting was held on August 11, 2011 with EPA Region 1 Coordinator and WPSC to discuss the plans to move forward with source removal of identified PCB Bulk Product materials. EPA Region 1 Coordinator confirms no formal submission of a plan is required but requests the project documentation be provided during the course of work to ensure they are made aware of the results of activities. Caution is offered by EPA Region 1 Coordinator that this process is only the first step with only goal of potentially occupying building in September 2011 and that long range plans and goals for continued monitoring and eventual elimination of all PCB Bulk Product Materials and addressing adjacent PCB Remediation Wastes must be developed by WCS

A plan was developed as part of documents prepared to obtained quotes and submitted to Ms. Kimberly Tisa on August 10, 2011 by e-mail.

8.2 Plan for Removal

PCB ABATEMENT REQUIREMENTS

PCB Decontamination and Bulk Product Waste Removal

1. Conduct detailed cleaning of all unit ventilation systems including both wall and ceiling units within entire school facility. Note interior unit ventilators with air intakes on roof shall include cleaning duct work from roof top to unit.
2. All unit ventilation systems shall be adjusted and balanced by a mechanical sub-contractor for optimum ventilation within entire school facility.
3. Decontaminate interior non-porous materials throughout school building utilizing methods of decontamination consistent with EPA and MADPH requirements. The work shall include the use of HEPA vacuum and wet wiping to remove all visible dust. Existing dust concentrations exceed EPA guidance of 1 microgram per 100 square centimeters (ug/100 cm^2) for a school facility. Surfaces shall be cleaned and sampling to confirm cleanliness shall be performed. Results of wipe samples collected must be below 1 ug/100 cm^2. For porous items (eg papers, books etc., these items shall be HEPA vacuumed and placed in storage containers to be provided by Westport Community Schools. Each container shall be labeled with location of items for proper storage.
4. Remove existing exterior caulking at all ground floor windows located below a unit ventilation system air intake and those within 10 feet of an air intake unit. It is estimated that this will require removal of approximately 2,000 LF of caulking. Caulking contains PCBs >50 ppm and asbestos. Materials will be properly disposed and area of caulking removal cleaned. Once cleaned install new silicone caulking to re-seal joints. Provide backer rods as necessary.
5. Remove existing interior caulking at all interior columns, doors and expansion joints. It is estimated that this will require removal of approximately 1,500 LF of caulking. Caulking contains PCBs >50 ppm and asbestos. Materials will be properly disposed and area of caulking removal cleaned. Once caulking has been removed, clean the adjacent surfaces and coat with two parts Sikagard 62 or equivalent heavy – build colored epoxy coatings. Coating shall be applied by brush to cover entire surface of prior caulking joint and minimum of ½ inch either side of joint. Product shall be installed with two contrasting colors so initial layer can be observed if wear of top coating occurs. Install new silicone caulking to re-seal joints. Provide backer rods as necessary.
6. Remove existing tectum ceilings located just below concrete floor or ceiling (not in grid). Material

removal will result in some removal of PCB containing mastic. Mastic contains PCBs >50 ppm PCB and asbestos. It is estimated that this will require removal of approximately 70,000 SF of tectum panels and associated mastic adhesive/felt. Remaining mastic shall be scraped to the extent possible to remove not less than 90% of all accessible material utilizing hand scraping and then clean all surfaces. Entire concrete ceiling and remaining mastic shall be encapsulated with a bridging encapsulant due to the presence of asbestos. Where mechanical equipment and above top of walls, prevents removal of the tectum and mastic, the materials will be left in place and also coated with the bridging encapsulant to seal edges.

7. Remove interior carpeting in all locations including cleaning of mastic to facilitate installation of new flooring consisting of VCT. Westport Community Schools to provide product requirements for replacement materials.
8. Interior work areas shall be cleaned to meet asbestos final visual inspection criteria of no visible dust. A post removal inspection shall be performed and work areas shall be required to meet final air clearance sampling in accordance with AHERA regulations by Transmission Electron Microscopy (TEM).
9. All wastes generated shall be disposed of as Bulk Product Waste> 50 ppm which also contains asbestos. Note segregation of interior non asbestos caulking at interior columns is at the discretion of the contractor.

PCB Bulk Product Waste Removal – Alternates

1. Remove all existing exterior caulking at all windows and doors at all remaining locations. It is estimated that this will require removal of approximately 3,500 LF of caulking. Caulking contains PCBs >50 ppm and asbestos. Materials will be properly disposed and area of caulking removal cleaned. Once cleaned install new silicone caulking to re-seal joints. Provide backer rods as necessary.
2. Conduct interim measures to coat existing interior window glazing compound with 2 coats of epoxy coating. Products to include Sikagard 62 or equivalent heavy –build colored epoxy coatings. Product shall be installed with two contrasting colors so initial layer can be observed if wear of top coating occurs. It is estimated that there are 240 window systems with glazing compounds to be included.
3. Remove existing interior foam filler at all interior columns and beams. It is estimated that this will require removal of approximately 12,000 LF of foam filler. Materials contain PCBs >50 ppm. Materials will be properly disposed and area removal cleaned. Once cleaned install new compressible filler to re-seal joints.
4. All wastes generated shall be disposed of as Bulk Product Waste> 50 ppm which also contains asbestos where noted. Note segregation of interior non asbestos foam filler at interior columns and beams is at the discretion of the contractor.

9 Conduct Bulk Product Removal and Interim Measures Throughout Entire Building

9.1 Project Objectives

The project was conducted for the removal of polychlorinated biphenyl PCB-containing materials with equal to or greater than 50 parts per million (ppm) PCB as PCB Bulk Product Waste. These material included all those materials identified within the building. It should be noted that the site was not fully inspected for the presence of PCBs and only the materials listed within this report were identified and tested for PCBs. The primary objective of the work is to reduce the indoor air concentrations to within EPA advisory concentration of 300 ng/m^3 for children ages 6 to 12 and 450 ng/m^3 for faculty and staff at 19 plus years (adults) in the school. The project included the decontamination of all interior non-porous items utilizing EPA and the Massachusetts Department of Public Health (MADPH) suggested protocols for cleaning surfaces contaminated with PCBs.

9.2 Removal Project

The project to begin removal of interior and exterior identified PCB source materials as PCB Bulk Product Waste began on August 11, 2011. The selected Contractor was Triumvirate. Triumvirateutilized as sub-contractors Dec-Tam Corporation (Dec-tam) as well as LVI Services (LVI) to assist with the project to maintain goal of opening school on September 6, 2011. The scope of work included the complete removal of all accessible interior "tectum" ceiling panels and the majority of associated asbestos and PCB-containing mastic/felt on concrete ceiling deck. Work also included complete removal of allPCB-containing interior caulking, allinterior PCB-containing foam filler, and removal of all exterior PCB-containing window caulking. PCB-containing caulking was removed from interior and exterior door systems to the height of the doors. Interior PCB-containing window glazing compound could not be removed and will need to be part of a future window replacement project, so as an interim measure work included encapsulation of the caulking. Initial phases of work included a thorough cleaning of the exterior of all room furnishings utilizing HEPA vacuums and wet wiping to clean potentially PCB laden dust. Once clean, wipe samples from representative locations were collected and furniture was tagged and moved to gymnasium or exterior storage trailer by a moving company. Locations of carpeting were removed where present with the exception of office areas and media center offices. Once rooms were emptied, a full negative pressure enclosure was established in accordance with requirements of 453 CMR 6.00 for asbestos removal. Tectum and associated mastic adhesives were removed from all classrooms and where located, program spaces such as the cafeteria and media center. Once completed, areas were final cleaned and ceilings encapsulated with an asbestos encapsulant and final air clearance samples by Transmission Electron Microscopy (TEM) were collected on rush turnaround. Once final air clearance was achieved for asbestos, the work area barriers (wall polyethylene sheeting) were partially removed to facilitate access to interior PCB materials which did not contain asbestos. These materials included interior foam filler, interior caulking, and interior window glazing compound. These materials were then removed with the exception of interior window glazing which was encapsulated as an interim measure with a new layer of caulking to conceal the glazing compound. Original intent was to utilize Sikagard to encapsulate, but it would not adhere to glass surfaces without etching which was beyond the scope of the work. For caulking locations and foam filler locations, once bulk\product materials were removed, Sikagard, encapsulant was installed in joint prior to re-caulking as an interim measure as recommended by the EPA Region 1 Coordinator.

While interior work was occurring, workers removed all of the exterior PCB containing caulking at windows and lower accessible portions of the door systems. Containment barriers included use of polyethylene sheeting on interior side of windows and door systems and covering of ground surfaces and unit vent intakes. Workers wore appropriate personal protective equipment. Exterior caulking materials also contained asbestos and required acceptable visual inspection by licensed asbestos project monitors prior to re-caulking of joints. See **Appendix N** for copies of Asbestos Project Monitor Licenses. See **Appendix O** for copies of the Final Visual Inspection Certifications. See **Appendix P** for Copies of the Site Logs. See **Appendix Q** for copies of the Contractor Sign-In Logs. See **Appendix R** for copies of the Daily Monitoring Sheets. See **Appendix S** for copies of the Background Air Sheets.

Upon completion of work to remove or encapsulate source materials, work areas were thoroughly cleaned and representative wipe samples for PCB were collected within each room on non-porous floor and porous window sills. HVAC systems were cleaned and balanced and run for a period of 12 hours in addition to continued ventilation with HEPA equipped negative air filtration devices. Post removal indoor air samples were collected for analysis using Method TO-10A Homolog analysis. Samples were collected in all classrooms and function spaces. Work was conducted in phases as each work area was completed.

9.3 Site Preparation and Controls

The work was performed in accordance with the work plan prepared by EnviroScience.
Prior to initiating PCB Removal the following site controls were implemented.

1. Remediation Contractor prepared a Health & Safety Plan (HASP) developed specific to the site and work activities to be performed. All workers followed applicable federal and state regulation with regard to work activities, including but not limited to OSHA regulation including personal protection and respiratory protection requirements.
2. During all remediation activities, Contractor maintained control of all entrances and exits to the project site to ensure only authorized personnel enter the work areas and are afforded proper personal protective equipment and as required respiratory protection.
3. Work zones were established to include abatement zone, decontamination zone, and support zone
4. The Support zone included parking lot areas adjacent to the building and loading dock area adjacent to Kitchen.
5. The Contractor placed waste containers on exterior paved surface in rear parking area and fenced off the parking area where dumpsters were stored.
6. Appropriate PCB waste containers were lined, covered and secured. The PCB waste containers were properly marked once loaded as described in 40 CFR part 761.40 and 761.45.
7. The decontamination zones included the corridors which run parallel to the work areas. The floor surface within the decontamination zone were completely covered with a single layer of 6-mil polyethylene sheeting.
8. Warning signs were posted in accordance with 29 CFR 19 10.1200 at all approaches to the work area. Asbestos warning signs were also posted in accordance with 29 CFR 1926.1101. Signs were conspicuously posted to permit a person to read signs and take precautionary measures to avoid exposure to PCBs or other Toxic or Hazardous Substances. The signs included the PCB ML markers at each entrance to the work area.
9. The Contractor established contiguous to each work area, a decontamination enclosure consisting of equipment room, shower room, and clean room in series. The only access between contaminated and uncontaminated areas was through this decontamination enclosure. The Contractor ensured that employees enter and exit the Abatement Zone through the decontamination area.
10. The equipment room was supplied with impermeable, labeled bags and containers for the containment and disposal of contaminated protective equipment.
11. Shower facilities were provided which complied with 29 CFR 1910.141(d)(3) and 29 CFR 1926.1101 for asbestos. The showers were in series between both the equipment room and the clean room.
12. The clean room was equipped with a locker or appropriate storage container for each worker's use. Following showering, each worker changed into street clothing in clean change areas.

Work Area Protection Abatement Zone

The work performed included the removal of asbestos containing materials requiring full containment within a negative pressure enclosure meeting requirements of DLS. The Abatement zone or regulated area included the following:

1. Posted warning signs in accordance with 29 CFR 1910.1200 and 29 CFR 1926.1101 at all approaches to the work area. Signs shall be conspicuously posted to permit a person to read signs and take precautionary measures to avoid exposure to PCBs or other Toxic or Hazardous Substances. These signs included the PCB ML markers at each entrance to the work area.
2. Isolation barriers were installed as critical barriers at interior side of all window and door systems to isolate the abatement zone from areas outside of proposed work to prevent release of asbestos or PCB dust, debris or liquids. Protection included two layers of 6-mil polyethylene sheeting securely affixed to the inside finish surfaces to isolate window or door systems.
3. Isolation barriers were installed on interior wall surfaces within the abatement zone to minimize dispersal of dust and debris. Protection included two layers of 4-mil polyethylene sheeting securely affixed to the interior finish surfaces.
4. To minimize dust and debris negative pressure filtration devices were utilized to provide a negative pressure enclosure. The use of negative air filtration units with HEPA filtration established a minimum of 4 air changes per hour within the work area. The design parameter for static pressure differential between the inside and outside of enclosures was in a range from 0.02 to 0.10 inches of water gauge, depending on conditions.
5. All zones inside the enclosure shall have less pressure than the ambient pressure outside of the enclosure (-0.02 inches water gauge differential).
6. All other openings to the building interior such as unit ventilation, ducts, grills were securely sealed with a two layers of 6-mil polyethylene sheeting from the building interior.
7. Isolation barriers remained in place throughout work to prevent migration of any dust, debris or liquids resulting from PCB Bulk Product Waste and asbestos removal.
8. All debris generated during operations was HEPA vacuumed continuously throughout the work shift and at the end of a work shift to avoid accumulation. Any tears or rips that occurred in isolation barriers were repaired or removed and replaced with new.
9. All equipment utilized to perform cutting, or demolition was equipped with appropriate dust collection systems.
10. All surfaces adjacent to materials removed were properly decontaminated (cleaned) upon completing the removal of PCB Bulk Product Waste and asbestos.

9.4 Remediation Methods

The work was performed to meet the objectives identified in section 9.1 Project Objectives in accordance with 40 CFR Part 761. The remediation was performed to ensure compliance with EPA Toxic Substance Control Act (TSCA) requirements and protect both public health and the environment. Materials classified as PCB Bulk Product Waste also contain asbestos and were properly removed and disposed in compliance with federal and state regulatory requirements of the MassDEP and DLS agencies.

The abatement activities performed by the Remediation Contractor included the following:

1. Site preparation and controls to facilitate remediation of PCBs and asbestos.
2. Health and Safety in accordance with Occupation Safety and Health Administration (OSJ{A) requirements.
3. Recordkeeping and distribution as required in accordance with 40 CFR part 761.125 (c)(5).
4. Performance of selective demolition to remove "tectum" ceiling panels to facilitate removal of mastic/felt at concrete ceiling. Note "tectum" contained less than 50 ppm but due to the presence of mastic adhesive on "tectum" waste was disposed of as containing >50 ppm PCB.
5. Work was performed upon setup of required containment prior to conducting removal.
6. PCB Bulk Product Waste was removed and properly disposed in accordance with 40 CFR Part 761.62.

PCB ABATEMENT PERFORMED

PCB Decontamination and Bulk Product Waste Removal

1. The Contractor conducted detailed cleaning of all unit ventilation systems including both wall and ceiling units within entire school facility. Note interior unit ventilators with air intakes on roof included cleaning duct work from roof top to unit.
2. All unit ventilation systems were adjusted and balanced by a mechanical subcontractor for optimum ventilation within entire school facility.
3. The Contractor decontaminated interior non-porous materials throughout school building utilizing methods of decontamination consistent with EPA and MADPH requirements. The work included the use of HEPA vacuum and wet wiping to remove all visible dust. Pre-existing dust concentrations exceeded EPA guidance of 1 microgram per 100 square centimeters (ug/100 cm^2) for a school facility.
4. Surfaces were cleaned and sampling to confirm cleanliness was performed by EnviroScience and included 4 representative wipe samples per room. Results of wipe samples collected were required to be below 1 ug/l00 cm^2. For porous items (E.g. papers, books etc., these items were HEPA vacuumed and placed in storage containers to be provided by WCS.
5. Each container and furnishings were labeled with location of items for proper storage and moving company retained by WCS placed in central location in the gymnasium or storage trailers outside of the building to allow for PCB Bulk Product removal work to be conducted.
6. The Contractor removed existing exterior caulking at all windows, expansion joints and door systems. Note door systems removal was limited to height of doors only. Removal included approximately 6,000 LF of caulking. Caulking contained PCBs >50 ppm and asbestos and any backer rod material was also removed as PCB Contaminated waste.
7. Materials were properly disposed and area of caulking removal cleaned. Once cleaned the contractor installed new silicone caulking to reseal joints, providing backer rods as necessary.
8. The Contractor removed existing interior caulking at all interior columns, doors and expansion joints. The removal included approximately 2,500 LF of interior caulking. Caulking contained PCBs >50 ppm and asbestos. Materials were properly disposed and area of caulking removal cleaned. Once cleaned Contractor provided an encapsulant to seal masonry on both sides of joint as an interim measure. The encapsulation included 2 coats of epoxy coating. Product utilized was Sikagard 62 epoxy coatings. Product was installed with two contrasting colors so initial layer could be observed if wear of top coating occurs. Upon completion the Contractor installed new silicone caulking to reseal joints providing backer rods as necessary.

9. The Contractor removed existing "tectum" ceilings located just below concrete floor or ceiling (not in grid). Material removal resulted in some removal of PCB containing mastic which was on the surface of "tectum" panels. Mastic contained PCBs >50 ppm PCB and asbestos. It is estimated that approximately 70,000 SF of "tectum" panels were removed.
10. Upon complete removal of all "tectum" the ceilings were scraped to remove associated mastic adhesive/felt. Remaining mastic was scraped to the extent possible to remove up to 95% of the materials and then cleaned. Use of mechanical chipping guns was employed to assist with the removal work within containment.
11. Once complete removal to the extent possible was conducted a visual inspection was performed by EnviroScience to ensure sufficient material was removed.
12. The entire ceilings and portion of exposed concrete beams and remaining mastic was encapsulated with a bridging encapsulant due to the presence of asbestos.
13. Where mechanical equipment and above tope of walls, prevented removal of the "tectum" and mastic, the materials were left in place and encapsulant utilized to seal.
14. The Contractor remove interior carpeting in all locations including cleaning of mastic to facilitate installation of new flooring consisting of VCT. WCS provided product requirements for replacement materials and retained flooring sub-contractor
15. Interior work areas where materials also contained asbestos were cleaned to meet asbestos final visual inspection criteria of no visible dust. A post removal inspection was performed by an EnviroScience licensed asbestos project monitor and work areas were required to first meet final air clearance sampling in accordance with AHERA regulations by Transmission Electron Microscopy (TEM) analysis. See **Appendix T** for the TEM analytical results.
16. The Contractor also conducted interim measures which included coat existing interior window glazing compound with new caulking to seal the materials. The original intent was to encapsulate materials with Sikagard 62 or equivalent epoxy coatings. It was determined during work that the encapsulant would not bond to glass without etching of glass. Decision was made to utilize caulking in lieu of the originally proposed encapsulant.
17. The Contractor removed existing interior foam filler at all interior columns and beams. It is estimated that approximately 12,000 LF of foam filler was removed. Materials removed contained PCBs >50 ppm. Materials will were properly disposed and area of removal cleaned. Once cleaned the contractor provided encapsulant and install new caulking to re-seal joints.
18. Post testing was performed for PCBs including indoor air samples from each classroom or program space and an additional two dust wipe samples were collected on representative floor surfaces. This testing was performed sequentially as containment areas were completed by EnviroScience's on site project monitors. If any results exceeded clearance objectives for indoor air or wipes, the areas were re-cleaned and use of negative air filtration devices was continued to work as air scrubbing devices. Areas were re-sampled which did not meet clearance objectives.
19. All wastes generated were disposed of as Bulk Product Waste> 50 ppm which also contained asbestos. PCB Bulk Product Waste were removed and transported off-site for disposal at a permitted hazardous waste landfill which is an EPA, TSCA approved facility for PCB waste 50 ppm.
20. Materials containing <50 ppm were transported to a non-hazardous solid waste disposal Facility and was limited to carpeting removed from floors of select rooms only.

9.5 Decontamination and Cleaning Methods

The Contractor was responsible for complete cleaning and decontamination of the Abatement Zone upon completion of work. The Abatement Zones were required to meet proposed Verification Sampling limits established in the Project Objectives.

The Remediation Contractor utilized HEPA vacuum and wet cleaning products to remove all visible dust and debris from all surfaces within the work area. Cleaning methods included the following:

- Cleaning of containment barriers was performed leaving critical barriers at openings, decontamination units and negative air filtration devices in place until results of post verification sampling indicate acceptable limits.
- Cleaning was performed from ceiling to floors.
- Any liquid used to wet the dust and debris to control fugitive emissions was collected and decontaminated in accordance with 40 CFR Part §761.79 (b)(l) or disposed of in accordance with §761.60 (a).
- All rags and other cleaning materials used to clean were also properly disposed as PCB Containing Waste.
- All PCB Remediation Waste was stored for disposal in accordance with 40 CFR Part §761.61(a) (5) (v) (A).
- All waste containers were appropriately marked in accordance with 40 CFR Part §761.40 and §761.45.
- Equipment utilized in connection with the removal of PCB Bulk Product Waste, including waste collection or that came in direct contact with the site contaminants were decontaminated prior to leaving the site to prevent migration of the contaminated residues from the project site.
- Decontamination was conducted in accordance with 40 CFR Part §761.79 and Sub-part S procedures.
- All non-disposable equipment and tools employed in the course of the project were decontaminated at the conclusion of each work day through the following sequence:
    1. Initial tap water rinse, to remove gross soil
    2. Hexane or equivalent wash
    3. Tap water rinse
    4. Second Hexane or equivalent wash
    5. Second tap water rinse
- The wash water and decontamination liquids were captured and containerized in DOT approved 55-gallon barrels for off-site disposal.

9.6 Waste Disposal

All waste containers were marked with the name of the waste contained; the date in which the first material was placed in the vessel; and the last date at which addition of waste occurred. All waste containers were marked with a PCB ML marker

All waste containers containing PCB Bulk Product Waste, and PCB contaminated debris, containment system components, used personnel protective equipment, personal and equipment wash water and decontamination fluids, or other wastes generated during the abatement work were packaged and labeled as follows:

DOT Class 9 UN3432 (solid)
Or UN2315 (liquid) PCB Waste

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Waste for Disposal

Federal law prohibits improper disposal.
If found, contact the nearest police or public safety authority or
the U.S. Environmental Protection Agency.
a. Generator's Information:______________________
b. Manifest Tracking No.: ______________________
c. Accumulation Start Date: ______________________
d. EPA ID No.: ______________________
e. EPA Waste No.: ______________________
f. Total Weight: ______________________
g. Container No.: ______________________

HANDLE WITH CARE!

All solid waste material, containment system components, used personnel protective equipment, and other solid wastes generated during the work, were placed directly in appropriate waste receptacles immediately upon removal from its in-situ position. Suitable waste receptacles consisted of roll-off containers or DOT-approved 55- gallon barrels.

- The Contractor was responsible for all packaging, labeling, transport, disposal and record-keeping associated with PCB or PCB contaminated waste in accordance with all federal, state and local regulations.
- The Contractor ensured that the person transporting the waste held valid permit issued in accordance with appropriate federal, state, and local regulations.
- The Contractor provided to the transporter at the time of transfer appropriate shipping records or uniform waste manifests as required by the federal, state and local regulations with a copy to the Owner and Owner's Authorized Representative. Refer to Appendix _, for a copy of waste shipment documentation.
- The Contractor maintained proper follow up procedures to assure that waste materials were received by the designated waste site in a timely manner and in accordance with all federal, state and local regulations.
- The Contractor shall assure that disposal of polychlorinated biphenyls (PCB) containing waste material is at a facility approved to accept such waste and shall provide a tracking/manifest form signed by the landfill's authorized representative.
- Properly containerized waste with PCB >50 ppm was transported by a licensed hauler and shipped as PCB Bulk Product Waste for disposal at a permitted facility for PCB waste 50 ppm.
- Any PCB Liquid Water Waste was properly containerized and decontaminated in accordance with 40 CFR Part 761.79 (b)(1) or disposed of in accordance with 40 CFR Part 761.60 (a).
- Any chemicals, solvents or other products used during decontamination were properly containerized as PCB Liquid Waste. Waste must be properly decontaminated or disposed in accordance with 40 CFR Part 761.60 (a) or 40 CFR Part 761.79 (g).

10 Conduct Post Removal Air and Wipe Sampling

10.1 Post Removal Sampling

Upon completion of work to remove or encapsulate source materials, work areas were thoroughly cleaned and representative wipe samples for PCB were collected within each room on non-porous floor and porous window sills. HVAC systems were cleaned and balanced and run for a period of 12 hours in addition to continued ventilation with HEPA equipped negative air filtration devices. Post removal indoor air samples were collected for analysis using Method TO-10A Homolog analysis. Samples were collected in all classrooms and function spaces at the request of WCS and WPSC. Work was conducted in phases as each work area was completed.

Results of indoor air samples in general were initially below EPA guidance of 300 ng/m^3. If a room or group of rooms were above the guidance criteria, the rooms were re-cleaned and ventilated for a period and then re-sampled. On September 6, 2011 all classrooms and Media Center with few exceptions were below the EPA guidance and school opening was allowed on September 8, 2011 after a two day delay to allow maintenance staff and teachers time to prepare rooms for use. Areas which did not initially fallbelow EPA guidance included Cafeteria, Kitchen area, Office area and few isolated rooms off media center, and Room 24. These areas were subjected to additional cleaning and ventilation for several weeks resulting in opening of the Cafeteria, Kitchen and most offices.

Continued review and interim measures including removal of carpeting in several rooms was conducted to attempt to lower indoor air in these few isolated locations which were not in use. These areas included Principals Office, two guidance offices, room 24, and three offices within the media center. These locations were above the EPA guidance of 300 ng/m^3. The locations have a lack of ventilation and efforts to force ventilation using air scrubbing devices have not resulted in lowering of indoor air to below EPA guidance for children. The areas are either not utilized or are restricted to teachers and office staff since results do not exceed 450 ng/m^3.

As part of the on-going management of PCBs within the building, quarterly indoor air sampling was required. The first round of indoor ai r samples was conducted on November 17, 2011. Locations were collectively chosen by the school, parents and teachers and represented approximately 25% of the school building. We continued sampling quarterly (school calendar year) and varied the locations to ultimately ensure a second round of testing in each of the locations sampled in August / September after removal work occurred. Analytical results for the post removal air sampling as well as the quarterly can be seen below in tables 14 – 17.

Refer to **Appendix U, V and W** for post remediation laboratory analysis results.

11 Conduct Quarterly Sampling

The on-going management of PCBs within the building required quarterly indoor air sampling and wipe sampling which has been conducted. The first round of indoor air and wipe samples was conducted on November 17, 2011, second round on January 23, 2012, third round March 29, 2012 and fourth round on June 9, 2012. Locations were collectively chosen by the school, parents and teachers and represented approximately 25% of the school building during each round with completion of 100% of all classrooms and program spaces upon completion.

11.1 Round 1 25% of Building

Table 14
First Quarter Post Remediation PCB Air Sample Results Summary
Collected on: 11/17/2011

Westport Middle School
400 Old County Road
Westport, MA
Report Date: 11/29/2011

Location	Last Result Nanograms/m3	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m3
Kitchen	180	9/18/2011	120	11/17/2011	300
Cafeteria (side A by offices)	160	9/18/2011	110	11/17/2011	300
Cafeteria (side D by 283)	190 210(duplicate)	9/18/2011	120	11/17/2011	300
Room 283	220	9/9/2011	170	11/17/2011	300
Room 278	100	8/29/2011	13	11/17/2011	300
Room 275	81	8/29/2011	31	11/17/2011	300
Room 263	140	9/18/2011	72	11/17/2011	300
Library (Media Center)	180	9/2/2011	120 100 (duplicate)	11/17/2011	300
Room 238	180	8/31/2011	100	11/17/2011	300
Nurse's Office	Non Detected	9/2/2011	200	11/17/2011	300
Room 108	84/81	9/7/2011	30	11/17/2011	300
Location	Last Result Nanograms/m3	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m3
Room 107	73	9/7/2011	49	11/17/201	300

				1	
Room 171	98	9/7/2011	120	11/17/2011	300
Room 166	170	9/1/2011	31	11/17/2011	300
Room 163	92	8/26/2011	7	11/17/2011	300
Room 122	190	8/30/2011	42	11/17/2011	300
Room 120	250	8/30/2011	97	11/17/2011	300
Gymnasium	170	9/2/2011	37 29 (duplicate)	11/17/2011	300
Boy's Locker Room	Non Detected	9/1/2011	41	11/17/2011	300
Girl's Locker Room	110	9/9/2011	43	11/17/2011	300
Rooms where last known results over 300 and current results					
Room 24	1500	9/13/2011	550	11/17/2011	300
Room 256	400	9/18/2011	390	11/17/2011	300
Principal Office (Room 220)	360	10/18/2011	410	11/17/2011	300 or 450 for adults

11.2 Round 2 25% of Building

Table 15
Second Quarter Post Remediation PCB Air Sample Results Summary
Collected on: 1/23/2012

Westport Middle School
400 Old County Road
Westport, MA
Report Date: 1/30/2012

Location	Last Result Nanograms/m³	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m³
Room 103	230	8/31/2011	0 & 3 (duplicate)	1/23/2012	300
Room 106	290	8/31/2011	39	1/23/2012	300
Room 112	230	8/31/2011	66	1/23/2012	300
Location	Last Result Nanograms/m³	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m³

Room 121	180	8/30/2011	57	1/23/2012	300
Room 124	39	8/30/2011	24	1/23/2012	300
Room 154	310	8/26/2011	38	1/23/2012	300
Room 164	94	8/26/2011	22	1/23/2012	300
Room 167	170	9/1/2011	30	1/23/2012	300
Room 175	190	8/31/2011	21	1/23/2012	300
Room 239	140	8/31/2011	160	1/23/2012	300
Room 241	180	8/31/2011	81	1/23/2012	300
Room 258	200	9/1/2011	140	1/23/2012	300
Room 274	120	8/29/2011	55	1/23/2012	300
Room 277	90	8/29/2011	22	1/23/2012	300
Small Gym	77	9/1/2011	11	1/23/2012	300
Auditorium	280	9/2/2011	18 & 23 (duplicate)	1/23/2012	300
ISS room (used as Principals office)	350	10/24/2011	110	1/23/2012	300
Principal office (yet to clear)	410	11/17/2011	320	1/23/2012	300

11.3 Round 3 25% of Building

Table 16
Third Quarter Post Remediation PCB Air Sample Results Summary
Collected on: 3/29/2012

Westport Middle School
400 Old County Road
Westport, MA
Report Date: 4/6/2012

Location	Last Result Nanograms/m³	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m³
Room 105	120	8/31/2011	5	3/29/2012	300
Room 102	180	8/31/2011	100	3/29/2012	300
Room 110	80	9/7/2011	66/72	3/29/2012	300
Room 125	110	8/30/2011	170	3/29/2012	300
Room 168	210	9/1/2011	160	3/29/2012	300
Location	Last Result Nanograms/m³	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m³
Room 118	293	8/26/2011	150	3/29/2012	300
Band Room	67	9/2/2011	84	3/29/2012	300

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Special needs by Rm 101	170	9/1/2011	Not Collected	3/22/2012	300
Room 237	240	8/31/2011	120	3/29/2012	300
Room 242	210	8/31/2011	110	3/29/2012	300
Room 250/251	290	9/9/2011	340	3/29/2012	300
Room 256	390	11/17/2011	220	3/29/2012	300
Room 257	360	9/1/2011	190	3/29/2012	300
Room 264	180	8/29/2011	160	3/29/2012	300
Room 279	Not Detected	9/2/2011	150	3/29/2012	300
Main office	630	9/9/2011	100	3/29/2012	300
Sec. Office	Not Collected	9/9/2011	240	3/29/2012	300
Assistant Principal office	350	10/24/2011	400	3/29/2012	300
Guidance 1 office	410	11/17/2011	330	3/29/2012	300
Kitchen food store	120	11/17/2011	42	3/29/2012	300
Principal's Office (Rm 220)	320	1/23/2012	400	3/29/2012	300
Room 24	330	12/16/2011	280	3/29/2012	300

11.4 Round 4 25% of Building

Table 17
Fourth Quarter Post Remediation PCB Air Sample Results Summary
Collected on: June 9, 2012

Westport Middle School
400 Old County Road
Westport, MA
Report Date: 6/14/2012

Location	Last Result Nanograms/m³	Date	Current Result Nanograms/m³	Date	EPA Threshold Nanograms/m³
Room 101	120	8/31/2011	58	6/9/2012	300
Room 104	110	8/31/2011	100	6/9/2012	300
Room 104 (Duplicate)	NA	NA	97	6/9/2012	300
Room 172	120/290	8/31/2011	69	6/9/2012	300
Gym custodial. Rm	180	8/30/2011	47	6/9/2012	300
Room 235	39	8/30/2011	110	6/9/2012	300
Room 249	350	9/9/2011	400	6/9/2012	300
Room 254	170	9/19/2011	330	6/9/2012	300
Room 259	170	9/1/2011	180	6/9/2012	300
Room 268	340	9/1/2011	250	6/9/2012	300
Room 268 (Duplicate)	420	9/1/2011	240	6/9/2012	300
Room 280	160	8/29/2011	150	6/9/2012	300
Guidance 2 office	180	8/31/2011	160	6/9/2012	300
coffee office room	200	9/1/2011	130	6/9/2012	300
staff room	120	8/29/2011	430	6/9/2012	300
Custodian office off loading dock	90	8/29/2011	180	6/9/2012	300
storage + load dock	77	9/1/2011	160	6/9/2012	300
Custodian area load dock	280	9/9/2011	260	6/9/2012	300
Kitchen locker Room	350	10/24/2011	NA (blocked off)	6/9/2012	300
kitchen office	410	11/17/2011	NA (blocked off)	6/9/2012	300
Blank	NA	NA	0	6/9/2012	300

Refer to **Appendix X** for quarterly laboratory analysis results.

Wipe samples were collected within rooms where indoor air sampling was conducted. Samples were randomly collected on horizontal surfaces to determine PCB concentrations in any settled dust. Typically 3-4 samples were collected on floors, furniture or other surfaces. In addition, per request of EPA, samples were collected on encapsulated ceilings.

See **Appendix Y** for quarterly wipe sample analytical results.

11.5 Quarterly Testing Summary

In general, the quarterly testing documented that the removal of sources of PCBs during the summer work improved indoor air quality as results continued to be below EPA guidance threshold of 300 ng/m^3. Many results demonstrated that indoor air samples continued to be lower over time. Each table identifies results taken after summer work and each quarters result. Exceptions include several locations within the Office area of the building and Room 24. Continued testing within these areas did not identify results to decrease and some were still over 300 ng/m^3. Room 24 was evaluated for additional primary sources of PCBs. Paint on walls was considered a possible secondary source of PCBs as walls were painted by Maintenance staff less than five years prior to remediation work. Samples collected of paint identified PCBs > 50 ppm. Wall surfaces were encapsulated using product used elsewhere within school. Measurements of indoor air within the room after encapsulation were reduced to below 300 ng/m^3.

12 Interim Measures and On-Going Management and Sampling

12.1 Indoor Air Sampling

Following the post remediation indoor air sampling EnviroScience conducted quarterly sampling and results indicate removal of PCB Bulk Products have allowed for continued safe occupancy of the school building and maintaining results of indoor air consistently below EPA guidance of 300 ng/m^3. WCS shall perform quarterly monitoring during school year 2012/2013.

The samples will be collected and analyzed per the requirements of EPA Method TO-10A and analyzed for Homologs. It is anticipated that indoor air samples will conducted until such time is additional remediation to remove secondary sources of PCBs from adjacent materials is conducted as well as removal of remaining PCB Bulk Products in identified locations.

12.2 Ceiling Encapsulant Monitoring

Following application of the Fiberlock asbestos coating, inspections of each area of application should be completed on an annual basis, in conjunction with indoor air sampling. The inspections will consist of visual observations to determine if there are any observable breaches or failures to the coating. Any observed breaches in the integrity of the coating will be documented and repairs will be made within one week. The repairs will also be documented. Surface wipe samples will be collected from the surface of the coatings to verify containment of PCB. The wipe samples will be collected in accordance with 40 CFR 761.123. The sampling will include a duplicate sample and a blank for QA/QC. The quantity and frequency of sampling may increase based on results.

The following is recommended for subsequent annual wipe sampling.

- 20 wipe samples from the coating on the interior ceiling surfaces are to be collected on an annual basis.

12.3 Best Management Practices

Exposure to potential PCB containing materials can greatly be reduced by implementing some simple Best Management Practices. The custodial and teaching staff at Westport Middle School have been trained on implementing the following simple, yet effective tasks, to reduce student/staff potential exposure to PCBs. This list should be reviewed and updated as necessary.

- Have students and faculty wash hands with soap and water frequently.
- Use of vacuums with HEPA filters. This practice is already in effect and has been so upon the discovery of PCBs at the school.
- Clean areas of dust accumulation more often. For example, these areas include window sills, floor intake vents for the unit ventilator, corners, hard to reach areas.
- Avoid dry dusting, mopping or sweeping. Use wet cloth's or HEPA vacuuming to clean surfaces.
- Improve ventilation. The unit ventilators were adjusted and maintained for optimum performance and should not be not be "tinkered" with by teaching staff. The storage of materials on top of the unit ventilator vents should be avoided. Filter changes (per manufacturer's recommendations or more frequent if dusty conditions require) and 1/4ly removal of dust with a HEPA vacuum should occur.

13 Data Validation and Usability

13.1 Modified Tier I Data Review

EnviroScience conducted modified Tier I data verification of the field and analytical data resulting from the assessment documented herein. Modified Tier I verification narratives checklists are included for each set of Con-Test reports in **Appendix Z**.

The analytical data is compliant with the data quality objectives.

14 PCB Operations and Maintenance Plan

14.1 Purpose and Intent

EnviroScience has prepared an Operations and Maintenance (O&M) Plan based on the completed work to remove significant sources of PCBs from the school in 2011. Some specific areas of PCBs could not be removed due to the difficulty in completing the work within the specific time allowed prior to occupancy in September 2011. The building is continuing to be monitored for PCBs utilizing indoor air sampling and wipe sampling. The current status of known PCBs within the interior and exterior of the building is as follows:

PCB Bulk Product Waste Materials Remaining

- Tectum ceiling panels with PCB mastic and felt remain within the following locations:
  - Stairwells
  - Loading Dock, Storage area, Custodial Office, and kitchen area
  - Top of walls
  - Above ceiling mounted unit ventilators
- Interior and exterior door caulking at building entrance doors containing PCB exist above door height to roof line.
- PCB Glazing compound associated with all window systems remains and as an interim measure is covered by new silicone caulking to prevent contact.
- PCB mastic adhesive on exposed ceilings is limited to very small percentage of ceiling area and is encapsulated with an asbestos bridging encapsulant.
- Secondary sources of PCB in paint in Room 24 remain and have been encapsulated.

PCB Remediation Wastes Identified and Remaining

- Porous brick on exterior jambs and sills adjacent to window systems contains >1 ppm PCB.
- Porous concrete on exterior beams adjacent to window systems contains >1 ppm PCB.
- Porous brick on interior jambs and sills adjacent to window systems contains >1 ppm PCB.
- Porous concrete on interior columns and beams adjacent to window systems contains >1 ppm PCB.
- Porous brick on interior expansion joints contains >1 ppm PCB, caulking has been removed and prior to installation of new caulking encapsulant was applied to the interior brick.
- Soil in limited locations has been identified to contain PCBs > 1 ppm.

This O&M Plan reflects the controls necessary for PCBs identified during previous inspection work and identified as remaining after the work in 2011.

The general intent and purpose of an O&M program is to ensure continued health & safety of building occupants as well as maintenance staff and outside contractors who may come into contact with PCB containing materials. In order to provide this assurance the following must be implemented:

1. Establish procedures to recognize, control and mitigate potential PCB hazards and inadvertent disturbance of PCBs.
2. Ensure worker safety in accordance with occupational safety and health regulations pertaining to PCBs.
3. Establish process for review of proposed maintenance activities and or work of outside contractors or vendors to determine potential of work to disturb PCBs.
4. Identify general work practices where contact with PCB materials or potential PCB contaminated dust or debris may be present.
5. Establish goals to maintain indoor air and dust concentrations for PCBs in accordance with health standards for continued occupancy.
6. Maintain proper ventilation systems within the building.
7. Identify procedures for reporting observances of conditions where PCB materials have become disturbed and special response procedures.
8. Identify testing schedules and frequency for verifying indoor air and dust concentrations within the building.
9. Identify training of maintenance staff and awareness of public through outreach activities and reporting.
10. Ensure any future planned renovations or other possible disturbance of PCBs are properly designed and conducted by appropriately trained contractors with workers experienced in handling of PCBs.

14.2 PCB Coordinator

A comprehensive PCB control program starts with the appointment of an PCB Coordinator and an PCB Consultant. It is also advisable to retain a PCB Remediation Contractor to handle emergency response action(s).

PCB related work shall take place only with the PCB Coordinator's knowledge; this includes abatement contractor's activities. Emergency situations will be brought to his/her attention as soon as possible after the fact. The PCB Coordinator is the Person who will have overall responsibility for the Operations and Maintenance Plan.

The PCB Coordinator's responsibility shall include coordination with the PCB Consultant and the PCB Remediation Contractor, documentation of response actions, communication with building occupants (where applicable), communication with outside contractors or vendors working at Westport Middle School, ensuring compliance with training of maintenance and custodial employees and periodic visual inspection of PCB materials present in the building and record keeping.

15 Long Range Plan Scenarios for Remediation and Goals

15.1 Renovation Plans

Any proposed removal or renovation potentially involving building materials suspected of containing PCB should be evaluated by the School District. If required to be completed, this should be performed by trained personnel.

Capital plan summary:

Westport Community Schools has been able to get the town and the Massachusetts School Building Authority to support some improvements to our districts school buildings. In Fiscal Year (FY 2013), we were able to complete the replacement of the Macomber School and the High School roofs. These projects came in under budget although it took longer to complete than anticipated. We asked the Town for $2.5 million to replace the roofs and the windows of the Middle School in FY 12. Unfortunately the engineering design phase indicated that the roofs at MAC and WHS would actually use up the $2.5 million allocated to the projects. The projects, thankfully came in at a little over $1 million.

In addition the architect Project team found PCBs in the caulk around the windows and in the glue holding up the sound panels on the ceilings of most of the school. At a cost of $3.2 million, the partial clean-up was very expensive and left us with a school that has to be monitored on a quarterly basis year to year to ensure PCB air and wipe samples remain below the thresholds that the EPA finds acceptable for middle school aged students.

The School Committee and the Board of Selectmen have been asked to support a plan to study and perhaps implement a plan to expand the HS and the Macomber schools in order to allow the schools to abandon the use of the middle school building as a school and renovate the old parts of WHS and Macomber and the Westport

Elementary School (WES). The ultimate plan would be to have the expanded schools to accept a redistributed set of grades so that the Macomber School would become the Macomber Elementary School with grades (PK-3), and the WES would become the Westport Intermediate School with grades (4-6) and the Westport High School would become the Westport Junior/Senior High School with grades (7-12).

A proposed possible schedule is as follows:
FY 14 = Plan Capital Improvements
FY 15 = Expand MACOMBER and WHS
FY 16 = Renovate WES and the old parts of MACOMBER/WHS
FY 17 = Macomber Elementary (PK-3), Westport Intermediate School (4-6) and Westport Jr. /Sr. High School (7-12)

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Appendix A

INITIAL INSPECTION REPORT – 5/11/2011

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Appendix B

SUBSTRATE SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix C

SOIL SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix D

INITIAL WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix E

INITIAL AIR SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix F

ADDITIONAL WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY - 6/27/2011

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Appendix G

ADDITIONAL BULK SAMPLING RESULTS AND CHAIN OF CUSTODY – 6/27&29/2011

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Appendix H

PILOT PRE-CLEANING WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY - 7/22/2011

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Appendix I

PILOT BASELINE AIR SAMPLING RESULTS AND CHAIN OF CUSTODY
7/23/2011

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Appendix J

PILOT BASELINE WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY - 7/23/2011

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Appendix K

PILOT POST REMOVAL AIR SAMPLING RESULTS AND CHAIN OF CUSTODY - 7/27/2011

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Appendix L

PILOT POST REMOVAL WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY - 7/27/2011

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Appendix M

DOCUMENT TO OBTAIN QUOTES

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Appendix N

ASBESTOS PROJECT MONITOR LICENSES

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Appendix O

CERTIFICATE OF FINAL VISUALS

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Appendix P

SITE LOGS

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Appendix Q

Contractor Sign-In Logs

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Appendix R

DAILY MONITORING DATA

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Appendix S

BACKGROUND AIR MONITORING SHEETS

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Appendix T

TEM SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix U

POST REMEDIATION AIR SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix V

POST REMEDIATION WIPES SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix W

POST REMEDIATION BULK SAMPLING RESULTS AND
CHAIN OF CUSTODY

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Appendix X

QUARTERLY AIR SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix Y

QUARTERLY WIPE SAMPLING RESULTS AND CHAIN OF CUSTODY

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Appendix Z

MODIFIED TIER I DATA VALIDATION FORMS

EXHIBIT 45

ROBERT MAY

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
____________________________/

VIDEOTAPED DEPOSITION OF
ROBERT L. MAY, JR.
Boston, Massachusetts
Wednesday, September 7, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 111868

ROBERT MAY

A. Correct.

Q. TSCA is a statute and is the law of the land, correct?

A. Correct.

Q. Though regulations set forth in 40 CFR 761 are also the law of the land, correct?

A. Correct.

Q. You'll agree with me that those TSCA regulations set forth in 40 CFR 761 are authoritative, correct?

A. Correct.

Q. If TSCA or the regulations promulgated under TSCA in 40 CFR 761 are violated, then the EPA has the power to enforce those regulations through court actions, including federal lawsuits or administrative proceedings, correct?

A. Correct.

Q. In your opinion is the standard of care for PCB remediation identical to what the EPA regulations require?

A. Yes.

Q. In your opinion is the standard of

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regarding a regulation.

Q. So, now, you attached a whole bunch of guidance documents as exhibits to your report, correct?

A. Correct.

Q. It's true, isn't it, sir, that these EPA guidance documents are not regulations, correct?

A. That is true.

Q. EPA guidance documents do not have the force of law, like regulations do, correct?

A. No, they do not.

Q. Following guidance and recommendations made by the EPA that goes beyond the TSCA regulations set forth in 40 CFR 761 is voluntary, correct?

MR. McCREA: Objection. Form.

A. It is.

Q. It's true that the EPA guidance documents are not authoritative, correct?

A. I wouldn't agree with that, as the authority has written those as their guidance interpretation for the subject matter of PCBs as it relates to building materials.

Q. So if someone complies with the authoritative regulations set forth in 40 CFR 761 and chooses to not follow EPA guidance, the EPA has no basis for an enforcement action, correct?

A. I would say if it's within the regulation and/or in exceedance or more strict than, no, that would not be subject to an enforcement action.

Q. Let me ask the question again.

If someone complies with the authoritative regulations and chooses to not follow EPA guidance, the EPA has no basis for enforcement actions, correct?

A. Correct.

Q. Guidance documents are just that, guidance, correct?

A. Correct.

Q. Is it safe to say that if the EPA guidance was required to be followed they'd be called requirements, right?

MR. McCREA: Objection. Form.

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A. Correct.

Q. All of those exhibits that you cite in that second full paragraph under letter I, those are guidance documents, correct?

MR. McCREA: Objection. Form.

A. Let me review them.

Q&A. Correct.

Q. And you don't cite anywhere in that list any regulations, correct?

A. Correct.

Q. So now the language in that first part of that paragraph, where you say, "Testing for PCBs in building materials prior to renovations was" -- and this is the phrase I'm interested in -- "expressly recommended."

By that phrase, "expressly recommended," do you mean that the guidance documents that you cite below recommend testing for PCBs in building materials prior to renovations?

A. Correct.

Q. Now, in the next paragraph, the first sentence of that paragraph, you say, "The above list of authorities." Are you referring to the guidance documents that are cited in that second full paragraph?

A. Yes. The documents by the authority, which is the EPA.

Q. Right.

A. Those documents.

Q. So referring to these documents as "authorities," isn't it true, sir, that it's the regulations that are the authority?

A. True.

Q. Okay. It's not -- these guidance documents are not authoritative?

A. They're not authoritative, but, as I mentioned, with the EPA being the authority, and having guidance put out there in terms of their interpretation of the regulation, yes, I would consider them the authority, but not --

Q. Not authoritative?

A. -- authoritative.

Q. So these are the statements from the authority, the EPA. Let me rephrase this question.

go to the first heading there, the heading of this section that contains this table titled, "Maximum concentrations of PCBs in school air," is titled, "Suggested concentrations of indoor air," right?

A. Correct.

Q. So I notice throughout the report you make reference to "EPA maximum concentrations." Is it safe for me to assume whenever you make that reference in your report you're referring to this table in Exhibit 1 in the section titled "Suggested concentrations of indoor air"?

A. Yes.

Q. And that document, I think we've already established, is a guidance document, correct?

A. Correct.

Q. So you will agree with me that there was no requirement in the regulations to notify EPA upon finding PCBs in caulk, correct?

A. Correct.

Q. If there was no requirement in the

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regulations, why was it logical to notify EPA following the initial discovery of PCB in caulk?

A. It was actually a tandem. We identified the caulk, as well as the indoor air sample results. It was a onetime notification and really had more to do with the identification of elevated air concentrations.

Q. So there was no requirement in the regulations to conduct air testing within WMS?

A. Correct.

Q. Why was it logical to conduct air testing at WMS if it was not required?

A. Based on your prior experiences developing risk based approval plans for projects similar to Westport, and the requirement in those projects, in discussions with EPA, Region 1 coordinator, to require that testing as part of the documentation in support of those applications.

Q. So I think that answer, you cited

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prior experience with what EPA Region 1 coordinator would require, right?

A. Correct.

Q. And you cited the guidance documents?

A. No.

Q. Okay. Was it just prior experience with what EPA Region 1 would require?

A. As far as the direct, why we tested after we discovered PCBs in caulking material, it was very specific to the plan to put together a risk based disposal approval for the encapsulation, likely encapsulation of the adjacent remedial wastes at Westport Middle School.

Q. So under the regulations you were able to forego testing of the air at Westport Middle School, correct?

A. Under the regulations forego -- there is no air testing portion of the regulation.

Q. So there is nothing in the regulation that required air testing?

A. Correct.

Q. In fact, doesn't it state in the guidance documents that there's no

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requirement to test?

A. The air?

Q. Yes.

A. Correct.

Q. But it's your opinion that despite the fact that the regulations are silent on a requirement to test the air or the caulk, and that the guidance documents say there's no requirement to test the air or caulk, that it was logical and reasonable to do that anyway?

A. Well, there was also a concern, once the PCB bulk product materials had been identified, Westport had concerns about its public, its teachers, its students, its staff.

There was evidence from those prior news articles, those prior projects that I mentioned, UMass Amherst, Estabrook and so forth, about testing and air and the findings of PCBs in the air.

So Westport was concerned, also in addition to the risk based disposal approval, and in the guidance document, if

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Q. Sure. There was no requirements in the regulations to conduct an investigation for additional sources, in other words, sources other than the caulk that was tested and the air samples that were tested of PCBs within Westport Middle School?

A. Not within the regulations. That came from the EPA Regional 1 coordinator, discussion with the Regional 1 coordinator.

Q. So you made the recommendation to the Town of Westport to identify additional sources of PCB within Westport Middle School based upon a conversation with EPA Regional 1 coordinator Kim Tisa?

A. Correct.

Q. Did Kim Tisa -- excuse me. Start over.

Did Kim Tisa -- my Boston accent is coming out.

Did Kim Tisa ever put her recommendation to you to conduct testing for additional sources of PCBs at Westport Middle School into a written communication?

A. Not that I can recall.

that?

A. That is Exhibit 7.

Q. Okay. All right. So next sentence "At Westport" -- "At WMS this testing was performed in June 2011. Once PCBs above regulated concentrations were discovered and the need to conduct remediation of adjacent surfaces confirmed, methods of remediation prompted consideration of encapsulation as a long-term measure for adjacent porous concrete beams. Such methods would require a plan be submitted for approval to EPA under 40 CFR 761.61(c)."

We have talked about a performance based disposal plan, and you don't reference a performance based disposal plan in this section of your opinion, right?

A. Correct.

Q. Okay. Where 40 CFR 761.61(b) requires no testing, correct?

A. It does require testing upon completion of the project.

Q. What regulation requires testing upon completion of a 761.61(b) project?

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A. What regulation?

Q. Yes. What requires it?

A. The regulation you just --

Q. 761 --

A. 761.61(b).

Q. Okay. Can you direct me to where that section of the regulation requires testing?

A. (Witness reviews document.)

I don't see it.

Q. So that section of the regulation doesn't require testing?

A. Correct.

Q. So as part of it -- as part of 761.61(b), you make the determination that building products removed from a remediation project are PCB remediation waste, and you dispose of it in a PCB landfill, correct?

A. Correct.

Q. And that's perfectly legal, correct?

A. Correct.

Q. That requires no notification to the EPA, correct?

A. Correct.

talks about the fact that EPA considers that unauthorized or illegal use and needs to be removed.

Q. So the regulations that you cite do not require removal. They identify PCBs in this paragraph, and the paragraph that you cited was 761.20(a), correct?

A. Correct.

Q. On Page 732 of the exhibit that you're looking at, I think it's Exhibit 3, correct?

A. Correct.

Q. But there's no language in this regulation that uses the word "removal" or anything like that, right?

MR. McCREA: Objection. Form.

A. Not that I'm aware of.

Q. Okay. So then you -- we switch to the guidance documents that are referred to in Footnote 3, and the Exhibit 1, Q&A, all of which are guidance documents, correct?

A. Correct.

Q. So back to the footnote. You know, I'm going to just touch on this. We have addressed this, because the language is repeated throughout the report, I'm going to touch on it.

You state in this footnote, "U.S. EPA guidance from 2009," and then in the parenthetical "which were still applicable and authoritative in 2011."

To the extent the guidance documents were authoritative, they were documents published by the EPA that did not require or did not have the weight of law like the regulations, correct?

A. Correct.

Q. So you -- let me see if I can find this here. I'm sorry. Next sentence. Now that we are at the top of Page 4 of your report.

"Under EPA regulation," it's the sentence beginning, "Under EPA regulation, 40 CFR 761.3," you will say a similar thing with respect to PCB bulk product waste requiring removal, and you cite generally 40 CFR 761.

Please direct me to the portion of

documents, correct?
A. To me, again, the guidance document discusses, again, the intent and guidance by EPA that that's what caulk is. It is a bulk product material, and it cannot be used any longer so, therefore, requires removal.
Q. And what states that removal is required is a guidance document?
A. A guidance document, correct.
Q. It's not a regulation?
A. Correct. But, again, the notion of .3 as a source. So you have source. You have identified a material. You've tested and determined it's a source. You plan on disposing of it.
So that's -- first, that's one of the intentions, is you're testing for disposal. So you plan to remove it, in this case, with the window caulk.
Secondly, it's unauthorized for continued use. But now that you know it's an unauthorized use of PCBs, because it's greater than 50 PPM.
Q. And the jump to removal would be

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required accordingly is based not upon the regulations, but upon the guidance?

A. Correct.

Q. Okay. Let's move on to June. This is B.

So "Because the above testing identified PCBs in building materials; i.e., window caulk, in WMS at greater than 50 PPM, Westport followed 2009 EPA guidance" -- and you cite the guidance -- "and tested the air and dust in WMS." And then Footnote 4 there refers to the same list of guidance exhibits that you attached to your report, correct?

A. Correct.

Q. And you use that -- the use of the word "authoritative" in Footnote 4 is the same meaning that you used in Footnote 3?

A. Correct.

Q. So the testing that was done -- the testing that is referred to in that first sentence, following 2009 EPA guidance, that testing was done voluntarily by Westport, correct?

A. Correct.

caulking and so forth was part of that process, in addition to the air sampling that we collected that identified indoor air concentrations exceeding the EPA guidance.

Q. But it was the indoor air concentrations that generated the -- and I guess to use, to paraphrase your words from for your expert report -- that changed the goal to identifying other sources of indoor PCBs; is that correct?

A. That's correct.

Q. So that was that data from June 7th and June 8th that changed the goal of the project that you stated in your report?

A. That air data and subsequent air data during the pilot project, correct.

Q. The pilot project was in July?

A. Correct.

Q. And the pilot project was an outcome of the air sampling, correct?

A. Correct.

Q. So back to that last sentence in the first paragraph, "EPA Region 1 coordinator provided direction to conduct an expanded

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investigation for additional indoor sources of PCBs."

You use the word "direction." The direction from the EPA Region 1 coordinator is really advice, right? She gave you advice to follow a certain course of action?

A. Correct.

Q. Was this advice in a formal writing from the EPA?

A. No, it was not.

Q. It was in a verbal statement to you?

A. Correct.

Q. Was that advice ever reduced to a writing by EPA?

A. Not in writing substantiated during meetings onsite with EPA in terms of the process we had gone through, testing the air and testing some additional sources. EPA did conduct a site visit and was on to confirm that that was the direction given.

Q. All of the interaction and advice that you received from Kim Tisa during this phase of the project was verbal, correct?

A. Correct. There may have been some

EXHIBIT 46

ROBERT MAY

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
________________________________/

RULE 30(b)(6) DEPOSITION OF
FUSS & O'NEILL
ROBERT L. MAY, JR., DESIGNEE
ROBERT L. MAY, JR., INDIVIDUALLY
Boston, Massachusetts
Monday, April 25, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 106642

ROBERT MAY

A. Yes. But it may be modified to the audience, depending on who the audience is. Some of the bullets are specific to audiences.

Q. Is this section that you're looking at here consistent with the presentation that would be given to consultants, say, EnviroScience employees?

A. (Witness reviews document.)

Yes. It looks like more for internal.

Q. So the first bullet on Page 35 under "Consultant Challenges" is that "the EPA does not mandate by regulations testing of material."

A. Correct.

Q. Why is that a challenge for consultants?

A. As we mentioned, our primary thing we are hired for is due diligence as part of product renovation.

So with no mandate to test, we are in a state of trying to educate and help our clients make a decision. We don't force

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their hand one way or other. But we are in a position of we need to tell them what's out there and let them make the decision to test or not test.

Q. When you're educating your clients about whether to test or not test, do you inform your clients that they don't have to test?

A. Absolutely.

Q. And do you inform your clients that if you don't test you don't have to remediate?

MR. MUNIZ: Objection.

MR. McCREA: Objection.

A. I wouldn't say that we talk that far down the road. It depends. It really depends on circumstances.

If we're in an educational forum, the PowerPoint, we talk about the steps where remediation could come up at a later date, what the potential down the road identification of this could be.

Q. Well, I guess let's specifically talk about Westport.

EXHIBIT 47

John P. Woodyard, PE

Expert Report

In the Matter of

Town of Westport v. Monsanto Company et al
Case Number: 14-cv-12041

I certify that this report is true under pains and penalties of perjury. All facts are of my personal knowledge, except those facts which are referenced to sources therein. For those facts, I relied upon the sources identified, as set forth in the report.

Background and Experience

I am a Registered Professional Engineer with over 40 years of experience in the environmental field. Since 1978, I have specialized in various aspects of PCB management, including regulatory compliance and analysis; spill response and remediation, building and equipment decontamination; and management of non-liquid PCBs. I have worked on hundreds of PCB projects during my career dating back to 1977, and have been directly involved in federal EPA PCB regulatory rulemakings and regional EPA project permitting dating back to 1983.

Previously, I was employed by Weston Solutions, Inc. (1988-2014), IT Corporation (1983-88), SCS Engineers (1976-1983) and the US Army Corps of Engineers (1974-75). Currently, I am an independent consultant.

I hold a BS in Industrial Engineering and an MS in Mechanical Engineering from the University of Illinois. I am a registered Professional Engineer in 3 states. I am also active in various professional societies and other organizations, including serving as former Vice President and Chairman of the Technical Council of the Air & Waste Management, Member of the Board of Directors of the Institute of Professional Environmental Practice (IPEP), President of the IPEP Foundation, and former member of the editorial review board of the Journal of the Air &Waste Management Association, among others.

A copy of my detailed resume is attached.

I am receiving $225/hour as compensation for my consulting services and $350/hour for deposition and trial testimony in this matter.

Summary of My Opinions

There was no need to remove PCB caulk from Westport Middle School.

- There is no regulatory requirement to sample building caulk for PCBs.
- There is no regulatory requirement to notify EPA when PCB-containing building products are discovered.
- There is no regulatory requirement to remove PCB caulk.
- There is no regulatory deadline for removing or otherwise managing PCB-containing caulk once discovered.
- There is no regulatory requirement to submit a PCB remediation plan to the EPA for review.
- EPA guidelines do not have the force of law and serve only as screening levels.
- Westport did not apply for or receive written approval from the EPA to remediate PCBs at the WMS.

The WMS PCB remedial project was therefore voluntary, and as such is not Monsanto's responsibility.

- None of the actions recommended by Fuss & O'Neill and undertaken by the Town of Westport and Triumvirate were required by the EPA.
- No further PCB remedial action is necessary at WMS.

The PCB remediation strategy was flawed because the people leading the Town of Westport's project team were not qualified to develop and implement such a strategy.

- Most of the PCB remediation consultants involved in the WMS PCB project were not hired based on their PCB remediation experience.
- The Town of Westport wisely hired a 3rd party consultant to review the PCB project team's work, but unwisely failed to engage them to influence the project's outcome.
- Fuss & O'Neill erroneously directed the Town of Westport to meet a much lower surface cleaning standard than is required under the EPA PCB regulations.
- Fuss & O'Neill never advised the Town of Westport that risk-based PCB remedial standards are based on long-term exposure to entire buildings, not isolated locations, and that averaging results is acceptable.
- Concern about a so-called "land use restriction" repeatedly cited by Fuss & O'Neill as a "burdensome regulatory requirement" was an unfounded misreading of the PCB regulations, and should not have factored into the Town's decision to abandon WMS.

The PCB remedial pilot study in 2011 was flawed and resulted in a misdirected remedial project.

- The experimental design for the project was flawed.
- The Tectum felt was not contributing PCBs to the air or surfaces at Westport Middle School

None of the Tectum felt needed to be removed at all.

- Excluded PCB Products are materials containing <50 ppm PCB as the result of manufacturing.
- There is no requirement to obtain EPA approval when determining whether or not a material is an excluded PCB product.
- All of the Tectum felt at the Westport Middle School, except for one room, was and is an Excluded PCB Product.
- Due to their lack of experience with PCBs, Fuss & O'Neill attributed the Aroclor 1254 contamination in the WMS to a building product, the Tectum felt, made with a completely different PCB Aroclor, Aroclor 1248, did not initially realize the significance of the Tectum mastic Aroclor difference, and mistakenly recommended to the Town of Westport that it be removed.
- Once Fuss & O'Neill realized their mistake 2 years later, they failed to inform the Town of Westport that most of the Tectum felt was an excluded PCB product and did not need to be removed.
- Fuss & O'Neill should not have recommended any Tectum felt removal

The WMS PCB project team never defined or understood the technical problem they were hired to solve.

- Understanding if and how PCBs were being transported was critical, but never determined.
- The PCB air levels measured in June 2011 were the result of the school being closed, the ventilation system not working, and the building air not circulating.
- Any remaining PCBs in the air at WMS were more likely emitted from inadvertently generated PCBs rather than "secondary sources" and were not produced by Monsanto.
- Most of the air sample results after November 2011 were below the EPA guidance levels, so there was no reason to abandon the school and relocate.
- Most of the air sample results after November 2011 were below the EPA guidance levels, so there was no reason to continue air sampling.

The cost of the project was further inflated by Fuss & O'Neill's misunderstanding of the PCB disposal regulations

- Fuss & O'Neill's misunderstanding of the PCB disposal regulations resulted in significant unnecessary expense to the project

May's report still did not reflect an understanding of the PCB regulations and did not explain the rationale for his mistakes.

- May still thinks incorrectly that the Tectum concrete form planks are glued-on acoustical ceiling panels.
- May still believes incorrectly that the EPA PCB regulatory requirements and EPA guidance and advice are the same thing and carry the same weight.
- May still cannot cite relevant experience on similar projects prior to WMS.
- May attempts to deflect blame for his mistakes to the EPA by citing non-existent EPA requirements and guidance.

Hartman's report does not reflect an understanding of the PCB regulations and did not explain the rationale for the many mistakes made by others on the WMS project.

- Hartman, like May, clings incorrectly to the belief that the Tectum form planks are glued-on acoustical ceiling panels rather than concrete forms used to construct the ceiling.
- Hartman also struggles with the PCB regulations and makes statements that could only be supported by guidance, not the regulations themselves.
- Harman makes general statement about the science of PCB behavior in buildings that are not supported by the WMS findings.
- Hartman made a number of statements that conflict with the facts in this case.
- Hartman stated in his conclusions that the cost of the project was "reasonable", suggesting that it was voluntary.
- Hartman was confused about the PCB disposal regulations, and makes statements in his report that are incorrect and that manifested themselves in the improper and costly disposal of WMS PCB waste.

Herrick's report is largely irrelevant to WMS given his lack of remedial experience, his intentional disregard for EPA standards, and his unsupported generalizations about PCB science.

- Herrick is not qualified to opine on any aspect of the WMS remedial project.
- Herrick should not have repeatedly showcased "detectable levels" of PCBs in caulk, since results that low are of no consequence to a remedial project.
- Herrick's discussion of PCB behavior in a generic school environment includes sweeping, unsupported and often incorrect generalizations that do not apply to WMS.
- The presence of PCB caulk on the exterior of a school cannot be correlated with PCB air levels inside the school.
- The EPA laboratory chamber studies cited by Herrick show that caulk containing PCBs could, under certain laboratory conditions, emit PCBS, but their findings only apply to interior caulk.
- Contrary to Herrick's unfounded statement that "PCBs move readily from the exterior to the interior of buildings", there is no known correlation between PCBs in exterior caulk and PCBs in the indoor air of the same building.

There was no need to remove PCB containing building products from Westport Middle School (WMS).

There is no regulatory requirement to sample building caulk for PCBs.

Nowhere in the EPA PCB regulations does it state that building caulk must be sampled to determine its PCB content. In their guidance document “What do I do if I think PCBs are in my building?” the EPA doesn’t even list sampling as a best management practice. [EPA fact sheet - 2015]

Instead, the EPA web site contains guidance for schools concerned about the possible presence of PCB-containing building materials. That guidance reiterates that sampling of building materials is not required, and that the prudent course of action would be to “ensure the ventilation system is operating properly”, regularly maintain the air handling system and unit ventilators, and collect air samples.

Still, Fuss & O’Neill recommended WMS building caulk sampling right from the outset of the project. “We [Fuss & O’Neill] recommend that (bulk PCB testing of building materials) be performed based on plans for renovation at the site…due to the significant impact and potential requirements for planning required by EPA…” [WSTPRTSCHL017137]

Yet less than 3 months later, when asked if Westport should sample caulk at the Town’s other schools, Fuss & O’Neill’s point person Bob May recommended [Pinck001128] that “If any testing is to be done EPA guidance suggests and we would recommend only conducting air samples”, not caulk or glazing samples.

There is no regulatory requirement to notify the EPA any time PCB-containing building products are discovered.

Nowhere in the EPA PCB regulations does it state that persons must notify the EPA upon discovering PCB-containing building materials. On the contrary, there is a provision in the PCB regulations (40 CFR 761.62(a)) that allows removal and disposal of PCB bulk product waste without notifying the EPA, such as during window removal, an option that was familiar to Fuss & O’Neill based on their limited past experience.

This so-called “performance-based disposal” option was not presented in any of the communications between the Town’s consultants and the Town of Westport. Information provided by Fuss & O’Neill to the Town of Westport more than a year later in fact cited projects where PCB bulk product waste had been removed and disposed of without notifying the EPA in accordance with this provision for other clients. [WSTPRTSCHL001739, 1741]

There is no regulatory requirement to remove PCB caulk.

Nowhere in the EPA PCB regulations or guidance documents does it state that persons must remove PCB-containing building materials once discovered.

Likewise, the Massachusetts Department of Public Health (MDPH) guidance clearly states that PCB-containing building products should be managed in place, and that "Caulking that is intact should not be disturbed" [MDPH, 2009].

MDPH communicated directly with the Town of Westport on this issue, stating that "the process of sampling caulk [in May 2011] and the subsequent sampling round [in June 2011] may have disturbed PCB materials resulting in measurable levels of PCBs detected in indoor air in June (at the WMS)[WSTPRTSCHL022662].

Still, Fuss & O'Neill made the following false representations to the Town of Westport early on, dictating the future direction of the project [WSTPRTSCHL017137]:

- "The USEPA requirements…require removal of PCBs once identified…as an unauthorized use of PCBs."
- "PCB caulking is present… Materials will require removal and disposal as TSCA regulated waste containing >50 ppm."

Based on this incorrect advice from Fuss & O'Neill, CGKV (the Town's architect) then represented to the Town of Westport on June 15, 2011 [WSTPRTSCHL017602] that:

- "For abandonment and remediation, the impacted materials [window caulk and building materials surrounding the windows] must be either removed and disposed of or encapsulated. According to Fuss & O'Neill, encapsulation would require ongoing maintenance and management, the property would be under a land use restriction, and annual sampling would be required. Because of the long term expense of managing and maintaining the encapsulated materials, and because PCB-contaminated materials would still be physically present at the site, *Fuss & O'Neill and CGKV recommend removal of impacted material*." (emphasis added)

There is no regulatory deadline for removing or otherwise managing PCB-containing caulk once discovered.

Nowhere in the EPA PCB regulations is there a deadline for removing PCB-containing building materials.

The EPA never set a deadline for caulk removal at WMS. In my opinion, since there is no regulatory requirement to test for or remove PCB caulk anyway, no EPA deadline for WMS would be expected.

In fact, according to Larry Borins at Pinck & Co., the EPA stated at the July 2011 visit to

Westport Middle School that "The EPA will not tell the school district that the (Westport) Middle School must be evacuated." (P167, Borins to Colley e-mail, 7/17/11). In his notes from the EPA meeting, Borins (June 3, 2011) quoted the EPA as saying "EPA does not recommend evacuation. Buildings can be occupied even in the worst of circumstances. "

The Town of Westport through its consultant promised voluntarily to inform the EPA of its decision regarding what it would do with the school and when, which it continued to operate as a school for 3 years after the initial remedial project but with PCB-containing material still in place. The school PCB air levels remained below the EPA's guidance levels throughout that time and for at least a year after students were transferred and remain so today.

Fuss & O'Neill did not suggest a decision or action deadline, only stating in an e-mail to the Town of Westport that "It should be noted that EPA considers the site in an interim status awaiting a project to complete full abatement and remediation of PCBs inside the building." (September 3, 2014, 3 years after the cleanup was completed and the school had been occupied by students) [ESI16210]

Campbell, who communicated directly with the EPA in 2015 after taking over WMS sampling duties from Fuss & O'Neill, also stated that the EPA did not suggest any time limit for evacuation [Campbell deposition, p. 196]

There is no regulatory requirement to submit a PCB remediation plan to the EPA for review.

Contrary to the advice provided to the Town of Westport by its consultant Fuss & O'Neill, PCB-containing building products can be removed and disposed of without notifying the EPA. As noted previously, the "Performance-Based Disposal" option under 40 CFR 761.62(b) clearly allows this approach, an approach Fuss & O'Neill was familiar with. [WSTPRTSCHL011739, 011741]

Regulatory guidelines do not have the force of law and serve only as screening levels.

Guidance documents and any associated PCB "action levels" do not supersede published regulations that were set as part of a notice-and-comment rulemaking process. As stated in the EPA PCB Q&A Manual [EPA 2014]:

> "This policy (manual) addresses use, cleanup, and disposal requirements for polychlorinated biphenyls (PCBs) only. This document is intended to be used as an informal reference, and as such, is not a complete statement of all the applicable PCB requirements. This document does not replace nor supplant the requirements of the Toxic Substances Control Act (TSCA) PCB regulations. Please refer to the regulations at 40 CFR Part 761 for specific regulatory and legal requirements."

Even Fuss & O'Neill acknowledged that the EPA PCB air guidelines were not enforceable regulatory levels numerous times, albeit months after the costly and unnecessary remedial work was completed and the money spent, stating for example [EPA-WESTPORT001096]:

- "It should be noted the above [EPA PCB air] advisory concentrations are considered "screening" values. The EPA has not set regulatory limits for the concentrations of PCBs in air."; and
- "[The EPA] cleanup concentration for non-porous surfaces is less than 10 µg/100 cm^2. We understand and have complied with EPA [unwritten, informal] requests to utilize a standard of 1 µg/100 cm^2."

Westport did not apply for or receive written approval from the EPA to remediate PCBs at the WMS.

In my experience, the EPA has the authority to propose using more stringent PCB remedial levels in response to a written request for approval under the Risk-Based Disposal Approval process contained in 40 CFR 761.61(c). However, any more stringent level proposed by the EPA is subject to negotiation based on precedents and/or risk assessment.

At no time before, during or after the WMS remedial project did the Town of Westport request or receive written approval of the PCB remedial project. As a result, Westport was under no obligation to meet more stringent cleanup standards than those set forth in the EPA PCB regulations.

As a result, Westport was not subject to any more stringent regulatory requirements to meet any particular standard for PCBs in air, nor were they required to meet a lower PCB standard for surfaces.

The WMS PCB remedial project was therefore voluntary, and as such is not Monsanto's responsibility.

None of the actions recommended by Fuss & O'Neill and undertaken by the Town of Westport and Triumvirate were required by the EPA.

May, Hartman, and Herrick all stated that they believe that the PCB remedial action taken at WMS was "reasonable", but none of them stated, nor could they state, that it was required (May report, p. 2; Hartman report, p. 1; Herrick, p. 3).

Nowhere in May's deposition or Hartman's deposition did they claim the WMS PCB remedial action was "reasonable".

The only action the Town of Westport could have taken that would have been required by EPA was proper disposal of the removed windows and attached PCB caulk as a PCB bulk product waste. As of August 2011, disposal options of PCB bulk product waste included disposal in a municipal sanitary landfill at minimal cost. As of today, none of the windows have been removed.

No further PCB remedial action is necessary at WMS.

The PCB air and surface levels at WMS are below EPA guidance levels and regulatory levels, respectively.

If the WMS building were to be demolished, no PCB remediation would be necessary, only waste segregation. Since most of the waste being segregated from clean debris is impacted by asbestos, the incremental cost of removing and disposing of the PCBs would be minimal.

The PCB remediation strategy was flawed because the people leading the Town of Westport's project team were not qualified to develop and implement such a strategy.

Most of the consultants involved in the WMS PCB remedial project were not hired based on their PCB remediation experience.

Most of the consultants that planned the WMS remedial project were hired as part of the MSBA Green Repair Program window replacement project before PCBs were discovered, and had no demonstrated qualifications to plan or manage the WMS PCB project.

As a result, the WMS project was misguided and resulted in an unnecessary sampling and remedial project.

Once the Town of Westport elected to embark on a PCB remedial project, they should have taken the time necessary to understand the associated regulatory requirements and selected a different set of qualified, experienced advisors that would guide them toward the appropriate solution.

Fuss & O'Neill. Fuss & O'Neill was not qualified to manage or scope the WMS remedial effort at the time of the project, which only became apparent to the Town of Westport long after the WMS remedial effort had been performed.

In my experience, a PCB remedial consultant must (a) be intimately familiar with the EPA PCB regulations governing PCB sampling and cleanup, (b) understand when to involve EPA if at all, (c) have experience negotiating PCB cleanup approvals, and (d) have staff experienced with overseeing PCB remedial contractors and collecting confirmation samples.

Fuss & O'Neill was originally hired as a subcontractor to the Green Project architect, CGKV, with responsibility for conducting the hazardous material survey at WMS. Fuss & O'Neill's initial sole-source *sampling* proposals in May, 2011 [ESI02016] and June, 2011 [ESI03564, ESI03552] did not include mention of any experience with PCBs.

Most importantly, Fuss & O'Neill was then retained by the Town of Westport as their PCB *remedial consultant*, again without competition in July, 2011, but this time without demonstrating their qualifications for planning or managing a PCB remedial project.

It was not until December 2012, more than 18 months after starting work and 12 months after remediation was completed, that Fuss & O'Neill was asked to submit a competitive proposal describing their PCB remedial capabilities. Their proposal [ESI00132] included resumes for several management personnel, ten project descriptions, and a table of projects involving PCBs in buildings.

The 2012 proposal represented to the Town of Westport that:

> "We (Fuss & O'Neill) have successfully developed *many remedial plans* in accordance with EPA regulation 40 CFR 761.61 for the remediation of PCBs *which have been approved by EPA*" (emphasis added) [WSTPRTSCHL0116__]

On the contrary, it turns out based on May's deposition testimony that *he had not worked on any such projects* before the WMS 2011 remedial project. This proposal statement was a gross exaggeration of the project team's experience and misled the Town of Westport.

May testified in deposition that he had been involved in at most three PCB remedial projects involving the EPA, two of which were so-called "self-implementing disposal" projects (Fisher and Chatfield), which in May's words were not approvals at all, but notifications:

> "The word "approval", it's less of an approval and more of a conformance to the regulations, that a plan complies with the regulation… as opposed to approval." [May deposition, p. 113:20-24}.

The third project where May involved the EPA (Westminster) was a performance-based disposal project, which in my experience doesn't normally involve the EPA at all and in May's words "did not require EPA notification" [May, p. 116:17-18].

It was therefore not surprising that Larry Borins of Pinck & Co., after reviewing the draft school web posting about the consultants in July 2011, had to instruct May that:

> "(Fuss & O'Neill's) paragraph needs another sentence or two describing F&O's considerable experience and expertise in PCB remediation work." [WSTPRTSCHL020837]

The resulting additional language was essentially the same false, misleading statement used later in the 2012 proposal:

> "Fuss & O'Neill has performed many projects involving the testing design and remediation oversight for PCBs and coordinating work and approvals of plans with the EPA in Region 1." [WSTPRTSCHL021261]

Most of the remaining projects listed in the 2012 Fuss & O'Neill proposal with detailed descriptions were also performed after May 2011 (i.e., after the WMS project had already begun). Almost all of the projects they cited simply involved sampling (other Hazardous Materials Assessments, some for the MSBA Green Repair Program), and further demonstrated their lack of PCB remedial experience before taking on the WMS project.

When they were finally forced to compete for the continuing quarterly air sampling work at WMS, the 2012 proposal competition was biased in Fuss & O'Neill's favor from the beginning, since they helped set the consultant selection criteria at the Town's request. In May's words;

> "I wrote the RFP which requires very specific qualifications which we meet to hopefully weed out competition and give us a leg up on this." [ESI00564, 11/21/12 May to Conneely]

The RFP included the vague requirement that proposers include no less than ten (PCB) projects completed for public/private schools within EPA Region 1 within the past five years [WSTPRTSCHL012922]. In fact, while there were more than seven expressions of interest from other consultants [WSTPRTSCHL012896], only one competitor submitted a proposal and was rejected [WSTPRTSCHL012794].

Pinck& Co. (Pinck). Pinck, the Green Repair Program's Owner's Project Manager (OPM) selected by the Town of Westport, had no experience addressing PCBs in building products or managing PCB investigation or remediation projects at the time of the WMS project.

An OPM is not necessary for a PCB remediation project.

Pinck was originally selected because they were a pre-approved MSBA OPM. They had no demonstrated experience addressing PCBs in building products or managing PCB investigation or remediation projects at the time of the WMS project, and Larry Borins [Borins deposition, p. 24:18-25, 25:2-7] and Jennifer Pinck [Pinck deposition, p. 28: 17-25] conceded as much.

Pinck was hired in March 2011 as OPM for the window replacement green repair project due largely to their pre-approval status with MSBA. Once PCBs were discovered, they were then appointed in June as the PM for the PCB remediation work, which they had never done before.

- In Pinck's listing as PCB Remediation PM in the "Project Team for the WMS PCB Remediation" document [WSTPRTSCHL021___], their stated experience "includes many private and public school projects involving hazardous materials", but I could not find any evidence of other PCB work by Pinck.
- Their web site includes Pinck's and Borin's resumes and the posted news items dating back to before 2011, and there is no mention anywhere of PCBs, hazardous materials or Westport.
- In Pinck's OPM proposal to MSBA, their standard "Project Approach" made no mention of PCBs, only Asbestos, nor did any of their resumes or projects, suggesting they had no experience [WSTPRTSCHL016390]

I could find no evidence of Pinck providing any technical or regulatory input of value to the PCB project, nor were they allowed to communicate directly with the EPA. Given their lack of PCB experience, Pinck's duties appeared to be limited thereafter to forwarding e-mails from Fuss & O'Neill to Colley and back, parroting the PCB sampling and removal "requirements". According to Borins [Borins deposition, p.25:2-7], they relied entirely on Bob May (Fuss & O'Neill).

CGKV Architects (CGKV). CGKV, the Green Repair Program architect originally selected by the

Town of Westport, had no experience addressing PCBs in building products or managing PCB investigation or remediation projects at the time of the WMS project.

An architect is typically not needed for a PCB remediation project.

They were originally selected as a prequalified MSBA Green Repair architect for window replacement at WMS, not PCB remediation.

- Their Green Repair presentation to Westport [WSTPRTSCHL028370] did not include any reference to PCBs or associated qualifications, nor did their similar proposal to MSBA [WSTPRTSCHL016931].
- Knutson admitted that Westport was the first public school project where they encountered PCBs on a project [Knutson deposition, p. 53]
- CGKV was responsible for bringing Fuss & O'Neill to the WMS project as a hazardous material investigation subcontractor, but (again) without any PCB qualifications in Fuss & O'Neill's portion of the proposal, either [ESI02016]
- Westport was the first CGKV project with Fuss & O'Neill as a subcontractor where PCBs had been found. [Knutson deposition, p. 90]

A significant change in the CGKV scope apparently occurred around October 2011, when Colley asked for "costs of a study" to (a) remove the [PCB] contaminants, (b) upgrade other features to code, and (c) giving the building to the town. [Pinck000060]

The CGKV "Feasibility Study", completed in 2013, focused almost entirely on PCB remediation. The record shows clearly that CGKV (Knutson) relied completely on Fuss & O'Neill and May for technical details and recommendations in the Feasibility Study [Knutson, p. 115:16-19] and associated remedial scope [May/Knutson e-mails: 6/17/11; 6/21, 6/30, 7/2/13] despite Fuss & O'Neill's demonstrated lack of related experience.

Triumvirate. Triumvirate was hired by the Town of Westport on an emergency basis to initially assist with the PCB removal pilot project in July 2011, and was then hired to complete the cleanup in August 2011. Triumvirate is a pre-qualified emergency cleanup contractor under the state CAC53 contract.

Based on my review of their qualifications and testimony, Triumvirate actually had experience addressing PCBs in building products and managing PCB investigation or remediation projects at the time of the WMS project, yet their role was limited to finding and managing laborers to scrape, clean, and dispose of materials at WMS.

Ross Hartman, their Project Executive at the time of the WMS project, testified that he couldn't recall that Triumvirate had input into the design of the WMS pilot program, and that Fuss & O'Neill developed the WMS remedial plan for Triumvirate to follow (Hartman deposition, pp. 71-72]

I could find no record that Triumvirate was involved in any strategic or technical decisions related to the WMS remediation projector was ever asked to review the data for their opinion.

Deposition testimony by Hartman confirmed that Triumvirate has been involved in at least 9 PCB building remediation projects [Hartman deposition, p. 36], but that their role at WMS was to simply carry out the remedial plan developed by Fuss & O'Neill.

Campbell Environmental (Campbell). Campbell is a consultant that the Town of Westport had used in the past on other non-PCB projects, such as closing underground fuel tanks.

As with Fuss & O'Neill, a PCB remedial consultant must (a) be intimately familiar with the EPA PCB regulations governing PCB sampling and cleanup, (b) understand when to involve EPA if at all, (c) have experience negotiating PCB cleanup approvals, and (d) have staff experienced with overseeing PCB remedial contractors and collecting confirmation samples.

Campbell was hired by the Town of Westport in June 2014 to conduct PCB air sampling at the Macomber School [WSTPRT027793], without competition, shortly after Dr. Colley left. Fuss & O'Neill was still under contract and performing air sampling at WMS at the time.

Campbell was then hired to do air sampling at WES (January 2015) and building product sampling at WMS (March 2015), again without competition or written qualifications.

In my opinion, Campbell was/is not qualified to work on the WMS PCB sampling program:

- In his deposition, Campbell admitted that he could not recall ever working on a PCB building material or building caulk project before being hired by Westport [Campbell deposition, p. 44]

- From his deposition, Campbell admitted he had never taken PCB air samples before [Campbell deposition, p. 245]. He also directed the lab to report any results that were less than 300 ng/m^{3}as non-detect; since the EPA normally requires that laboratory detection limits be a minimum of five to ten times lower than the project action level, his air sampling results would probably be rejected by the EPA.

- His deposition testimony also revealed that he didn't know how to collect wipe samples properly. He testified that he followed the EPA wipe sampling protocol, but instead he simply laid wetted gauze on the surface without moving it around (i.e., "wiping") [Campbell deposition, p. 203-204]. His wipe sample data is therefore invalid.

It was unnecessary for the Town of Westport to hire yet another consultant to collect air samples and wipe samples. At the time, the air and wipe results had remained below the project action levels for years, the school has been vacant since 2014, and the EPA never required continuation of the testing.

The Town engaged a 3rd party consultant, Woodard & Curran, to review Fuss & O'Neill's work, but never actually involved them to influence the project outcome.

Dr. Colley requested from May names of consultants to act as an independent 3rd party to critique the PCB assessment and remedial work at WMS [Pinck001360]. Fuss & O'Neill recommended EH&E and Woodard & Curran, and Woodard & Curran was then was hired based on competitive cost and technical proposals.

Based on my review of project documents and the Woodard & Curran production, Woodard & Curran was never involved in the project, never performed an actual 3rd party review, and was not hired in time to change the course of the project.

May initially recommended Woodard & Curran to Borins as "a potential peer review firm" [PINCK001360]. Based on a request on August 4, 2011, the Woodard & Curran proposal was timely submitted on August 8, 2011 by Jeff Hamel [WSTPRTSCHL021830] and selected on or before August 11 [WSTPRTSCHL021636]. Dr. Colley directed Karen Augusto to forward the proposal to Bob May "so he can start meeting w/Mr. Hamel" [WSTPRTSCHL021658].

Also based on my review of their production, Hamel was not engaged in time to have any impact on the project. The WMS PCB remedial work began on August 11, 2011 and was completed on September 6, 2011; engaging Mr. Hamel immediately was essential if he were to have any value, but he was not formally involved until at least September 2011 if not later, and even then had no impact on the project. When Dr. Colley was asked later if he was familiar with Woodard & Curran and "what they did in conjunction with this project", he had no memory of them at all [Colley, p. 224].

The only documented communications involving Woodard & Curran's 3rd party review were limited to the following:

- Mr. Hamel's next e-mail to Colley, May and Borins wasn't until September 1 to check on the project, stating "to date, I have not been contacted to provide any support". [ESI20190] On September 7, the day after the remedial project had already ended and the day before WMS reopened, Colley asked May if he had even talked to them [ESI16410]. Hamel was therefore not asked to critique the project before field work was completed.

- On September 19 (after the remedial project was completed), May indicated to Colley that he was sending Hamel "some of the early summary memorandums… to give him some idea of the background". [ESI16477]

- Also on September 19, May and Hamel had a telephone conversation in which May described his investigation, his conclusions, and the results of the remedial project. Based on Hamel's notes:

- May apparently misled Hamel that the Tectum felt was the source of PCBs in the air since there was "no difference" in air levels between rooms with air "intake from roof not perimeter [univents]" [WOODARD000004] despite the fact that the pilot study rooms all had univents and formed the misdirected basis for the Tectum felt remediation,
- May apparently misled Hamel that all of the Tectum felt contained >50 ppm PCB despite data to the contrary [WOODARD000003], and
- May apparently misled Hamel that all of the Tectum felt contained Aroclor 1254, by including the erroneous Table 1 from the investigation report [WOODARD000016].

- In November 2011, May wrote to Borins that "Woodard & Curran… indicated they would not have had the confidence to pull off what we did, but agreed it was the necessary choice." [PINCK001215]. I could find no documentation of this or any meeting with Woodard & Curran, any reports or opinions from them, or even an invoice from them.

Most of the other Woodard & Curran production consisted of downloads from the Town of Westport web site, such as letters to parents [WOODARD000028-58].

Absent more technical information, it would have been impossible in my opinion for Hamel to conduct a 3rd party review of the work at WMS in time to influence the project approach or outcome.

Since the remediation had already been completed and the money spent by the time May first briefed Hamel, it would have been impossible in my opinion for Hamel to fulfill his role as 3rd party reviewer and influence the direction and outcome of the project, so in my opinion a post mortem by Hamel was useless.

Fuss & O'Neill never advised the Town of Westport that the PCB risk-based remedial standards are based on long term exposure to entire buildings, not isolated locations, and that averaging results is acceptable.

In my experience, the EPA allows the use of averaging when analyzing sample results over a large area with similar access. Tools such as ProUCL (an EPA statistical program) are commonly used to determine the upper 95% confidence level of the mean concentration for comparison with regulatory standards.

Kevin Miller, Fuss & O'Neill's risk assessment expert, correctly suggested as late as January 2013 that the use of averaging for wipe sample results in classrooms was appropriate [ESI16718, 1/28/13 email Miller to May]:

"I do not believe there is significant risk to students or staff based on these results. As you indicate the standard is <10 for high occupancy. We are using <1 as a precaution only. Out of the 40 plus [wipe] samples collected, 3 samples are greater than one… From a risk perspective we would consider the average concentration… I still conclude there is insignificant risk to occupants based on the average result."

To illustrate the importance of averaging:

- The average of the *pre-cleaning wipe sample results* from the pilot study area was 0.68 µg/100 cm^2 [EPA-WESTPORT001199],
- The average of 33 other pre-cleaning wipe sample results collected on June 8 and June 24 throughout the school was already 1.0 µg/100 cm^2 (excluding 3 stairwell floor samples)[EPA-WESTPORT001190-91].

Both pre-cleaning averages were well below the 10 µg/100 cm^2 EPA regulatory standard and even met the self-imposed guideline of 1 µg/100 cm^2. Little or no cleaning should have been required, let alone the intensive, multi-year recleaning program developed by Fuss & O'Neill.

Fuss & O'Neill erroneously directed the Town of Westport to meet a much lower surface cleaning standard than required by the EPA PCB regulations.

Fuss & O'Neill cited the correct 10 µg/100 cm2 regulatory surface cleaning standard in their original proposal to the Town of Westport [ESI03553, 7/12/11 Fuss & O'Neill proposal to Colley].

They then amended their proposal later, reducing the surface cleanup "requirement" by a factor of 10, without citing the basis for the change [ESI03565, 8/1/11 Fuss & O'Neill proposal to Colley].

In a Fuss & O'Neill Memo to CCKV Knutson, 6/14/11 [WSTPRTSCHL021064] they erroneously stated that:

- "Wipe sample locations equal to or greater than ≥1 µg/100 cm^2 will require cleaning", and that

- "Existing dust concentrations exceed the EPA guidance of 1 microgram per 100 square centimeters (1 µg/100 cm^2) for a school facility" without citing the source of that guidance.

Communications from Fuss & O'Neill to the Town of Westport stated that the basis for setting a lower PCB surface standard for WMS was because it met the EPA definition of a so called "high occupancy" area. On the contrary, the regulatory surface cleanup standard for so called "high occupancy" areas is 10 µg/100 cm^2, not 1 µg/100 cm^2. "High Occupancy" is in fact clearly defined in the PCB regulations to include schools (40 CFR 761.3):

> "High occupancy area means any area where PCB remediation has been disposed of on-site and where occupancy for any individual not wearing dermal and respiratory protection for a calendar year is 840 hours or more… for non-porous surfaces and 335 hours… for bulk PCB remediation waste. *Examples could include a residence, school, day care center…*" (emphasis added)

In a later internal Fuss & O'Neill communication, Kevin Miller (Fuss & O'Neill's designated risk assessment specialist) even correctly reminded May that 10 µg/100 cm^2 was the appropriate regulatory standard [ESI16718, 1/28/13 email Miller to May], yet May apparently chose to ignore his advice.

This misunderstanding of the regulations is important, since it led May to recommend extensive and unnecessary cleaning costs and years of unnecessary sampling. Even before the initial cleaning at WMS, all but a few of the wipe sample results already met the regulatory standard, and the average of the *pre-cleaning wipe sample results* from June 2011 in the pilot study area was 0.68 µg/100 cm^2 [EPA-WESTPORT001199], clearly below both the 10 µg/100 cm^2 EPA regulatory standard and even the self-imposed guideline of 1 µg/100 cm^2.

Several years later, May admitted that the change to 1 µg/100 cm^2 was based on informal communication with the EPA, as noted earlier [ESI 16284]

Concern about a so-called "land use restriction" repeatedly cited by Fuss & O'Neill as a "burdensome regulatory requirement" was an unfounded misreading of the PCB regulations, and should not have factored into the Town's decision to abandon WMS.

There is no requirement to record any type of land use restriction for high occupancy areas (such as schools), even if access is restricted by a cap (such as encapsulating PCB-impacted building materials). The only regulatory requirement potentially applicable to WMS is stated in 40 CFR 761.61(a)(8), which requires that the cap be maintained "in perpetuity", or until the building is demolished.

The only time a land use restriction (also known as a "deed restriction" in the EPA's regulatory terminology) is required is if a cleanup is conducted according to the self-implementing disposal provisions of the PCB regulations under 40 CFR 761.61(a), and only then for caps, fences, and low occupancy areas (40 CFR 761.61(a)(8)). The WMS cleanup was not subject to a self-implementing approval and therefore was not subject to this requirement.

Fuss & O'Neill steered the WMS project team away from encapsulation and toward removal of substrate, in part by exaggerating the significance of a deed restriction and associated monitoring. In a June 15, 2011 memo from CGKV to Pinck (the Town's Project Manager) [WSTPRTSCHL017602], it stated:

> "According to Fuss & O'Neill, encapsulation would require ongoing maintenance and

management, the property would be under a land use restriction, and annual sampling would be required"

This statement was incorrect and misleading. In my experience and based on the PCB regulations, the only possible requirement after encapsulation would be to inspect the encapsulant periodically to verify its integrity, even in high occupancy settings.

The town of Westport's consultants estimated the cost of ongoing maintenance and monitoring to be $70,000/year. In my opinion, this cost was inflated and may not have even been necessary.

The remediation pilot study in 2011 was flawed and resulted in a misdirected remedial project

Fuss & O'Neill and Triumvirate conducted a pilot project in July 2011 intended to determine which primary source(s) of PCB were contributing the most PCBs to the WMS indoor air and thereby determine which source removal to prioritize.

The pilot tests, conducted in Rooms 212, 164 and 264, involved cleaning the rooms, testing the air, removing select PCB sources, and retesting the air.

Fuss & O'Neill incorrectly concluded from the pilot test that the PCB air levels dropped the most due to the removal of the Tectum felt, and therefore mistakenly recommended to Westport that the Tectum mastic be removed throughout the school at a cost of over $2 million.

The experimental design for the pilot project was flawed.

A reasonable experiment would have changed only one variable per test to determine which variable had the most impact on air levels; variables in this instance included Tectum felt removal, window caulk removal, foam filler removal, concrete encapsulation, and increased ventilation. Instead, Fuss & O'Neill changed multiple variables at the same time, and as a result could not tell which variable had the greatest impact.

In the Room 212 test (the room with the largest PCB air level reduction), Triumvirate removed window caulk, foam filler, removed the Tectum (1 ppm) and felt (9.3 ppm), and coated the ceiling concrete, yet Fuss & O'Neill somehow concluded that Tectum felt removal was the primary reason for the reduction.

Incredibly, within a month after the pilot test and the Tectum felt removal, *the PCB air levels in Room 212 had increased from 280 ng/m^3 to 1,400 ng/m^3, proving conclusively that the Tectum felt PCB was not the primary source of PCBs in the air* [CONTEST001232], and that poor ventilation was the most likely explanation . This dramatic increase was apparently lost on, or embarrassing to, Fuss & O'Neill, since no mention of the change was made in their reports or Town of Westport communications.

The pre-cleaning and associated wipe sampling in pilot test rooms 212, 164, and 264 detected only Aroclor 1254 in the wipe samples results.

The Tectum felt in Rooms 212, 164, 264 and 265 contained only Aroclor 1248, and could therefore not be the source of any surface contamination in the pilot test rooms. The air samples collected during the pilot test were analyzed for PCB by homolog so no direct comparison with Aroclors is possible. Still, in the face of the above evidence, Fuss & O'Neill recommended that the Tectum felt be removed and made it the centerpiece of their recommended remedy. Instead, the Tectum felt in every room tested other than Room 106 contained <50 ppm PCB and should have been identified as an excluded PCB product and left in place.

Fuss & O'Neill should have tested the Tectum felt in every room before deciding to have the Tectum felt removed, since they knew or should have known from their sampling that 80% of the felt samples were <50 ppm PCB. Instead they assumed that the entire school's felt was >50 ppm PCB based on sampling in just one room, and provided written guidance to the remedial contractors to remove the felt regardless of the concentration. [May to Atwood e-mail, July 29, 2011]

The Tectum felt material was not contributing PCBs to the air or surfaces at WMS.

Aroclor 1254 was present in the building caulk.

Aroclor 1248, a distinctly different commercial PCB mixture, was present in the Tectum felt in 80% of the rooms where the felt was tested.

Most of the 13 rooms at WMS where pre-remediation air testing was performed in June 2011 (a) contained Tectum panels and (b) already had air levels that were below the EPA guideline *before the pilot test or remediation effort took place*, demonstrating that the Tectum felt was not the source of airborne PCBs at WMS [Limited Hazardous Building Materials Inspection Report, May 2011, Table 4].

Almost every wipe sample collected from throughout WMS contained *only* Aroclor 1254, and could not have come from Aroclor 1248 found in the Tectum felt.

The air samples, while analyzed for PCB homologs rather than Aroclors, contained predominantly pentachlorobiphenyl, which is characteristic of Aroclor 1254.

Despite all of this evidence to the contrary, Fuss & O'Neill still made Tectum felt removal the cornerstone of the WMS remedy, and misrepresented its relative contribution:

- "The significant sources of PCB bulk product waste include more than 70,000 square feet of ceiling mastic" [WSTPRTSCHL019250]

- "Results of the pilot project determined the effectiveness of reducing indoor air concentrations by removing most of the identified sources of PCBs…" [WSTPRTSCHL019250]

Fuss & O'Neill then indicated that "Tectum ceiling panels with PCB mastic and felt remain within…stairwells, loading dock, storage area, custodial office, kitchen area, top of walls, and above ceiling-mounted unit ventilators" [WSTPRTSCHL019287], without any sampling data from these materials to support this statement.

The flawed assumption that all of the remaining Tectum felt required removal formed much of the basis for the cost estimates in the CGKV Feasibility Study.

None of the Tectum felt needed to be removed.

The Tectum felt was not the source of PCBs in the WMS based on differences in the type (Aroclor) of PCB found.

The type of PCB found on surfaces in the WMS was different than the type of PCB found in the Tectum felt.

The type of PCB found in the air in the WMs was different than the type of PCB found in the Tectum felt.

The type of PCB found in the soil outside the WMS was different than the type of PCB found in the Tectum felt.

The type of PCB found on the outer (exposed) surface of the Tectum itself was different that then type of PCB found in the Tectum felt.

Excluded PCB products are materials containing <50 ppm PCB as the result of manufacturing[1].

Under the EPA PCB regulations, a material must simply meet all of the following criteria under 40 CFR 761.3 to be considered an excluded PCB product, as outlined in a presentation cited by Campbell [CAMPBELLENV002662]:

- "Concentration [<50 ppm]
- Sold/distributed in commerce prior to 1984, and
- No dilution [i.e., not the result of a spill or release]"

These materials "may remain in place without further restrictions/requirements".

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[1] The actual definition: "Excluded PCB products means PCB materials which appear at concentrations less than 50 ppm, including but not limited to:
(1) Non-Aroclor inadvertently generated PCBs as a byproduct or impurity resulting from a chemical manufacturing process.
(2) Products contaminated with Aroclor or other PCB materials from historic PCB uses (investment casting waxes are one example).
(3) Recycled fluids and/or equipment contaminated during use involving the products described in paragraphs (1) and (2) of this definition (heat transfer and hydraulic fluids and equipment and other electrical equipment components and fluids are examples).
(4) Used oils, provided that in the cases of paragraphs (1) through (4) of this definition:
(i) The products or source of the products containing < 50 ppm concentration PCBs were legally manufactured, processed, distributed in commerce, or used before October 1, 1984.
(ii) The products or source of the products containing < 50 ppm concentrations PCBs were legally manufactured, processed, distributed in commerce, or used, i.e., pursuant to authority granted by EPA regulation, by exemption petition, by settlement agreement, or pursuant to other Agency-approved programs;
(iii) The resulting PCB concentration (i.e. below 50 ppm) is not a result of dilution, or leaks and spills of PCBs in concentrations over 50 ppm."

EPA has also stated in the same presentation that "State requirements may require removal", but in Massachusetts there are no such requirements. On the contrary, the 2009 MDPH guidance suggests that PCB-containing building products be left in place and managed [MDPH, 2009]

There is no requirement to obtain EPA approval when determining whether or not a material is an excluded PCB product.

The process of determining if a material is an excluded PCB product is based solely on the criteria set forth in the regulations under 40 CFR 761.3 and summarized by EPA above.

When the issue of excluded PCB products was first brought up unnecessarily by May for the EPA's input, the EPA had been provided the incorrect Tectum felt Aroclor data, was unaware that the PCB Aroclors in the Tectum felt and caulk were different, and did not know that the felt mostly contained <50 ppm PCB.

The Tectum panels themselves contained little or no PCB. When they did, they contained low levels of Aroclor 1254, presumably from the room air. No Aroclor 1248 was detected in any of the Tectum panels, which one would expect to see if the Aroclor 1248 was passing through the Tectum and entering the building air; the Tectum itself would have served as a filter. Therefore, any PCBs in the Tectum felt could not have diffused through the Tectum panels into the room air.

All of the Tectum felt at WMS, except for one room, was and is an excluded PCB product

Tectum felt samples from 4 of 5 rooms where Tectum felt was sampled contained <50 ppm PCB.

The Tectum felt is part of the original school construction, when the Tectum form panels were used for the original concrete roof construction. The Tectum felt was therefore sold before 1984.

Tectum felt samples from 4 of 5 rooms sampled contained Aroclor 1248. Aroclor 1254, a distinctly different commercial PCB product, was present in the building caulk. The PCBs in most and possibly all of the Tectum felt is not associated with contamination from the caulk.

Comparing the EPA criteria cited above with these data, it is clear that most of the Tectum felt at WMS would be considered an excluded PCB product and should have been left in place.

Due to their lack of experience with PCBs, Fuss & O'Neill attributed the Aroclor 1254 contamination in the WMS to the Tectum felt, which made with a completely different PCB Aroclor, Aroclor 1248, and mistakenly recommended to the Town of Westport that it be

removed.

Declaring the felt to be an excluded PCB product alone would have eliminated the need to remove almost all of the tectum and felt. There is no requirement to prove this to the EPA or get their approval; you simply make your own determination based on the facts.

Fuss & O'Neill made the following erroneous statements in support of their incorrect recommendation:

- "USEPA requirements apply only if PCBs are present…at concentrations ≥50 ppm… Note materials containing <50 ppm may also be regulated unless proven to be an "excluded PCB product". If PCBs greater than 1 ppm are present in a material, it must be demonstrated (proven) that the materials containing <50 ppm PCBs are an "excluded PCB product", which for this circumstance would be a product legally manufactured or use prior to October 1, 1984. (p. 8)" [ESI017138].

- "It should be noted that the two (caulk) results containing <50 ppm are likely a result of maintenance activity which could have removed original caulking or glazing compound containing ≥50 ppm PCB… Therefore, an "exclusion" is not likely to exist for these materials and all window and door systems should be included in proposed remediation plan." [WSTPRTSCHL017139] This was the tipping point in Fuss & O'Neill's analysis; they then extended this flawed logic to anything with >1 ppm PCB, implying <u>everything</u> at WMS containing >1 ppm PCB was contaminated by the caulk, i.e., all secondary sources, even if the data showed it contained a different type of PCBs than the caulk.

- "Since a regulated source of PCBs exists (in caulking)…EPA requires a determination of potential contamination as an evaluation of potential remediation wastes." [WESTPRTSCHL017139] This was again incorrect; Fuss & O'Neill was involved in other projects where PCB caulk was removed and no further action was taken. (p. 9)

- PCBs in concentrations higher than the EPA guidelines were found in: Felt above "Tectum" ceiling panels. Materials also contained asbestos." [WSTPRTSCHL019255]

- An "exclusion" for these materials was not sought and all window and door systems (and Tectum felt) were included in the proposed remediation [WSTPRTSCHL019257]

Once Fuss & O'Neill realized their mistake 2 years later, they failed to inform the Town of Westport that most of the Tectum felt was an excluded PCB product and did not need to be removed.

In preparing their 2013 report [PCB Source Removal Project Report and Management Plan, April 1, 2013, p. 22, Table 7], Fuss & O'Neill apparently realized their significant mistake and corrected the Aroclor in the Table to Aroclor 1248, but without so much as a comment on its dramatic cost impact to the previous WMS project. [WSTPRTSCHL019267].

Nowhere in the report or other documentation could I find evidence that Fuss & O'Neill acknowledged their error to their client or identified the significance of the error. The cost of Tectum felt removal accounted for more than 80% of the cost of the remedial project, or more than $2 million.

When confronted with their mistake during his deposition, May first admitted [May, pp. 266-268] that he made the change, and that he "probably looked back at the data to correct and make sure everything was accurate." When asked why the report didn't explain "the significance of that correction", he couldn't explain their oversight.

Fuss & O'Neill should not have recommended any Tectum felt removal at WMS

Tectum remediation was the largest single expense on the remedial project, accounting for $2 million, or more than 80% of the WMS remedial cost. This expense was wasted and based solely on bad advice from Fuss & O'Neill and the mistaken assertion that the PCBs in the school air were in fact coming from the Tectum felt.

When asked, based on the data, if he "could have made the recommendation that the ceiling and felt in Room 212 remain in place as an excluded PCB product..." May replied "If that was the goal of the project, sure." [May, p. 264]

The "goal of the project" should have been to reduce PCB air levels to below the appropriate risk-based levels for middle school students in the most cost-effective manner possible. Achieving that goal would not include wasting money on removing material that is not required by the EPA and not demonstrated to be contributing to PCB air levels.

Virtually no PCB remedial work needed to be performed at WMS

The window assemblies containing residual PCB caulk and any removed caulk would have been disposed of as PCB bulk product waste, if they had been removed.

If Westport wanted to reduce the PCB air levels at WMS, the broken ventilation system would have needed repair to operate properly, and supplemental ventilation (fans) would have been needed to flush out the stale air.

There is nothing about the discovery of PCBs in caulk and window glazing during the Green Repair program that warranted the intensive remediation effort Westport engaged in.

The WMS PCB project team never defined or understood the technical problem they were hired to solve

Developing a "conceptual site model" (where PCBs are and how they behave) is critical to defining and selecting the proper remedy. Considerations at WMS should have included:

- Whether the initial air sampling results were biased due to lack of ventilation,
- Whether the initial air sampling results were biased due to the lack of a properly functioning ventilation system
- Whether the PCBs in the air were dust or vapor,
- Whether disturbing the PCB-containing building products increased the PCB air levels, and
- Whether PCBs were in fact redepositing on building surfaces.

Understanding if and how PCBs were being transported was critical, but never confirmed.

Fuss & O'Neill communications with the Town of Westport repeatedly suggested that "dust" in the air and dust deposition on surfaces was the problem, yet the air sampling method they used could not distinguish between dust and vapor.

Collecting and analyzing separate collection "traps" from the air sampling device is possible under either the EPA Compendium Method TO-4A or TO-10A, but this approach was never used at WMS.

Instead, Fuss & O'Neill continued to communicate that dust was transporting the PCBs without proof.

- They continuously referred to wipe samples as "dust wipes" in their communications with the Town of Westport, when in fact wipe samples are intended to dissolve vapor or liquid deposits [CAMPBELLENV001121]. Other methods are designed to collect actual dust, none of which were used by Fuss & O'Neill.
- Fuss & O'Neill never collected and analyzed any samples of actual dust based on my review of the record, even though dust was visibly present in unit ventilators during my visit to WMS.
- Fuss & O'Neill also specified that the rooms be cleaned with HEPA filter-equipped vacuums, another unnecessary expense. HEPA filters are only designed to collect solid particles [Fuss & O'Neill O&M Plan, p. 51].

As noted previously, the PCB levels on surfaces remained virtually unchanged from before the remedial cleaning until the last set of wipe samples were collected.

Dust was and is still present, caked onto the univent coils and exhaust ductwork/registers, and was certainly being recirculated through the rooms as a result.

- I observed substantial dust, dirt and debris accumulations in the univents during my site inspection. Michael Duarte, head of WMS building maintenance, testified that the univents had remained assembled to the school from 1969 to the present and therefore the backs of the univents never accessed (Michael Duarte deposition, p. 132) , proving that portions of the univents were never completely cleaned since 1969.
- Duarte also agreed that the univents could simply recirculate stale air if the fresh air intake baffles were not operating or were not operating properly (Michael Duarte deposition, pp. 184-185),
- Likewise, Duarte testified that the rooms exhausted to a common duct that was attached to roof mounted exhaust fans (Michael Duarte deposition, p. 123). Those exhaust ducts were original equipment (Michael Duarte deposition, p. 129) and, other than the music room, never cleaned since 1969.

In my experience, dust accumulations from deferred maintenance can continue to be the predominant source of indoor air PCB contamination if not removed.

Even what little ductwork that was cleaned by Enpro was cleaned “as best we could” (McCusker deposition, p. 12) rather than to a specific standard. They used a rudimentary tool crafted on site, a stick with a rag attached to it (McCusker deposition, p. 33):

> “You vacuum everything up, all the dust you could first, and then put Simple Green on a rag, and just poke it along and try to wipe up as best we could,”

In my experience, professional dust cleaners use specialized equipment to do a more thorough job. Professional duct cleaners removing PCB contamination also collect wipe and/or dust samples to confirm that the job was done. There is no evidence that Enpro did any testing to confirm that they had removed PCBs from the ductwork, suggesting that it is still there.

The PCB air levels measured in June 2011 were the result of WMS being closed, the ventilation system not operating properly, and the building air not circulating.

Pinck noted (7/29/11) that the initial baseline air tests were done “when the ventilation system had been off for almost a month, and the windows were shut. No internal air was circulating. The current baseline test results were taken after ventilators (cleaned and balanced) were running for 24 hours… The baseline results indicate that just cleaning/balancing the ventilators and cleaning the rooms will not reduce the PCB level significantly” [WSTPRTSCHL020828]. It should be noted that the WMS heating and ventilating system was not cleaned or properly calibrated at that time.

The EPA made the suggestion early on to add fresh air. May reported to the Town of Westport on July 11, 2011 that “Per EPA’s request, we need to review the current unit ventilation system in terms of fresh air and use.”[May e-mail, July 11, 2011]

May then enlisted his mechanical engineer, David Jackson, to evaluate the "ventilation system in terms of fresh air and use" before meeting with EPA on July 14, 2011. Jackson concluded that operating the unit ventilators alone would not be sufficient to fully ventilate the building. [P165], but Fuss & O'Neill proceeded to do it anyway, without success.

The WMS project team was then faced with two options: (a) increase the ventilation rate with outside air, purge the stale air, and see if the indoor PCB air levels rise again afterwards, or (b) begin an expensive PCB removal project and hope the PCB air levels decline. The team made the wrong decision, since air levels increased or remained the same after PCB removal in some rooms after remediation, and PCB air levels in other rooms decreased without remediation.

In less than a month after the PCB remediation was over, Dr. Colley pointed out to the school committee that "Time and ventilation seem to be working." "Ventilation and cleaning do seem to be helpful in reducing the air levels."

Significantly, he then noted that the Room 24 air levels dropped more than 50% with cleaning and ventilation only; Room 24 never contained any Tectum felt.

Finally, he gave examples:

> "In one room we did nothing and the [PCB air levels] went down… (940 to 640)… In another room we ventilated and it went way down from 1300 to just at 320." [WSTPRTSCHL022022]

Regarding Room 24 and the difficulty lowering the PCB air level, Dr. Colley asked May:

> "Can we ventilate the ----- out of the room first just to see if we have stale air?" [Colley e-mail to May, September 27, 2011]

Note again (see previous discussion) that the data showed surface cleaning did not significantly reduce PCB levels on surfaces, and that the surface PCB levels were acceptable even before cleaning began.

In my experience on numerous building cleanups, active ventilation is commonly implemented before indoor air sampling is performed. Records show that Dr. Colley communicated with the Town of Lexington regarding this option, where previous work at the Estabrook School in Lexington had shown that purging of the stale air from the school with high volume auxiliary fans was necessary to reduce PCB air levels permanently. This finding was communicated to Fuss & O'Neill, but the finding was largely ignored and auxiliary ventilation with additional fresh air was never employed.

As also noted previously, dust accumulations still exist in the univents today and probably in the portions of ductwork that were not cleaned or not cleaned properly, so a lack of fresh air makeup would also allow dust from these devices to reenter the air through recirculation. Michael Duarte agreed that closing off the univent air intake or operating a broken univent would simply recirculate contaminated air, such as "during morning startup" [Michael Duarte deposition, pp. 184-185].

Any remaining PCBs in the air at WMS were more likely emitted from inadvertently generated PCBs rather than "secondary sources" and were not produced by Monsanto.

Fuss & O'Neill appeared to first discover the concept of "secondary sources" almost 2 years into the project, and immediately and conveniently attributed the remaining airborne PCBs at WMS to these sources without any supporting data or scientific basis.

It is just as likely that these secondary sources are in fact inadvertently generated PCBs from excluded manufacturing processes [40 CFR 761.3]. A majority of the PCB building product tests were either non-detect or found PCB levels that were non-functional components. Given that some of these test results were flagged by the laboratory as non-Aroclor, and that at least one sample was from paint (Room 24) that had been applied long after the use of PCBs in paint had ceased, the PCBs in some of these products were not Aroclor PCBs and were therefore not produced by Monsanto.

Most of the air sample results after November 2011 were below the EPA guidance levels, so there was no reason to abandon the school and relocate.

The PCB air test results in almost every room at WMS were below the applicable EPA guidance levels before school reopened in September 2011. Given that there is no regulatory requirement to meet a particular deadline for removing PCB-containing building products, WMS could have remained open indefinitely.

Most of the air sample results after November 2011 were below the EPA guidance levels, so there was no reason to continue air sampling.

The PCB air levels remained below the EPA guidance levels in almost every room for more than 4 years, until the children were relocated.

Throughout 2013-2015, Fuss & O'Neill repeatedly acknowledged in e-mails to the Town of Westport that the air sampling results at WMS were "below" or "well below" the EPA guidelines or "all good". [WSTPRTSCHL 026334, WSTPRTSCHL 026447, ESI16107, ESI16727, ESI11488, ESI11957]

Quarterly air sampling in the WMS has been conducted since the beginning of the remedial project despite data showing it to be unnecessary after the first few months following the cleanup [WSTPRTSCHL021522-524].

The decision to conduct PCB air sampling in 100% of the rooms and to keep sampling the air was made by the Town of Westport, not the EPA, and should have been discontinued at any time if the results were satisfactory, which they were:

> "School has decided to initially undertake [air] sampling of 100% of the rooms where work occurs." [EPA-Westport001109, May to Tisa, 8/10/11]

Then, only weeks later [ESI16544, 8/29/11 memo], the Town of Westport was apparently rethinking the commitment to 100% sampling. Said May in an e-mail to Colley:

> "…one item I heard was a rumor of not testing all rooms for PCB [in air] in reference to a conversation with [the School Committee] and Triumvirate and subsequent discussion by Triumvirate with Kim |Tisa [EPA]"

Still, from that point forward The Town of Westport and its consultant never approached the EPA about reducing or eliminating air sampling, despite data showing the air was below the EPA guidelines and hints from the EPA in 2011 that this might be considered:

> "EPA has even held out saying we were successful although somewhat off the record Ms. Tisa said the initial [air] data looks good so a second round would confirm." [11/19/11 e-mail from May, no Bates]

Later, the EPA expressed concern that:

> "…many rooms had not been sampled on an annual basis as was proposed by the school", not required by EPA [8/14/14 e-mail, Tisa to May; no Bates]

On November 21, 2014, *after more than 3 years of quarterly air sampling*, May suddenly deemed the quarterly air sampling to be required by the EPA, stating "This is the expectation of EPA… EPA is looking to see that we (Westport) fulfill its [Westport's, not the EPA's] plan to test all rooms at least one time during the school year." [ESI12011, 11/21 May to Hand].

The cost of the project was further inflated by Fuss & O'Neill's misunderstanding of the PCB disposal regulations

Fuss & O'Neill's misunderstanding of the PCB disposal regulations resulted in significant unnecessary expense to the project

The PCB regulations governing the disposal of waste from a PCB remedial project can be summarized as follows:

- PCB remediation waste (i.e., soil, contaminated demolition debris, etc.) must be disposed of at a licensed PCB disposal facility, unless the EPA approval is received to dispose of <50 ppm waste in "a facility permitted, licensed or registered by a State to manage municipal solid waste… or non-municipal non-hazardous waste…" (40 CFR 761.61(a)(5)(v)(A))", in other words a local sanitary landfill of demolition landfill;

- PCB bulk product waste (i.e., PCB-containing caulk or paint at any PCB concentration) may be disposed of in "a facility permitted, licensed or registered by a State to manage municipal solid waste… or non-municipal non-hazardous waste…" (40 CFR 761.61(a)(5)(v)(A))". In other words, the PCB caulk could have been disposed of at a local landfill rather than upstate New York or Michigan, and at a lower per ton cost.

Almost all of the waste generated during the WMS PCB project was disposed of at licensed PCB disposal facilities, when in fact the PCB bulk Product Waste and <50 ppm PCB Remediation Waste could have been taken to a municipal landfill if the Town of Westport had simply asked the EPA's permission to do so.

The Fuss & O'Neill remedial plan (PCB Source Removal and Decontamination Project, August 4, 2011)[WSTPRTSCHL013674] stated that it "has been prepared to comply with the [EPA] requirements for proper removal and disposal of PCB containing building materials as PCB bulk product waste."

This statement was incorrect; in reality, almost all of the waste from the remedial project was sent to a more expensive disposal site, the EQ Landfill in Michigan. The plan stipulated incorrectly:

- "Note Tectum contains <50 ppm PCB but due to the presence of mastic adhesive on Tectum shall be removed and disposed of as waste containing >50 ppm PCB" [WSTPRTSCHL013678]. This directive assumed that the Tectum felt contained >50 ppm PCB, when in fact the data generated by Fuss & O'Neill itself showed that most of it did not.

- "Remove existing Tectum ceilings located just below concrete floor or ceiling. Materials removal will result in some removal of PCB containing mastic. Mastic contains PCB >50 ppm" [WSTPRTSCHL013679]. This directive also assumed that the Tectum felt contained >50 ppm PCB, when in fact most of it did not.

- "[PCB] Concentrations exceed 1 ppm but are <50 ppm so waste can be disposed of as PCB containing waste at a facility which can accept PCB waste <50 ppm. Adjacent masonry substrates…exceed 1 ppm but are <50 ppm so waste can be disposed of at a facility that can accept <50 ppm PCB. Materials containing <50 ppm will be transported to a non-hazardous solid waste disposal facility. [WSTPRTSCHL013689]". These statements seemingly contradict the preceding statements, and as pointed out above are illegal unless approved in writing by the EPA.

May's expert report still does not reflect an understanding of the PCB regulations and does not explain the rationale for his mistakes

May's expert report was little more than an attempt to retell the failed WMS project story as a success, still ignoring or downplaying the numerous and costly technical and regulatory mistakes and his lack of relevant experience.

May still thinks the Tectum concrete form planks are glued-on acoustical ceiling panels.

During his deposition 4 years after the WMS project began, May was made aware that the Tectum form panels were part of the formwork used in 1969 to pour the WMS concrete ceiling, [May deposition, p. 249-251]. Despite that knowledge, he still states erroneously in his report that several pounds of encapsulant per panel "was likely to cause failure of the panels" [May report, p. 11], when in fact they were designed to hold up to tons of liquid concrete. Enviroscience never produced an engineering analysis supporting May's theory, nor could they based on the facts.

May completely ignores his huge, costly Tectum felt mischaracterization mistake described earlier, which he admitted making in his deposition. Given the opportunity to research the EPA regulations governing excluded PCB products since his deposition and include a correction in his report, he still could not defend his mistake.

May also completely avoids (again) explaining why he corrected the mistaken PCB Tectum felt data in his report two years after the project without telling his client or admitting the huge magnitude of the mistake. He clearly has no explanation or excuse.

May still believes incorrectly that the EPA PCB regulatory requirements and the EPA guidance/advice are the same thing and carry the same weight.

May completely ignores the lack of regulatory drivers for PCB testing and removal, stating instead that the various EPA guidance documents are "authoritative" [May report, p. 3] when in fact guidance can never take the place of regulatory requirements.

May completely ignores the lack of regulatory drivers for PCB testing and removal, creating instead an imaginary "standard of care" that he invokes in his report as a convenient substitute for the EPA regulations [May report, pp. 3, 8, 9], a standard that had never been cited before or defined during the WMS project, wasn't included with his report, and certainly doesn't represent published industry consensus. The reason is simple: no such standard exists; it's one of his own creation.

May completely ignores the lack of regulatory drivers for PCB testing and removal, instead claiming most of their decisions were "reasonable" [May report, pp. 2, 3, 5, 6, 7, 8] as justification for his numerous and unnecessary regulatory departures. He never attempted to cite any such standard before or during the WMS project, and couldn't cite a reference to any such industry standard in his report.

May states that the EPA's 2009 "guidance" "expressly recommends" testing caulk for PCBs [May report, p. 2] and that the same EPA guidance "requires removal" [May report, p. 4], but fails to acknowledge that the governing PCB regulations do not recommend or require either PCB caulk sampling or removal.

May still cannot cite relevant experience on similar projects prior to WMS.

May opines generally that "PCB regulatory knowledge and experience was limited in the summer of 2011" [May report, p. 8], which was clearly true for May and EnviroScience based on their limited resume, but was certainly not true in the industry generally. PCB building cleanup projects date back to the 1980s and were performed by numerous consultants and contractors, including those whom May recalls hearing at various seminars and conferences [May deposition, pp. 67-68, 97-99].

During his deposition, May could not cite any projects prior to WMS where he had managed an EPA-approved PCB building remediation project. Given the opportunity in his report to correct the record and identify such projects, he still could not. Instead, his report instead attempts to resurrect his non-existent 2011 experience by rephrasing his deposition responses, claiming *generally* that "Enviroscience successfully met EPA requirements for initial site characterization and planning through letters of project approval from EPA Region 1 for multiple prior to the work at WMS." [May report, p. 9] If he could demonstrate that they had the necessary experience, he could have just stated it and cited specific examples.

May attempts to deflect blame for his mistakes to the EPA by citing non-existent EPA requirements and guidance.

May claims to have "followed a standard operating procedure for developing a plan for remediation" according to 40 CFR 761.61(a) and (c) [May report, p. 3], yet there is no such procedure anywhere in the regulations, either now or back when the WMS project began. This betrays his lack of experience and perhaps an effort to divert blame for his mistakes onto the EPA.
May then brings up the issue of secondary sources, claiming it was "reasonable and necessary for Westport to consider future removal of secondary sources of PCBs that are *potentially* contributing to PCB sources in the air (emphasis added) [May report, p. 7]. Nowhere in the PCB regulations are so-called "secondary sources" of PCB even mentioned, nor is their removal required, so consideration of removal was not necessary

More importantly, the WMS air levels were already below The EPA guidelines by that time, and May and Enviroscience had no evidence whatsoever that "secondary sources" were contributing to PCB air levels at all.

May also fails to acknowledge that many of these so-called “secondary sources” all contained PCBs at non-functional levels, were identified as non-Aroclor PCBs, and were just as likely to be inadvertently generated PCBs [40 CFR 761.3], that is, PCBs that were also not manufactured by Monsanto.

The WMS sampling data and activity chronology clearly suggest that time and ventilation were the solution to reducing the initial stale air measurements, and was suggested by the EPA early on. May’s first attempt at remediation however, turning on the existing, broken HVAC system for a day (mostly unit ventilators which had not been properly cleaned/maintained), was even dismissed by his own engineer, who stated that using the existing system “would not likely [produce] favorable results”. Then, instead of bringing in bigger fans, he proposed a multi-million dollar removal project.

Hartman's expert report does not reflect an understanding of the PCB regulations and does not explain the rationale for the many mistakes made by others on the WMS project

Hartman's expert report isn't much different than May's, in the sense that he also retells the project story as though it was a success (i.e., they completed the work as scoped by May) rather than a waste of money, and shows his lack of understanding of the PCB regulations. Unlike May, he then makes generalizations about how PCBs behave in caulk that aren't supported by any of the findings at WMS.

Hartman, like May, clings incorrectly to the belief that the Tectum form planks are glued-on acoustical ceiling panels rather than concrete forms used to construct the ceilings.

Hartman states that the Tectum felt was "used to adhere Tectum form planks to the interior concrete ceilings." [Hartman report, p. 4] He then states that encapsulation of the Tectum was not an option because the added weight "may have pulled (the panels) loose from the ceiling." [Hartman report, p. 6] Neither of these statements is true.

He also states that Fuss & O'Neill detected PCBs >50 ppm in the Tectum felt, which is only true in one room out of 60 classrooms but nowhere else. May represented to Triumvirate in their work scope that *all of the Tectum felt was >50 ppm PCB* and didn't share the supporting data with Hartman.

Hartman states incorrectly that the EPA indicated that the contractor must remove a minimum of 95% of all felt [Hartman report, p. 6], and that this requirement was cause for extensive removal of the felt. In fact, May realized after the pilot study that 100% removal wasn't possible, and modified the bid spec to only remove 90%:

- "A meeting was held between representatives of the school and Fuss & O'Neill Enviroscience, and it was determined that the contractor would remove the loose mastic (to approximately 90%) and leave areas of mastic embedded in the concrete slab." [ESI 17310]

Nowhere is there any communication about this issue with the EPA asking them to approve it, and the EPA certainly didn't approve it. In fact, the EPA didn't formally approve any part of the WMS project.

Hartman also struggles with the PCB regulations and makes statements that could only be supported by guidance, not the regulations themselves.

Hartman believes incorrectly the EPA PCB regulations state that PCBs must be removed when found [Hartman, p. 2].

Hartman states incorrectly that WMS is not in compliance with the PCB regulations because there was no EPA approval of the interim removal project. On the contrary, there is no regulatory requirement to remove PCB bulk product waste, nor is there any regulatory requirement to obtain EPA approval for a removal project. EPA even communicated to May that no approval was necessary for the 2011 WMS remedial project.

Hartman states incorrectly that the EPA initially recommended closing the school and abating the materials. Borins' notes to the Westport School Committee stated the opposite, *that the EPA told Westport that they would never recommend closing the school.* I'm not aware of any school with PCB building materials being closed because the EPA told them to close it, nor am I aware of any situation involving PCB bulk product waste where EPA initiated any enforcement action.

Hartman makes general statements about the science of PCB behavior in buildings that are not supported by the WMS findings.

Hartman states that PCBs can off-gas from primary and secondary sources. None of the WMS air test results were collected in a way to demonstrate that PCBs were "off-gassing" at all (i.e., they didn't collect separate particle and vapor samples).

The whole issue of secondary sources wasn't even raised in project communications until more than a year after the remedial project was over, Hartman was no longer involved, and the air levels were acceptable.

Hartman also ignores the fact that at least some of the non-functional PCB levels in WMS building products were most likely due to inadvertently generated PCBs in paint, caulk and other materials, particularly those containing pigments.

Hartman makes a number of statements that conflict with the facts in this case.

The following representations are made by Hartman that I do not believe are true:

1. *The EPA recommended closing WMS.* Incorrect. (see earlier discussion)
2. *Fuss & O'Neill determined that all ballasts had been removed.* The record indicates [Michael Duarte deposition, p. 68] that the ballasts had been removed as part of a program in the 1980s, that another 15 to 20 PCB ballasts were discovered later by Duarte and removed [Michael Duarte deposition, p. 70-71]. There is no record of Fuss & O'Neill doing its own investigation.
3. *Fuss & O'Neill inspected light fixtures for staining.* I found no record of this inspection, and there's nothing in their report about it.
4. *Pilot study work began upon receipt of an e-mail notification from the EPA that it didn't require submission of a plan to the EPA.* The EPA originally recommended that Westport do a pilot study, but there's nothing I could find in the record suggesting that they were

waiting for EPA approval or that they received any such approval.

5. *The EPA indicated that the contractor must remove a minimum of 95% of all felt, and that this requirement was cause for extensive removal of the felt.* Incorrect (see earlier discussion).
6. *The WMS building is under a site use restriction.* Incorrect, there is currently no deed restriction on the building, nor is one required under the regulations.
7. *A. M. Fogarty's cost estimate for WMS was based on their PCB remediation experience at Hammond Hall.* This misrepresents the testimony of Peter Timothy (A. M. Fogarty' project manager). Timothy testified that the only PCB remediation cost data in his database was limited to brick replacement at Hammond Hall, yet Hartman's statement implies Timothy had access to a broader cost database for other remedial tasks, which he stated he did not.

Hartman states in his conclusions that the cost of the project was "reasonable," suggesting that is was voluntary

None of the PCB remedial work performed at WMS was required by EPA or the EPA PCB regulations, and all of it was unnecessary, so any cost would be unreasonable.

None of the PCB remedial work performed at WMS was required by EPA or the EPA PCB regulations, so all of the work was essentially voluntary, at the Town of Westport's discretion, and is therefore not the responsibility of Monsanto.

Hartman is confused about the PCB disposal regulations, and makes statements in his report that are incorrect and that manifested themselves in the improper and costly disposal of WMS PCB waste.

The EPA PCB regulations provide that you are allowed to dispose of PCB bulk product waste (caulk, etc.) in a RCRA Subtitle D (i.e., municipal solid waste) landfill if they will accept it (40 CFR 761.62). In 2012, The EPA "reinterpreted" this rule to include disposal of any attached substrate (like bricks) along with the caulk in the same landfill. This provision is useful for demolition projects, but not so much for removal and repair projects.

Apparently unknown to Hartman, the regulations have also stated since 1998, long before the WMS project, that you can dispose of PCB remediation waste <50 ppm in a municipal landfill if (a) they will accept it and (b) if you get an EPA self-implementing approval (what May considered a simple "notification", which given all their communication with the EPA should have been easy). [40 CFR 761.61(a)(5)(v)(A)]

May requested and received remedial bids that included disposal costs for <50 ppm PCB waste, but neglected to ever use them.

Triumvirate disposed of <u>all</u> the waste from WMS at an expensive PCB landfill (except for some carpeting) and didn't have to. If they had asked the EPA for approval, they could have disposed of almost all the non-caulk waste at a <50 ppm landfill (of which there are several in New England), since more than 80% of the waste volume was <50 ppm Tectum panels.

The 2012 "reinterpretation" cited by Hartman would not have had any effect on the project because (to my knowledge) there are no municipal landfills that will accept >50 ppm PCB caulk anyway.

Herrick's report is largely irrelevant to WMS given his lack of remedial experience, his intentional disregard for EPA standards, and his unsupported generalizations about PCB science.

Herrick is not qualified to opine on any aspect of the WMS remedial project.

Based on his resume, Herrick has never been involved in planning or implementing a PCB building remediation project, and has no qualifications or experience from which to judge whether steps taken to remediate PCBs are required by EPA, let alone "reasonable".

Herrick opines that the Town of Westport "was reasonable in its decision to take actions to remove or otherwise remediate PCB contamination" at WMS [Herrick report, p. 3]. What Herrick fails to mention is that the Town of Westport was not required by EPA's own regulations to conduct any of the remedial activities they had voluntarily undertook.

Like May and Hartman, Herrick invokes a vague and undefined "reasonableness" standard as support for the WMS project, without defining what that means. In my opinion, the WMS remedial project was unnecessary and any associated expense was therefore unreasonable.

Herrick fails to acknowledge that the PCB air levels at WMS did not exceed <u>any</u> established EPA regulatory standard. Instead, Herrick creates a variety of misleading terms and phrases that suggest incorrectly that the PCB air levels at WMS were out of compliance with actual regulatory standards. To illustrate:

- PCB air levels were over "the EPA's maximum exposure recommendation" (Herrick report, p. 3)
- Air levels in many rooms "showed compliance with EPA's guidance…" (Herrick report, p. 3)
- Air inside school buildings "…exceed EPA's reference values" (Herrick report, p. 10)
- The Town of Westport was reasonable in its decision…to provide maximum protection…with the expectation that under no circumstance would exposure (above the EPA guidance levels) be permissible. (Herrick report , p. 19)

He then contradicts himself by acknowledging that "EPA states that these (PCB air guideline) values should not be interpreted or applied as "bright line" or "not-to-exceed" criteria…"

Similarly, Herrick creates terminology suggesting incorrectly that the PCB levels on surfaces at WMS exceeded the EPA surface standard, stating that "the EPA threshold for surface contamination is 1 µg/100 cm^2". On the contrary, the most stringent EPA regulatory surface standard for PCBs is 10 µg/100 cm^2 (40 CFR 761.3) and applies to high occupancy areas such as schools, and which the WMS met in all of the classrooms even before beginning remediation.

Herrick should not have repeatedly highlighted "detectable levels of" PCB in caulk, since

those results are below any regulatory standards and of no consequence to a remedial project.

Herrick's continuing reference to detectable levels of PCB suggests that any level of PCB in air and on surfaces is unacceptable, contrary to EPA's established, risk-based regulatory standards.

The laboratory detection limits for PCB in bulk, wipe, and air samples are typically 10 to 1,000 times lower than any established regulatory limit or guideline, so the mere detection of PCBs in a sample should not be a cause for remediation. EPA has been clear on this issue, and in my experience often requires that laboratory detection limits be 10 to 100 times below a project action level; detection levels are often controlled by sample size, i.e., extracting and analyzing a larger sample often results in a lower detection limit.

Herrick clearly disagrees with EPA and their regulatory standards and believes that any level of PCBs is unsafe. Throughout his report, he ignores established EPA standards and instead highlights any measureable levels in an apparent attempt to alarm the reader; some examples:

- "The levels of PCBs in the school's air may have to be lower (than the EPA guidelines)" (Herrick report, p. 12)
- "Bulk samples of other materials…contained detectable PCB levels…" (Herrick report, p. 18)
- "All 12 of these (caulk and glazing) samples contained detectable levels of PCB" (Herrick report, p. 18)
- "PCBs were detected in 19 of 20 surface wipe samples…" (Herrick report, p. 19)
- "Baseline air samples…showed detectable PCB concentrations in all 9 samples…" (Herrick report, p. 19)

Herrick's discussion of PCB behavior in a generic school environment includes unsupported and often incorrect generalizations that do not apply to WMS.

Herrick states that "the presence of PCBs is of particular concern in schools, where PCB congeners…volatilize from building materials." (Herrick report, p. 6). There is no data from WMS showing that PCBs volatilized from building materials at any level.

Herrick states that "PCBs move readily from the exterior to the interior of buildings" (Herrick report, p.11) citing only his own survey article, which upon closer scrutiny cites a number of studies that do not support his statement. (See related opinion below)

Herrick states that "Dust (containing PCBs)… reflects the mobilization of PCBs from the vapor released from the primary sources to dust particles that are initially airborne but settle onto surfaces." [Herrick report, p. 11] Besides his not citing a scientific reference for this statement, there is no data or other evidence that this process was going on at WMS.

Herrick then states that the primary sources of PCB contamination at WMS were window caulking, door caulking, and window glazing, but excludes Tectum felt. He then states that PCBs "from these and other sources had spread throughout the (WMS) building" and that "Bulk samples of other materials such as mastics, foam and felt contained detectable PCB levels in 7 of 9 materials." [Herrick report, p. 18] He fails to mention that the type of PCB found in the mastic and felt was different than the "sources" he cites and could not have come from them, and that PCBs from inadvertent production are likely present in at least some of the paint and caulk at WMS from original construction or repair/repainting projects.

The presence of PCB caulk on the exterior of a school building cannot be correlated with PCB air levels inside the school.

I disagree with Herrick that "PCBs move readily from the exterior to the interior of schools (Herrick report, p. 11). On the contrary, there is no demonstrated mathematical correlation at all between indoor air levels in schools and PCB levels in exterior caulk, nor are there any credible scientific sources that agree with his statement.

This lack of a demonstrated correlation between indoor air and exterior caulk PCB levels by Herrick is important, since the studies cited by Herrick were either based on sampling of exterior caulk only (Herrick 2004, Klosterhaus, 2014, Robson) or the location of the caulk was not given [Kohler 2005].

Studies cited by Herrick in fact include examples of schools with high PCB levels in exterior caulk having little or no PCBs in the indoor air [Balfanz, Corner]. Even the data from the New York City schools studies he cites do not support any correlation between exterior PCB caulk concentrations and interior PCB air concentrations.

Most of the studies he cites did not present individual data points that (a) identified where the PCB caulk was located or (b) would allow actual mathematical correlation of PCB caulk and air levels in individual buildings.

Without such a mathematical correlation between exterior caulk PCB levels and interior air PCB levels, such a positive correlation does not exist.

The EPA laboratory chamber studies cited by Herrick show that caulk containing PCBs at higher levels could, under certain laboratory conditions of no known relevance to WMS emit PCBs, but their findings only apply to interior caulk.

However, the applicability of laboratory chamber tests to real life buildings is subject to numerous building-specific factors that Herrick does not and cannot address.

The EPA study cited by Herrick [Guo, 2010] measured the rate of PCB release from caulk into a chamber, which is intended to simulate releases from *interior* caulk into a room. The EPA study is only potentially applicable to rooms where PCB-containing caulk is present on the interior surfaces. Studies cited by Herrick were based almost entirely on findings of PCB caulk on the exterior of the buildings.

However, even empirical data from studies cited by Herrick show much lower (even non-detect) air levels when PCB caulk is present, and conflicts with the model's apparent conclusions.

The only study cited by Herrick that investigated PCB caulk on Massachusetts buildings was his own study [Herrick, 2004], which tested exterior caulk (Herrick deposition, p. 113) on only 3 elementary and middle school buildings, and did not collect any air samples from those schools.

Contrary to Herrick's unfounded statement that "PCBs move readily from the exterior to the interior of buildings", there is no known quantitative correlation between PCBs in exterior caulk and PCBs in the indoor air of the same building.

None of the findings in the research from five countries cited by Herrick made any attempt to show an actual mathematical correlation between measured indoor PCB air levels in buildings containing PCB in caulk and sealants, whether interior or exterior, nor did they even suggest such a relationship.

Other factors of perhaps greater significance to indoor PCB air levels cited by researchers and referenced by Herrick include ventilation design, operation, and maintenance quality/frequency, and the presence of dust [Corner, Zennegg, Kohler 2002, Kohler 2005, Burckhardt, and Fredricksen]

Most of the studies Herrick cites only tested caulk from public buildings generally and did not indicate (a) whether schools were tested at all or (b) if the results from other types of buildings were even applicable to schools [Robson, Klosterhaus, Kohler, Benthe, Balfanz, Sundahl, Fredricksen].

The mere presence of PCBs in exterior building caulk and sealants does not in and of itself result in indoor air levels that exceed any established guideline. According to studies cited by Herrick, indoor PCB air levels far below even the EPA Guidelines were also measured in buildings that also contained PCB in caulk and sealants (Benthe (1992), Balfanz (1993), Fromme (1996), B. Gabrio (2000), Don, Neu, Corner (2002), Coghlan (2002), Kohler (2005)).

References

Balfanz E, et al. "Sampling and Analysis of Polychlorinated Biphenyls (PCB) in Indoor Air due to Permanently Elastic Sealants," *Chemosphere* 26, 5 (1993): 871-880.

Benthe C, et al., "Polychlorinated Biphenyls. Indoor Air Contamination Due to Thiokol-Rubber Sealants in an Office Building," Chemosphere (1992): 1481-1486.

Burkhardt U, et al., "Indoor Air Pollution by Polychlorinated Biphenyl Compounds in Permanently Elastic Sealants," *Offentl Gesundheitweis* 52, 10 (1990):567-574.

Coghlan KM, Chang MP, Jessup DS, Fragala MA, McCrillis K, and Lockhart TM. (2002). Characterization of Polychlorinated Biphenyls in Building Materials and Exposures in the Indoor Environment. Proceedings: Indoor Air 2002. The 9th International Conference on Indoor Air Quality and Climate, Monterey, CA, USA, June 30-July 5, 2002.

Corner R, et al., "PCB in Indoor Air and Dust in Buildings in Stockholm," in *Indoor Air 2002*, proceedings from the 9th International Conference on Indoor Air Quality and Climate, Monterey, California, June 30–July 5 (2002) 4: 141-146.

Currado G, et al., 2008. Comparison of Polychlorinated Biphenyl Concentrations in Indoor and Outdoor Air and the Potential Significance of Inhalation as a Human Exposure Pathway. Environmental Science & Technology 32(20).

EPA Fact Sheet, www.epa.gov/pcbs/fact-sheet-practical-actions-reducing-exposure-polychlorinated-biphenyls-pcbs-schools-and-other

EPA PCB Q&A Manual. 2014.

EPA Questions & Answers - 2015

Fromme H, et al., "Polychlorinated Biphenyls (PCB) in Caulking Compounds of Buildings-Assessment of Current Status in Berlin and new indoor air sources [in German]. Gesundheitswesen 58(12):666–672.

Frederiksen M, Meyer HW, Ebbehoj NE, Gunnarsen L. (2012). Polychlorinated Biphenyls (PCBs) in indoor air originating from sealants in contaminated and uncontaminated apartments within the same housing estate. Chemosphere, 89(4):473-479.

Gabio T, Piechotowski I, Wallenhorst T, Klett M, Cott L, Friebel P, Link B, Schwenk M. (2000). PCB-Blood Levels in Teachers, Working in PCB-Contaminated Schools. Chemosphere, 40:1055-1062.

Guo Z, Liu X, Krebs KA, Stinson RA, Nardin JA, Pope RH, and Roache NF. (2011).Laboratory Study of Polychlorinated Biphenyl (PCB) Contamination and Mitigation in Buildings Part 1. Emissions from Selected Primary Sources. National Risk Management Research Laboratory, U.S. EPA. EPA/600/R-11/156, October 2011.

Haven, R. National Investigation of PCB Sources in Danish Buildings. Presented at the Eighth International PCB Workshop, Woods Hole, MA, October 5-9, 2014.

Herrick RF, McClean MD, Meeker JD, Baxter LK, and Weymouth GA. (2004). An Unrecognized Source of PCB Contamination in Schools and Other Buildings. Environ Health Perspect, 112(10):1051-1053.

Klosterhaus S, McKee LJ, Yee D, Kass JM, Wong A. Polychlorinated biphenyls in the exterior caulk of San Francisco Bay Area buildings, California, USA. Environment International 66 (2014) 38–43

Kohler M, Tremp J, Zennegg M, Seiler C, Minder-Kohler S, Beck M, Lienemann P, Wegmann L, and Schmid P. (2005). Joint Sealants: An Overlooked Diffuse Source of Polychlorinated Biphenyls in Buildings. Environ Sci Technol, 39:1967-1973.

Kohler, M, Zennegg M, Waeber R. Coplanar Polychlorinated Biphenyls in Air (2002). Environ Sci Technol, 36:4735-40.

Lee, Sharon. MA Department of Public health's Experience Responding to PCBs in Building Materials and the Environment. Presented at the Eighth International PCB Workshop, Woods Hole, MA, October 5-9, 2014.

MacIntosh DL, Minegishi T, Fragala MA, Allen JG, Coghlan KM, Stewart JH,McCarthy JF. (2012). Mitigation of Building-related Polychlorinated Biphenyls in Indoor Air of a School. Environ Health, 11:24, 1-10.

MacIntosh, D. et al. Risk Assessment for PCBs in Indoor Air of Schools. 2012. Unpublished.

MacIntosh, d. et al. Mitigation of building-related polychlorinated biphenyls in indoor air of a school. *Environmental Health* 2012, **11**:24.

MacIntosh, D. et al. Whole House Particle Removal and Clean Air Delivery Rates for In-Duct and Portable Ventilation Systems. Journal of the Air & Waste Management Association, Volume 58, November 2008.

MDPH. An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings. December 2009. Page 5 of 6.

Priha E, Hellman S, Sorvari J. (2005). PCB Contamination from Polysulphide Sealants in Residential Areas – Exposure and Risk Assessment. Chemosphere, 59, 537-543.

Sundahl, M.; Sikander, E.; Ek-Olaussen, B.; Hjorthage, A.; Rosell, L.; Tornevall, M. Determinations of PCB within a project to develop cleanup methods for PCB-containing elastic sealant used in outdoor joints between concrete blocks in buildings. J. Environ. Monit. 1999, 1, 383-387

Thomas K, Jianping X, Williams R, Jones P, Whitaker D. 2012. Polychlorinated Biphenyls (PCBs) in School Buildings: Sources, Environmental Levels, and Exposures, EPA, Office of Research and Development, National Exposure Research Laboratory, EPA/600/R-12/051, September 30, 2012.

Zennegg, M, Kohler M, et al. (2004) Joint Sealants, An Overlooked Diffuse Source of PCB – results of a nationwide study in Switzerland. Organohalogen Compounds – Volume 66, pp. 899-904.

Westport Materials Reviewed

Discovery production

- Town of Westport, including meeting minutes and videos
- Westport schools, including meeting minutes and videos
- EPA
- Enpro
- CGKV
- Pinck
- Contest
- M. Fogarty
- Arcadis
- Campbell Environmental
- Dec-Tam
- EH&E
- Enpro
- Fuss & O'Neill
- LVI
- MADEP
- Triumvirate
- Walsh
- Woodard & Curran

Deposition testimony

- Robert May
- Jonathan Hand
- Ross Hartman
- Timothy King
- Carlos Colley
- Michael Duarte
- Jennifer Pinck
- Larry Borins
- Antonio Vivieros
- Michelle Duarte
- Jason Knutson
- Craig Dutra
- George Campbell

Expert reports

- Robert May
- Ross Hartman
- Robert Herrick

- Franklin Dorman
- Jack Matson
- James Olsen
- Robert Sugarman

Complaints

- Plaintiff's original complaint
- Plaintiff's first amended complaint

John P. Woodyard, PE, QEP

610 Paradise Lane
Libertyville, Illinois 60048

Registrations

- Registered Professional Engineer in the States of California, Kansas and Colorado
- Qualified Environmental Professional (QEP)

Credentials

- M.S., Mechanical Engineering—University of Illinois (1976)
- B.S., Industrial Engineering—University of Illinois (1974)

Specialty: PCB Management

- Audits of past and present practices;
- Regulatory compliance, interpretation, and permit negotiation;
- Building and equipment decontamination technology and regulatory issues, including facility decommissioning;
- Contaminated property site assessment, remedial design, self-implementing and risk-based disposal permitting, and remediation;
- Spill response and cleanup practices;
- PCB-related CERCLA project involvement
- Treatment and disposal technology and permitting.
- Management of non-liquid PCBs
- Acquisition due diligence;
- Litigation support.

Affiliations

Air and Waste Management Association

- International Board of Directors (1996-99)
- Fellow Member (1995)
- Chairman, Waste Division (1985-1988)
- Chairman, Technical Council (1993-1996)

Editorial Review Board, *Journal of the AWMA*

Editorial Review Board, *Journal of Environmental Regulation*

Institute for Professional Environmental Practice

- Board of Trustees (2000-Present)

- Exam Advisory Committee (QEP)
- President (2007-2010)

IPEP Foundation
- President (2010-Present)

Western Energy Institute/Pacific Coast Gas Association
- Environmental Committee (Chairman, 2000)

Commonwealth Club of California, Chairman, Environmental Committee (1994-97)

Southern California Waste Management Forum (Chairman, 1986)

Los Angeles County Hazardous Waste Planning Committee (1985-1988)

Employment History

2014-Present	Independent Consultant
1988-2014	Weston Solutions, Inc./Roy F. Weston
1983-1988	International Technology Corporation
1975-1983	SCS Engineers
1974-1975	U.S. Army Construction Engineering Research Laboratory

Deposition & Trial Testimony
(Last 4 years)

Town of Lexington v. Monsanto, US District Court of MA, 12-CV-11645 2015 (deposition)

LJ Jordan v. Ameren Illinois, 20th Judicial Circuit, St. Clair County, IL, 12-L-576. 2016 (deposition)

Project Experience

Mr. Woodyard has over 40 years of professional experience as a consulting engineer specializing in all aspects of PCB management. His experience includes hundreds of assignments spanning the above list of specialties.

The following examples illustrate the range of Mr. Woodyard's expertise.

Non-Liquid PCB Management

PCB Galbestos Contamination Assessment, Decontamination Oversight, and EPA Permitting/Enforcement Support, Akron Airdock Continued Use Authorization, Lockheed Martin, Project Director/Consultant. Assisted client with characterizing site contamination from use of PCB-containing roofing material on huge airship hangar. Responsible for oversight and confirmation of building contents contamination. Assisted in developing EPA approval strategy for continued use of the Airdock as well as negotiating several approvals and consent agreements associated with building decontamination and waste disposal.

PCB Galbestos Contamination Assessment, Decontamination Oversight, and EPA Permitting/Enforcement Support, Riverbank Local Redevelopment Authority, Project Director/Consultant. Assisted client with characterizing site contamination from use of PCB-containing roofing material on former Army ammunition plant BRAC transfer. Responsible for oversight and confirmation of building contents contamination. Assisted in developing EPA approval strategy for continued use of the buildings as well as negotiating several approvals and consent agreements associated with building decontamination and waste disposal.

PCB Caulk Abatement Strategy Development and EPA Approval, Boston, Confidential Client. Assisted in the development of a PCB-oriented abatement strategy for PCB caulk being removed from a high rise office building. Work included development of sampling and abatement procedures, worker exposure assessment, and application for EPA Region 1 approval of the project.

PCB Caulk Abatement Strategy Development and EPA Approval, Metropolitan Water District, Los Angeles. Led the development of an abatement approach for PCB caulk being removed from a drinking water treatment basin. Work included development of the characterization plan, data analysis, exposure/risk assessment, and negotiation of abatement approval with EPA Region 9.

Management of Mixed Waste for Nuclear Plant Decommissioning Project, Massachusetts, Yankee Atomic Electric Company, Consultant. Supported client's efforts to assess extent of PCB-containing paint as part of decommissioning operations at their Rowe, MA plant. Work included drafting and/or review of various regulatory interpretation, sampling plan, remedial management, and permit application documents.

Management of Mixed Waste for Nuclear Plant Decommissioning Project, Wisconsin, Dairyland Power, Consultant. Assisted client in developing a procedure for removal of PCB –containing paint from concrete as part of cutting concrete for storage and disposal. Included negotiation of procedure and demonstration details with EPA.

Decontamination and Partial Demolition of Spare Parts Warehouse. Energy Transfer, Divernon, Illinois. Project Director. Assisted client with characterizing PCB contamination of warehouse building and contents, flowed by decontamination and removal of all parts, and removal of contaminated building panels and paint. PCB contamination resulted from deterioration of PCB-containing insulation adhesive used in roof construction.

PCB Paint Contamination Assessment, Remedial Engineering and Oversight, New York, NY, Kensico Shaft 18, Project Director. PCB, lead, mercury, and asbestos contamination assessment, engineering specification and remedial construction management at New York City's Kensico Reservoir Shaft 18, involving a full complement of sampling and decontamination technologies in a particularly sensitive environmental setting.

PCB Caulk Abatement Strategy Development, El Paso University Medical Center, El Paso. Technical Director. Assisted in the development of a PCB-oriented abatement strategy for PCB caulk being removed from a large regional hospital. Work included development of sampling and abatement procedures, worker exposure assessment, and communication with EPA Region 6.

PCB Spill and Fire Response

Power Plant Fire Contamination Assessment and Remedial Engineering, Montana Lumber Mill, Project Director. Following fire that damaged nearby PCB equipment, initiated sampling and containment response on emergency basis. After results and risk assessment showed cleaning to be infeasible, developed demolition specification and managed waste disposal and demolition contractors.

Assessment and Remedial Oversight, Spill/Fire at Substation Offices, Florida, Florida Power and Light, Project Director. Responsible for building contamination assessment, remedial options analysis, and remedial oversight for demolition of former power plant building in Miami Beach contaminated by electrical fire. Work included two phases of remedial procurement specification and field management of remedial and waste disposal contractors over a 9-month period of performance.

Spill Response and Cleanup, Indianapolis Television Station, Project Director. Responded to equipment fire at a television transmitter. Work included emergency sampling investigation and management of cleanup work for PCBs and asbestos, and support for building renovation and transmitter replacement.

Emergency Spill and Fire Responses, Various Locations, Multiple Clients, Project Director/Technical Advisor. This project involved numerous emergency PCB spill and fire responses and subsequent remedial efforts, including Louisiana State University (LSU) Medical Center, Shreveport, Louisiana; Columbus and Southern Ohio Electric Company, Columbus, Ohio; Owens Illinois, Oakland, California; Exxon, Baton Rouge, Louisiana; NASA, Cleveland, Ohio; and Pennsylvania Power and Light, Scranton, Pennsylvania.

PCB Remediation Permitting and Implementation

Risk-Based PCB Disposal Approval Applications, Various Clients, Project Director/Consultant. Assisted numerous clients in the pursuit and/or acquisition of 40 CFR 761.61(c) Risk-Based Disposal Approvals for an assortment of TSCA PCB compliance issues, focusing primarily on spill cleanup and site remediation.

Focused Site Investigation and Decontamination/Remediation, Illinois, North Shore Gas, Project Director. Provided direction for coordination and execution of field activities at this PCB-impacted site. Scope involved building decontamination/soil remediation and reporting activities to be completed for EPA and under the Illinois Voluntary Site Remediation Program

Site Investigation and Remedial Planning and Implementation, Centerpoint Energy, Minnesota, Project Director. Developed and implemented a site investigation for an active peak shaving facility that formerly used PCB as an air compressor lubricant. Scope of work included remedial planning, development of a bid specification, and selection and management of a remedial contractor for the building and air compressor system.

Site Investigation and Remedial Planning and Implementation, El Paso Natural Gas LLC, Andrews, Texas, Project Director. Developed and implemented a PCB site investigation for the former site of a natural gas compressor station. Scope of work included site investigation, remedial planning, development of a bid specification, development of a self-implementing EPA disposal approval application, and oversight of the remedial contractor during the 30,000 cu yd excavation project.

Site Investigation and Remedial Planning and Implementation, Kinder Morgan/Colorado Interstate Gas, Wyoming & Colorado, Project Director. Developed and implemented a PCB remediation program at 3 active natural gas compressor stations. Scope of work included site investigation, remedial planning, development of bid specifications, development of self-implementing EPA disposal approval applications, and oversight of the remedial contractor during the excavation.

Spill Assessment and Remediation, Pennsylvania, Technical Advisor. Helped advise project team on complex spill situation in urban cemetery, including structural and cross-contamination impacts on adjacent hospital.

PCB Building and Equipment Decontamination

Development and Implementation of a Self-Implementing Strategy for Removing PCB-Containing Paint from Equipment, Project Manager/Consultant, Transwestern Pipeline. Arizona. Responsible for developing a strategy for testing and removal PCB-containing paint on natural gas equipment as part of the demolition and salvage of three stations. Included development of work plans, bid documents, and environmental oversight of decontamination and demolition work.

Power Plant Decontamination, Assessment and Remedial Engineering, Austin, TX, City of Austin Electric Utility Department, Project Director. Conducted plant interior contamination assessment following discovery of vent screen oil bath cross contamination, developed plant and drain line decontamination specification for bid, and managed remedial program on site.

PCB Decontamination of Die Casting Facility, Central Illinois, Project Director. PCB contamination assessment and remediation in operating die-casting facility, including engineering of wastewater treatment system modifications and decontamination/encapsulation of plant floor and drainage system.

Spill Assessment, Building Remedial Engineering, Cleanup Oversight and Demolition Support, Colorado, Rocky Mountain Steel Mills, Project Director. Following a major PCB spill inside an operating steel mill, implemented a comprehensive site investigation, developed a remedial plan and bid specification, and managed the contractor selection and cleanup.

Specialty Chemical Plant Contamination Assessment and Remedial Design, New Jersey, Project Director/Technical Advisor. This project involved a chemical plant where PCBs had been used as a heat-transfer fluid. Work included sampling, assessment, cleanup standards negotiation, remediation, and expert-witness testimony.

Assessment and Remediation of Past Chemical Contamination at an Operating Electrical Component Manufacturing Facility, Project Director. Work included preliminary and detailed assessment of contamination in and around plant under state RCRA, employee risk assessment, standards negotiation with state regulatory agency, remedial design, and emergency decontamination of plant equipment.

Assessment, Remedial Planning, and Decontamination of High-Temperature Hydraulic Presses and Press Pits, Pratt & Whitney, East Hartford, CT, Project Director. Investigated presence of residual PCBs in jet engine plant resulting from previous use in hydraulics. Developed and implemented large press and pit decontamination plan for over 100 presses.

Natural Gas PCB Management

Pipeline Abandonment Technology Literature Review and Technology Selection, Gas Distribution Industry Consortium, Project Manager. Managed multi-year investigation of technologies for sampling, filling, and decontaminating natural gas pipe contaminated with PCBs, based on requirements set forth in PCB "Mega-rule". Project included extensive literature of potentially applicable technologies, followed by field demonstration of several systems.

PCB Management Planning for Natural Gas Distribution Companies, Project Director. Assisted several US gas companies to develop and implement PCB management programs and associated field procedures in response to EPA PCB Mega-rule requirements.

Development of EPA Approval Applications for PCB-Impacted Pipe Soaking and Cleaning. National Grid, Project Manager.

Development and Implementation of a Testing Program for Wipe Sampling Small-Diameter Natural Gas Pipe Using a Specially Designed Device. NYSearch, Project Manager.

Plastic Pipe PCB Absorption Research, NYSearch/National Grid, Technical Advisor. Research project to determine the extent to which PCBs in gas pipeline condensate penetrates high- and medium-density gas pipe, for purposes of disposal profiling.

Natural Gas Pipeline Contamination Litigation, Various Location, Multiple Clients, Expert Witness. Supported gas transmission companies in several suits involving inadvertent use of PCB valve grease in high pressure valves.

Remedial Design, Coal Creek (NPL) Site, Washington (Electric Utility PRP Group), Project Director. Implemented RD/RA involving on-site incineration of 10,000 tons of PCB soil, tank removal, building demolition, and on-site landfill at a former transformer salvage yard.

Natural Gas Systemwide Contamination Assessment, Midwestern Gas Transmission Company, Project Director. Responsible for developing system sampling strategy, data interpretation, and development and negotiation of PCB management/remediation work plan with EPA.

PCB Management Planning, Various Clients, Project Director and Principal Author. Prepared a broad range of PCB management planning documents for electric and gas utility clients, including Peoples Energy, Nicor, New Jersey Natural Gas, and Minnegasco.

Gas Pipeline Contamination Assessment and Remedial Technology Research Program, Various Locations, Gas Research Institute, Project Director. Manage multi-year PCB management research program in support of gas transmission and distribution companies throughout the U.S. Responsibilities include monitoring and assessment of PCB remediation technologies, statistical sampling guidance, and risk assessment. Additional activities include case study monitoring of ongoing remediation projects and innovative remedial technologies.

Natural Gas Systemwide Remedial Planning Support, Various Locations, Eastern Gas Transmission Company, Technical Advisor. Responsible for technical support to multi-state PCB remedial planning effort under CERCLA Administrative Order, focusing specifically on compressed air system decontamination.

Systemwide Decontamination Planning and Implementation at 50 Compressor Stations Nationwide, Panhandle Energy, Project Director. Performed extensive PCB investigation of building, equipment, and site contamination throughout the Midwest, developed bid specifications and work plans, and provided full time on-site management during implementation.

Risk Assessment for PCB Use in Canadian Natural Gas Systems, GRI Canada, Project Director. Conducted risk assessment for various scenarios involving PCB release for gas pipelines, in support of industry response to Environment Canada rulemaking for PCBs in gas pipelines.

Electric Utility PCB Management

Electric Substation Assessment and Remediation, San Antonio, TX, City Public Service, Project Director. Responsible for assessment of PCB contamination at four substations, including agency negotiations, work plan development, and remedial specifications and construction oversight.

PCB and Asbestos Removal from a Former Power Plant Site, City of Austin, Texas Power and Light, Project Director. Implemented state RCRA remedial design, construction, and closure program for abandoned power plant foundation, underground tanks, and wet well that were allegedly backfilled with PCB and asbestos-containing soil.

PCB Disposal Manual, Electric Power Research Institute, Project Manager. Responsible for development of the first (1979) and second (1985) editions of the Manual.

Case Study Evaluation of PCB Fires, Various Locations, Electric Power Research Institute, Project Manager. Development comprehensive analysis of two major PCB fires in San Francisco, CA, and Binghamton, NY, including specific recommendations for utility risk management.

PCB Spill Cleanup Modeling Support, Edison Electric Institute, Project Manager. Developed spill scenarios and modeling cost statistics in support of utility comments on "Totally Enclosed" rule.

CERCLA PCB Matters

RSE-EE/CA Consulting Support for Contaminated Buildings at NPL Site, PCB Inc. Steering Committee, Consultant. Provided technical support to Technical and Allocation Committees for assessment and remedial planning stages of CERCLA project, at former site of PCB treatment contractor/broker. Participated in generating or reviewing all technical documents and negotiation of innovative risk assessment implementation strategy with EPA Region 7.

PCB Contamination Assessment, Remedial Planning, and Waste Management, Rocky Mountain Arsenal, CO, U.S. Army, Technical Advisor. Responsible for advising Army and WESTON project personnel on PCB decontamination/remedial technology selection, cleanup standards, and sampling/analytical strategy.

Remedial Design/Construction Oversight, Coal Creek (NPL) Site, Washington (Electric Utility PRP Group), Project Director. Implemented RD/RA involving on-site incineration of 10,000 tons of PCB soil, tank removal, building demolition, and on-site landfill at a former transformer salvage yard.

Compliance Audits

TSCA Compliance Audit, Electrical Components Manufacturing Facility, Project Director. Internal compliance audit for major manufacturing facility, including litigation/penalty defense.

Electrical Equipment Survey/Audit, Various Locations, State of California, Project Manager. PCB electrical equipment survey/audit at 94 State of California facilities, including TSCA compliance and electrical code inspection, remedial engineering and cost estimates, and PCB disposal/management plans statewide.

Environmental Management Program Audits, Austin, TX, City of Austin Electric, Project Director. Performed complete review of environmental management program for $500 million public power company, including detailed interviews with all levels of management and operations personnel; review of job descriptions and policies and procedures; and development of a consensus environmental mission statement through a senior management workshop.

PCB Management Compliance Audit, Confidential Investor-Owned Electric Utility, Project Director/Auditor. Conducted company-wide audit of past/present PCB management practices and procedures, focusing on changes in management requirements brought about under the 1998 PCB Disposal Amendments.

PCB Management Compliance Audit, Confidential Municipal Utility, Project Director/Auditor. Conducted company-wide audit of past/present PCB management practices and procedures for one of the largest municipal utilities. Scope of work included inspection of numerous service center, substations and corporate office, and development of a detailed report and inspection log.

PCB Management Procedures Update, Hawaiian Electric, Project Manager. Conducted company-wide review of PCB management procedures, and made revisions to procedures focusing on changes in management requirements brought about under the 1998 PCB Disposal Amendments.

PCB Management Compliance Audit, Confidential Investor-Owned Electric & Gas Utility, Project Director/Auditor. Conducted company-wide audit of past/present PCB management practices and procedures, focusing on changes in management requirements brought about under the 1998 PCB Disposal Amendments.

Industry Association Support and Advocacy

PCB Management and Regulatory Support, American Gas Association. Consultant. Provided regulatory support to AGA members during 2010 EPA PCB rulemaking.

Review and Updating of EPA's PCB Transformer Database, USWAG, Project Manager. Assisted USWAG in reviewing the EPA's database website and correcting errors, and deleting requested deletions. Work product was presented to EPA.

Development of an Industry White Paper about the Formation and Behavior of Liquids in Natural Gas Pipelines. INGAA. Project Manager. Authored the white paper for presentation to EPA as part of the 2010 EPA PCB rulemaking.

Technical and Regulatory Support during 2008 Environment Canada PCB Rulemaking, Canadian Gas Association/CEPEI, Project Manager. Worked with CGA members on comments during PCB rulemaking process, then performed gap analysis and best practices development after regulations were published.

Technical and Regulatory Support for Reuse of Recycled Plastic containing PCB, Institute of Scrap Recycling Industries, Consultant. Worked with ISRI members to develop a technical case and risk assessment supporting the reuse of shredder fluff-derived plastic containing measureable PCB levels. Petition resulted in EPA policy change allowing such uses.

Presentations and Publications Since 2005

Woodyard, J. *Environmental Considerations in Pipe Abandonment*. Presented at the Canadian Gas Association Engineering Conference. Winnipeg, Manitoba, April 2013.

Woodyard, J. *Planning for Retired Plant Decommissioning*. Presented at the American Public Power Association Engineering and Operations Conference, March 2013, Kissimmee, FL.

Woodyard, J. *Power Plant Decommissioning Risk: Anticipation and Mitigation*. Presented at the EPRI Power Pant Decommissioning Workshop, November 2012, Fayetteville NC.

Woodyard, J. *Adaptive Reuse of and Redevelopment of Power Plant Properties*. Presented at the EUCI Decommissioning Conference, October 2012, Charlotte, NC.

Woodyard, J. *Addressing PCBs in Caulk, Paint, and Other Building Materials*. Presented at the EPRI Plant Decommissioning Interest Group Workshop. Austin, TX. November 2011.

Woodyard, J. *PCBs and the Gas & Electric Utility Industry*. Presented at the Midwest Energy Association Learning Summit, Minneapolis, MN May 2011.

Woodyard, J. *PCBs – How to Delist Portions of Your service Territory*. Presented at the 2011 AGA Operations Conference, Nashville, TN. May 2011.

Woodyard, J. *The Latest on PCBs at EPA*. Presented at the AGA Operations Conference, May 2010.

Woodyard, J. *Understanding the Behavior of PCBs in Natural Gas Systems*. Presented at the 2009 AGA Operations Conference, Nashville, TN.

Woodyard, J. *Understanding the Behavior of PCBs in Natural Gas Systems*: Status of Recent Natural Gas Industry Dealings with EPA. Presented at the 2009 SGA Environmental Roundtable, Ft. Worth, TX.

Woodyard, J. *Status Report on PCB/Pipeline Liquids Management*. Presented at the AGA Operations Conference, May 2006.

Woodyard, J. *Current PCB Regulatory and Technical Issues Affecting Natural Gas Transmission and Distribution Systems.* Presented at Natural Gas Technologies 2006: Energy and the Environment. Orlando, FL.

Woodyard, J. *Continuing Non-Liquid PCB Use in U.S Military and Industrial Applications: Regulatory, Policy and Technical Issues.* Presented at the American Chemical Society International Chemical Conference, Honolulu, Hawaii. December 2005.

EXHIBIT 48

ROSS HARTMAN

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT and
WESTPORT COMMUNITY SCHOOLS
Plaintiffs
v. Case No.
MONSANTO COMPANY, 14-cv-12041
SOLUTIA, INC. and
PHARMACIA CORPORATION
Defendants
___________________________/

VIDEOTAPED DEPOSITION OF
ROSS HARTMAN
Boston, Massachusetts
Thursday, September 8, 2016

Reported by:
Deborah Roth, RPR-CSR
Job No. 111870

ROSS HARTMAN

these regulations building materials containing greater than 50 milligrams per kilogram are unauthorized use."

"Unauthorized use," that's from 761.20, correct?

A. That's correct.

Q. But nowhere in 761.20 does it say that PCBs must be removed and disposed of, correct?

A. It's an unauthorized use. It does not specifically say that it needs to be removed in that portion of the document.

However, if you have building materials that have PCBs in them, and they are considered unauthorized use, the EPA has considered that an unauthorized use, and it needs to be removed.

Q. Needs -- so my question, sir, is, does it say anywhere in the regulations, so in the four corners of CFR --

A. Yeah.

Q. -- 40 CFR 761, does it say anywhere in the four corners of that document these words, "must be removed," or something like

ROSS HARTMAN

Q. So, now, you agreed with me earlier that if the regulations are violated, then the EPA can bring an enforcement action, correct?

A. Correct.

Q. Are you aware of any enforcement action taken against a town or school system for not removing caulk?

A. I am -- not specifically. I believe there was some sort of agreement that was reached between University of Massachusetts and the EPA for building materials, about the time frame in which those building materials had to be removed.

I don't know the specifics, but I know there was a consent order on the school system for New York, which my understanding was that that was generated as a result of PCBs in building materials, but I don't have an in-depth look into that.

Q. So the two things that you just mentioned, UMass and New York, what is the basis for your opinion about these -- about what you just testified about? Is this

DJ-5

COPY

Dr. D.V.N. Hardy
Dr. H.R. Newman.

Monsanto Chemical Company

St. Louis, Missouri

September 20, 1955

Dr. J.W. Barrett

London

Your memo September 8 to Mr. Nason

AROCLOR TOXICITY

Howard Nason has given me your memo of September 8. I will be happy to discuss this with Dr. Newman during his visit here. I think, however, there are several points that I can answer you now.

You comment upon the difference in toxicity between Aroclor 1254 and 1242. This is not particularly surprising because in the earlier work it was found that toxicity increased with chlorination. Of course, from the standpoint of volatility in the case of inhalation or absorption from the gut from the point of view of ingestion are important. Frankly, there was not too great a difference between the two compounds, however. As you know, the maximum allowable concentrate is 0.1 ml/cubic meter in the case of 1254, and as high as 10.0 mgm in the case of 1268. I think the former is too low and the latter is too high. In this country they don't use the MACs very routinely, but certainly in England I think it would be alright to consider 0.2 mgm/cubic meter as perfectly safe.

I don't know how you would get any particular advantage in doing more work. What is it that you want to prove? I believe your work should be directed towards finding out what the concentrations are of Aroclor during different operations whether it is industrial or painting. The reports you have seen from Kettering Laboratory are the result of approximately $15,000 to $20,000 expenditure by MCC.

MCC's position can be summarized in this fashion. We know Aroclors are toxic but the actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an individual developes any type of liver disease and gives a history of Aroclor exposure. I am sure the juries would not pay a great deal of attention to MACs.

PENGAD-Bayonne,N.J.
PLAINTIFF'S
EXHIBIT
4A02

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We, therefore, review every new Aroclor use from this point of view. If it is an industrial application where we can get air concentrations and have some reasonable expectation that the air concentrations will stay the same, we are much more liberal in the use of Aroclor. If, however, it is distributed to householders where it can be used in almost any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict. No amount of toxicity testing will obviate this last dilemma and therefore I do not believe any more testing would be justified.

Let's see what our discussions with Dr. Newman and yourself bring out.

R. Emmet Kelly, M.D.

REK:k

refute the evidence already presented. I would suggest the following:

1. A substantial analytical program to monitor air and water effluents from Monsanto plants producing PCB and also those of major customers.

2. Prompt correction of effluent conditions where PCB can be demonstrated.

3. Serious consideration of curtailing sales of PCB for uses such as plasticizers, adhesives, and carbon paper where waste is certain to enter environment.

4. Review of disposal and recovery methods for PCB in capacitors, transformers, heat transfer fluids, and hydraulic fluids. Emphasize to customers importance of preventing environmental contamination.

5. Thorough investigation of environmental fates of various PCB's including photochemical oxidations, chlorination in water systems, etc.

6. Biochemical and electron microscopic study of levels of PCB ingestion which cause proliferation of endoplasmic reticulum and induction of multifunction oxidases in chickens and rats (perhaps these are partially included in present Industrial Biotest experiments).

7. Begin investigations of possible biodegradable substitutes for PCB's as plasticizers, adhesives, fire resistant hydraulic fluids, etc., anticipating loss of these markets as a necessary corollary of environmental problems. Are, for example, chlorinated diphenyl oxides or diphenyl sulfides suitable for these uses. They should be considerably more biodegradable.

DJ-6

Buchanan-Davis

From MONSANTO CHEMICAL COMPANY

At St. Louis Roberts Building

Date May 29, 1956

To J. T. Garrett

Reference

At Main Office

Subject PYDRAUL 150

This afternoon Bob Sido called and stated that the Navy is not satisfied with the toxicity of Pydraul 150 for use in submarines. It is particularly concerned since as in the case of the atomic powered submarines, these vessels will remain submerged for periods up to six weeks. Therefore, any possible toxicological effects cannot be tolerated.

There will be a meeting on June 6 in Washington to discuss this matter and Sido would like very much to have you or someone else in the Medical Department, sit in to discuss our fluids. Others attending the meeting will be a Mr. Curran, Commander Seigel, BuMed, Mickey Elbert, BuShips, and Captain Alvis, who has recently replaced Dr. Holler. The subject of the meeting will be the demise of Pydraul 150 in the antenna retracting mechanisms of submarines unless we can present a convincing story as to its safety of use. If Pydraul 150 is ruled unsatisfactory, we would then suggest that the Navy consider the use of OS-16. This fluid is merely Santicizer 141 dyed blue, and was developed as an extremely non-toxic fluid for use in underground mining equipment. The physical properties are such that it could be substituted for the Pydraul 150 and I am sure that you have ample evidence of its non-toxicity. We would prefer at this stage of the game to have the Navy continue to use Pydraul 150; however, we have OS-16 as an ace in the hole.

HSL

H. S. Litzsinger

HSL:sj

MONS 095631

DJ-7

Messrs.:
C. R. Buchanan - Robts.
R. E. Hatton - M.C.
F. H. Langenfeld-Robts.
H. S. Litzsinger-Robts.
O. R. Sido-Washington, D.

St. Louis, Missouri

January 21, 1957

Mr. H. I. Armstrong

Roberts Building

PYDRAUL 150

Dr. Treon and I spent an afternoon with the Navy people to discuss Pydraul 150. Those present were Captain Shone, Captain Alvis, Captain Sessions, Commander Siegel and Mr. Mickey Albert. They discussed their information concerning Pydraul 150 which was obtained at the Naval Institute of Medical Research. While reports were not available, they had the following general data:

> Skin applications of Pydraul 150 caused death in all of the rabbits tested. (The amount administered was not given.) A like amount of Cellulube 220 did not cause any deaths.

> The inhalation of 10 milligrams of Pydraul 150 per cubic meter or approximately 2 tenths of a part of the Aroclor component per million for 24 hours a day for 50 days caused, statistically, definite liver damage. No matter how we discussed the situation, it was impossible to change their thinking that Pydraul 150 is just too toxic for use in a submarine. It may be that such concentrations would never be reached in the submarine but the Navy does not appear willing to even put the material in a trial run to see if it will work.

It would appear, therefore, that we should discontinue to sell Pydraul 150 for this particular application and try to develop a hydraulic fluid without Aroclor as one of its components. In this connection, Cellulube 220 is not used in a submarine but it was used in this test merely as a yardstick.

The Navy said they did not have any competitive fluid far enough along engineering-wise to even consider the toxicity of it.

R. Emmet Kelly, M.D.

REK:SMB

MONS 095640

DJ-7

Messrs.:
C. R. Buchanan - Robts.
R. E. Hatton - M.C.
F. H. Langenfeld-Robts.
H. S. Litzsinger-Robts.
O. R. Sido-Washington,D.

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January 21, 1957

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>
> The inhalation of 10 milligrams of Pydraul 150 per cubic meter or approximately 2 tenths of a part of the Aroclor component per million for 24 hours a day for 50 days caused, statistically, definite liver damage. No matter how we discussed the situation, it was impossible to change their thinking that Pydraul 150 is just too toxic for use in a submarine. It may be that such concentrations would never be reached in the submarine but the Navy does not appear willing to even put the material in a trial run to see if it will work.

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R. Emmet Kelly, M.D.

REK:SMB

MONS 095640

DJ-8

From MONSANTO CHEMICAL COMPANY

At St. Louis - Roberts 2

cc C.E. Caspari - M.O. 2
H.C. Koehler - Robts. 3
J.M. Magner - Robts. 2
K.E. Maxwell - S. Clara
J.W. Starrett - Robts.
M.C. Throdahl - Robts.

Date August 30, 1957

To Mr. P. G. Benignus

At Roberts 3

Reference PGB Sales Information Bulletin 8-27-57
OD 1149 - "Aroclors As Agricultural

Subject Chemicals", 4-1-57 by JMM

AROCLOR USE TO INCREASE THE INSECTICIDAL LIFE OF LINDANE

It is most surprising to see that you are recommending without restriction a use for Aroclor which has not been approved by U.S.D.A.-F.D.A. For the protection of the company it appears that salesmen who may try to promote this use of Aroclor in agriculture should be fully apprised of limitations and of risks involved if promoted for use on feed and food crops. In turn they should apprise customers of the true status of the development and advise them that if they use Aroclor in insecticide formulations on food or feed crops they should first obtain government approval.

You may already know that since Aroclors are toxic and, according to your attached reference, may extend the residual life of the pesticide, the Federal Government would require the following before selling for use on food and feed crops:

(1) Proof of benefits from the application.

(2) Data to show whether or not residual Aroclor is present and whether it modifies the residual amount of Lindane or other active ingredient at harvest.

(3) If Aroclor is present or if the residual quantity of Lindane or other active ingredient has been significantly changed, tolerances for the Aroclor and for the pesticide in question must be developed.

(4) If a toxic quantity of Aroclor is present at harvest in food or feed crops a tolerance cannot be established until after two year chronic toxicity feeding tests have been completed for the Aroclor.

Obviously, much of the above is obviated if the Aroclor-insecticide formulation is not used on food or feed crops. Even then the label must show safe handling procedures, since Aroclor is toxic.

Incidentally, the findings published by Duda, as per your attached reference, are not in accord with research findings reported in reference report OD 1149. In this report you will note that Aroclor

PLAINTIFF'S EXHIBIT NO. 77 FOR IDENTIFICATION
DATE: 9-14-95 RPTR: JRS

TRAN 053674

contributes to longevity of insecticidal action only when combined with highly volatile compounds, and then only when applied to hard, smooth surfaces such as glass...not on agricultural plants. This is called to your attention because government label approval for use in agriculture also calls for proof of performance.

Admittedly, your August 27 bulletin does not specify using Aroclor in insecticides for use on food or feed crops but neither does it specify such a combination should not be used on food or feed crops. Perhaps this is an over-sight which you will wish to call to the attention of recipients of the bulletin.

Lloyd
L. V. Sherwood

LVS/eb

p.s. We repeatedly find that users of formulations prepared for a specific use will apply the material for other uses. In other words, even though Monsanto may encourage the use of Aroclor in pesticide formulations for non-agricultural use you can rest assured that some of it will be used on agricultural commodities. For these reasons alone it is strongly recommended that we state very specifically in any Monsanto literature, including correspondence, that Aroclors not be used on agricultural commodities. I believe our Legal Department will confirm that there is an important legal aspect involved.

DJ-9

Monsanto

FROM (NAME & LOCATION) W. R. Richard - Research Center

DATE : March 6, 1969

SUBJECT : AROCLOR WILDLIFE ACCUSATIONS

REFERENCE : Toxicity

TO : E. Wheeler - EWHEE

H. Bergen	HBERG
J. Springate	JSPRI
W. Schalk	WSCHA
D. Olson	DOLSO
R. Kelly	RKELL
J. Garrett	JGARR
P. Hodges	PHODG
P. Park	PPARK
R. Keller	JFQ
E. Tucker	JFQ

Risebrough in a recent paper "Nature", Vol. 220, Dec. 14, 1968, has attacked chlorinated biphenyls in three ways:

(1) a pollutant - widely spread by air-water; therefore an uncontrollable pollutant.

(2) a toxic substance - with no permissible allowable levels causing extinction of peregrine falcon by induced hepatic enzymes which degrade steroids upsetting Ca metabolism leading to reproductive weakness, presumably through thinner egg shells.

(3) a toxic substance endangering man himself; implying that the peregrine falcon is a leading indicator of things to come.

As outlined in Science, Vol. 163, Pg. 548, Environmental Defense Fund (EDF) is attempting to write new legal precedents in conservation law by hearings and court action. In the Wisconsin case, water quality standards are at issue. "A substance shall be regarded as a pollutant if its use results in public health problems or in acute or chromic (injury) to animal, plant or aquatic life". Wisconsin is one of 7 states which now have federally approved water quality standards. According to Bern Wright, acting chief of the Federal Water Pollution Control Administration's Water Quality Standards Branch, DDT would fit the definition of a pollutant upon a showing that it is harmful to aquatic life.

These people in EDF are saying we must not put stress on any living thing through a change in air or water environment. Eagles, plant life, anything which lives or breathes. This group is pushing hard on the extension of the word harmful. They claim "enzyme inducer" activity is the real threat of DDT and PCB's and are using these arguments to prove that very small amounts of chlorinated hydrocarbons are "harmful".

Monsanto is preparing to challenge certain aspects of this problem but we are not prepared to defend against all of the accusations.

(a) Monsanto is preparing itself to identify trace ppb quantities of chlorinated biphenyls in water samples, in concentrated collected air samples, and in animal tissues. We will know whether we have been falsely identified and accused or not. We will eventually know where any pollution is taking place and the extent of the pollution.

DSW 201134

(b) We are not prepared to defend ourselves against the accusations made of enzyme and hormone activity, the isolation of enzymes or metabolic products, the indirect accusation of cancer, or the splitting of genes, when this accusation is made. Whether we can defend this route or not needs further discussion.

(c) Through the Industrial Bio-Test program we are to establish the long term allowable limits of chlorinated biphenyls for certain birds-fish-animals by feeding experiments, pathological examination, and tissue analysis for chlorinated biphenyls. We may be able to answer reproductive ability in some animals.

DDT has been under attack for some years because of its chlorine content, its persistent ability to be identified, and the wildlife problems attributed to it. We will still be under the same attack by the mechanisms listed in (b) even though we might establish safe operating limits for humans and certain animals.

Where does this leave us?

Under identification and control of exposure - we will be able to identify and analyze residues as well or better than anyone in the world. We will probably find residues other than DDT and PCB's. We will probably wind up sharing the blame in the ppm to ppb concentration level.

We can take steps to minimize pollution from our own chlorinated biphenyl plants, we can work with our larger customers to minimize pollution, we can continue to set up disposal and reclaim operations. We can work for minimum exposure in manufacture and disposal of capacitors, transformers and heat transfer systems, and minimize losses for large hydraulic users.

But, we can't easily control hydraulic fluid losses in small plants. It will be still more difficult to control other end uses such as cutting oils, adhesives, plastics and NCR paper. In these applications exposure to consumers is greater and the disposal problem becomes complex. If chlorinated biphenyl is shown to have some long term enzyme or hormone activity in the ppm range, the applications with consumer exposure would cause difficulty.

Risebrough has taken known Aroclor samples and claims to have evidence of enzyme and hormone change. Here there is no question of identification. Either his position is attacked and discounted or we will eventually have to withdraw product from end uses which have exposure problems. Since Risebrough's paper in "Nature", Dec. 1968 has just been published, it is timely, perhaps imperative, that this paper and its implications be discussed with certain customers. This is a rough one because it could mean loss of business on empty and false claims by Risebrough.

DSW 201135

Well prepared discussions with Ind. Bio-Test, Monsanto biochemists, the medical and legal departments must take place now. The position of DDT manufacturers should be determined as a guide. We are being accused of the same things attributed to DDT.

I have written this memo to clarify some of the issues. May I please have comments.

Thanks,

W. R. Richard

ms

Att.

DJ-10

April 2, 1969

REPORT AND COMMENTS ON MEETING ON CHLORINATED BIPHENYLS IN THE ENVIRONMENT AT INDUSTRIAL BIOTEST LABORATORIES, CHICAGO, MARCH 21, 1969

Robert L. Metcalf

From the background data presented it appears that something of the order of 80 million pounds of polychlor biphenyls (PCB) are produced annually. These products contain from 3 to 9 chlorine atoms per molecule and become increasingly inert and stable to environmental oxidation with higher degree of chlorination. However, about half the production is in the 3-chlorine atom variety (Aroclor 1242).

At first thought it seems unlikely because of the major uses of PCB in capacitors, transformer oils, heat transfer fluids in closed systems, that these materials could be the source of the substantial degree of environmental contamination reported. However, about 40 million pounds annually is stated to be used as plasticizers, hydraulic fluid, adhesives, and in carbon paper. From this amount a very substantial percentage must escape into the environment as waste. Because of the apparent high stability of PCB, amounts entering the environment would be degraded very slowly and it seems possible that at least 10million pounds annually may become environmental contaminants. Since the PCB's were introduced commercially in 1929 there have been 40 years of production. If this has averaged 50 million pounds per year, then about 2×10^9 pounds have been made and perhaps 2×10^8 pounds have entered the environment. Because of the apparent stability of these compounds most of this amount may still be circulating in the global ecosystem and this is suggested by the levels reported by Holmes _et_ _al_. (1967) and Risebrough _et_ _al_. (1968) in animal tissues which are quite comparable to those found for DDT. Both PCB and DDT are extremely stable and water insoluble and have been produced in roughly the same total amounts over the past 30 years.

Thus it seems quite reasonable to conclude that the environmental contamination described for PCB is due to waste amounts of these compounds. This, coupled with the thorough evidence from mass spectometry strongly suggests that there is an important environmental quality problem involved in wastes of PCB.

Experimental Work Planned at Industrial Biotest.--

This laboratory is highly experienced and seems quite competent to provide standard data required by FDA for evaluating the safety (or hazard) of agricultural or industrial chemicals. The long term feeding studies on rats and dogs will doubtless serve to indicate the chronic toxicity hazards of chronic ingestion of the PCB at ppm levels and this will almost certainly result in severe liver damage at some reasonable level. The chicken reproduction investigations at 0.01, 1, 10, and 100 ppm should be considerably more meaningful particularly in regard to studies of egg hatchability, shell thickness, etc.

While the fish toxicity investigations will be interesting, I cannot see that they are particularly relevant or necessary at this time and I would think this data could be obtained from Fish and Wildlife investigations, etc., and will undoubtedly be forthcoming, unsolicited.

Conclusions and Suggestions.--

It seems to the writer that the evidence regarding PCB effects on environmental quality is sufficiently substantial, widespread, and alarming to require immediate corrective action on the part of Monsanto. The defensive measures presently inderway will do little if anything to refute the evidence already presented. I would suggest the following:

1. A substantial analytical program to monitor air and water effluents from Monsanto plants producing PCB and also those of major customers.

2. Prompt correction of effluent conditions where PCB can be demonstrated.

3. Serious consideration of curtailing sales of PCB for uses such as plasticizers, adhesives, and carbon paper where waste is certain to enter environment.

4. Review of disposal and recovery methods for PCB in capacitors, transformers, heat transfer fluids, and hydraulic fluids. Emphasize to customers importance of preventing environmental contamination.

5. Thorough investigation of environmental fates of various PCB's including photochemical oxidations, chlorination in water systems, etc.

6. Biochemical and electron microscopic study of levels of PCB ingestion which cause proliferation of endoplasmic reticulum and induction of multifunction oxidases in chickens and rats (perhaps these are partially included in present Industrial Biotest experiments).

7. Begin investigations of possible biodegradable substitutes for PCB's as plasticizers, adhesives, fire resistant hydraulic fluids, etc., anticipating loss of these markets as a necessary corollary of environmental problems. Are, for example, chlorinated diphenyl oxides or diphenyl sulfides suitable for these uses. They should be considerably more biodegradable.

DJ-11

Monsanto

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

Feb 1970
(Feb 27, '70 MAILING)

Direct Customer

Dear Customer:

Recently several newspaper and magazine articles have been published indicating that Polychlorinated Biphenyls (PCBs) have been discovered at some points in some marine, aquatic and wildlife environments. The quantities detected are said to be in the parts per million and parts per billion categories.

It is claimed that the PCBs found strongly resemble chlorinated biphenyls containing 54% and 60% chlorine by weight. Products which are sold by Monsanto under the tradenames of Aroclor® 1254 and 1260 contain chlorinated biphenyls.

As your supplier of Aroclor® 1254 and 1260, we wish to alert you to the potential problem of environmental contamination as referred to in the newspaper and magazine articles.

We would like to point out the following additional facts.

1. Certain Monsanto products which are sold under the Aroclor® trademark, namely Aroclor® 5060, 5442 and 5460, are not polychlorinated biphenyls.

2. PCBs with a chlorine content of less than 54% have not been found in the environment and appear to present no potential problem to the environment.

EXHIBIT 54
WIT: Kaley
DATE: 4-4-14
C. Campbell, RPR CRR CSR #13921

We feel that all possible care should be taken in the application, processing and effluent disposal of these products to prevent them becoming environmental contaminants. Of interest to you may be an article in Chemical Week, October 29, 1969 regarding water pollution standards set by each state in the Union. It is attached. This article reflects the view that good manufacturing practice in the future may require that no products used by any company be lost or discharged in such a manner as to ultimately be found in waterways.

Very truly yours,

W. E. Schalk

W. E. Schalk
Director of Sales
Plasticizers

ek

CHEMICAL WEEK / OCTOBER 29, 1969

Environment

The huge water requirements of the chemical industry—now the nation's third largest user—make water quality and availability increasingly important factors for site selectors. Legislation enacted in recent years has forced planners to pay close attention to pollution control standards.

All 50 states have had their water quality standards approved entirely or in part by the Federal Water Pollution Control Administration (FWPCA). Recently a state-by-state summary of key standards was put together for the first time. Surprisingly, it was not the FWPCA that did the job. Instead it was handled by an American Public Health Assn. (APHA) subcommittee headed by TVA Health Director F. E. Gartrell, assisted by the APHA Engineering and Sanitation Section. A portion of the study, covering standards for surface industrial water, is summarized in the tables starting on p. 80.

Contrary to widely held opinions, there is considerable variation in state standards. Take the dissolved oxygen (DO) standard, for example. Minimum allowable DO (as milligrams per liter or percent saturation) is the single most important standard to chemical site evaluators. As a rough rule of thumb, a 2-mg./l. standard is considered to be one industry can live with comfortably, while a 6.0 mg./l. value is pegged "extremely tough."

California, Wyoming and Washington have set the standard at 6 mg./l. or higher. But a few states such as Connecticut, Maine, Illinois, Indiana, Massachusetts, Virginia and Wisconsin require 2 mg./l. or lower.

Other standards—notably turbidity, taste, odor, color and solids—may also be important, depending upon the nature of the chemical plant's waste effluents. These standards also exhibit state-by-state differences. Moreover, they are generally less specific than the straight numerical DO standards.

Although chemical plant site experts see little point in "running from tough standards," the criteria do make a difference: Plans for two nonferrous metals plants in Puerto Rico are now on the shelf, because of standards that call for a 4.5 mg./l. DO, no wastes that interfere with the esthetics of the waters and other specifications.

No compilation of ground water standards has yet been published. Ground water standards may prove important in the future as companies are forced to use costly deep-well disposal for wastes. Availability of ocean waste disposal services is also looming more important.

Waste Cost.: The price tag for pollution control is high. A recent FWPCA study on the organic chemicals industry estimated that water waste-treatment facilities can increase installed capital equipment costs 40% or more. Between '69-'73, the organic chemical industry would have to shell out $182.5 million to remove 10% of its biological and chemical oxygen demand waste and 65% of its suspended solids. Removal levels of 83%, 13% and 71%, respectively, for biologic oxygen demand, chemical oxygen demand and suspended solids would require $242.6 million, while 98%, 30% and 89%, respectively, would up the ante to $608 million.

Cleaner Air: Establishment of air quality standards is not nearly as far advanced as are water standards. The National Air Pollution Control Administration (NAPCA) is still designating regional air control regions. At last count, 16 regions had been formally designated and another 41 had been proposed. NAPCA has issued air quality criteria and control technology data for sulfur oxides and particulate matter, will follow with similar studies for other pollutants.

Once criteria and control data have been issued for a pollutant and control regions have been designated, a complex process involving standards, hearings and implementation and enforcement plans will be initiated that can take over a year to produce standards.

So far, no firm sulfur oxide or particulate standards have emerged. But NAPCA's criteria for setting the standards suggest they'll be tough. The oxide criteria report, for example, emphasizes that there are deleterious effects to man at concentrations as low as 0.04 ppm.

NAPCA's control data reports present detailed appraisals of various methods and equipment, along with estimated costs. As in the case of water, the costs will be high, although some pollutants—mainly sulfur dioxide—will have recovery values. NAPCA is sponsoring a number of research projects to improve technology. Pollution control is being spurred by financial assistance programs (mandated by state law) now operative in the following 28 states:

Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Maine, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington, Wisconsin and West Virginia.

In addition, Pennsylvania offers financial aid sanctioned by administrative regulation. Several states, including Utah and Maryland have legislative studies under way.

The incentives take a variety of forms. Most common are exemption from personal property taxes (e.g., Arkansas), fast depreciation (Arizona), exemption from ad valorem equipment and structures taxes (Connecticut), exemption from local taxes for stated period of time (New Hampshire), operating loss deductions (New York); credit against state income tax (Oregon).

Quantity: The large chemical complexes now in vogue make water—and lots of it—a major site criterion. The cooler the water is, the better, for it can reduce the investment in heat-exchange equipment. Occasionally, plants can manage on ground water, but usually surface water is required. That means location on or near the big, drought-resistant rivers. There are less than 200 rivers in the U.S. with minimum flows over 50 cu. ft. per second *(CW Oct. 5, '68, pp. 94-95)*. For companies whose plant needs at least 100 cu. ft/second, the list numbers only 150 (excluding Alaska). Sea water is generally avoided because of high equipment corrosion costs.

Piping water in is expensive. Duval, now opening a 1.5 million tons/year sulfur mine in the arid Northwest area, was forced to install a 36-in., 38-mile-long water line and a 40-million-gal. reservoir. Cost of the water supply system hasn't been disclosed, but it is estimated that the tab was at least several million dollars.

The adequacy of domestic water resources in the year 2000 has recently been evaluated by the Geological Survey. Nationally, projected demand will be 173% of potentially assured supply. Only in three regions, New England, Ohio, and the South Atlantic Eastern Gulf, will future water requirements be easily met. Economic growth may be handicapped in nine regions: Eastern Great Lakes, Lower Mississippi, Upper Missouri-Hudson Bay, Lower Missouri, Western Gulf—Rio Grande, Pecos, Colorado, Great Basin, and Central and South Pacific.

For the first time, a summary of water quality standards set by all 50 states.

	pH Allowable Range	pH Allowable Deviation	Temperature (°F) allowable Maximum	Temperature (°F) allowable Increase above ambient	Dissolved oxygen (minimum, mg./1. or %)	Other Requirements
Alabama	6.0–8.5	1.0	90° (24 hrs.) 93° (any 8 hrs.) 93° (cooling water)	10% — 10°	2.0 at 5 ft. or middepth if less than 10 ft.	**Radioactivity, Color, Taste and Odor, Toxic Substances:** Only in amounts that would not render waters unsuitable for industrial-cooling and process-water supply purposes. **Solids:** Free from waste materials that cause unsightly or putrescent conditions or interfere directly or indirectly with industrial use.
Alaska	7.0–8.0	0.5	70°	—	5.0	**Radioactivity:** Not to exceed limits of PHS Drinking Water Standards. **Turbidity:** No imposed values that would interfere with established levels of treatment. **Color:** True color less than 50 color units. **Taste and Odor:** Shall not unreasonably impair esthetic considerations. **Solids:** No dissolved solids above natural conditions causing corrosion or scaling problems. No visible evidence of other floating solids or sludge deposits. No imposed sediment loads that would interfere with established treatment levels.* **Toxic Substances:** Chemical constituents should be below concentrations found to be of public health significance.*
Arizona	6.5–8.6	0.5	93°	5°	—	**Radioactivity:** Not to exceed 1/30 of the MPC$_w$ value given for continuous occupational exposure in NBS Handbook 69. **Turbidity:** 50 JCU (streams); 25 JCU (lakes). **Color:** Free from waste materials in amounts sufficient to change existing color enough to interfere with industrial use or to create a nuisance. **Taste and Odor:** Free from wastes in amounts sufficient to produce enough taste and odor to create a nuisance or interfere with industrial use. **Solids:** Free from wastes that would be unsightly, putrescent, odorous or in amounts that would interfere with industrial use. **Toxic Substances:** Free from wastes toxic to human, animal, plant or aquatic life or in amounts that would interfere with industrial use.
Arkansas	6.0–9.0	1.0 (24 hrs.)	95°	5°	4.0 (average for any cross section)	**Radioactivity:** "Rules and Regulations for the Control of Ionizing Radiation," Arkansas Board of Health, apply. **Turbidity:** No distinctly visible increases due to wastes. **Color:** Shall not be increased to the extent that it interferes with industrial use, present or future. **Taste and Odor:** Must not cause offensive odors or otherwise interfere with industrial use. **Solids:** No distinctly visible persistent solids, bottom deposits or sludge banks due to wastes. **Toxic Substances:** Must not be present in amounts toxic to human, animal, plant or aquatic life.
California	6.5–8.6 7.0–8.6 (Coastal waters)	—	71.6°* (fresh water)	None that would cause ecological change or harm aquatic life (coastal waters)*	6.0 Coastal water: 5.0 (unless naturally lower)	**Radioactivity:** Shall not exceed 1/10 of the MPC$_w$ values given for continuous occupational exposure in NBS Handbook 69. **Turbidity:** Free from wastes that could alter water's existing turbidity. **Color:** Free from substances attributable to wastes that produce detrimental color. **Taste and Odor:** No substances that impart foreign taste or odor. **Solids:** Dissolved solids in fresh water must not exceed 300 mg./1. at any time; annual mean: 175 mg./1. Settleable solids must not be able to change nature of stream bottom or harm aquatic environment. **Toxic Substances:** At all times free from concentrations harmful to humans, aquatic life or wild or domestic animals.
Colorado	5.0–9.0	—	93°	—	3.0	**Radioactivity:** Not to exceed 1/30 of the 168-hr.-week values in NBS Handbook 69. **Turbidity:** Must not interfere with established levels of treatment. **Color:** Wastes present must not cause appreciable change in color or interfere with industrial use. **Taste and Odor:** Free from wastes that cause odor or appreciable change in taste. **Solids:** Free from wastes that are unsightly, putrescent or odorous or would interfere with use. **Toxic Substances:** Free from wastes in concentrations or combinations sufficient to harm human or animal life.
Connecticut	6.0–9.0	—	—	None unless it does not exceed recommended limits for industrial use	2.0	**Radioactivity:** Limits to be approved by appropriate state agency. **Turbidity, Color, Taste and Odor:** None in such quantities that would impair industrial use. **Solids:** Limited to small amounts that may result from discharge of appropriately treated wastes. **Toxic Substances:** Free from chemical constituents in concentrations or combinations harmful to human, animal or aquatic life.
Delaware	6.5–8.5	—	—	5°	50%* or 4.0	**Radioactivity:** Alpha emitters limited to 3 pc/1.; beta emitters, to 1,000 pc/1. **Color, Taste and Odor:** None in concentrations that cause color, taste or odor. **Solids:** Free from unsightly and malodorous nuisances due to floating solids or sludge deposits. **Toxic Substances:** None in concentrations harmful (synergistically or otherwise) to humans, fish, shellfish, wildlife or aquatic life.
Florida	6.0–8.5	1.0	—	—	4.0	**Radiation:** Gross beta—1,000 pc/1. (in absence of Sr-90 and alpha emitters). **Turbidity:** 50 JCU. **Color:** Must not render water unfit for industrial-cooling or process-water supply purposes. **Taste:** Must not render water unfit for industrial use; phenols 0.001 maximum. **Solids:** Dissolved solids must not exceed 1,000 mg./1.; monthly average: 500 mg./1. Must be free from floating wastes that are unsightly or deleterious or other wastes that settle to form putrescent or objectionable sludge deposits. **Toxic Substances:** Free from wastes harmful to human, animal or aquatic life. Cu, 0.5 mg./1.; Zn, 1.0; Cr, 0.05; Pb, 0.05; Fe, 0.3; As, 0.05; F, 10.0; Cn, none detectable.

	pH Allowable Range	pH Allowable Deviation	Temperature (°F) allowable Maximum	Temperature (°F) allowable Increase above ambient	Dissolved oxygen (minimum mg./l. or %)	Other Requirements
Georgia	6.0-8.5	—	93.2°	10° (above intake)	2.5 3.0 (daily average)	**Radioactivity:** Must conform to state statutes. **Turbidity, Color, Taste and Odor:** Free from wastes that cause objectionable conditions or interfere with industrial use. **Solids:** Free from wastes that are unsightly, putrescent or otherwise objectionable or would interfere with industrial use. **Toxic Substances:** No wastes in concentrations that would prevent fish survival or interfere with industrial use.
Hawaii	6.5-8.5	—	—	—	4.5	**Radioactivity:** Not to exceed 1/30 of the values given by NBS Handbook 69. **Turbidity:** Free from soil particles from erosion caused by land development or agricultural use. **Taste and Odor:** Wastes, after dilution and mixture, must not interfere with industrial use. **Toxic Substances:** Free from substances in concentrations harmful to human, animal, or marine life or that make waters unsuitable for industrial use.
Idaho	6.5-9.0	0.5	—	2° Only if water 68° or less	75% (at seasonal low)	**Radioactivity:** Not to exceed limits of '62 PHS Drinking Water Standards. **Turbidity:** No objectionable turbidity that can be traced to a point source. **Solids:** No floating or submerged matter; no sludge deposits that could adversely affect industrial use. **Toxic Substances:** No wastes of other than natural origin in concentrations of public health significance or that could adversely affect industrial use.
Illinois	5.0-9.0	—	95°	—	2.0 3.0 (for 16 hrs. in any 24-hr. period)	**Color, Taste and Odor:** Free from wastes that produce color, odor or taste in such a degree as to create a nuisance. **Solids:** Free from floating wastes that settle and form unsightly, deleterious or putrescent deposits. **Toxic Substances:** Free from wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Indiana	5.0-9.0	—	95°	—	1.0 2.0 (daily average)	**Color, Taste and Odor:** Free from wastes that produce color, taste or odor in such a degree as to create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; monthly average, 750 mg./l. Must be free from unsightly, putrescent, deleterious or otherwise objectionable wastes. **Toxic Substances:** Free from wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Iowa	—	—	—	—	—	**Color, Taste and Odor:** Free from wastes that produce color, taste or odor in such a degree as to be detrimental to industrial use. **Solids:** Free from floating wastes in amounts that would be unsightly or deleterious or other wastes that settle to form putrescent or objectionable sludge deposits. **Toxic Substances:** No wastes in concentrations or combinations detrimental to human, animal or aquatic life or to industrial use.
Kansas	6.5-9.0	—	90°*	—	4.0*	**Turbidity:** No increase that causes substantial visible contrast with natural appearance or that is detrimental to industrial use. **Color:** Discharges of color-producing substances limited to concentrations not detrimental to industrial use. **Taste and Odor:** Concentrations limited to those that would not result in noticeable offensive odors or otherwise interfere with industrial use. **Solids:** Free from floating debris or material in amounts that would be unsightly or detrimental to industrial use. **Toxic Substances:** Pollutional substances must be maintained below concentrations detrimental for industrial use.
Kentucky	5.0-9.0	—	95° 73° (Dec.-Feb.)	2°/hr 10°/day	—	**Color, Taste and Odor:** Wastes must not create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; monthly average: 750 mg./l. No floating wastes in unsightly or deleterious amounts; no other wastes that settle to form putrescent or objectionable sludges. **Toxic Substances:** No wastes in concentrations or combinations harmful to human, animal, plant or aquatic life.
Louisiana	6.0-9.0	—	96.8°	5.4°	50%	**Radioactivity:** Specific limits set for all radioactive isotopes released as waste. **Solids:** None that would produce floating masses, sludge banks or beds on bottom, either organic or inorganic. **Toxic Substances:** No wastes in concentrations or combinations harmful to animal or plant life.
Maine	6.0-9.0*	0.5*	90°*	—	2.0*	**Radioactivity:** Not to exceed '62 PHS Drinking Water Standards. **Turbidity, Color, Taste and Odor:** Free from wastes that impart turbidity, color, taste or odor or impair industrial use. **Solids:** Free from sludge deposits, solid refuse and floating solids. **Toxic Substances:** No chemical constituents from waste sources harmful to humans or that adversely affect industrial use.
Maryland	5.0-9.0 (unless natural)	—	100°	—	4.0 (unless naturally lower)	**Color, Taste and Odor:** Free from waste materials that change existing color or produce taste and odor to such a degree as to create a nuisance or interfere with industrial use. **Solids:** Free from wastes that float, settle to form deposits, create a nuisance or interfere with industrial use and are unsightly, putrescent or odorous. **Toxic Substances:** Free from toxic wastes that interfere with industrial use or that are harmful to human, plant, animal or aquatic life.
Massachusetts	6.0-9.0	—	90°	—	2.0	**Radioactivity:** None in concentrations harmful to human, animal or aquatic life. **Turbidity, Color, Taste and Odor:** None in concentrations that would impair industrial use. **Solids:** None allowed except that which may result from the discharge from waste-treatment facilities providing appropriate treatment. **Toxic Substances:** None in concentrations or combinations harmful to human, animal or aquatic life.

Water quality standards

	pH Range	pH Allowable Deviation	Temperature (°F) Maximum	Temperature (°F) allowable increase above ambient	Dissolved oxygen (minimum mg./1. or %)	Other Requirements
Michigan	6.5–8.8	0.5	—	10°	Enough to prevent nuisance	**Radioactivity:** Standards to be established when information is available on deleterious effects. **Turbidity, Color:** No objectionable unnatural turbidity or color in quantities sufficient to interfere with industrial use. **Taste and Odor:** Below levels that are or may become injurious to industrial use. **Solids:** Dissolved solids must not exceed 750 mg./1.; monthly average: 500 mg./1. No floating solids or objectionable deposits in quantities that would interfere with industrial use. **Toxic Substances:** Limited to concentrations less than those that are or may become injurious to this use.
Minnesota	6.0–9.0	—	86°	—	—	**Color, Taste and Odor, Solids:** Free from wastes that cause nuisance conditions, such as material discoloration, obnoxious odors, significant floating solids, excessive suspended solids or sludge deposits.
Mississippi	6.0–8.5	1.0	93°	10°	3.0	**Color, Taste and Odor:** Free from wastes that produce color or odor in such degree as to create a nuisance. **Solids:** Dissolved solids must not exceed 1,500 mg./1.; monthly average 750 mg./1. Must be free from floating wastes that settle to form unsightly, deleterious, objectionable or putrescent deposits. **Toxic Substances:** No wastes in concentrations or combinations harmful to human, animal or aquatic life.
Missouri	6.5–9.0	—	90°	9° (average of cross section)	4.0*	**Radioactivity:** Gross beta: 1,000 pc/1. (in absence of Sr-90 and alpha emitters). Sr-90: 10 pc/1. Dissolved Ra-226: 3 pc/1. **Color:** Wastes must not cause substantial visible contrast with natural appearance of stream or interfere with industrial use. **Taste and Odor:** Limited to concentrations that would not result in noticeable offensive odors or otherwise interfere with industrial use. **Solids:** No noticeable organic or inorganic deposits or floating materials in unsightly or deleterious amounts. **Toxic Substances:** Concentrations not detrimental to industrial use or toxic to humans, fish, wildlife. F:1.2.
Montana	6.5–9.5	0.5	—	No adverse change	—	**Radioactivity:** Not to exceed '62 PHS Drinking Water Standards. **Turbidity:** Must not interfere with established levels of treatment. **Color, Taste and Odor:** Water shall be maintained in condition not offensive to sense of sight or smell. **Solids:** No floating solids and sludge deposits in amounts deleterious to industrial use; no sediments or settleable solids that affect treatment levels. **Toxic Substances:** Amounts present must not adversely affect industrial use.
Nebraska	6.5–9.0	1.0	90°	5° (May-Oct.) 10° (Nov.-Apr.) Rate: 2°/hr.	5.0	**Radioactivity:** Must conform with Radiological Health Regulations (1st. ed.), State of Nebraska, '66. **Turbidity:** No more than 10% increase above normal level. **Color:** No evidence of matter that creates nuisance conditions. **Taste and Odor:** Less than amounts that would degrade water quality for industrial use; phenol: 0.001 mg./1. **Solids:** Dissolved solids must not exceed 1,500 mg./1. No more than 20% increase (limit 100 mg./1.) from any point source. No waste solids that permit deposition or are deleterious to industrial use. **Toxic Substances:** None in concentrations or combinations that would render water unsuitable for industrial use.
Nevada	6.5–8.5 Annual median: 7.4–8.3	—	77.0° (summer) 57.2° (winter)	—	5.0 6.0 (average, June–Sept.)	**Radioactivity:** Limited to 1/10 of the 168-hr.-week values in NBS Handbook 69. **Turbidity, Color, Taste and Odor:** Free from wastes in amounts sufficient to change existing turbidity or color enough to create a nuisance or interfere with industrial use, or to produce taste or odor in the water. **Solids:** Free from floating or other wastes that settle to form sludge banks or deposits in amounts that would be unsightly or odorous or interfere with industrial use. **Toxic Substances:** Free from wastes in concentrations or combinations toxic to human, animal, plant or aquatic life or that interfere with industrial use.
New Hampshire	6.0–8.5 (unless natural)	—	90°*	No increase that would interfere with this use*	5.0	**Turbidity, Color, Taste and Odor:** None in objectionable amounts. **Solids:** No floating solids or sludge deposits in objectionable amounts. **Toxic Substances:** None in toxic concentrations or combinations.
New Jersey	6.5–8.5 (unless natural)	—	87° (unless natural)	5° (up to 87°)	4.0*	**Turbidity, Solids:** None noticeable in water or deposited along shore. **Color, Taste and Odor:** None that are offensive to humans or detrimental to aquatic biota. **Toxic Substances:** None that would affect humans or be detrimental to aquatic biota.
New Mexico	6.6–8.6	—	—	Must not pollute or make water unfit for this use	No oxygen demand that would cause pollution	**Radioactivity:** Not greater than 1/10 of the 48-hr. value in NBS Handbook 69. **Turbidity:** Shall not cause substantial visible contrast with natural appearance. **Color:** Should not create an esthetically undesirable condition. **Taste and Odor:** No odors, other than of natural origin, that are esthetically objectionable or obnoxious. **Solids:** No objectionable floating solids or debris and sediment that significantly alter properties of bottom. **Toxic Substances:** No amounts toxic to humans, plants, fish, animals.
New York	6.0–9.5	—	86°	5° (average 7 days) Rate: 2°/hr. 9°/24 hrs.	3.0	**Color:** No colored wastes that alone or in combinations make water unsuitable for industrial use. **Solids:** No floating or settleable solids or sludge deposits that are readily visible and attributable to wastes. **Toxic Substances:** None alone or in combinations that would impair industrial use.

Water quality standards

	pH Allowable		Temperature (°F) allowable		Dissolved oxygen	
	Range	Deviation	Maximum	Increase above ambient	(minimum) mg./l. or %)	Other Requirements
North Carolina	Normal for area, usually 6.0–8.5; as low as 4.3 in swamps	—	95°*	7°	3.0	Color: Must not render water unfit for industrial cooling. Solids: Must not, after dilution and mixture, make water unfit for industrial cooling. Toxic Substances: Must not make water unfit for industrial cooling.
North Dakota	6.0–9.0	0.5	93°	10°	3.0 5.0 (for 16 hrs./day)	Radioactivity: No discharge allowed unless materials are readily soluble or dispersible and of quantities acceptable to state health department. Color, Taste and Odor: No wastes that color water or result in objectionable odors to a degree that impairs industrial use. Solids: No unsightly floating wastes that would adversely affect industrial use or wastes that settle to form putrescent or objectionable deposits. Toxic Substances: No concentrations or combinations harmful to human, animal or aquatic life.
Ohio	5.0–9.0	—	95°	—	1.0 2.0 (daily average)	Color, Taste and Odor: Free from wastes that produce color or odor to a degree that creates a nuisance. Solids: Dissolved solids must not exceed 1,000 mg./l.; monthly average: 750 mg./l. Must be free from floating or other wastes that settle to form putrescent or objectionable deposits or that are unsightly or deleterious. Toxic Substances: No wastes in concentrations or combinations harmful to human, animal or aquatic life.
Oklahoma	6.5–8.5	—	93°	5°	4.0	Radioactivity: Average concentration at points of controlled release shall not exceed State Board of Health Radiation Protection Regulations. Turbidity: None that causes visible contrast with natural conditions. Color: None that is persistent in concentrations detrimental to industrial use. Taste and Odor: No concentrations that would cause offensive odors in vicinity of water or otherwise interfere with industrial use. Solids: Free from floating debris, bottom deposits or other materials. Toxic Substances: None in quantities that make water toxic to human, animal, plant or aquatic life.
Oregon	6.5–9.0	—	—	2° (only if water 70° or less)	5.0	Radiation: Shall not pose external hazard. Turbidity: 5 JCU above natural. Color, Taste and Odor: No objectionable discoloration or conditions esthetically offensive to human senses of taste or smell. Solids: No floating solids, organic or inorganic deposits injurious to industry. Toxic Substances: No conditions injurious to public health.
Pennsylvania	6.0–9.0	—	93°	2°/hr.	4.0 5.0 (daily average)	Color, Taste and Odor: No wastes that produce colors, tastes or odors in amounts harmful to industrial use. Solids: Dissolved solids must not exceed 750 mg./l.; monthly average: 500 mg./l. No floating wastes or substances that settle to form sludge in amounts harmful to industrial use. Toxic Substances: None in amounts harmful to industrial use.
Rhode Island	6.0–8.5	—	—	4°	3.0* 5.0* (16 hrs./day)	Radioactivity, Toxic Substances: No concentrations or combinations harmful to human, animal or aquatic life. Turbidity, Taste and Odor: None in concentrations that would impair industrial use. Solids: No solid refuse, floating solids or sludge deposits.
South Carolina	6.0–8.5 5.0–8.5 (swamps)	—	93.2°*	10°*	3.0* 2.5* (swamps)	Turbidity, Color, Taste and Odor: Free from wastes that change the existing turbidity or color or that produce taste or odor to such a degree as to cause a nuisance or interfere with industrial use. Solids: None from waste sources in amounts that are unsightly, putrescent, odorous or that cause a nuisance or interfere with industrial use. Toxic Substances: Free from wastes harmful to human, animal, plant or aquatic life or that interfere directly or indirectly with industrial use.
South Dakota	6.0–9.5	1.0	—	—	—	Radioactivity: None permitted in water unless readily soluble or dispersible and in quantities allowed by federal or state agencies. Color, Taste and Odor: No wastes that produce material discoloration or undesirable odors. Solids: Dissolved solids must not exceed 2,000 mg./l. No wastes producing floating solids, sludge deposits or other offensive effects. Toxic Substances: None in concentrations toxic to human, animal or aquatic life.
Tennessee	6.0–9.0	1.0 (24 hrs.)	93°	10° Rate: 3°/hr.	Enough to prevent offensive conditions	Radioactivity: None that could adversely affect industrial use. Turbidity, Color: None in amounts or concentrations that could not be reduced to acceptable levels by conventional treatment. Taste and Odor: None that would result in taste or odor that would prevent use for industrial processing. Solids: Dissolved solids must not exceed 500 mg./l. No distinctly visible solids, bottom deposits or sludge banks that could be detrimental to industrial use. Toxic Substances: None that produces toxic conditions that would adversely affect water for industrial use.
Texas	5.0–8.5 5.0–9.0 (cooling water)	—	—	—	4.0	Radioactivity: Regulated by Texas Radiation Control Act and Texas Regulations for Control of Radiation. Turbidity: No substantial increase due to wastes. Color: No substantial visible contrast with natural appearance of receiving waters after wastes receive best practical treatment. Taste and Odor: No concentrations that produce offensive odors. Solids: Dissolved solids must not exceed 1,000 mg./l., unless water used only for cooling. Must be essentially free from floating or settleable suspended solids that would adversely affect industrial use. Toxic Substances: Shall not show acute or chronic toxicity to humans, animals or aquatic life to such an extent as to interfere with industrial use.

Water quality standards

	pH Allowable		Temperature (°F) allowable		Dissolved oxygen	
	Range	Deviation	Maximum	Increase above ambient	(minimum mg./l. or %)	Other Requirements
Utah	6.5-9.0	—	—	—	—	**Radioactivity:** Shall not exceed 1/30 of MPC$_w$ values for continuous occupational exposure in NBS Handbook 69. **Turbidity, Color:** No wastes in amounts that would change existing turbidity or color enough to create public nuisance or interfere with industrial use. **Taste and Odor:** No wastes in amounts that would produce taste or odor. **Solids:** No floating wastes that are unsightly or that interfere with industrial use; no wastes that settle to form unsightly or odorous sludge or bottom deposits. **Toxic Substances:** No wastes in concentrations or combinations toxic to human, animal, plant or aquatic life or that would interfere with industrial use.
Vermont	6.0-8.5	—	—	4°	3.0* 5.0* (16 hrs./day)	**Radioactivity:** To be approved by appropriate state agency. **Turbidity, Color, Taste and Odor:** None in concentrations that would impair industrial use. **Solids:** No floating solids, sludge deposits or solid refuse. **Toxic Substances:** No chemical constituents in concentrations or combinations harmful to human, animal or aquatic life.
Virginia	5.0-9.0 (swamps as low as 4.3)	—	95°* (unless naturally higher)	No sudden changes that could harm aquatic life	1.0* 2.0* (daily average)	**Color, Taste and Odor:** No wastes that change existing color or produce odor to such a degree as to create a nuisance or interfere with industrial use. **Solids:** No floating wastes that are unsightly or create a nuisance or other wastes that settle to form unsightly, putrescent or odorous deposits. **Toxic Substances:** No wastes in concentrations or combinations that would interfere directly or indirectly with industrial use.
Washington	6.5-8.5	0.5	70°	t = 110/(T-15)†	6.5 or 70%	**Radioactivity, Toxic Substances:** Below concentrations that could adversely affect industrial use. **Turbidity:** Less than 10 JCU over natural conditions. **Color, Taste and Odor, Solids:** Dissolved, suspended, floating or submerged matter shall not reduce esthetic values so as to affect industrial use.
West Virginia	Process water: 5.5-9.0 Cooling water: 5.0-9.0	—	Cooling water: 93° (May-Nov.) 73° (Dec.-Apr.) Process water must permit fish passage	5° Rate: 2°/hr. (Dec.-Apr.) —	1.0 2.0 (daily average)	**Color:** None that is objectionable. **Taste and Odor:** No objectionable odors in vicinity of the water. **Solids:** No distinctly visible floating, settleable or suspended solids of unreasonable kind or quantity. No objectionable bottom deposits or sludge banks. **Toxic Substances:** No concentrations of materials poisonous to human, animal or fish life.
Wisconsin	6.0-9.0	0.5	89°	—	1.0 2.0 (daily average)	**Color, Taste and Odor:** No materials producing color, taste or odor in amounts that would create a nuisance. **Solids:** Dissolved solids must not exceed 1,000 mg./l.; daily average: 750 mg./l. No floating or submerged debris or waste substances that would cause objectionable deposits in amounts to create a nuisance. **Toxic Substances:** None in concentrations or combinations toxic to humans or of public health significance.
Wyoming	6.5-8.5	...	—	4° 2° (for streams where temp. not over 70°)	6.0	**Radioactivity:** Not to exceed 1/30 of NBS Handbook 69 values. **Turbidity:** No more than 15 JCU above natural (when turbidity is 150 JCU or less); otherwise, no more than 10% above natural. **Color:** Essentially free of wastes that visibly alter natural color of water or impart color to vessels or structures. **Taste and Odor:** Essentially free from substances that would produce detectable odor at site of use. **Solids:** Essentially free from floating or settleable solids that are unsightly or settle to form sludge, bank or bottom deposits. **Toxic Substances:** Free from toxic substances in concentrations or combinations toxic to human, animal or aquatic life.

* Standard reserved from Federal Water Pollution Control Administration approval.
† t — total cumulative heat addition allowed from unnatural waste sources, at any point throughout the given stream reach. T — highest occurring temperature for a given period, in a specific stream reach.
Abbreviations: PHS—Public Health Service; NBS—National Bureau of Standards; JCU—Jackson Candle Units; pc/l.—picocuries per liter.
Source: Water Quality Standards of the United States, Territories, and the District of Columbia. American Public Health Assn., Subcommittee on Water Quality Control, and Engineering and Sanitation Section.
Note: Specific limits for coliforms, biologic oxygen demand, plant nutrients, oil, grease, scum, bottom deposits, pesticides, specific conductance, carbon chloroform extract, synthetic detergents not included. Some states set standards for each stream reach or river basin; in such cases, table shows least stringent requirement.

This reprint is an excerpt from the "Plant Sites, '69" report
that appeared in the October 29, 1969 issue of CHEMICAL WEEK

MEMORANDUM

FROM (NAME & LOCATION) Cumming Paton - General Offices

MAR 3 1970

DATE : March 2, 1970

SUBJECT : CUSTOMER NOTIFICATION LETTER ON PCBs

REFERENCE :

TO : P. C. Park
W. B. Papageorge

cc: M. W. Farrar
D. A. Olson
W. E. Schalk
J. E. Springgate
W. F. Waychoff

CONFIDENTIAL

The Plasticizer Group mailed a PCB notification letter to our direct Aroclor customers. 660 were mailed on February 27, 1970 and one (Nelson Oil) was mailed on March 2, 1970.

The Presidents of our distributors, namely:

Central Solvents and Chemicals
Great Western Chemical
Tab Chemicals
American Mineral Spirits Company

were notified on February 24, 1970.

Cumming Paton

/dbw

this list was used through the June 1, 1970 mailings — per W. Clark.
May 2, 1973

MN-10 REV 11-65

NAME	ADDRESS	DATE MAILED	PER
1. AAA Capacitors	P. O. Box F Cherry Tree, Pa. 15724	2-27-70	DK
2. Abco, Inc.	P. O. Box J Irwin, Pa. 15642	2-27-70	DK
3. Acme Adhesives	207 West Central Ave. Maywood, N. J. 07607	2-27-70	DK
4. Action Products	Nitro, W. Va. 25143	2-27-70	DK
5. Adams Carbide Corp.	141 Market St. Kenilworth, N. J. 07033	2-27-70	DK
6. Adchem Corp.	625 Main St. Westbury, L.I., N. Y. 11590	2-27-70	DK
7. Adelphi Paint & Color Works, Inc.	8600 DuMont Avenue Ozone Park, L.I., N.Y.11817	2-27-70	DK
8. Adhesives Mfg. Ind.	724-26 N. First St. St. Louis, Mo. 63102	2-27-70	DK
9. Adhesives Research	100 Eight Ave. York, Pa. 17404	2-27-70	DK
10. Advanced Chem. Corp.	Route 547 Box 355 Farmingdale, N. J. 07727	2-27-70	DK
11. Airco Chemicals & Plastics Div. Air Reduction Co.	150 East 42nd St. New York, N. Y. 10017	2-27-70	DK
12. Airco Speer Electrodes	Packard Rd. at 47th St. Niagara Falls, N. Y. 14302	2-27-70	DK
13. Airco Speer Electronic	Bolivar Drive Bradford, Pa. 16701	2-27-70	DK
14. Airco Speer Carbon	Theresia St. St. Marys, Pa. 15857	2-27-70	DK
15. Airex Rubber Prods.	Portland, Conn. 06480	2-27-70	DK
16. Akron Rubber Corp.	29 West Market St. Akron, Ohio 44308	2-27-70	DK
17. Masury Columbia Co.	2525 W. Armitage Ave. Melrose Park, Ill. 60160	2-27-70	DK
18. Albion Industries,Inc.	P. O. Box 411 Albion, Mich. 49224	2-27-70	DK
19. Alcan Metal & Powder Div.	P. O. Box 290 Elizabeth, N. J. 07207	2-27-70	DK

NAME	ADDRESS	DATE MAILED	PER
20. Alfa Ink & Chem. Corp.	214½ Washington Ave. Carlstadt, N. J. 07072	2-27-70	DX
21. All Tronics, Inc.	45 Bond St. Westbury, L.I., N.Y. 11590	2-27-70	DX
22. All Rite Pen Co., Inc.	241 Hudson St. Hackensack, N. J. 07602	2-27-70	DX
23. Allentown Paint	East Allen & Graham Sts. Allentown, Pa. 18103	2-27-70	DX
24. Allied Chemical	40 Rector St. New York, N. Y. 10006	2-27-70	DX
25. Allied Material Corp.	Stroud, Okla. 74079	2-27-70	DX
26. Alpha Metals	56 Water St. Jersey City, N. J. 07305	2-27-70	DX
27. Aluminum Co.	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	2-27-70	DX
28. Amax Specialty Metals	Box 1748 Parkersburg, W. Va. 26101	2-27-70	DX
29. American Cyanamid Co.	1937 W. Main St. Stamford, Conn. 06902	2-27-70	DX
30. American Cyanamid Co.	Organic Chemicals Div. Boundbrook, N. J. 08805	2-27-70	DX
31. Amercoat Corp.	201 North Berry St. Brea, California 92621	2-27-70	DX
32. Western Elec. Mfg. Dept.	Hawthorne Station Chicago, Illinois 60623	2-27-70	DX
33. Western Elec.	Box 14000 W. Omaha Sta. Omaha, Nebraska 68114	2-27-70	DX
34. American Adhesive Mfg. Co., Inc.	30 Waverly Ave. Brooklyn, N. Y. 11205	2-27-70	DX
35. American Aerosols	182 East 12th St. Holland, Michigan 49423	2-27-70	DX
36. M. & T. Chemicals, Inc.	P. O. Box 1104 Rahway, N. J. 07065	2-27-70	DX
37. American Can Co.	Highway 22 Union, N. J. 07083	2-27-70	DX
38. Amer. Finish & Chem. Co.	10 - 12 Broadway Chelsea, Mass. 02150	2-27-70	DX

NAME	ADDRESS	DATE MAILED	PER
39. American Lacquer Solvents Co.	Valley Forge, Pa. 19481	2-27-70	DH
40. American Motor Corp.	14250 Plymouth Road Detroit, Mich. 48227	2-27-70	DH
41. American Optical Corp. AO Instrument Co. Div.	Buffalo, N. Y. 14215	2-27-70	DH
42. American Stencil	4290 Holly St. Denver, Colo. 80216	2-27-70	DH
43. American Lacquer Solvents Co.	Factory Office Tampa, Fla. 33601	2-27-70	DH
44. Amer. Mach. & Foundry	689 Hope St. Stamford, Conn. 06907	2-27-70	DH
45. Amer. Metal Seal Corp.	509 Washington Ave. Carlstadt, N. J. 07072	2-27-70	DH
46. Amer. Paint Corp.	3001 W. Superior St. Duluth, Minn. 55806	2-27-70	DH
47. American Petro Chem.	Spruce St. Ext. P. O. Box 382 Wooster, Ohio 44691	2-27-70	DH
48. Amer. Petro Chem.	3134 California St., N.E. Minneapolis, Minn. 55418	2-27-70	DH
49. Ames Rubber Co.	Hamburg, N. J. 07419	2-27-70	DH
50. Amity Lacquer Pt. & Mfg. Co.	Amity, Ark. 71921	2-27-70	DH
51. AMP, Inc.	Eisenhower Blvd. Harrisburg, Pa. 17111	2-27-70	DH
52. Amsterdam Color Works	1546 Stillwell Ave. Bronx, N. Y. 10461	2-27-70	DH
53. Anaconda Wire & Cable Co.	Hastings-On-Hudson, N.Y. 10706	2-27-70	DH
54. Anderson & Ruzzin, Inc.	37030 Green St. New Baltimore, Mich. 48047	2-27-70	DH
55. Andrews Paper & Chem. Co.	P. O. Box 509 75 Shore Road Port Washington, N.Y. 11050	2-27-70	DH
56. Apex Alkali Prod. Co.	Main & Rector Sts. Philadelphia, Pa. 19127	2-27-70	DH

NAME	ADDRESS	DATE MAILED	PER
57. Archem Corp.	1514 11th St. Portsmouth, Ohio 45662	2-27-70	DH
58. Argonne Nat'l. Lab.	P. O. Box 299 Lemont, Ill. 60439	2-27-70	DH
59. Armour-Dial, Inc.	P. O. Box 4309 Chicago, Ill. 60680	2-27-70	DH
60. Armour Indust. Pro.	Box 1805 401 N. Wabash Chicago, Ill. 60690	2-27-70	DH
61. Armstrong Cork	2500 Columbia Ave. Lancaster, Pa. 17603	2-27-70	DH
62. Armstrong Pt. & Varnish Works	1330 S. Kilbourne Ave. Chicago, Ill. 60623	2-27-70	DH
63. Arwood Corp.	Rockleigh Industrial Park Rockleigh, N. J. 07647	2-27-70	DH
64. Ashland Chem. Co. Div. Resins & Plast.	32 Henry St. Bethel, Conn. 06801	2-27-70	DH
65. Ashland Chem. Co.	142nd St. Paxton Ave. Calumet City, Ill. 60409	2-27-70	DH
66. Assoc. Rubber	Quakertown, Pa. 18951	2-27-70	DH
67. Astro Chem.	2063 Baker Ave. Schenectady, N. Y. 12309	2-27-70	DH
68. Atlan Gummed PPR	1 Main St. Brooklyn, N. Y. 11201	2-27-70	DH
69. Atlantic Paint	5901 W. Beaver St. Jacksonville, Fla. 32205	2-27-70	DH
70. Aviation Fluids Serv. Co.	2617 Poe Ave. Overland, Mo. 63114	2-27-70	DH
71. Babcock & Wilcox	Harrisburg & Sawburg Rd. Alliance, Ohio 44601	2-27-70	DH
72. Barker Chem. Co.	700 East 138th St. Chicago, Ill. 60627	2-27-70	DH
73. Barrstalfort Co. Div. of Pitway Corp.	6100 W. Howard St. Niles, Ill. 60648	2-27-70	DH
74. Bartlett Chem.	1460 South Peters St. New Orleans, La. 70130	2-27-70	DH

NAME	ADDRESS	DATE MAILED	PER
75. Basf Corp.	50 Central Ave. South Kearny, N.J. 07032	2-27-70	DK
76. J. H. Baxter	P. O. Box 2809 Eugene, Oregon 97402	2-27-70	DK
77. Mobay Chem.	Penn Lincoln Parkway West Pittsburgh, Pa. 15215	2-27-70	DK
78. Frye Mfg. Co.	2531 Dean Ave. Des Moines, Iowa 50317	2-27-70	DK
79. Belray Co., Inc.	Farmingdale, N. J. 07727	2-27-70	DK
80. Adhesive Eng.	1411 Industrial Road San Carlos, Calif. 94070	2-27-70	DK
81. Benjamin Foster	5841 W. 66th St. Chicago, Ill. 60638	2-27-70	DK
82. Benjamin Moore	134 Lister Newark, N. J. 07105	2-27-70	DK
83. Benson Chemical	2250 First Ave. So. Seattle, Wash. 98134	2-27-70	DK
84. Berco Ind. Corp.	1250 Shames Drives Westbury, L.I., N.Y. 11590	2-27-70	DK
85. Betosia Corp.	185 Foundry St., Bldg. 4 Newark, N. J. 07105	2-27-70	DK
86. Bixby Box Toe Co.	179 Washington St. Haverhill, Mass. 01830	2-27-70	DK
87. Blair Process	363 N. E. Ave. Tallmadge, Ohio 44278	2-27-70	DK
88. Bond Chemical Prod.	2100 N. Fulton Chicago, Ill. 60612	2-27-70	DK
89. Bond Stazon Co.	255 Factory Road Addison, Ill. 60101	2-27-70	DK
90. Borden, Inc.	350 Madison Ave. New York, New York 10017	2-27-70	DK
91. Marbon Chem. Div. Borg Warner Corp.	P. O. Box 68 Washington, W. Va. 26181	2-27-70	DK
92. Borne Chem. Co.	632 S. Front St. Elizabeth, N. J. 07202	2-27-70	DK
93. Bradley & Vrooman	2629 Dearborn St. Chicago, Ill. 60616	2-27-70	DK

NAME	ADDRESS	DATE MAILED	PER
94. W. H. Brady Co.	727 W. Glendale Ave. Milwaukee, Wisc. 53209	2-27-70	DK
95. Brandt Assoc.	2018 Naamans Road Wilmington, Del. 19803	2-27-70	DK
96. Bridgeport Chem.	1 Willow Park Center Farmingdale, L.I., N.Y. 11735	2-27-70	DK
97. Briner Paint Mfg. Co.	3713 Agnes St. Corpus Christi, Texas 78405	2-27-70	DK
98. Brod Dugan Paint Co.	2145 Schuetz St. Louis, Mo. 63141	2-27-70	DK
99. Brookline Wall Decor	1105 Coney Island Ave. Brooklyn, N. Y. 11230	2-27-70	DK
100. Brooklyn Paint & Varnish	50 Jay St. Brooklyn, N. Y. 11201	2-27-70	DK
101. Bruning Paint Co.	Fleet & Haven Sts. Baltimore, Md. 21224	2-27-70	DK
102. George N. Brunt, Inc.	Industrial Blvd. Calhoun, Ga. 30701	2-27-70	DK
103. Brush Beryllium Co.	17876 St. Clair Ave. Cleveland, Ohio 44110	2-27-70	DK
104. William L. Buckwald, Jr. c/o H.C. Oswald Supply Co.	120 East 124th St. New York, N. Y. 10035	2-27-70	DK
105. Budd Co.	2450 Hunting Park Ave. Philadelphia, Pa. 19132	2-27-70	DK
106. Buhl Chem.	Weirsdale, Fla. 32695	2-27-70	DK
107. Burroughs Corp.	Box 299 Detroit, Mich. 48221	2-27-70	DK
108. Butler Mfg. Co.	135 and Bates Rd. Grandview, Mo. 64030	2-27-70	DK
109. Butterfield Barry	800 Huyler St. Teterboro, N. J. 07608	2-27-70	DK
110. Ultramar Chem. Co.	P. O. Box 48 Honolulu, Hawaii 96810	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
111.	C. D. Sparling Plastics Industries, Inc.	9229 General Court Plymouth, Mich. 48170	2-27-70	ok X
112.	C. J. Webb, Inc.	Dresher, Pa. 19025	2-27-70	DX
113.	Capitol Prtg. Ink Co., Inc.	806 Channing Place, N.E. Washington, D.C. 20018	2-27-70	DX
114.	Caprock Paint Mfg. Co.	P. O. Drawer 5427 Lubbock, Texas 79417	2-27-70	DX
115.	Cardinal Paint Corp.	2533 Sullivan Ave. St. Louis, Mo. 63107	2-27-70	DX
116.	R. P. Cargille Lab, Inc.	33 Factory St. Cedar Grove, N.J. 07009	2-27-70	DX
117.	Castrol Oils, Inc.	254 Doremus Ave. Newark, N. J. 07105	2-27-70	DX
118.	CBS Laboratories	227 High Ridge Road Stamford, Conn. 06905	2-27-70	DX
119.	Celanese Ctgs. Co.	Station E Box 8248 Louisville, Ky. 40208	2-27-70	DX
120.	Cellular Products Corp.	18656 Fitzpatrick Detroit, Mich. 48228	2-27-70	DX
121.	Century Laboratories	4936 Veterans Mem. Hwy. Metairie, La. 70002	2-27-70	DX
122.	Certain-Teed-Saint Gobain	P. O. Box 15080 Kansas City, Kansas 66115	2-27-70	DX
123.	Champion Foils	36 High St. Amesbury, Mass. 01913	2-27-70	DX
124.	Champion Papers	Hamilton Mill Hamilton, Ohio 45013	2-27-70	DX
125.	U. S. Plywood Champion Papers	130 N. Franklin St. Chicago, Illinois 60606	2-27-70	DX
126.	Chapman Chemical Co.	416 Brooks Road Memphis, Tenn. 38109	2-27-70	DX
127.	Chemical Prods. Co.	King Philip Road E. Providence, R.I. 02916	2-27-70	DX
128.	Chemagro Corp.	P. O. Box 4913 Station F Kansas City, Mo. 64120	2-27-70	DX
129.	Chemical Components	20 DeForest Ave. Hanover, N. J. 07936	2-27-70	DX
130.	Chemetron Corp.	P. O. Box 2166 Huntington, W. Va. 25722	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
131.	Chem-Fast Chemical Fastners, Inc.	127 N. Summit St. Akron, Ohio 44304	2-27-70	DH
132.	Chemical Eng. Assoc.	603 E. Pulaski Hwy. Elkton, Md. 21921	2-27-70	DH
133.	Chem. Research	83 Eastwater St. Rockland, Mass. 02370	2-27-70	DH
134.	Chemical Sealing Corp.	5401 Banks Ave. Kansas City, Mo. 64130	2-27-70	DH
135.	Chem. Service, Inc.	P. O. Box 15 Media, Pa. 19063	2-27-70	DH
136.	Chemtech Corp.	7882 Folk Ave. St. Louis, Mo. 63143	2-27-70	DH
137.	Chem-Trend, Inc.	Howell, Mich. 48843	2-27-70	DH
138.	Ciba Pharmaceuticals	556 Morris Ave. Summit, N. J. 07901	2-27-70	DH
139.	Cincinnati Milling Machine Co. Prods. Div.	Marburg & South Sts. Cincinnati, Ohio 45209	2-27-70	DH
140.	Cities Serv. Oil Co.	P. O. Box 245 Tulsa, Okla. 74102	2-27-70	DH
141.	Clearprint Mfg. Co.	1482 67th St. Emeryville, Calif. 94608	2-27-70	DH
142.	Clearview Textile Corp.	1414 Clearview St. Scranton, Pa. 18508	2-27-70	DH
143.	Coburn Coating Corp.	256 East Third St. Mount Vernon, N. Y. 10550	2-27-70	DH
144.	Colonial Chem. Corp.	P. O. Box 865 Dalton, Ga. 30720	2-27-70	DH
145.	Colonial Press	1 Green St. Clinton, Mass. 01510	2-27-70	DH
146.	Colonial Rubber Works, Inc.	Dyersburg, Tenn. 38024	2-27-70	DH
147.	Columbia River & Carbon Mfg.	Glen Cove, N. Y. 11542	2-27-70	DH
148.	Columbia Paint & Varnish	452 Communipaw Ave. Jersey City, N. J. 07304	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
149.	Columbia Technical	26-60 Brooklyn-Queens Exp. Woodside, N. Y. 11377	2-27-70	DK
150.	Commercial Steel Co.	Forest Hill Industrial Pk. Jarrettsville Road Forest Hills, Md. 21050	2-27-70	DK
151.	Commerical Ink Corp.	627 Broadway New York, N. Y. 10012	2-27-70	DK
152.	Conap, Inc.	184 East Union St. Allegany, N. Y. 14706	2-27-70	DK
153.	Conchemo, Inc.	1401 Severn St. at Bush St. Baltimore, Md. 21230	2-27-70	DK
154.	Concrete Cure Chem.	9260 N. Hooker St. Westminister, Colo. 80030	2-27-70	DK
155.	Congoleum Ind.	195 Belgrove Drive Kearny, N. J. 07032	2-27-70	DK
156.	Conley Corp.	91st & Delaware Ave. Tulsa, Okla. 74105	2-27-70	DK
157.	Construction Spec.	8301 Landsowne Ave. Upper Darby, Pa. 19082	2-27-70	DK
158.	Continental Aviation & Aircraft Co.	1510 Laskey Road Toledo, Ohio 43612	2-27-70	DK
159.	Continental Can Co., Inc.	135 S. LaSalle St. Chicago, Ill. 60603	2-27-70	DK
160.	Continental Prods. Co.	East 222nd & Nickel Pl. Cleveland, Ohio 44123	2-27-70	DK
161.	Cook Paint & Varnish Co.	P. O. Box 389 Kansas City, Mo. 64141	2-27-70	DK
162.	Corning Glass Works	Corning, N. Y. 14830	2-27-70	DK
163.	Coronado Paint Co.	P. O. Box 308 Edgewater, Fla. 32032	2-27-70	DK
164.	Curd Enterprises	211 Iroquois Ave. N. Charleston, S.C. 29406	2-27-70	DK
165.	Curtis-Young Corp.	2550 Haddonfield Road Pennsauken, N. J. 08110	2-27-70	DK
166.	Custom Chemicals	30 Paul Kohner Place E. Patterson, N. J. 07407	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
167.	Cutlers Paint Stores	3500 Cottman St. Philadelphia, Pa. 19149	2-27-70	DK
168.	Dave Loes	2014 Norfolk St. Paul, Minn. 55116	2-27-70	DK
169.	Don V. Davis Co.	4200 North Second St. St. Louis, Mo. 63107	2-27-70	DK
170.	DCA Food Industries	31-01 Washington Blvd. Catonsville, Md. 21228	2-27-70	DK
171.	Defender Industries	384 Broadway New York, N. Y. 10013	2-27-70	DK
172.	Del Paint & Mfg. Co.	3105 East Reno Oklahoma City, Okla. 73117	2-27-70	DK
173.	Dennis Chemical Co.	2701 Papin Street St. Louis, Mo. 63103	2-27-70	DK
174.	Dennison Mfg. Co.	300 Howard St. Framingham, Mass. 01701	2-27-70	DK
175.	Dergen Oil & Chem. Co.	200 Kellogg St. Jersey City, N. J. 07305	2-27-70	DK
176.	Design & Development Pkg. Co.	2156 Flintstone Drive Tucker, Ga. 30084	2-27-70	DK
177.	Diamond Shamrock	P. O. Box 430 Painesville, Ohio 44077	2-27-70	DK
178.	Hydro-Dredge Accessory Co.	P. O. Box 11 Smithton, Ill. 62285	2-27-70	DK
179.	Doubleday & Co., Inc.	Berryville, Va. 22611	2-27-70	DK
180.	Dow Chemical Co.	P. O. Box 1724 Midland, Mich. 48640	2-27-70	DK
181.	Dow Corning Corp.	P. O. Box 592 Midland, Mich. 48640	2-27-70	DK
182.	L. A. Dreyfus	3775 Park Ave. Edison, N. J. 08818	2-27-70	DK
183.	Dumont Chemical	2126 E. 33rd St. Erie, Pa. 16510	2-27-70	DK
184.	E. I. Dupont Denemours & Co.	Room 6074 Dupont Bldg. Wilmington, Del. 19801	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
185.	Durkee Atwood Co.	215 7th St. N. E. Minneapolis, Minn. 55413	2-27-70	DX
186.	Dynasurf Chemical Corp.	1411-13 Fleet St. Baltimore, Md. 21231	2-27-70	DX
187.	Eagle-Picher Co.	Couples Plant Joplin, Mo. 64801	2-27-70	DX
188.	Distillation Prods. Ind.	755 Ridge Road West Rochester, N. Y. 14613	2-27-70	DX
189.	Eastman Kodak Co.	543 State St. Rochester, N. Y. 14604	2-27-70	DX
190.	Eaton-Allen Corp.	67 Kent Ave. Brooklyn, N. Y. 11222	2-27-70	DX
191.	Economics Lab, Inc.	914 Guardian Bldg. St. Paul, Minn. 55101	2-27-70	DX
192.	EDP Supply	50 Ledgewood Drive Norwalk, Conn. 06850	2-27-70	DX
193.	Egyptian Lacquer Mfg. Co.	P. O. Box 444 Newark, N. J. 07101	2-27-70	DX
194.	Elan Chemical Co.	671 Hope St. Springdale, Conn. 06907	2-27-70	DX
195.	Elan Chemical Co.	268 Doremus Ave. Newark, N. J. 07105	2-27-70	DX
196.	Electrical Ind.	691 Central Ave. Murray Hill, N. J. 07974	2-27-70	DX
197.	Electromold Corp.	140 Enterprise Ave. Trenton, N. J. 08638	2-27-70	DX
198.	Electro Chemical Eng. & Mfg.	750 Broad St. Emmaus, Pa. 18049	2-27-70	DX
199.	Elliot Paint & Varnish Co.	4525 Fifth Ave. Chicago, Ill. 60624	2-27-70	DX
200.	Endicott Johnson Corp.	Endicott, N. Y. 13760	2-27-70	DX
201.	Engineered Yarns, Inc.	372 Main St. Coventry, R. I. 02816	2-27-70	DX
202.	Enmar, Inc.	25th & New York Wichita, Kansas 67201	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
203.	Wallace Erickson	842 North Wells Chicago, Ill. 60610	2-27-70	DH
204.	Essex Chem. Corp.	1401 Broad St. Clifton, N. J. 07013	2-27-70	DH
205.	Ethyl Corp.	P. O. Box 341 Baton Rouge, La. 70821	2-27-70	DH
206.	Exotic Rubber & Plastics	26302 W. Seven Mile Road Detroit, Mich. 48240	2-27-70	DH
207.	Farac Oil & Chem.	13601 S. Ashland Riverdale, Ill. 60627	2-27-70	DH
208.	Fasson Prod. Div. Avery Adhesives	250 Chester St. Painesville, Ohio 44077	2-27-70	DH
209.	Fiber Resin Corp.	23395 Hoover Warren, Mich. 48089	2-27-70	DH
210.	Fiber Industries, Inc.	P. O. Box 10038 Charlotte, N. C. 28201	2-27-70	DH
211.	Fiberite Corp.	516 West Fourth St. Winona, Minn. 55987	2-27-70	DH
212.	Fibreglas Masonry PR	1400 Marietta Way Sparks, Nevada 89431	2-27-70	DH
213.	Field Rubber Co.	State Rd. 32 East Noblesville, Ind. 46060	2-27-70	DH
214.	Findley Adhesives, Inc.	3033 West Pemberton Ave. Milwaukee, Wisc. 53210	2-27-70	DH
215.	Firestone Tire & Rubber Co.	South Main St. Akron, Ohio 44311	2-27-70	DH
216.	Flex-O-Glass, Inc.	4647 W. Augusta Blvd. Chicago, Ill. 60651	2-27-70	DH
217.	Flexon Chemical Corp.	8 Jane St. Trenton, N. J. 08638	2-27-70	DH
218.	Flintkote Co.	Oak St. & Central Ave. E. Rutherford, N. J. 07073	2-27-70	DH
219.	Florasynth Labs, Inc.	P. O. Box 12 900 Van Ness Ave. New York, N. Y. 10062	2-27-70	DH

NAME	ADDRESS	DATE MAILED	PER
220. Flouramrics, Inc.	P. O. Box 438 Westwood, N. J. 07675	2-27-70	DX
221. FMC Corp.	P. O. Box 1616 Baltimore, Md. 21203	2-27-70	DX
222. FMC Corp., Div. Am. Vi.	1617 Pennsylvania Blvd. Philadelphia, Pa. 19130	2-27-70	DX
223. Focal Paint, Inc.	3710 S. Roswell Rd., Rt. 3 Marietta, Ga. 30060	2-27-70	DX
224. Foeseco, Inc.	20200 Sheldon Road Cleveland, Ohio 44142	2-27-70	DX
225. Foote Mineral Co.	Route 100 Exton, Pa. 19341	2-27-70	DX
226. Ford Paint & Varnish Co.	601 Crosby St., N. W. Grand Rapids, Mich. 49504	2-27-70	DX
227. Formax Mfg. Corp.	3171 Bellevue Ave. Detroit, Mich. 48207	2-27-70	DX
228. Fort Pitt Chem. Co.	26th & Smallman Sts. Pittsburgh, Pa. 15222	2-27-70	DX
229. Franklin Glue Co.	2020 Bruck St. Columbus, Ohio 43207	2-27-70	DX
230. Frekote	4300 N. Emmeran Ave. Indianapolis, Ind. 46218	2-27-70	DX
231. Franklin Paint Co.	Franklin, Mass. 02038	2-27-70	DX
232. Tenn. Eastman	Div. of Eastman Kodak Kingsport, Tenn. 37662	2-27-70	DX
233. Texas Eastman Co.	Div. of Eastman Kodak Longview, Texas 75601	2-27-70	DX
234. Endurall Coatings	3333 10th Avenue North Birmingham, Ala. 35205	2-27-70	DX
235. Pabco Paint	P. O. Box 8502 Emmryville, Calif. 94608	2-27-70	DX
236. H. B. Fuller Co.	2400 Kasota Ave. St. Paul, Minn. 55108	2-27-70	DX
237. Gard Industries	1970 Estes Blvd. Elk Grove Village, Ill. 60007	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
238.	Gates Engr. Co.	200 W. 9th St. P. O. Box 1711 Wilmington, Del. 19899	2-27-70	DK
239.	Geigy Chemical Corp.	Saw Mill River Road Ardsley, N. Y. 10702	2-27-70	DK
240.	Gemini Products	P. O. Box 82607 Oklahoma City, Okla. 73108	2-27-70	DK
241.	Sylvania Elec. Prod., Inc.	Emporium, Pa. 15834	2-27-70	DK
242.	General Foam	109 Kero Rd. Carlstadt, N. J. 07072	2-27-70	DK
243.	General Motors Corp. Ternstedt Div.	30007 Van Dyke Ave. Warren, Mich. 48090	2-27-70	DK
244.	General Motor Corp.	Inland Division Dayton, Ohio	2-27-70	DK
245.	Genesco, Inc.	61st & Centennial Blvd. Nashville, Tenn. 37209	2-27-70	DK
246.	General Latex & Chem. Corp.	666 Main St. Cambridge, Mass. 02139	2-27-70	DK
247.	General Motors Corp. Research Lab	Box 388 Warren, Mich. 48090	2-27-70	DK
248.	General Electric	Coshocton, Ohio 43812	2-27-70	DK
249.	General Electric	1430 E. Fairchild St. Danville, Ill. 61832	2-27-70	DK
250.	General Electric	1 Plastic Avenue Pittsfield, Mass. 01201	2-27-70	DK
251.	General Tire & Rubber Co.	1708 Englewood Ave. at Holmes St. Akron, Ohio 44305	2-27-70	DK
252.	Gentex Corp.	Maine & Simpson Sts. Carbondale, Pa. 18407	2-27-70	DK
253.	P. D. George Co.	5200 North Second St. St. Louis, Mo. 63107	2-27-70	DK
254.	Gerin Mfg. Co.	683 N. 5th St. Newark, N. J. 07107	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
255.	Germain C. Crossmen	23 Esternay Lane Pittsford, N. Y. 14534	2-27-70	DH
256.	Giles Varnish Co.	109-09 15th Ave. College Point, N. Y. 11356	2-27-70	DH
257.	Girdler Thermex Div.	P. O. Box 96 Carlton Hill, N. J.	2-27-70	DH
258.	Given Paint Mfg. Co.	111 North Piedras El Paso, Texas 79905	2-27-70	DH
259.	Gleam Chem. Prod., Inc.	Box 448 Austin, Texas 78767	2-27-70	DH
260.	Glenco Corp.	200 Durham Avenue Metuchen, N. J. 08840	2-27-70	DH
261.	Globe Woven Belting	1400 Clinton St. Buffalo, N. Y. 14206	2-27-70	DH
262.	Glue Specialties	East Ontario & Bath Sts. Philadelphia, Pa. 19134	2-27-70	DH
263.	B. F. Goodrich Co. Sponge Rubber Prods. Div.	P. O. Box 433 Derby, Conn. 06485	2-27-70	DH
264.	Goodyear Tire & Rubber Co.	1144 East Market St. Akron, Ohio 44316	2-27-70	DH
265.	W. R. Grace & Co. Const. Prods. Div.	6051 W. 6th St. Chicago, Ill. 60638	2-27-70	DH
266.	Marco Chem. Div. W. R. Grace Co.	1711 W. Elizabeth Linden, N. J. 07036	2-27-70	DH
267.	W. R. Grace & Co. A. C. Horn Div.	2133 85th St. N. Bergen, N. J. 07047	2-27-70	DH
268.	Hampshire Mfg. Co.	Factory Street Nashua, N. H. 03060	2-27-70	DH
269.	Grand Trunk WRR Co.	c/o Gen. Supt. MP & Car Equipment Battle Creek, Mich. 49015	2-27-70	DH
270.	Graniteville Co.	Graniteville, S. C. 29829	2-27-70	DH
271.	Grignard Chem. Co.	23 S. Front St. Elizabeth, N. J. 07202	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
272.	Gr. Lakes Dental Lab.	17138 W. McNichols Detroit, Mich. 48235	2-27-70	DH
273.	Gulton Industries	312 Durham Ave. Metuchan, N. J. 08840	2-27-70	DH
274.	Jaime C. Guttman	Wagner Circle Clark Shores Palm Beach, Fla. 33406	2-27-70	DH
275.	Guyan Mach. Co.	P. O. Box 156 Logan, W. Va. 25601	2-27-70	DH
276.	H. E. Wisdom	10270-T Pacific Ave. Franklin Park, Ill. 60131	2-27-70	DH
277.	H. H. Robertson Co.	1107 Two Gateway Center Pittsburgh, Pa. 15222	2-27-70	DH
278.	Hadley Adhesives & Chem. Co.	514 Calvery Ave. St. Louis, Mo. 63147	2-27-70	DH
279.	Hallett Construction	P. O. Box 13 Boone, Ia. 50036	2-27-70	DH
280.	Hallmark Cards	P. O. Box 437 Kansas City, Mo. 64141	2-27-70	DH
281.	Hardman, Inc.	600 Cortlandt St. Belleville, N. J. 07109	2-27-70	DH
282.	Lake Chemical Co.	P. O. Box 112 Chicago, Ill. 60690	2-27-70	DH
283.	Harshaw Chemical Co.	19200 Villaview Road N.E. Cleveland, Ohio 44119	2-27-70	DH
284.	Hartin Paints & Filler	590 Belleville Turnpike Kearny, N. J. 07032	2-27-70	DH
285.	Hart Manufacturing	Malvern Ave. Hot Springs, Ark. 71901	2-27-70	DH
286.	Haskell Chemical	6101 Staples Mills Rd. Richmond, Va. 94806	2-27-70	DH
287.	Hastings & Co.	2314 Market Philadelphia, Pa. 19103	2-27-70	DH
288.	Hawley Products Co.	333-39 North 6th St. St. Charles, Ill. 60174	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
289.	Heat Tapes, Inc.	1812 S. Halstedt. St. Chicago Heights, Ill. 60411	2-27-70	DX
290.	Helene Curtis Ind. Protective Treatment	4401 N. North Avenue Chicago, Ill. 60639	2-27-70	DX
291.	Hempels Marine Paint, Inc.	25 Broadway New York, N. Y. 10004	2-27-70	DX
292.	Hercules, Inc.	900 Market St. Wilmington, Del. 19801	2-27-70	DX
293.	Haveg Corp.	900 Greenbank Road Wilmington, Del. 19808	2-27-70	DX
294.	Hercules Packaging Corp.	11061 Walden Road Alden, N. Y. 14004	2-27-70	DX
295.	Hexagon Laboratories	3536 Peartree Ave. Bronx, N. Y. 10469	2-27-70	DX
296.	Hi-Strand Chemicals	P. O. Box 368 Lenoir, N. C. 28645	2-27-70	DX
297.	Hickory Adchem	P. O. Box 1451 Hickory, N. C. 28601	2-27-70	DX
298.	High Strength Plastics	1407 W. Jackson Chicago, Ill. 60607	2-27-70	DX
299.	Hilton-Davis Chem. Co., Div. Sterling Drug, Inc.	2235 Langdon Garm Road Cincinnati, Ohio 45237	2-27-70	DX
300.	H. & M. Plastics	129 South Second St. Philadelphia, Pa. 19106	2-27-70	DX
301.	Hoboken Paints, Inc.	40 Industrial Road Lodi, N. J. 04674	2-27-70	DX
302.	Hollingsworth & Vose Co.	112 Washington St. East Walpole, Mass. 02032	2-27-70	DX
303.	Holliston Mills of Tenn., Inc.	Kingsport, Tenn. 37662	2-27-70	DX
304.	Holz Rubber Mfg. Co.	1129 So. Sacramento St. Lodi, California 95240	2-27-70	DX
305.	Honeywell Test In Div.	P. O. Box 5227 Denver, Colo. 80217	2-27-70	DX
306.	Hooker Chemical Corp.	P. O. Box 344 Niagara Falls, N.Y. 14305	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
307.	Grow Chem. Coatings	1246 West 70th St. Cleveland, Ohio 44102	2-27-70	DJ
308.	Howmet Corp. Misco Div.	1713 Seventh St. Muskegon, Mich. 49443	2-27-70	DJ
309.	Humphrey Chem.	Devine St. No. Haven, Conn. 06473	2-27-70	DJ
310.	Fuller O'Brien Corp.	450 East Grand Ave. So. San Francisco, Calif. 94080	2-27-70	DJ
311.	Hysol Div. Dexter Corp.	Olean, N. Y. 14760	2-27-70	DJ
312.	Illinois Bronze	300 E. Main Lake Zurich, Ill. 60047	2-27-70	DJ
313.	Illinois Adhesive Prod. Co.	3101 S. California Chicago, Ill. 60608	2-27-70	DJ
314.	Indurall Coatings	P. O. Box 2371 Birmingham, Ala. 35201	2-27-70	DJ
315.	Industrial Chem. Div. Allied Chem.	P. O. Box 218 Riegelwood, N. C. 28456	2-27-70	DJ
316.	Industrial Coated Prods. of Am.	P. O. Box 3285 Bristol, Tenn. 37620	2-27-70	DJ
317.	Industrial Latex	306 North Pleasant Ave. Wallington, N. J. 07055	2-27-70	DJ
318.	Industrial Roll Co.	1613 Guilford Ave. Baltimore, Md. 21202	2-27-70	DJ
319.	Industrial Synthetic Adhesives Co.	Rear of 4120 Holly Hills St. Louis, Mo. 63116	2-27-70	DJ
320.	Inland Steel Co.	East Chicago, Ill.	2-27-70	DJ
321.	Inmont Corp.	707 East 62nd St. Los Angeles, Calif. 90001	2-27-70	DJ
322.	Inmont Corp.	4168 Meramec St. Louis, Mo. 63116	2-27-70	DJ
323.	Inmont Corp.	475 Division St. Elizabeth, N. J. 07201	2-27-70	DJ
324.	Institute Gas Tech.	17 West 34th St. Chicago, Ill. 60616	2-27-70	DJ

NAME		ADDRESS	DATE MAILED	PER
325.	Intercoastal Corp.	1300 Walnut St. E. St. Louis, Ill. 62201	2-27-70	DK
326.	Inter-Coastal Corp.	Dundalk P. O. Baltimore, Md. 21222	2-27-70	DK
327.	International Paint Co.	South Linden Ave. So. San Francisco, Calif. 94080	2-27-70	DK
328.	International Shoe	P. O. Box 14260 St. Louis, Mo. 63178	2-27-70	DK
329.	Int'l. Bus. Machine Corp.	P. O. Box 6 Endicott, N. Y. 13760	2-27-70	DK
330.	I-Sis Chemicals, Inc.	P. O. Box 685 Springdale, Conn. 06907	2-27-70	DK
331.	J. I. Holcomb Mfg. Co. Premier Indust. Corp.	1601 Barth Ave. Indianapolis, Ind. 46207	2-27-70	DK
332.	Jaegle Paint & Varnish Co.	19th & Hayes Ave. Camden, N. J. 08105	2-27-70	DK
333.	Jamestown Finishes	125 Blackstone Ave. Jamestown, N. Y. 14701	2-27-70	DK
334.	Jewel Paint & Varnish Co.	345 N. Western Ave. Chicago, Ill. 60612	2-27-70	DK
335.	Jema American, Inc.	824 South Avenue Middlesex, N. J. 08846	2-27-70	DK
336 .	John H. Witte & Son	Burlington, Iowa 52601	2-27-70	DK
337.	John Lucas & Co., Inc.	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	DK
338.	Johns Manville Research Center	Manville, N. J. 08835	2-27-70	DK
339.	Chicopee Mfg. Co.	Milltown, N. J. 08850	2-27-70	DK
340.	Johnson & Johnson	501 George New Brunswick, N. J. 08901	2-27-70	DK
341.	Permacel	U. S. Highway No. 1 New Brunswick, N. J. 08903	2-27-70	DK
342.	Johnson Plastic	P. O. Box 100 Chagin Falls, Ohio 44022	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
343.	Jones Chem. Co.	1901 W. Commerce Dallas, Texas 75208	2-27-70	DY
344.	Jordon Paint Co.	7250 Franklin Forest Park, Ill. 60130	2-27-70	DY
345.	Joslyn Mfg.	3700 South Morgan Chicago, Ill. 60609	2-27-70	DY
346.	Joslyn Mfg. Co.	Pinco Div. Lima, N. Y. 14485	2-27-70	DY
347.	Kaiser Chemical Research Lab	1945 Davis St. San Leandro, Calif. 94577	2-27-70	DY
348.	Kansas Paint & Color Co.	132 North Mosley Wichita, Kansas 67202	2-27-70	DY
349.	Kare Prod. Co., Inc.	214 South Feltus St. South Amboy, N. J. 08879	2-27-70	DY
350.	Kawecki Berylco Ind., Inc.	P. O. Box 60 Boyertown, Pa. 19512	2-27-70	DY
351.	Kee Lox Mfg.	P. O. Box 137 Rochester, N. Y. 14601	2-27-70	DY
352.	Kendall Company Bauer & Black Div.	2500 S. Dearborn St. Chicago, Ill. 60616	2-27-70	DY
353.	Kenrich Petrochemicals Inc.	Foot of East 22nd St. Bayonne, N. J. 07002	2-27-70	DY
354.	Kentucky Thermo Plastics	St. John Road Elizabethtown, Ky. 42701	2-27-70	DY
355.	Kerns United	824 State St. Calumet City, Ill. 60409	2-27-70	DY
356.	Key Polymer Corp.	275 Lowell St. Lawrence, Mass. 01840	2-27-70	DY
357.	Keystone Lubricating	21st & Clearfield Sts. Philadelphia, Pa. 19134	2-27-70	DY
358.	Keystone Refining Co.	4821 Garden St. Philadelphia, Pa. 19137	2-27-70	DY
359.	Killark Electric	3940 Easton St. Louis, Mo. 63113	2-27-70	DY
360.	Kimberly Clark Corp.	P. O. Box 31 Neenah, Wisc.	2-27-70	DY

NAME		ADDRESS	DATE MAILED	PER
361.	George Koch & Sons	P. O. Box 385 Evansville, Ind.	2-27-70	DK
362.	Kohler McLister Pt.	P. O. Box 546 Denver, Colo.	2-27-70	DK
363.	Koppers Co.	750 Koppers Bldg. Pittsburgh, Pa.	2-27-70	DK
364.	Lakeside Plastics Corp.	P. O. Box 1007 Oshkosh, Wisc.	2-27-70	DK
365.	Lava Corp.	1650 W. Irving Park Rd. Chicago, Ill. 60613	2-27-70	DK
366.	Leepoxy Plastics	Ferguson Rd. & Baer Rd. Fort Wayne, Ind. 46809	2-27-70	DK
367.	Libby-Owens-Ford Co.	811 Madison Ave. Toledo, Ohio 43624	2-27-70	DK
368.	Lilly Industrial Coatings, Inc.	666 South California Indianapolis, Ind. 46225	2-27-70	DK
369.	Liquid Nitrogen Proc. Corp.	412 King St. Malvern, Pa. 19355	2-27-70	DK
370.	Litho Chem. & Sup.	46 Harriet Place Lynbrook, L.I., N.Y. 11563	2-27-70	DK
371.	Fitchburg Coated Products	P. O. Box 1106 Scranton, Pa. 18501	2-27-70	DK
372.	Litton Industries	336 N. Foothill Road Beverly Hills, Calif. 90213	2-27-70	DK
373.	The Livingston Co. c/o Roisman Prods. Co.	207 S. Compress Oklahoma City, Okla. 73125	2-27-70	DK
374.	Lloyd Studios	419 First Ave. New York, N. Y. 10009	2-27-70	DK
375.	L & M Const. Chemical	404 Pierce Omaha, Nebraska 68108	2-27-70	DK
376.	Lord Corp.	1635 West 12th St. Erie, Pa. 16505	2-27-70	DK
377.	Ludlow Corp.	Fine Papers Div. Ware, Mass. 01082	2-27-70	DK
378.	M. R. Plastics & Coatings	11460 Dorsett Road Maryland Heights, Mo. 63042	2-27-70	DK

NAME	ADDRESS	DATE MAILED	PER
379. M. Shiller Corp.	87 North 12th St. Brooklyn, N. Y. 11211	2-27-70	DK
380. Maas & Waldstein	1221 McCarter Highway Newark, N. J. 07104	2-27-70	DK
381. Mace Adhesives & Coatings	48 Berlin Road Cromwell, Conn. 06416	2-27-70	DK
382. Magid Corporation	350 Cantor Ave. Linden, N. J. 07036	2-27-70	DK
383. Magie Bros.	9101 Fullerton Franklin Park, Ill. 60131	2-27-70	DK
384. Magnolia Plas.	5547 Peachtree Ind. Blvd. Chamblee, Ga. 30341	2-27-70	DK
385. Manhattan Adhesives Corp.	425 Greenpoint Ave. Brooklyn, N. Y. 11222	2-27-70	DK
386. Marbleloid	2046 88th St. North Bergen, N. J. 07047	2-27-70	DK
387. Marine Industrial Paint Co.	6998 49th St. N. Pinellas Park, Fla. 33565	2-27-70	DK
388. Marks Polarized Co.	453 16 Tenth Ave. Whitestone, L.I., N.Y. 11357	2-27-70	DK
389. Martin Cantine Co.	Saugerties, N. Y. 12477	2-27-70	DK
390. Martin Marietta Corp.	Sand Lake Road Orlando, Fla. 32805	2-27-70	DK
391. Sinclair & Valentine	201 E. 16th Ave. N. Kansas City, Mo. 64108	2-27-70	DK
392. Maryland House of Correction	Jessups, Md. 20794	2-27-70	DK
393. Master Builders	2490 Lee Blvd. Cleveland, Ohio 44118	2-27-70	DK
394. Matcote Company	P. O. Box 10762 Houston, Texas 77018	2-27-70	DK
395. Matthews Paint Co.	400 S. Mercantile Court Wheeling, Ill. 60090	2-27-70	DK
396. Mautz Pt. & Varnish	939 E. Washington Ave. Madison, Wisc. 53703	2-27-70	DK
397. McCloskey Varn. Co.	7600 State Road Philadelphia, Pa. 19136	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
398.	McCormick Dental Lab.	17006 W. Warren Detroit, Mich. 48228	2-27-70	DK
399.	Medtronic, Inc.	3055 Old Highway Eight Minneapolis, Minn. 55418	2-27-70	DK
400.	Micalline Product	1513 Lyon St. Columbia, S. C. 29204	2-27-70	DK
401.	Michigan Chrome & Chem. Co.	8615 Grinnell Ave. Detroit, Mich. 48213	2-27-70	DK
402.	Michigan Plastic Prod., Inc.	Grand Haven, Mich. 49417	2-27-70	DK
403.	Micro Switch	Freeport, Ill. 61033	2-27-70	DK
404.	Midland Adhesive Chem. Corp.	14100 Stansbury Detroit, Mich. 48227	2-27-70	DK
405.	Midland Div. Dexter Corp.	East Water St. Waukegan, Ill. 60085	2-27-70	DK
406.	Midwest Rubber	Box 744 East St. Louis, Ill. 62202	2-27-70	DK
407.	Mine Safety Appliances	Braddock Thomas & Mead St. Pittsburgh, Pa. 15221	2-27-70	DK
408.	Minnesota Mining	2501 Hudson Road St. Paul, Minn. 55101	2-27-70	DK
409.	Minnesota Paints	1101 Third St. South Minneapolis, Minn. 55415	2-27-70	DK
410.	Miracle Adhesives Corp.	250 Pettit Ave. Bellmore, N. Y. 11710	2-27-70	DK
411.	Mobil Chemical Co.	P. O. Box 1388 Plainfield, N. J.	2-27-70	DK
412.	Monarch Rubber Co.	3500-22 Pulaski Hwy. & Corkling Sts. Baltimore, Md. 21224	2-27-70	DK
413.	Wood Treating Chem. Co.	5137 Southwest Ave. St. Louis, Mo. 63110	2-27-70	DK
414.	Standard T Chem Co.	2600 Richmond Terrace Staten Island, N.Y. 10303	2-27-70	DK
415.	Benj. Moore & Co.	134 Lister St. Newark, N. J. 07105	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
416.	Morris Paint & Varnish	1823 Washington St. Louis, Mo. 63103	2-27-70	DK
417.	J. W. Mortell	144 Grant St. Perth Amboy, N. J. 08861	2-27-70	DK
418.	Morton Chem.	110 N. Wacker Drive Chicago, Ill. 60606	2-27-70	DK
419.	Nashua Corporation	44 Franklin St. Nashua, N. H. 03060	2-27-70	DK
420.	National Chemical & Plastics Co.	1424 Philpot St. Baltimore, Md. 21231	2-27-70	DK
421.	Nat'l. Cash Register	Main & K Streets Dayton, Ohio 45409	2-27-70	DK
422.	Nat'l. Floor Prod. Co.	P. O. Box 354 Florence, Ala. 35630	2-27-70	DK
423.	Baker Castor Oil Co.	35 Avenue A Bayonne, N. J. 07002	2-27-70	DK
424.	Nat'l. Lead Co.	P. O. Box 831 Perth Amboy, N. J. 08862	2-27-70	DK
425.	National Starch & Chem. Corp.	1735 West Front St. Plainfield, N. J. 07063	2-27-70	DK
426.	Nazar Rubber Co.	2727 Avondale Toledo, Ohio 43607	2-27-70	DK
427.	Nelson Oil Co.	P. O. Box 795 Lenoir, N. C.	2-27-70	DK
428.	New York Bronze Powder Co.	519 Dowd Ave. Elizabeth, N. J. 07201	2-27-70	DK
429.	Niagara Rubber Co.	Front St. S. Plainfield, N. J.	2-27-70	DK
430.	Nichols Industries, Inc.	P. O. Box 1191 Jacksonville, Texas	2-27-70	DK
431.	Niles Chem. Paint	Third & Front Niles, Mich.	2-27-70	DK
432.	North American Rockwell	Route 69 By Pass NE McAlster, Okla. 74501	2-27-70	DK
433.	North American Rockwell	P. O. Box 309 Canoga Park, Calif.	2-27-70	DK
434.	North Electric	Portland Way North Galion, Ohio 44833	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
435.	Norton Company	1 New Bond St. Worcester 6, Mass.01606	2-27-70	DK
436.	Novagard Corp.	835 New York Ave. Trenton, N. J. 08638	2-27-70	DK
437.	Numec	609 Warren Ave. Apallo, Pa. 15613	2-27-70	DK
438.	Olin Corp.	P. O. Box 547 Brandenburg, Ky. 40108	2-27-70	DK
439.	Olin Mathieson Corp.	Winchester Plant New Haven, Conn. 06517	2-27-70	DK
440.	O'Neil Duro Co.	P. O. Box 1166 Milwaukee, Wisc. 53201	2-27-70	DK
441.	Onyx Chem. Co.	190 Warren St. Jersey City, N. J. 07302	2-27-70	DK
442.	Ore-Lube Corp.	126-06 18th Avenue College Point, N. Y. 11356	2-27-70	DK
443.	Oscar Mayer	910 Mayer Ave. Madison, Wisc. 53701	2-27-70	DK
444.	Owens Illinois	1510 North Westwood Ave. Toledo, Ohio 43607	2-27-70	DK
445.	Owens Corning Fiber-glas Corp.	Granville Technical Center Granville, Ohio 43023	2-27-70	DK
446.	Owens Corning Fiber-glas Corp.	Case Avenue Newark, Ohio 43055	2-27-70	DK
447.	Packaging Corp. of Am.	415 E. Fulton St. Grand Rapids, Mich. 49502	2-27-70	DK
448.	Palm Bros. Decal-comania Co.	Spencer Regent & Lexington Cincinnati, Ohio 45212	2-27-70	DK
449.	Panatlas Corp.	Woolworth Bldg. 233 Broadway New York, N. Y. 10007	2-27-70	DK
450.	Parker Stearns & Co.	300 Sheffield Ave. Brooklyn, N. Y. 11207	2-27-70	DK
451.	Park Name Plate Co.	3410-10 Linden Pl. Flushing, L.I., N.Y. 11354	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
452.	Parr Paint & Sealants Co.	5151 Denison Ave. Cleveland, Ohio 44102	2-27-70	DH
453.	W. M. Parr & Co.	310 State Hwy. No. 10 Hanover, N. J. 07936	2-27-70	DH
454.	Penn-Jersey Paint & Varnish Co.	1256 McCarthy Highway Newark, N. J. 07104	2-27-70	DH
455.	Penwalt Corp.	Lincoln Hwy. East of State St. Chicago Heights, Ill. 60411	2-27-70	DH
456.	Polytech Coatings Corp.	35 High Ridge Rd. Dover, N. J. 07801	2-27-70	DH
457.	Penn Poly Corp.	Route 611 Mount Bethel, Pa. 18343	2-27-70	DH
458.	Penn Refining	2686 Lisbon Road Cleveland, Ohio 44104	2-27-70	DH
459.	Pennzoil Co.	Drake Bldg. Oil City, Pa. 16301	2-27-70	DH
460.	Pentalic Corp.	132 West 22nd St. New York, N. Y. 10011	2-27-70	DH
461.	Permatex Co., Inc.	3255 Harvester Road Kansas City, Kansas 66115	2-27-70	DH
462.	Perry Brothers	6112 32nd Ave. Woodside, L.I., N.Y. 11377	2-27-70	DH
463.	Pettys Exterminating	1515 S. Pulaski Road Chicago, Ill. 60623	2-27-70	DH
464.	Phillips Petroleum	1245 Adams Bldg. Bartlesville, Okla. 74003	2-27-70	DH
465.	Photocircuits Corp.	31 Sea Cliff Ave. Glen Cove, N. Y. 11542	2-27-70	DH
466.	Photolastic, Inc.	67 Lincoln Highway Malvern, Pa. 19355	2-27-70	DH
467.	Pierce & Stevens Chem. Corp.	710 Ohio St. Buffalo, N. Y. 14203	2-27-70	DH
468.	Pigment Dispersions	29 Meridian Rd. Iselin, N. J. 08830	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
469.	PPG Industries, Inc.	One Gateway Center Pittsburgh, Pa. 15222	2-27-70	DH
470.	Plabell Rubber Prod., Inc.	318 So. St. Claire St. Toledo, Ohio 43604	2-27-70	DH
471.	Plastics Research & Dev. Co.	3619 Jenny Lind Fort Smith, Ark. 72901	2-27-70	DH
472.	Plough, Inc.	3022 Jackson Ave. Memphis, Tenn. 38101	2-27-70	DH
473.	DAP, Inc.	5300 Huberville Ave. Dayton, Ohio 45401	2-27-70	DH
474.	Plymouth Rubber Co.	Canton, Mass. 02021	2-27-70	DH
475.	Poly Resins, Inc.	P. O. Box 276 11655 Wicks St. Sun Valley, Calif. 91352	2-27-70	DH
476.	Poly Cast Corp.	69 Southfield Ave. Stamford, Conn. 06902	2-27-70	DH
477.	Polymel Corp.	514 Ensor St. Baltimore, Md. 21202	2-27-70	DH
478.	Polymer Corp.	125-7 Fifth St. Reading, Pa. 19601	2-27-70	DH
479.	Polymers Southern	Plant 4, P. O. Box 2184 Greenville, S. C. 29602	2-27-70	DH
480.	Polymer Ind.	Viaduct Road Springdale, Conn. 06907	2-27-70	DH
481.	Polyplastex United, Inc.	6200 49th St., North Pinellas Park, Fla. 33565	2-27-70	DH
482.	Polyshell Chem. Corp.	209 Pitkin Ave. Brooklyn, N. Y. 11207	2-27-70	DH
483.	H. K. Porter Co.	P. O. Box 1088 2300 North Lewis Tulsa, Okla. 74110	2-27-70	DH
484.	Porter Paint Co. Prod. Finishes Div.	1301 W. Kentucky St. Louisville, Ky. 40210	2-27-70	DH
485.	Premier Thermo Plastics Co.	Middletown Road Jeffersontown, Ky. 40299	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
486.	Premier Vacuum Process Corp.	58-87 55th St. Maspeth, L.I., N.Y. 11378	2-27-70	DK
487.	Prods. Research & Chem. Corp.	2919 Empire Ave. Burbank, Calif. 91504	2-27-70	DK
488.	Purdue Aeronautics	Purdue University Airport West Lafayette, Ind. 47906	2-27-70	DK
489.	Pyrolac Corp.	55 Schoon Ave. Hawthoren, N. J. 07507	2-27-70	DK
490.	Quaker Chem.	Lime Elm & Sandy Sts. Conshohocken, Pa. 19428	2-27-70	DK
491.	Quaker Oil Corp.	801 East Red Bud St. Louis, Mo. 63147	2-27-70	DK
492.	Quelcor, Inc.	Paper Mill Road Media, Pa. 19063	2-27-70	DK
493.	Radiant Color Div. Hercules, Inc.	2800 Radiant Ave. Richmond, Calif. 94804	2-27-70	DK
494.	Radiation Machinery Corp.	1280 Route 46 Parsippany, N. J. 07054	2-27-70	DK
495.	Radio Eng. Labs, Inc.	2901 Borden Avenue Long Island City, N. Y. 11101	2-27-70	DK
496.	Ram Chemicals Div.	P. O. Box 192 Gardena, Calif. 90247	2-27-70	DK
497.	Raritan Plastics	1 Raritan Road Oakland, N. J. 07436	2-27-70	DK
498.	Raybestos Manhattan, Inc.	61 Willett St. Passaic, N. J. 07055	2-27-70	DK
499.	Raychem Corp.	300 Constitution Ave. Menlo Park, Calif. 94025	2-27-70	DK
500.	Rubber Engineering & Mfg. Co.	P. O. Box 15392 Salt Lake City, Utah 84115	2-27-70	DK
501.	Reactive Metal Prods. Div. Howmet Corp.	555 Benstone Road Whitehall, Mich. 49461	2-27-70	DK
502.	Red Spot Paint & Varnish Co.	110-112 Main St. Evansville, Ind. 47708	2-27-70	DK
503.	Regal Finishing Co.	427 N. Hull Ave. Benton Harbor, Mich. 49022	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
504.	Reichhold Chemicals, Inc.	525 N. Broadway White Plains, N. Y. 10601	2-27-70	DH
505.	Reilly Whiteman Walton Co., Inc.	Conshohocken, Pa. 19428	2-27-70	DH
506.	I. Reiss & Co, Inc.	120 Bayway Ave. Elizabeth, N. J. 07202	2-27-70	DH
507.	Reliance Universal, Inc.	1901 Sheridan Road North Chicago, Ill. 60064	2-27-70	DH
508.	Repco Replacement Parts Co.	P. O. Box 40176 Everman, Texas 76140	2-27-70	DH
509.	Republic Dye & Chemical Corp.	60 S. Seiberling St. Akron, Ohio 44305	2-27-70	DH
510.	Republic Powdered Metals	2628 Pearl Road Medina, Ohio 44256	2-27-70	DH
511.	Research Molding & Film Co.	Route 1 Mendon, Mich. 49072	2-27-70	DH
512.	Fiberfil Corp.	Fox Farm Road Evansville, Ind. 47710	2-27-70	DH
513.	R. J. Reynolds Tobacco Co.	Winston-Salem, N.C. 27102	2-27-70	DH
514.	Reynolds Metals Co.	7734 Hall St. St. Louis, Mo. 63147	2-27-70	DH
515.	W. C. Richards Co.	3555 W. 123rd St. Blue Island, Ill. 60406	2-27-70	DH
516.	Richardson Chemical Cleaning Service	68 Liberty St. Metuchen, N. J. 08840	2-27-70	DH
517.	Robertshaw Control Co.	155 Hill St. Milford, Conn. 06460	2-27-70	DH
518.	G. P. Roeser	P. O. Box 92 Lahaska, Pa. 18931	2-27-70	DH
519.	Royal Lubricants Co.	River Road Hanover, N. J. 07936	2-27-70	DH
520.	Royal Typewriter Co., Inc.	1031 New Britain Ave. West Hartford, Conn. 06110	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
521.	Rubatex Corp., Div. Gr. American Ind.	Bedford, Va. 24523	2-27-70	DK
522.	Rubber Industries	Box 6 Shakopee, Minn. 55379	2-27-70	DK
523.	Rubbermaid, Inc.	Route 5 Wooster, Ohio 44691	2-27-70	DK
524.	Rubber Silicone Prods. Co.	Montesano Road Fairfield, N. J. 07006	2-27-70	DK
525.	S. C. Johnson & Son	1525 Howe St. Racine, Wisc. 43403	2-27-70	DK
526.	Glidden-Durkee Div. SMC Corp.	Union Commerce Bldg. Euclid & 9th Sts. Cleveland, Ohio 44115	2-27-70	DK
527.	Samuel Schmidt Chemical Co.	410 Frelinghuysen Ave. Newark, N. J. 07114	2-27-70	DK
528.	Sandoz Pharmaceuticals	P. O. Box 11 Hanover, N. J. 07936	2-27-70	DK
529.	Sandusky Abrasive Wheel Co., Div. Yates Mfg. Co.	441 W. Huron St. Chicago, Ill. 60610	2-27-70	DK
530.	Sapolin Co., Inc.	229 East 42nd St. New York, N. Y. 10017	2-27-70	DK
531.	Schenectady Chemicals Inc.	P. O. Box 1046 Schenectady, N.Y. 12301	2-27-70	DK
532.	Schermerborn Paint Prods.	1521 Hilton Road Ferndale, Mich. 48220	2-27-70	DK
533.	M. Schiller Corp.	87 N. 12th St. Brooklyn, N. Y. 11211	2-27-70	See DK 319
534.	Schramm Fiber Glass Prods.	2849 Montrose Ave. Chicago, Ill. 60618	2-27-70	DK
535.	Seaboard Chem. Corp.	Products Drive Texas, Md. 21030	2-27-70	DK
536.	DeSoto, Inc.	300 State St. Chicago Heights, Ill. 60411	2-27-70	DK
537.	Sem Products Co.	Shoreway Road & Sem Lane Belmont, Calif.	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
538.	Shallcross Co.	48th & Grays Ferry Ave. Philadelphia, Pa. 19131	2-27-70	DH
539.	Shawnee Plastics, Inc.	601 N. Ninth Ave. Evansville, Ind. 47707	2-27-70	DH
540.	Shell Chem. Co.	P. O. Box 500 Geismar, La. 70734	2-27-70	DH
541.	Acme Quality Paints, Inc.	8250 St. Aubin Detroit, Mich. 48211	2-27-70	DH
542.	Lowe Brothers	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	DH
543.	Sherwin Williams	P. O. Box 6027 Cleveland, Ohio 44101	2-27-70	DH
544.	Sigma Plastronics, Inc.	10319-21 Grand River Ave. Detroit, Mich. 48204	2-27-70	DH
545.	Simplex Wire & Cable Co.	79 Sidney St. Cambridge, Mass. 02139	2-27-70	DH
546.	Sinnet Lacquer Mfg. Co.	1378 N. Kingsland St. Louis, Mo. 63133	2-27-70	DH
547.	Smith Alsop Paint Co.	North 3rd St. & New York Central Railroad Terre Haute, Ind. 47801	2-27-70	DH
548.	Solar Compounds Corp.	Box 227 Linden, N. J. 07036	2-27-70	DH
549.	Sonneborn Building Prods.	Hancock Ave. Belleville, N. J. 07109	2-27-70	DH
550.	Sonoco Prod. Co.	Hartsville, S. C. 29550	2-27-70	DH
551.	Sou-Tex Chemical Co.	P. O. Box 866 Mt. Holly, N. C. 28120	2-27-70	DH
552.	Sparling Plastics	9229 General Court Plymouth, Mich. 48170	2-27-70	DH
553.	Spartan Electronics	2400 E. Ganson St. Jackson, Mich. 49202	2-27-70	DH
554.	Spencer Kellogg Div. Textron, Inc.	P. O. Box 807 Buffalo, N. Y. 14240	2-27-70	DH
555.	Remington Office Machines	333 Wilson Ave. So. Norwalk, Conn. 06854	2-27-70	DH

NAME		ADDRESS	DATE MAILED	PER
556.	Sprayon Products, Inc.	26300 Fargo Ave. Bedford Heights, Ohio 44146	2-27-70	DX
557.	St. Clair Rubber Co.	Empire Building 107 Clifford St. Detroit, Mich. 48226	2-27-70	DX
558.	Staley Chem. Co.	320 Schuyler Ave. Kearny, N. J. 07032	2-27-70	DX
559.	UBS Chemical Div.	495 Main St. Cambridge, Mass. 02142	2-27-70	DX
560.	Esso Research & Eng. Co.	P. O. Box 243 Elizabeth, N. J. 07203	2-27-70	DX
561.	American Oil Co.	P. O. Box 401 Texas City, Texas 77590	2-27-70	DX
562.	Standard Packaging Co.	Forsgate Industrial Park Cranbury, N. J. 07821	2-27-70	DX
563.	Standard Drywall Prods.	Box 578 Bristol, Pa. 19007	2-27-70	DX
564.	Amoco Chemicals Corp.	130 East Randolph Chicago, Ill. 60601	2-27-70	DX
565.	Standard Pressed Steel	Jenkintown, Pa. 19046	2-27-70	DX
566.	Stanley Chem. Div.	77 Berlin St. East Berlin, Conn. 06023	2-27-70	DX
567.	Paisley Pro-Div.	1153 Bloomfield Ave. Clifton, N. J. 07012	2-27-70	DX
568.	Star Chemical	9830 Derby Lane Westchester, Ill. 60153	2-27-70	DX
569.	State Chem. Co.	205-207 Polk St. Amarillo, Texas 79107	2-27-70	DX
570.	Sterling Lacquer Mfg. Co.	3150 Brannon St. Louis, Mo. 63139	2-27-70	DX
571.	H. B. Stuck Adhesives, Inc.	3327 Chartres St. New Orleans, La. 70117	2-27-70	DX
572.	Sullivan Co.	212 East Trigg Ave. Memphis, Tenn. 38102	2-27-70	DX
573.	Sun Chem.	631 Central Ave. Carlstadt, N. J. 07072	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
574.	Sun Chem. Corp. Gen. Printing Co.	390 Central Ave. E. Rutherford, N.J. 07073	2-27-70	DK
575.	Sun Oil Co.	1608 Walnut St. Philadelphia, Pa. 19103	2-27-70	DK
576.	Sun Chem. Corp.	750 Third Ave. New York, N. Y. 10017	2-27-70	DK
577.	Sunolin Chem. Co.	North Claymont, Del. 19703	2-27-70	DK
578.	Sunflo Paint	P. O. Box 227 Amsterdam, N. Y. 12010	2-27-70	DK
579.	Super Tire Engineering Co.	7255 Crescent Blvd. Camden, N. J. 08110	2-27-70	DK
580.	Supronics Corp.	100 Dorsa Ave. Livingston, N. J. 07039	2-27-70	DK
581.	W. J. Sutcliffe Co.	P. O. Box 5 E. Rutherford, N.J. 07073	2-27-70	DK
582.	Swift & Co.	115 West Jackson Blvd. Chicago, Ill. 60604	2-27-70	DK
583.	Talon Adhesives	160 Passaic Ave. Kearny, N. J.	2-27-70	DK
584.	Charles S. Tanner Co.	450 Furman Hall Rd. Greenville, S. C. 29608	2-27-70	DK
585.	Technical Tape Corp.	1 LeFevre Lane New Rochelle, N. Y. 10801	2-27-70	DK
586.	Tech. Coatings	1056 Walsh St. Santa Clara, Calif. 95050	2-27-70	DK
587.	Technical Coatings Co., Benj. Moore Co.	134 Lister Ave. Newark, N. J. 07105	2-27-70	DK
588.	Technical Sealants & Adhesives	43 East Water St. St. Paul, Minn. 55107	2-27-70	DK
589.	Technological Lab, Inc.	P. O. Box 395 Ozark, Mo. 65721	2-27-70	DK
590.	Tenneco Chemicals	9001 Randolph Houston, Texas 77017	2-27-70	DK
591.	Tenneco Chemicals, Inc.	P. O. Box 51 Reading, Pa. 19603	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
592.	Texas Rubber & Specialty Corp.	930 Adele St. Houston, Texas 77016	2-27-70	DX
593.	Tex F Tessier	P. O. Box 656 Petaluma, Calif. 94952	2-27-70	DX
594.	Thieile Engdahl, Inc.	1100 Fairchild Winston-Salem, N.C. 27105	2-27-70	DX
595.	Thiem Prod.	9800 W. Rogers St. Milwaukee, Wisc. 53227	2-27-70	DX
596.	Thiokol Chem. Corp.	780 North Clinton Ave. Trenton, N. J. 08607	2-27-70	DX
597.	Tip Top Prods. Co.	1508 Burt St. Omaha, Neb. 68102	2-27-70	DX
598.	Titanine, Inc.	Morris & Elmwood Ave. Union, N. J. 07083	2-27-70	DX
599.	Tri-Wall Containers, Inc.	One DuPont St. Plainview, L.I., N.Y. 11803	2-27-70	DX
600.	Et Trotters Co.	939 Port Washington Port Washington, L.I., N.Y. 11050	2-27-70	DX
601.	Tru-Rite, Inc.	43 Hall St. Brooklyn, N. Y. 11205	2-27-70	DX
602.	Tull Chemical Co.	P. O. Box 246 Oxford, Ala. 36201	2-27-70	DX
603.	Wagner Electric	6400 Plymouth St. Louis, Mo. 63133	2-27-70	DX
604.	UMC Corp. Hermetitie Div.	245 Patterson Plank Rd. Carlstadt, N. J. 07072	2-27-70	DX
605.	U. S. Gypsum Co.	101 S. Wacker Drive Chicago, Ill. 60606	2-27-70	DX
606.	Palmer Products, Inc.	P. O. Box 33 Worcester, Pa. 19490	2-27-70	ek
607.	Ultra Chem., Inc.	1400 N. Walnut St. Wilmington, Del. 19809	2-27-70	DX
608.	Unimar, Inc.	3539 Pinemont Houston, Texas 77040	2-27-70	DX
609.	Union Camp Paper Corp.	793 N. Lathrop Ave. Savannah, Ga. 31401	2-27-70	DX

NAME		ADDRESS	DATE MAILED	PER
610.	UPACO Adhesives, Inc.	1605 Hyde Park Ave. Hyde Park, Mass. 02136	2-27-70	DK
611.	Union Carbide Corp.	270 Park Ave. New York, N. Y. 10017	2-27-70	DK
612.	Uniroyal	312 N. Hill St. Mishawaka, Ind. 46544	2-27-70	DK
613.	United Resins Prods., Inc.	100 Sutton St. Brooklyn, N. Y. 11222	2-27-70	DK
614.	U. S. Steel	Homestead Steel Works Homestead, Pa. 15120	2-27-70	DK
615.	United Electric Controls Co.	85 School St. Watertown, Mass. 02172	2-27-70	DK
616.	United Lacquer Mfg. Corp.	1001 W. Elizabeth Ave. Linden, N. J. 07036	2-27-70	DK
617.	Universal Oil Prod. Co.	State Highway Route 17 E. Rutherford, N.J. 07073	2-27-70	DK
618.	U. S. Government Office In Charge	Naval Ordnance Laboratory 8050 George Ave. Silver Springs, Md. 20910	2-27-70	DK
619.	U. S. Government Printing Office	Purchasing Div. Washington, D. C. 20402	2-27-70	DK
620.	U. S. Government Dir. Procurement & Prod.	Bldg. 4455 Edgewood Arsenal, Md. 21010	2-27-70	DK
621.	U. S. Catheter & Instr. Corp.	P. O. Box 30 Glens Falls, N. Y. 12801	2-27-70	DK
622.	U. S. Paint Lacquer & Chemical Co.	2115 Singleton St. Louis, Mo. 63103	2-27-70	DK
623.	U. S. Tar Products	Lloyd Road Matawan, N. J. 07747	2-27-70	DK
624.	Vacuum Finishing	15615 W. High St. Middlefield, Ohio 44062	2-27-70	DK
625.	Varcraft Paint Co.	Keim & Cross Sts. Pottstown, Pa. 19464	2-27-70	DK
626.	Vernon Specialties, Inc.	42 River St. North Tarrytown, N.Y. 10591	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
627.	Viking Cooling Co.	15-20 129th St. College Point, N. Y. 11356	2-27-70	DK
628.	Vimasco Corp.	P. O. Box 465 Nitro, W. Va. 25143	2-27-70	DK
629.	Virginia Paint Mfg.	623 West 24th St. Norfolk, Va. 23517	2-27-70	DK
630.	Vulcan Materials Co.	P. O. Box 545 Wichita, Kansas 67201	2-27-70	DK
631.	W & M Mfg., Inc.	Geneva, Ind. 46740	2-27-70	DK
632.	Wallace & Tiernan, Inc.	Harchem Div., Box 178 Newark, N. J. 07101	2-27-70	DK
633.	Wallace Company	P. O. Box 1048 Gonzales, La. 70737	2-27-70	DK
634.	Warwick Chem. Co.	Sun Chem Prods. Div. Wood River Jct., R.I. 02894	2-27-70	DK
635.	Warwick Rubber Molding Corp.	Forester Ave. Warwick, N. Y. 10990	2-27-70	DK
636.	Welborn Paint Mfg. Co.	215 Roosmore Rd., SW Albuquerque, N. M. 87102	2-27-70	DK
637.	West Chester Chem. Co.	Box 39 West Chester, Pa. 19380	2-27-70	DK
638.	West Virginia Pulp & Paper	3400 E. Biddle Baltimore, Md. 21213	2-27-70	DK
639.	Westinghouse Elec. Co.	Industrial Plastics Div. Manor, Pa. 15665	2-27-70	DK
640.	Wetherill Chem.	820 Sherman Ave. Pensauken, N. J. 08110	2-27-70	DK
641.	White Rodgers Co.	9797 Reavis Road St. Louis, Mo. 63123	2-27-70	DK
642.	Wilhold Glues, Inc.	2943 W. Carroll Chicago, Ill. 60612	2-27-70	DK
643.	Willow Grafic, Inc.	2201 S. Wantagh Ave. Wantagh, L.I., N.Y. 11793	2-27-70	DK
644.	Wisconsin Elec. Coop.	1810 St. Part St. P. O. Box 686 Madison, Wisc. 53701	2-27-70	DK

NAME		ADDRESS	DATE MAILED	PER
645.	Wisc. Rubber Prods., Inc.	P. O. Box 454 Union Grove, Wisc. 53182	2-27-70	DK
646.	Woburn Chem. Corp.	1200 Harrison Ave. Harrison, N. J. 07029	2-27-70	DK
647.	Wolverine Fabricating & Mfg. Co.	Princess St. & McRR Inkster, Mich. 48141	2-27-70	DK
648.	Wooster Finishes	Wooster, Ohio 44691	2-27-70	DK
649.	Walter Wurdack, Inc.	4977 Fyler Ave. St. Louis, Mo. 63139	2-27-70	DK
650.	Wyandotte Chemicals Corp.	Wyandotte, Mich. 48192	2-27-70	DK
651.	Xandadu Corporation	P. O. Box 537 Saddle River, N. J. 07458	2-27-70	DK
652.	Yates Mfg.	1615 W. 15th St. Chicago, Ill. 60608	2-27-70	DK
653.	Yoder Mfg.	1823 E. 17th St. Little Rock, Ark. 72202	2-27-70	DK
654.	Zenith Prods. Co.	9420 W. Byron St. Schiller Park, Ill. 60176	2-27-70	DK
655.	Outside Carpets, Inc.	P. O. Box 692 Rome, Ga. 30161	2-27-70	DK
656.	Raybestos Manhattan, Inc.	P. O. Box 1021 Bridgeport, Conn. 06602	2-27-70	DK
657.	Fiberfill Div. Dart Industries, Inc.	1701 N. Heidelbach Evansville, Ind. 47717	2-27-70	DK
658.	Cosden Chem. Coatings	P. O. Box 230 Norristown, Pa. 19405	2-27-70	DK
659.	Chrysler Corporation Chemical Division	5437 W. Jefferson Trenton, Mich. 48183	2-27-70	DK
660.	North Central Chem.	P. O. Box 3091 Eastside Sta. Madison, Wisc. 53704	2-27-70	DK
661.	Nelson Oil Co.	P. O. Box 795 Lenoir, N. C. 28645	3/2/70	CP

DJ-12

CONFIDENTIAL

MINUTES OF AROCLOR "AD HOC" COMMITTEE

First Meeting

Date: September 5, 1969

Present: M. W. Farrar
P. B. Hodges, Secretary
E. V. John
W. R. Richard
E. P. Wheeler, Chairman

Objectives: (Agreed to by the Committee)

Submit recommendations for action which will:

1. Permit continued sales and profits of Aroclors and Terphenyls.

2. Permit continued development of uses and sales.

3. Protect image of Organic Division and of the Corporation.

Background Discussion of Problem:

1. Agreed that we should concentrate on Aroclor 1254 and 1260. Aroclor 1242 has not yet been incriminated for these possible reasons:

   a. Nature of uses of 1242 minimizes environmental contamination.

   b. It may degrade biologically.

   c. Unless analytical techniques are performed carefully, 1242 can be destroyed by oxidation during the analyses.

2. PCB has been found in:

   a. Fish, oysters, shrimp, birds.

   b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries, Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant.

3. PCB has been tied to DDT in effects on disappearance of wild birds which have fish diets. Ratio of PCB to DDT has been about 40-50:1 generally. Dr. Reisboro reported almost 1:1 ratio. PCB may be contributing to or exaggerating the effects of other chlorinated aromatics.

4. Sample acceptance from the numerous researchers was discussed. This has been done on a limited basis. Our corroboration of testing of their samples adds to our knowledge and demonstrates a willingness by Monsanto to help define the problem, but it is expensive and also tightens any possible legal cases against us--it rules out possibilities that Aroclors are not involved.

5. Toxicity levels:

   Aroclors have been shown to be safe for man in reasonable exposure concentrations. We are testing 100 ppm in diet of rats and dogs on a rule-of-thumb basis that 1/100 of toxicity level is safe and 1 ppm is probably the upper limit in total diet.

   "Allowable levels" are probably lower than DDT. The worst example to date is the test at Pensacola where 5 ppb was found to be toxic to shrimp in 18 days exposure.

   One problem we are facing is to keep the "safe level" (?) for shrimp from being applied to e.g. Lake Michigan where more tolerant fish species probably exist. We need to show the safe level in shrimp, clams, oysters and several species of fish.

   Many toxicity studies on PCB are underway and it was agreed to be desirable to keep contact with all laboratories which have requested Aroclor samples. One-half to two-thirds of the sample requests have come from state labs (who would let us know what they are doing) and about 1/3 have come from universities (who may give us the "brush-off"). Question of who should call on the laboratories was not resolved.

6. Escambia River Problem:

   For a clearer understanding of the general problem, the situation at Pensacola was reviewed. From a relatively negligible discharge of 1-3 gal/day into a large river, 1/4 mile downstream levels of 42 ppb in water and 476 ppm in mud were found. Although use of Aroclor was halted immediately, we can expect the water contamination to continue for a lengthy period by leaching from the contaminated mud. No downstream samples have yet been taken to measure the decrease in contamination (as of 9/5/69).

7. Problem in Producing Plants:

P. Hodges reviewed what was being done to stop gross losses at Anniston and at WGK. Basically, the work to date consists of stopping or trapping any sewering of free Aroclor with return to process or land fill disposal of the trapped Aroclor. This will reduce levels in plant effluents to below solubility ranges, particularly as we move to install traps (or sumps) back into the waste source points where flows are small and as yet undiluted by Aroclor-free waste streams. The question of exactly how far to reduce (how much money to spend) is not yet clear and expenditures to date have been comparatively small. It was agreed that, until the problems of gross environmental contamination by our customers have been alleviated, there is little object in going to expensive extremes in limiting discharges from the plants.

One problem that has been interfering with logical development of our plant Aroclor waste reduction programs has been delays in obtaining analytical results from in-plant and ex-plant sampling. It was agreed that additional help was necessary in Dr. Tucker's lab but no specific actions were proposed. In addition to in-plant work, the plants are sampling the receiving streams.

Air pollution reduction has not been considered by the plants to date except as incidental prevention of product contamination during tank car and drum loading operations. Long range (1-2 year) improvements at Anniston are planned to reduce product contamination (and air emissions) in car loading operations. It was agreed that a comprehensive air sampling and testing program would be very expensive and is probably not justified at this stage of the problem.

8. Environmental Contamination by Customers:

Our in-plant problems are very small vs. problems of dealing with environmental contamination by customers. In one application alone (highway paints), one million lbs/year are used. Through abrasion and leaching we can assume that nearly all of this Aroclor winds up in the environment.

Because the rate of natural (bio-degradation) is very low, other degradation must destroy PCB equal to the rate of environmental exposure in order to avoid build-up of contamination.

A general discussion was held on philosophy of controlling sales or working with customers to prevent pollution by PCB.

Action Planned:

Each member of the group will submit to the other members for consideration possible ideas and programs to help accomplish the overall objectives set by the Committee. Following review of the suggestions, the Committee will meet again at an early date to be arranged by the Chairman.

P. B. Hodges
Secretary

:ju

DJ-13

CONFIDENTIAL

Date: October 2, 1969

Subject: REPORT OF AROCLOR "AD HOC" COMMITTEE

To: Howard S. Bergen, Jr.
James E. Springate

From: M. N. Farrar
P. B. Hodges, Secretary
E. V. John
W. R. Richard
E. P. Wheeler, Chairman

CONTENTS

on August 25,

OBJECTIVES

At a meeting of business group directors of Function Fluids and Plasticizers with Organic Division and Corporate Staff members, an "ad hoc" committee was appointed to prepare a resume of the situation concerning the environmental contamination through the manufacture and use of polychlorinated biphenyls (Aroclors).

The objective of the committee was to ~~prepare~~ recommended action that will:

1. Protect continued sales and profits of Aroclors;

2. Permit continued development of new uses and sales, and

3. Protect the image of the Organic Division and the Corporation as members of the business community recognizing their responsibilities to prevent and/or control contamination of the global ecosystem.

PROBABILITY OF SUCCESS

The committee believes there is little probability ~~[illegible]~~ that any action that can be taken will prevent the growing incrimination of specific polychlorinated biphenyls (the higher chlorinated--e.g. Aroclors 1254 and 1260) as nearly global environmental contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp), and the possible extinction of several species of fish eating birds.

Secondly, the committee believes that there is no ~~possi-ble~~ practical course of action that can so effectively police the uses of these products as to prevent completely some environmental contamination.

There are, however, a number of ~~possible~~ actions which must be undertaken in order to prolong the manufacture, sale and use of these particular Aroclors as well as to protect the continued use of other members of the Aroclor series. (Less than 5 Chlorines)

The ultimate that can be expected is the continued use of the lower chlorinated biphenyls and the chlorinated terphenyls in applications amenable to such control that there is practically zero losses to the environment. In the interim we would hope to establish by appropriate research efforts "tolerance" or safe levels for particular Aroclors in the environment.

- The identification is ~~posi~~ positive
- Toxcity towards certain species is high.
- Persistance is high. —
- Likely hood of natural origin or degradation is remote. —

RECOMMENDATIONS

OK 1. In view of legal and moral considerations, notify all Aroclor 1254 and 1260 customers of environmental contamination problem. + advising customers.

3, ~~2~~. Consult with appropriate federal agencies' headquarters in Washington to determine current status of concern and to inform appropriate individuals therein of Monsanto's research and control efforts.

4, ~~3~~. Personally contact all governmental and university laboratories which have requested Aroclor samples and indicated interest in the environmental contamination problem.

2, ~~4~~. Reduce losses of Aroclors in liquid wastes from Monsanto plants to ~~absolute~~ minimum. Goal ~~0~~ to <5 ppb ~~10 parts per million~~. For 1254 1260.

5. Determine extent of atmospheric losses from Aroclors from Anniston and WGK Plants and develop plans for control.

6. Analyze in Organic Division laboratories (or by contract) selected appropriate samples from:

   a. Environment of Anniston and WGK Plants.

   b. Monsanto products where contamination is possible.

   c. Agencies and/or laboratories attempting to pinpoint specific sources of contamination.

   d. Customer plants' environments.

   e. Research efforts involved in biological studies--i.e. animal, bird and fish toxicity studies and biodegradation studies.

7. Expand analytical capabilities in conjunction with items 5. and 6. above.

RECOMMENDATIONS (Continued)

8. Assign one individual from the division full-time for three to six months to coordinate division and Corporate Staff department efforts.

9. Establish special budgetary account to allow implementation of these recommendations and the continuation of the toxicological research effort now underway and continuing until June, 1971.

BASIS FOR RECOMMENDATIONS

1. Notification of All Customers

Feb.

On ~~September~~ 24, 1969 the San Francisco Chronicle published a "scare" story following an interview with Dr. Robert Risebrough of the University of California. The latter had recently published in Nature the finding of polychlorinated biphenyls in fish, birds and eggs in the California coastal areas.

On March 3, 1969, the Functional Fluids group sent a letter to the 31 major Aroclor customers in the transformer and capacitor applications. The letter included a copy of the Chronicle story and a Monsanto statement concerning the situation. This was intended to announce to these customers that the polychlorinated biphenyls might be in trouble and implied that the customers should make every effort to prevent loss of these materials to the environment. There has been subsequently some follow-up with at least General Electric and Westinghouse.

It has been recognized from the beginning that other functional fluid uses could lead to losses of the Aroclors to liquid waste streams from the customers' plants. Losses could occur from spills, unusual leakage of large volumes and daily losses of smaller volumes.

It has also been recognized that there could be vapor losses but it has been felt that these were perhaps of less significance than the vapor losses in plasticizer applications. The concern for vapor losses rises from the published proposed theory that even minute quantities of vapors are eventually transferred to the water environment and accumulated therein.

Another possible source of air environmental contamination is the eventual destruction of materials which have Aroclors in them. Of particular significance might be the burning or partial incineration of waste or used products containing the Aroclors.

BASIS FOR RECOMMENDATIONS (Continued)

As the alarm concerning the contamination of the environment grows it is almost certain that a number of our customers or their products will be incriminated. The company could be considered derelict, morally if not legally, if it fails to notify all customers of the potential implication.

A case in point is the recent determination (mid-sept. ~~August~~) that milk to be marketed by the Maryland Cooperative Milk Producers, Inc. in Baltimore was contaminated with polychlorinated biphenyls. The source of the PCB's was isolated to six dairy herds in Martinsburg, West Virginia. Investigation by the Producers Association is continuing but to our knowledge the specific source of the PCB has not been pin-pointed.

When the Aroclors were indited as causing poisoning in cattle in the mid-1950's, chlorinated naphthalenes were eventually identified as the causative agent. The naphthalenes were used in greases or lubricants for cattle feed machinery and had contaminated the animal food. (Members of the Medical Department have been told that the Texas company "bought" 6,000 head of cattle around the country as a result of this incident. It is not known whether or not the suppliers of the naphthalenes to Texaco were brought into the settlement.) Are our customers selling grease or lubricants containing Aroclors that are now responsible for the milk contamination?

In the plasticizer use area, the Aroclors may be used in rubber based paints or surface coatings. The uses for these surface coatings include the interior walls of potable water supply storage tanks in some communities. In Europe we have been told that similar paints are widely used for swimming pools. In spite of the low degree of solubility of the PCB's in water, there are sentiments among the European scientists (and our PCB competitive manufacturers) that such uses may be sources of pollution.

Other customer applications or uses which could be suspect include highway marking paints, ~~and~~ any of the oil and/or grease lubricant applications, caulking compounds + sealants,

BASIS FOR RECOMMENDATIONS (Continued)

2. Consultation with Federal Agencies

In August of 1968 when the current effort related to this problem got underway, the scientists at the U. S. Department of Interior, Fish and Wildlife Laboratories at Paturent, Maryland were visited. In the six to twelve months that the laboratory had been looking for PCB residues, they had identified such compounds in dead eagles as well as marine birds. At that time they did not report positive findings in fish, shell fish or other marine organisms. We know that their efforts have been continuing at an accelerated rate but the laboratory has not been revisited to learn of current developments.

The U. S. Food and Drug Administration in Washington called Dr. Kelly in June to report that the State of Georgia had found PCB's in milk (we had in April supplied samples of our Aroclors to the Georgia State Department of Agriculture Laboratories in Atlanta).

The analyses of milk from the Maryland co-op mentioned in 1. above were performed by an FDA laboratory.

On Friday, September 26, we were asked to send samples to the Atlanta Toxicological Branch of the FDA and to the Residue Chemical Branch Division of Pesticides, FDA in Washington. The stated reason for the request was for these laboratories to determine the "acute toxicity" of Aroclors 1254 and 1260.

In the past year we have had request for samples from five or six of the regional laboratories of the Federal Water Pollution Control Administration-- an agency within the U. S. Department of Interior. We have not had an opportunity to follow-up with these laboratories as to their interest or concern.

In August a laboratory of the Bureau of Commercial Fisheries, Department of Interior, at Pensacola, Florida, reported finding PCB's in the river below our Pensacola Plant. Subsequently, they reported that 5 parts per billion of Aroclor 1254 killed baby shrimp in 18 days. There has been no follow-up by St. Louis based personnel since our Pensacola Plant discontinued the use of Pydraul AC.

BASIS FOR RECOMMENDATIONS (Continued)

Appropriate individuals in the parent federal agencies should be visited to determine their current activities and concern and, secondly to make these agencies aware of Monsanto's interest, research and control efforts.

3. Contact with other Governmental and University Laboratories

In addition to the above, Monsanto has provided samples of the Aroclors to 30 or 40 other governmental and university laboratories or scientists. It would be prudent and appropriate for someone from Monsanto to personally follow-up the supplying of the samples and determine the status of the efforts of these groups. For example, the State Department of Agriculture Laboratory in Hartford, Connecticut reported in July that they had found PCB in fish off the coast of Connecticut. This led to two articles in the Hartford Times and a five minute radio program through a syndicated outlet of 108 radio stations.

4. Losses from Monsanto Plants

Efforts to reduce the losses of Aroclors in liquid wastes from the Anniston and WGK Plants are completed or underway. It is impossible to establish a limit as to what can be discharged "safely". Investigation has shown that the waters in receiving streams below the Anniston Plant contain significant (parts per million) concentrations of PCB. More ominous perhaps is the fact that sediment in the bottom of these streams miles below our plants may contain up to 2% Aroclor.

To prepare for the eventual publication in the press of the discharge of PCB's in Alabama and to the Mississippi River, a significant effort must be made to determine the present levels of contamination and more importantly, determine the levels of contamination as "clean up" procedures begin to show an effect.

The incident at the Monsanto Plant at Pensacola indicates that all Monsanto Plants using Aroclors should be made aware of the potential problem and efforts made to eliminate any losses. The significance of "any losses" may be related to the one to three gallons per day which was being lost at the Pensacola Plant.

BASIS FOR RECOMMENDATIONS (Continued)

Hopefully research efforts will indicate that a "safe level" of losses would be higher in fresh water streams not adjacent to coastal estuaries. At the present time we know of no claims that the PCB's are "destroying" fish.

5. Atmospheric Losses at Anniston and WGK

The determination of atmospheric losses for our Aroclor manufacturing plants will be more tedious and time consuming than in the case of liquid wastes. We will never be prepared to discuss intelligently potential problems of our customers where there may be atmospheric losses until we have some data on our own plants. This is particularly true if we ever expect to recommend to our customers measures for control of atmospheric losses.

6. Analytical Capabilities (a. through e. inclusive)

In each of the recommendations 2. through 5. above, there is the implication that Monsanto's best interest could be served by appropriate sampling and analysis. In connection with any of the governmental and other laboratories, we must accept their reported analytical results or in specific instances offer to run duplicate analyses to confirm for ourselves the validity of the reported results.

The committee agrees that to perform analyses that would confirm all of the reported findings represents an unreasonable cost in terms of personnel and facilities. At the same time there appears to be no alternative to the acceptance in the last three months that confirmation analysis in selected cases should be done. This has led to an accumulation of a backlog of samples which need attention. Delays in analysis are occurring because of shifting priorities for samples as they are received or as they have been retained.

A case in point is the delay in analyzing thirteen samples from the Inorganic Division. Samples were submitted following the finding that five of five commercially available electric dishwashing compounds analyzed showed the presence of PCB's. The Inorganic Division can not exonerate the products it sells to the detergent manufacturers until it has some data showing whether or not Monsanto supplied materials are contaminated. In the meantime Inorganic Division Quality Control has

BASIS FOR RECOMMENDATIONS (Continued)

suggested to its Division Engineering that future designs for making detergent components insure that the use of Aroclors will not permit contamination. Secondly, it is obvious that the Division cannot approach its detergent manufacturing customers about their potential problem until the above data indicate that "our own skirts are clean".

This week it was agreed that milk and water samples from the Maryland co-op in Baltimore should take precedence over other samples which had been scheduled.

In summary, the committee believes there will be a growing number of samples from the following:

a. Environment of Anniston and WGK Plants.
b. Monsanto products where contamination is possible.
c. Agencies and/or laboratories attempting to pin-point specific sources of contamination.
d. Customer plants' environment.
e. Research efforts involved in biological studies--i.e. animal, bird and fish toxicity studies and biodegradation studies.

7. Expansion of Analytical Capabilities

The recommendation to expand the analytical capabilities is a necessity in view of the preceding recommendations.

8. Assignment of Full-Time Effort

Up to this time the coordination of the Division effort has been principally the responsibility of W. R. Richard and E. P. Wheeler with support from R. E. Keller and Cumming Paton. Each of these individuals has other responsibilities to the extent that, although the Aroclor problem may have been a predominant issue, other areas of interest could not be slighted.

The committee believes that the problem is of sufficient seriousness to warrant the full concentration of at least one individual for the next three to six months. Those who have been involved up to this point would obviously continue in their

BASIS FOR RECOMMENDATION (Continued)

supporting efforts where the individual's background or expertise would make it appropriate. For example in connection with the follow-up with the federal agencies in Washington, Dr. Kelly would expect to be present for any contact with USFDA officials.

Other members of the Medical Department would be made available for contacts with the pollution control agencies or those laboratories or universities where toxicity appears to be of interest or concern.

Certainly Dr. Keller and Scott Tucker should accompany anyone making visits where the specific question of analytical techniques was to be discussed.

This still leaves a number of man months to be devoted to the other laboratories or agencies which have up to this point not made their specific interest known.

Equally if not more important is the effort which must be made relating to the contacts with customers. The committee does not believe that this can be handled by district marketing representatives without supplying such "local" individuals with a complete background of the problem.

9. Budgetary Considerations

The committee recognizes the restrictions placed on those currently involved by mandates to operate within normal or proposed reduced budgets. It should be clear, however, that the product groups, the Division and the Corporation are faced with an extraordinary situation. There can not be too much emphasis given to the threat of curtailment or outright discontinuance of the manufacture and sales of this very profitable series of compounds. If the products, the Division and the Corporation are to be adequately protected, adequate funding is necessary.

EXHIBIT L

(MONS 100123-100124)

to

PLAINTIFFS' ORIGINAL COMPLAINT

TOWN OF WESTPORT and WESTPORT COMMUNITY SCHOOLS, Plaintiffs

v.

MONSANTO COMPANY, SOLUTIA INC. and PHARMACIA CORPORATION, Defendants

Filed in the United States District Court,
District of Massachusetts, on
May 7, 2014

Monsanto

FROM (NAME & LOCATION) N. T. Johnson St. Louis

DATE February 16, 1970

SUBJECT

REFERENCE POLLUTION LETTER

TO

P. Craska - Wilmington
C. Clay - St. Louis
J. H. Davidson - Los Angeles
R. A. Damiani - Chicago
G. F. Fague - Detroit
R. A. Garcia - Akron
R. Garnsworthy - Melbourne
J. A. Heilala - Akron
R. Irwin - Houston
J. S. Pullman - New York
J. J. Roder - Chicago
R. Giles - Melbourne

cc: P. J. A. Marsh - Brussels
R. Enrhardt - New York
T. W. Oneson - Montreal
J. N. Haggart - Brussels
V. Morse - St. Louis
J. Brydon - Montreal
R. Graham - New York
P. G. Benignus
J. G. Bryant
D. E. Roush
J. R. Fallon
D. A. Hall
D. R. Pogue
D. F. Smith
D. A. Olson

Attached is a list of questions and answers which may be asked of you by customers receiving our Aroclor-PCB letter. You can give verbal answers; no answers should be given in writing. If the customer asks a question you can't answer or if he wants an answer in writing, then send his questions to me and we will answer from here.

We want to avoid any situation where a customer wants to return fluid. The new reformulated products will be available within a month. We would prefer that the customer use up his current inventory and purchase Pydraul 625A, Pydraul ACA, Pydraul ACA Winter Grade and Pydraul 540A when available. He will then top off with the new fluid and eventually all Aroclor 1254 and Aroclor 1260 will be out of his system. We don't want to take fluid back. Sell him the replacement.

We must be very positive in our approach with each customer relative to our decision to eliminate the use of Aroclor 1254 and Aroclor 1260 in our Pydraul products. We (your customer and Monsanto) are not interested in using a product which may present a problem to our environment. We certainly have no reason to be defensive or apologetic about making this change. The decision to change makes good sense and our customers should commend us, not criticize our actions. No one has forced us to make this

PLAINTIFFS EXHIBIT

2002

change. We have done it to keep our customers out of possible trouble. They should appreciate our effort, and stay with us as a customer on the reformulated Pydrauls. To make this change has cost us research monies and time. Fortunately, we possess the technical skills to make a change in our formulations without affecting the performance of products. Be positive, Take the offense. Don't let a customer or competitor intimidate you. I doubt if our competitors know whether their product could present a problem to our environment. You might ask your customer, if he has ever asked Houghton or Stauffer, Carbine, etc. about the effects of their products.

We should also recognize (point this out to your customer) we must clean-up. The Chemical Week article gives him an idea of laws in effect in his state. Read this yourself. Be familiar with the data on each state in which your customers are located. Use this in your discussions.

We have no replacement products for Aroclor 1254 and Aroclor 1260. We will continue to make these products; however, customers will have to use their own judgement on continued use.

We can't afford to lose one dollar of business. Our attitude in discussing this subject with our customer will be the deciding factor in our success or failure in retaining all our present business. Good luck.

(We have also attached a copy of the letter sent to transformer customers.)

N. T. Johnson

lb

DJ-14

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TOWN OF WESTPORT, and	)	
WESTPORT COMMUNITY SCHOOLS,	)	
Plaintiffs,	)	C.A. No. 14-CV-12041
v.	)	
	)	
MONSANTO COMPANY, SOLUTIA INC., and	)	
PHARMACIA CORPORATION	)	
Defendants.	)	

MEMORANDUM OF LAW IN SUPPORT OF DEFENDANTS' MOTION FOR SUMMARY JUDGMENT

Defendants Monsanto Company, Solutia Inc., and Pharmacia Corporation (collectively "Pharmacia") seek the dismissal of this action. This is a products liability action brought by the Town of Westport and Westport Community Schools ("Westport" or "Plaintiffs") for alleged property damage due to the volatilization of polychlorinated biphenyls ("PCBs") from building materials, such as caulk, used in the construction of the Westport Middle School ("WMS") in 1969. In its pending *Daubert* motions, Pharmacia challenges the admissibility of Plaintiffs' experts' opinions on liability, injury, and damages, any of which, if granted, mandates the entry of summary judgment in Pharmacia's favor.[1] Even with Plaintiffs' experts, however, Plaintiffs have failed, as a matter of law, to establish a *prima facie* claim. Indeed, Plaintiffs' own experts' admissions mandate the entry of judgment in Pharmacia's favor.

STATEMENT OF THE CASE

A. Factual Background

Pharmacia incorporates by reference herein its concurrently-filed Statement of Material Facts.

[1]There is no dispute that, given the chemical complexity of PCBs, Plaintiffs cannot establish their claims absent competent expert testimony. *See, e.g., Town of Lexington v. Pharmacia Corp.*, 133 F. Supp. 3d 258, 266 (D. Mass. 2015) (rejecting product liability claims involving PCBs not supported by expert opinion).

B. Procedural History

Westport brought this suit in May 2014 alleging property damage due to the presence of PCBs in the WMS. Westport pled claims for breach of implied warranty for defective design (Count I); breach of implied warranty for failure to warn (Count II); negligence (Count III); public nuisance (Count IV); private nuisance (Count V); trespass (Count VI); and violation of the Massachusetts Oil and Hazardous Material Release Prevention and Response Act (Count VII). Upon Pharmacia's motion to dismiss, the Court dismissed Plaintiffs' counts for public nuisance (Count IV); private nuisance (Count V); trespass (Count VI); and violation of the Massachusetts Oil and Hazardous Material Release Prevention and Response Act (Count VII). *See* D.Ct. (Mar. 24, 2015) Order (Doc. 44). Plaintiffs filed an Amended Compliant with leave of Court limited to breach of warranty and negligence in May 2016. (Doc. 119). Pharmacia now moves for summary judgment on Westport's remaining claims.

STANDARD FOR SUMMARY JUDGMENT

"The court shall grant summary judgment if the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(a). The moving party need only show that there is an absence of evidence to support the non-moving party's case in order to prevail on summary judgment. *Cellco Partnership v. Town of Grafton*, 366 F. Supp. 2d. 71, 82 (D. Mass. 2004). The non-moving party "must, with respect to each issue on which she would bear the burden of proof at trial, demonstrate that a trier of fact could reasonably resolve that issue in her favor." *Borges v. Serrano-Isern*, 605 F.3d 1, 5 (1st Cir. 2010). Where, as here, the plaintiff fails to establish a *prima facie* claim or where the plaintiff's own admissions negate an essential element of its claim, summary judgment is warranted. *See Carmona v. Toledo*, 215 F.3d 124, 133 (1st Cir. 2000) (citing *Celotex Corp. v. Catrett*, 477 U.S. 317, 325 (1986)).

ARGUMENT

I. WESTPORT FAILED, AS A MATTER OF LAW, TO ESTABLISH A BREACH OF WARRANTY

To establish its breach of warranty claims, Westport must prove that PCBs were unreasonably dangerous at the time they left Pharmacia's hands. *Alves v. Mazda Motor of Am., Inc.*, 448 F. Supp. 2d 285, 300 (D. Mass. 2006) (requiring proof that "a defect or unreasonably dangerous condition existed at the time the product left the defendant's hands so that it was not reasonably suitable for the ordinary uses for which goods of that kind were sold") (quoting *Lally v. Volkswagen Aktiengesellschaft*, 45 Mass. App. Ct. 317, 337 (1998)). A product may be defective because of a defective design or inadequate warnings. *Evans v. Lorillard Tobacco Co.*, 465 Mass. 411, 422 (2012). Westport has failed, as a matter of law, to establish breach of warranty for either a defective design or failure to warn.

A. Westport Failed to Establish a Breach of Warranty for Design Defect

A product is not unreasonably dangerous simply because it is capable of causing harm. *Kotler v. American Tobacco Co.*, 926 F.2d 1217, 1225 (1st Cir. Mass. 1990). For a design defect claim, the adequacy of a product's design is measured by "the gravity of the danger posed by the challenged design, the likelihood that such danger would occur, the mechanical feasibility of a safer alternative design, the financial cost of an improved design, and the adverse consequences to the product and to the consumer that would result from an alternative design." *Back v. Wickes Corp.*, 375 Mass. 633, 642 (1978). The safety of the product is measured at the time it leaves the manufacturer's hands. *Kearney v. Philip Morris, Inc.*, 916 F. Supp. 2d 61, 64 (D. Mass. 1996). Westport cannot establish its design defect claim because there is no alternative design for PCBs and, alternatively, the risk of PCBs volatilizing from window caulk into the air at WMS at concentrations capable of causing human disease was neither reasonably foreseeable nor reasonably discoverable in 1969, when the WMS was constructed, or today.

1. No Alternative Design Existed for PCBs

Massachusetts law does not permit categorical product liability against an entire class of products. *Evans*, 465 Mass. at 431 n. 11 ("our case law does not permit a jury to impose categorical product liability on all cigarettes"). A plaintiff cannot, therefore, maintain a claim for product defect simply by asserting that the kind of product, or category of product, should never have been manufactured. *Id.* "To establish a prima facie case of defect, the plaintiff must prove the availability of a technologically feasible and practical alternative design that would have reduced or prevented the plaintiff's harm." *Id.* at 429. The reasonable alternative design must be the same product as the allegedly defective product. *Id.* at 431 ("in a case where the allegedly defective product is a cigarette, the reasonable alternative design must also be a cigarette."). Westport lacks evidence that PCBs could be redesigned. "PCBs cannot be PCBs without the presence of PCBs themselves, along with their inherent characteristics." *Town of Lexington v. Pharmacia Corp.*, 133 F. Supp. 3d 258, 270 (D. Mass. 2015). Because Westport can point to no aspect of Pharmacia's design of PCBs, other than the PCBs themselves, as "defective," it cannot establish a claim for defective design as a matter of law. *See, e.g., id.*

2. The Alleged Harm Was Unforeseeable in 1969

Even if Westport could establish a reasonable alternative design, it cannot establish that the alleged harm at issue in this case was reasonably foreseeable in 1969.

The manufacturer's duty is limited to avoiding the reasonably foreseeable risks attending the product's use in the setting in which it is intended to be used. *Back*, 375 Mass. at 640-41. The fitness of a product is, therefore, gauged by whether the specific risk of harm at issue was reasonably foreseeable at the time the product was sold. *See Lexington*, 133 F. Supp. 3d at 269. Plaintiffs must, therefore, establish that, in 1969, it was reasonably foreseeable that PCBs, used as a component in caulk, would volatilize from the caulk into indoor air at levels capable of causing human disease. *See, e.g., id.* ("the specific risk at issue is the presence of PCBs in caulk and the resulting presence of PCBs in the indoor air of a building").

Plaintiffs' own experts admit that it was not foreseeable in 1969, or today, that PCBs at the levels detected at the WMS were capable of causing human disease. Plaintiffs' toxicologist, Dr. Olson, repeatedly declined to state at his deposition that PCBs cause any human disease. Olson Dep. at 48, 50, 61 (SOF¶35)[2]. Plaintiffs' experts, in fact, concede that there were no scientific studies in 1969, or even today, that purport to demonstrate: (1) that PCBs volatilizing from building products such as caulk cause human disease and (2) that PCBs at levels found at the WMS cause human disease. Olson Dep. at 54-55, 104-05, 245 (SOF¶¶28,29); Herrick Dep. at 151 & 152 (SOF¶¶31); Matson Dep. at 122, 201, 332 (SOF¶¶28,29,30). It was not until after 2000 that the first scientific chamber test of PCB-volatilization from caulk took place. Matson Dep. at 188 (SOF¶36). A product manufacturer cannot be found liable because it failed to foresee a risk of harm that to this day has not been scientifically established. *See Back*, 375 Mass. at 640-41.

3. The Alleged Harm Was Not Reasonably Discoverable in 1969

Westport, likewise, failed to establish that the alleged harm at issue in this case was reasonably discoverable through reasonable testing in 1969. First, there was no legal requirement, government or industry standard, or recommendation from any source that required long-term toxicology tests for low-level chronic PCB exposures prior to its sale in 1969. Olson Dep. at 121-22, 143, 229-31, 234-35 (SOF¶33). Nor was there any requirement for a manufacturer of a component part, such as Pharmacia, to test the volatilization of PCBs from another manufacturer's consumer end product. *See* Wood Report at 11-14 (SOF¶37). If, however, Pharmacia had performed tests using PCB levels found at the WMS, Westport's

[2]"SOF¶" refers to the corresponding paragraph in Defendants' Statement of Material Facts.

toxicologist, Dr. Olson, admits that it would not have found anything, Olson Dep. at 245 (SOF¶32), which renders any failure to test irrelevant. *Mason v. General Motors Corp.*, 397 Mass. 183, 192 (1986) (failure to test not relevant absent showing that testing would have provided useful information). Further, as discussed above, an alleged risk cannot be said to have been reasonably discoverable in 1969 when it has not been scientifically established 48 years later.

B. Westport Failed to Establish a Breach of Warranty for Failure to Warn

Plaintiffs failed, as a matter of law, to establish a failure-to-warn claim because: (1) no duty to warn of the alleged harm at issue existed at the time of sale; (2) assuming it did have a duty to warn, Pharmacia discharged its duty under the bulk supplier doctrine; and (3) no post-sale duty required Pharmacia to warn the universe of end users of PCB-containing building products.

1. The Alleged Harm Was Not Reasonably Foreseeable/Discoverable in 1969

For the reasons discussed above, Plaintiffs failed to establish that the alleged harm at issue in this case was reasonably foreseeable or reasonably discoverable in 1969. To establish a failure-to-warn claim, the plaintiff must establish that the product is unreasonably dangerous because foreseeable users were not adequately warned of the foreseeable risks of harm associated with its use. *Evans*, 465 Mass. at 439. Massachusetts has rejected any hindsight analysis of the duty to warn. *Vassallo v. Baxter Healthcare Corp.*, 428 Mass. 1, 23 (1998). The manufacturer's duty is limited to warning of dangers that were reasonably foreseeable at the time of sale, or could have been discovered by way of reasonable testing prior to marketing the product. *Id.* at 22-23. The failure to warn under breach of warranty is judged by the reasonableness of the defendant's actions under the circumstances. *Hoffman v. Houghton Chem.*

Corp., 434 Mass. 624, 637 (2001). Because the alleged harm at issue in this case was not reasonably foreseeable or discoverable in 1969, no duty to warn of the alleged risk arose as a matter of law.

2. Pharmacia Discharged Its Duty to Warn by Relying on Its Customers

To the extent, if any, that Pharmacia had a duty to warn end users of risks associated with PCBs in 1969, Pharmacia discharged its duty by reasonable reliance on its customers, pursuant to the bulk supplier doctrine. *Hoffman*, 434 Mass at 637.

The bulk supplier doctrine applies where: (1) the product is delivered in bulk to an intermediary vendee; (2) the supplier gave adequate and sufficient warning about the product to the intermediary; and (3) the supplier reasonably relied on the intermediary to warn the ultimate end users of the products. *Id.* The Supreme Judicial Court recognizes that, as a practical matter, where bulk product is delivered in tank trucks, box cars, or large industrial drums to the intermediary, who generally repackages or reformulates the product, any warning label that could be provided would be unlikely to reach the end user. *Id.* at 633. In contrast, the Court recognizes that "the intermediary vendee, particularly the large industrial company, has its own independent obligation to provide adequate safety measures for its end users, an obligation on which bulk suppliers should be entitled to rely." *Id.*

In this case, there is no question that Pharmacia sold its PCBs in bulk, gave adequate and sufficient warning to its customers, and had no reason to anticipate any failure on the part of its customers to pass knowledge of the product along to the end users.

Pharmacia sold PCBs in bulk (1) to distributors, who would then resell the PCBs to formulators, and (2) to formulators, who would resell PCB-containing products to distributors, who might sell the products to general contractors, who resold the caulk to contractors, builders, and architects, and who then ultimately resold the caulk to the end user. Kaley (04/05/16) Dep. at 54, 60-61, 72, 196-199 (SOF¶¶13,18).

It was common knowledge in the industry that plasticizers used in plastics will volatilize from the end product. Dorman Dep. at 98-100 (SOF¶15); Matson Dep. at 318-19 (SOF¶21). Pharmacia supplied its customers with Aroclor product bulletins and warning labels, which contained then-known toxicological information regarding exposures to PCBs and information on their safe handling. October 11, 1937 Warning (SOF¶23). For example, Pharmacia's warnings notified customers about the risk of systemic injuries such as liver damage. *See* warnings cited at SOF¶24. These bulletins also included physical and chemical characteristics for Aroclor, and environmental hazards. *See* warnings cited at SOF¶¶23,27; Letter from Monsanto Company to Customer (February 27, 1970) (SOF¶26).

The caulk formulations were proprietary to the caulk manufacturers; the formulators, not Pharmacia, made the final decisions as to which chemicals and plasticizers would be included. Matson Dep. at 28, 58-60, 154, 156, 318-19 (SOF¶¶14,19). Because the rate at which PCBs volatilized from caulks depended on many factors, including the selection and quantities of other chemicals used and the end-use conditions, Matson Dep. at 188, 326-28 (SOF¶¶16,17); Matson Report at 11 (SOF¶16); Dorman Dep. at 89-92 (SOF¶16), it would have been impossible for Pharmacia to predict the rate of volatilization of PCBs from caulk that had been used in a building, such as WMS, unknown and unknowable to Pharmacia. *See* Matson Report at 11 (SOF¶17). Consequently, in its communications with customers, Pharmacia encouraged them to provide similar toxicological, environmental, and safe handling information to their customers' customers. Letter from Monsanto Company to Customer (February 27, 1970) (SOF¶26).

Westport cannot prove that the provision of additional information regarding volatility would have influenced the manufacturer's use or rejection of PCBs as plasticizers. *Calisi v. Abbott Labs.*, 2013 U.S. Dist. LEXIS 139257, *38-41 (D. Mass. Sep. 27, 2013). As Dr. Matson, Westport's designated state-of-the-art expert, admits, "we can't reconstruct what was in the minds of plasticizer purchasers back in [the] 1950s." Matson Dep. at 310-11 (SOF¶21).

The uncontroverted evidence, therefore, establishes that Pharmacia discharged its duty to warn by providing legally sufficient warnings to its own customers. Because Plaintiffs have proffered no evidence that creates any genuine issue of material fact regarding Pharmacia's discharge of its duty to warn under the bulk supplier doctrine, Pharmacia is entitled to summary judgment on Plaintiffs' failure-to-warn claims.

3. No Post-Sale Duty to Warn Existed

Plaintiffs vaguely plead that, had Pharmacia provided post-sale warnings regarding the presence of PCB-containing caulk in buildings nationwide, "Plaintiffs . . . would have taken steps to ensure that PCB-Aroclors were treated differently to prevent potential exposure," Am'd Compl., ¶¶ 120-21 (Doc. 119). Plaintiffs cannot establish, however, that any post-sale duty to warn Westport existed. Nor do Plaintiffs proffer any expert testimony establishing how any breach of a post-sale duty to warn caused harm.

Although Massachusetts recognizes a post-sale duty to warn, it is limited to warnings supplied to direct purchasers. *Vassallo*, 428 Mass. at 23. Even if a post-sale duty to warn extended to end users, the duty to warn is limited to those who can be identified. *Lewis v. Ariens Co.*, 434 Mass. 643, 648 (2001) ("a seller's inability to identify those for whom warnings would be useful 'may properly prevent a post-sale duty to warn from arising.'") (citation omitted). The Supreme Judicial Court has cautioned that "the costs of identifying and communicating with product users years after sale are often daunting," and "in light of the serious potential for overburdening sellers in this regard, the court should carefully examine the circumstances for and against imposing a duty to provide a post-sale warning in a particular case." *Id.* In *Lewis*, the Supreme Judicial Court, therefore, rejected a claim that a manufacturer had a post-sale duty to warn a remote purchaser of a retail product because "he is a 'member of a universe too diffuse and too large for manufacturers or sellers of original equipment to identify.'" *Id.*

No post-sale duty to warn Westport existed. As previously-discussed, before Pharmacia's product reached the end user, it traveled a complex supply chain from a bulk sale to distributors or formulators, back to distributors or to general contractors in caulk, then to contractors, builders, and architects, who then resold the caulk to the end user. Kaley (04/05/16) Dep. at 54, 60-61, 72, 196-99 (SOF¶¶13,18). Westport cannot prove that it was identifiable to Pharmacia more than 40 years after the sale of PCBs to a third-party distributor or manufacturer. Rather, Westport is a "member of a universe too diffuse and too large" for the manufacturer of raw materials to identify. *Lewis,* 434 Mass. at 648.

As for its claimed harm, Westport, further, has proffered no expert testimony regarding the nature of the post-sale warning Pharmacia allegedly should have provided to it or the steps Westport allegedly might have taken to "treat PCB-Aroclors differently" to prevent potential exposure.

II. WESTPORT FAILED, AS A MATTER OF LAW, TO ESTABLISH NEGLIGENCE

Westport's negligence claims fail for the same reasons as its breach of warranty claims for design defect and failure to warn. Because a defendant cannot be found negligent without having breached the implied warranty of merchantability, *Evans*, 465 Mass. at 444, Plaintiffs' failure to establish a breach of warranty precludes a finding of negligence, *Hayes v. Ariens Co.*, 391 Mass. 407, 410 (1984).[3] For the previously discussed reasons that Plaintiffs failed, as a matter of law, to establish a breach of warranty claim, Plaintiffs thus failed, as matter of law, to establish a negligence claim.

III. WESTPORT FAILED, AS A MATTER OF LAW, TO ESTABLISH A COMPENSABLE INJURY

Westport has failed, as a matter of law, to establish a compensable injury as required to prove liability under any theory. A multitude of deferred maintenance problems unrelated to PCBs plagued the WMS that would have required over $19 million in repair costs. There may well have been good and valid reasons that required Westport to abandon the building, but PCBs was not one of them. PCBs did not render WMS unsafe for human occupancy. Because Westport has failed to establish that PCBs caused a compensable injury, Westport failed, as a matter of law, to establish a valid cause of action under any theory.

A. Westport Failed to Meet Its Burden of Establishing PCBs Rendered WMS Unsafe for Human Occupancy

To succeed on a claim for product defect in a tort action, the plaintiff must establish that the defect caused a compensable injury. *See Alves*, 448 F. Supp. 2d at 299-300 (citing *Smith v. Ariens Co.*, 375 Mass. 620, 624, 377 N.E.2d 954 (1978) (requiring proof that negligent design caused injury) and *Lally v. Volkswagen Aktiengesellschaft*, 45 Mass. App. Ct. 317, 337 (1998) (requiring proof that unreasonably defective condition was a legal cause of injury)).

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[3]A negligent design claim is measured by the same factors as the breach of warranty inquiry for defective design. *Kotler*, 926 F.2d at 1225; *Evans v. Lorillard Tobacco Co.*, 465 Mass. 411, 443-44 (2012)) ("In claims alleging negligence in the design of a product, as with claims of a design defect in breach of the implied warranty of merchantability, the plaintiff must show 'an available design modification which would reduce the risk without undue cost or interference with the performance of the product,' and the jury must consider whether a safer alternative design was available in deciding whether the defendant was negligent for failing to adopt that design.") (citations omitted). "In a design defect case premised on negligence, the existence of a safer alternative design is a *sine qua non* for the imposition of liability." *Id*. Likewise, a failure to warn under negligence and breach of warranty theories are judged by the same standard: the reasonableness of the defendant's actions in the circumstances. *Hoffman*, 434 Mass. at 637; *Calisi v. Abbott Labs.*, 2013 U.S. Dist. Lexis 139257, *46 (D. Mass. Sept. 27, 2013) ("The Supreme Judicial Court has effectively collapsed the two standards for negligence and breach of warranty where the plaintiff's allegations are based upon a failure to warn . . . ."); *Hoffman*, 434 Mass at 637 (the bulk supplier doctrine permits a manufacturer/supplier to discharge its duty to warn end users by reasonable reliance on an intermediary as a defense to negligence).

Recovery is not available where the defect that made the product unfit caused no compensable injury to the claimant. *See, e.g., Rule v. Fort Dodge Animal Health, Inc.*, 607 F.3d 250, 252 (1st Cir. 2010). In *Rule*, where the plaintiff's dog ingested a defective drug, the plaintiff's failure to establish that the product defect caused harm to the dog defeated any right to recovery in tort. In other words, "while the sale to [the plaintiff] may have been of an unfit drug, its unfitness did not give rise to any injury to [the plaintiff] against which the warranty was designed to guard." *Id.* at 252.

The claimant in a toxic tort property damage case must, like the personal injury claimant, establish a compensable injury. *See Milward v. Rust-Oleum Corp.*, 820 F.3d 469, 471 (1st Cir. 2016) (involving product liability claim under Massachusetts law for occupational exposure to benzene). Like the personal injury plaintiff, the property damage claimant bears the burden of proving not only that exposure to a toxic substance is capable of causing adverse human health conditions, but that the level of the toxic substance on the plaintiff's property is capable of causing adverse human health conditions. *See, e.g., Berish v. Bornstein*, 2006 Mass. Super. Lexis 330 (May 22, 2006), *aff'd*, 2007 Mass. App. Unpub. Lexis 626 (Mass. App. Ct. Dec. 28, 2007) (Rule 1:28 memorandum) (rejecting property damage claim for mold due to lack of proof of harmful levels of mold growth) (Exhibit A); *Gleason v. Town of Bolton*, 2002 Mass. Super. Lexis 208 (Mass. Super. Ct. May 23, 2002) (rejecting property damage claim for well water contamination due to lack of proof of harmful levels of contamination).

In *Berish*, condominium owners filed a negligence action against the developer for mold growth and the risk of decay due to improper bathroom and attic ventilation. Despite finding mold growth, the Court found that the mold growth was not unsafe:

> [T]he Trustees claim that the lack of a proper ventilation system caused and promoted mold growth. Although this may be true, and the evidence certainly

> would reflect that there was a certain amount of mold growth, this Court finds that ***the mold growth was insignificant as it related to the health and safety of the occupants*** and was not the cause of any sickness by those who occupied any of the units within the condominium.

Berish, 2006 Mass. Super. Lexis 330 at *15 (emphasis added). The Court, therefore, rejected the negligence claim due to the lack injury to the property, explaining that "the mere possibility of future personal injury or property damage is insufficient property damage to avoid the economic loss doctrine and permit recovery in negligence." *Id.* at *64. The Court, thus, dismissed the plaintiffs' negligence claims for failure to prove actual property damage. *Id.* at *63-*65.

In *Gleason*, a restaurant owner brought a negligence action alleging contamination of its water supply with methyl tert-butyl ether ("MTBE") due to the release of gasoline from the town's underground storage tanks. *Gleason*, 2002 Mass. Super. Lexis 208 at *2-*3. The town conceded that MTBE was present in the plaintiff's water, but argued that the levels were not sufficient to establish legal injury. *Id.* at *8. In reaching its decision, the Court recognized that "the question of contamination is not at issue. Rather, the issue is whether the plaintiff suffered any damage as a result of the contamination." *Id*. at *8-*9. The Court rejected the plaintiff's claim finding "***no evidence of physical harm to the plaintiff's property or of personal injury***." *Id.* at *9 (emphasis added).

Pursuant to *Berish* and *Gleason*, proof of a compensable injury is not a question of mere contamination, but "whether the plaintiff suffered any property damage as a result of the contamination," *Gleason*, 2002 Mass. Super. Lexis 208 at *9. Accordingly, Westport bears the burden of proving, not only that PCBs cause human disease, but that the levels of PCBs in the WMS do, in fact, cause human disease.

Plaintiffs offer no expert testimony that PCBs cause human disease generally or that PCBs at the levels found at the WMS cause human disease. *See* Argument I-A, *supra*. Absent competent expert testimony that the alleged "unfitness" of PCBs rendered the WMS unsafe for human occupancy, Westport cannot meet its burden of proving a compensable injury in this action. *See, e.g.*, *Rule*, 607 F.3d at 252 (rejecting property damage claim where the plaintiff's dog ingested an unfit product but the unfitness of the product caused the dog no injury). In other words, Plaintiffs failed to establish injury because "the [alleged] defect that made the product unfit caused no injury to the claimant." *Id.*

B. Plaintiffs Rely on a Non-Cognizable Theory of Injury to Property

Because Plaintiffs cannot meet their burden of proving that PCBs rendered WMS unsafe for human occupancy, Plaintiffs seek to avoid proving property damage all together.[4] Instead, Plaintiffs cobble together the untenable theory that the mere presence of PCBs at WMS "*below the level shown to cause disease*" constituted "*enough of a hazard*" that Westport was "*reasonable in deciding*" to remediate PCBs.[5] Admittedly short of proof of actual harm, Plaintiffs' theory distills to nothing but a non-cognizable fear of injury.

1. Plaintiffs' "Reasonableness" Theory Improperly Conflates Damage Concepts with Proof of Injury

Plaintiffs cannot establish a compensable injury through proof of the reasonableness of their decision to remediate. The alleged reasonableness of Plaintiffs' decision to remediate does not establish any element of Plaintiffs' burden of proof.

By citing case law relating to damages, *Trinity Church v. John Hancock Mut. Life Ins. Co.*, 399 Mass. 43 (1987), Plaintiffs improperly seek to merge damages concepts with proof of injury.[6] "Injury" and "damages" are two distinct elements. *See Goodyear v. Discala*, 849 A.2d

[4] *See, e.g.,*. Pls.' Mem. Law in Response to Motion to Exclude Oslon (Doc. 184) at 7-8.
[5] *See* Pls.' Mem. Law in Response to Motion to Exclude Herrick (Doc. 186) at 8; Pls.' Mem. Law in Response to Motion to Exclude Oslon (Doc. 184) at 8.
[6] *See, e.g.,* Pls.' Mem. Law in Response to Motion to Exclude Herrick (Doc. 186) at 7.

791, 799-800 (Conn. 2004).[7] In short, "injury" is the legal harm for which recovery is sought and "damages" constitutes the measure of recovery. *Turcotte v. De Witt*, 333 Mass. 389, 391 (1955) ("'Damages' is the word which expresses in dollars and cents the injury sustained by a plaintiff.").

If a plaintiff proves a compensable injury to property, the plaintiff's right to recover is governed by well-settled rules governing the measure of damages. *See Guaranty-First Trust Co. v. Textron, Inc.*, 416 Mass. 332 (1993).[8] The property damage rules have no application to proof of injury. *See, e.g., Guaranty-First Trust*, 416 Mass. at 336 (addressing measure of recovery for undisputed physical injury to property). Under the damage rules, if the injury is reasonably curable by repairs, the expense of repairs, if less than the diminished market value, is the measure of recovery. *Guaranty-First Trust*, 416 Mass. at 336. The repair itself must be "reasonably necessary" in light of the injury to the property and the cost of the repairs must be reasonable. *Trinity Church*, 399 Mass. at 49. The "reasonable necessity" of Plaintiffs' remediation actions would be relevant to proof of damages, but not to whether Plaintiffs sustained a compensable injury. The reasonableness of Westport's decision to remediate is not relevant to any element of Plaintiffs' case.

2. Plaintiffs' Claim Amounts to a Non-Cognizable Fear of Injury

[7] There can be no damages absent proof of injury:

> The concept of "damages" . . . is distinct from the legal injury from which damages arise. E.g., *Oklahoma City* v. *Hopcus*, 1935 OK 988, 174 Okla. 186, 187-88, 50 P.2d 216 (1935) ("there is a clear distinction between injury and damages"); *North Vernon* v. *Voegler*, 103 Ind. 314, 319, 2 N.E. 821 (1885) ("['Injury' and 'damages'] are . . . words of widely different meaning . . . . They describe essentially different things."). "'The word "injury" denotes the illegal act; the term "damages" means the sum recoverable as amends for the wrong. The one is the legal wrong to be redressed, the other the scale or measure of recovery.'" *Oklahoma City* v. *Hopcus*, supra, 188; see also *American Stevedores, Inc. v. Porello*, 330 U.S. 446, 450 n.6, 67 S. Ct. 847, 91 L. Ed. 1011 (1947) (term "damages" connotes "a compensation in money for a loss or damage" [internal quotation marks omitted]). "Damages flow from an injury"; 4 Restatement (Second), Torts § 902, comment (a), p. 453 (1979)".

Goodyear v. Discala, 849 A.2d 791, 799-800 (Conn. 2004).

[8] The same rules governing the measure of recovery for property damage apply to negligence and implied breach of warranty claims. *Mailman's Steam Carpet Cleaning Corp. v. Lizotte*, 415 Mass. 865 (1993).

In the end, absent proof that PCBs rendered WMS unsafe for human occupancy, Westport is seeking to recover for the fear of injury not available to the personal injury claimant. Massachusetts does not recognize a personal injury cause of action for fear of future injury due to exposure to a toxic substance that causes no physical injury. *Kempinski v. Mass. Tpk. Auth.*, 2000 Mass. Super. LEXIS 66, *12 (Mass. Super. Ct. 2000). As Massachusetts does not recognize a personal injury claim for fear of future injury due to exposure to a toxic substance, it does not recognize a property damage claim for future injury due to exposure to a toxic substance. *Berish*, 2006 Mass. Super. Lexis 330, *64 ("the mere possibility of future personal injury or property damage is insufficient property damage to avoid the economic loss doctrine"). If the Court were to adopt Plaintiffs' argument, it would allow the property damage claimant to recover where the personal injury claimant cannot. *See, e.g.*, *Milward*, 820 F.3d at 471. Instead, like the dog owner who failed to prove injury to her dog from ingestion of a defective product in *Rule*, Plaintiffs cannot establish a compensable injury solely from the presence of an allegedly toxic substance on their property without proof of actual harm.

IV. WESTPORT FAILED, AS A MATTER OF LAW, TO ESTABLISH DAMAGES

A. Westport Is Not Entitled to Compensatory Damages

To recover repair costs for property damage, the plaintiff bears the burden of proving that the repairs were "reasonably necessary in light of the damage inflicted by the defendant." *Berish*, 2006 Mass. Super. Lexis 330 at *69. The property damage rules differentiate between the standard of mere "reasonableness," which applies only to the actual costs of the repairs, and the heightened standard of "reasonable necessity," which applies to the actions undertaken to

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repair the damage. *Id.*[9] Westport cannot establish that its claimed damages were reasonably necessary because its experts concede that the actions it undertook at the WMS were not necessary but voluntary.

The Toxic Substances Control Act ("TSCA") and related regulations promulgated by the EPA are the sole source of authority for PCB remediation. *See* May (09/07/16) Dep. at 115 (SOF¶50). It is undisputed that the regulations do not require building owners to test for PCBs, May (4/25/16) Dep. at 199-200 (SOF¶51); remove PCB-containing building products, Hartman (09/08/16) Dep. at 238 (SOF¶52); May (09/07/16) Dep. at 201, 211, 214 (SOF¶52); or notify the EPA, conduct air testing, locate source materials, or monitor PCBs air levels, May (09/07/16) Dep. at 175-78, 180, 200-01 (SOF¶53). While Westport's consultants contend that they relied on EPA *guidance* documents and *advice* to direct its PCB remediation, May (09/07/16) Dep. at 147-48 (SOF¶54), Robert May, Westport's designated damages expert, concedes that the EPA's guidelines and advice are not regulations, do not have the force of law, and cannot establish regulatory requirements for PCB remediation. May (09/07/16) Dep. at 117, 118, 147-48, 212, 215, 260-61 (SOF¶54).

The EPA has not taken any enforcement actions against a town or school system for PCB-containing building products in its schools. Hartman (09/08/16) Dep. at 246 (SOF¶56). The EPA itself explained that the PCBs in indoor air levels are guidance levels that "are not meant to be interpreted or applied as a 'bright line' or 'not-to-exceed' criteria." EPA, "PCBs in Building Materials – Questions and Answers" (July 28, 2015) (SOF¶41). The EPA further stated that "[i]solated or infrequent indoor air PCB measurements that exceed the exposure levels would not signal unsafe exposure to PCBs," but that measurements above these levels may

[9]The property damage rules reflect two distinct concepts: the term "reasonable" means "being in accordance with reason, not extreme or excessive;" whereas, the definition of "necessary" is "absolutely needed, required." Merriam-Webster.com, 2017, https://www.merriam-webster.com (Jan. 10, 2017).

trigger the need for further investigation. Id. Westport's hazardous materials consultant, Fuss & O'Neill EnviroScience, LLC, had even advised Westport in May 2011 that "[s]ampling for PCB's in the above matrices [windows and doors] is presently not mandated by the U.S. Environmental Protection Agency (EPA)…" Letter from Robert L. May, Jr., Vice President, Fuss & O'Neill EnviroScience, LLC, to Jason Knutson, Principal, CGKV Architects, Inc. (May 6, 2011) (SOF¶47); Knutson Dep. at 39 (SOF¶47). Robert May, Westport's designated damages expert, in fact, admits that adherence to the EPA guidelines is purely voluntary. May (09/07/16) Dep. at 118 (SOF¶54).

Any costs associated with Westport's testing and remediation of the WMS were, therefore, voluntary. May (09/07/16) Dep. at 117, 118 (SOF¶55). Because Westport voluntarily incurred the expense of testing and remediation, it should not be permitted to shift its costs onto Pharmacia under the guise of a property damage claim.

B. Westport Is Not Entitled to Punitive Damages

In its Amended Complaint, Plaintiffs continue to plead punitive damages despite the dismissal of their statutory claims. Because punitive damages are not available as a matter of Massachusetts common law, *Flesner v. Technical Communications Corp.*, 410 Mass. 805, 813 (1991), Plaintiffs' claims for punitive damages cannot stand.

V. WESTPORT'S CLAIMS ARE TIME-BARRED AS A MATTER OF LAW

Last, Westport failed, as a matter of law, to commence this action within three years of the date that it knew, or should have known, of its injury and its cause and, therefore, its claims are barred by the statute of limitations.

Plaintiffs were required to bring their breach of warranty and negligence claims within three years of the accrual of the causes of action. G.L. c. 106 § 2-318. In both products liability negligence cases and breach of warranty cases, a cause of action accrues when the plaintiff knows or reasonably should know that it has been injured as a result of the defendant's conduct. *Pitts v. Aerolite SPE Corp.*, 673 F. Supp. 1123, 1127 (D. Mass. 1987); *Fidler v. Eastman Kodak Co.*, 714 F.2d 192, 197 (1st Cir. 1983). The plaintiff is put on inquiry notice if it has knowledge or notice that it has been injured and its injury resulted from the defendant's conduct. *Bowen v. Eli Lilly & Co., Inc.*, 408 Mass. 204, 208 (1990). In the toxic tort context, if the plaintiff is put on inquiry notice that it may have been injured, the statute of limitations is not tolled until the plaintiff actually confirms through testing that its property is damaged. *See, e.g.*, *Church v. GE*, 1997 U.S. Dist. LEXIS 3297, *9 (D. Mass. Mar. 20, 1997) (rejecting claim that "[plaintiffs] did not 'discover' their injury and its likely cause until they were explicitly informed, following specific testing, that their particular properties were contaminated.").

Westport avers in its complaint that it sustained injury in May 2011 when it detected allegedly dangerous levels of PCBs at WMS. *See* Am'd Compl., ¶ 77 (Doc. 119). Even with the benefit of the discovery rule, however, the uncontroverted evidence establishes that Westport knew, or should have known, by April 6, 2011, at the latest, that the WMS may have been contaminated by PCBs:

- In September 2009, the EPA issued a pamphlet entitled, "Preventing Exposure to PCBs in Caulking Material," which informed schools that "[c]aulk containing high levels of PCBs (polychlorinated biphenyls) has been found in many schools and other buildings built or remodeled before 1978." US EPA OFFICE OF POLLUTION PREVENTION AND TOXICS, PREVENTING EXPOSURE TO PCBS IN CAULKING MATERIAL, EPA-747-F-09-005, September 2009 (SOF¶41).

- Concurrently, the EPA issued a press release entitled, "Public Health Levels for PCBs in Indoor School Air," in which the EPA published its "calculated prudent public health levels" for PCBs in indoor air. Press Release, Public Health Levels for PCBs in Indoor School Air (September 25, 2009) (SOF¶41).

- In December 2009, the Massachusetts Department of Public Health ("DPH") issued a booklet entitled, "An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings," intended to "provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere." DPH Information Booklet, p.2 (SOF¶42).

- The DPH advised schools, "Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning." DPH Information Booklet, p.5 (SOF¶42).

- On April 6, 2011, Westport met with CGKV Architects in conjunction with the Massachusetts State Building Authority's Green Repair Program for the WMS. In response to Westport's question, "What is your experience with hazardous materials in roof & window replacement projects?," CGKV answered, "We have worked with Fuss & O'Neill/EnviroScience for many years on several projects with hazardous materials. It is common to find asbestos in sealants for windows and roofs and lead paint at windows, ***but we must also be sure to test for PCBs.***" CGKV, Presentation to Westport (April 6, 2011) at 37 (emphasis added) (SOF¶45).

- CGKV explained to Westport that PCBs were likely present within building products at WMS. Knutson Dep. at 54-56; Duarte Dep. at 153-156 (SOF¶42).

By May 4, 2011, Westport had, in fact, decided to test for PCBs. Knutson Dep. at 70, 76-77; Pinck & Co., "Feasibility Cost Estimate", May 4, 2011 (SOF¶46).

Westport did not commence this action until May 7, 2014 (Doc. 1) despite the fact that it was undisputedly put on inquiry notice of its injury and its cause by April 6, 2011. Because Westport failed to bring this action within the three-year statute of limitations, it is time-barred.

CONCLUSION

Based on the foregoing, Pharmacia respectfully requests that this Honorable Court grant summary judgment in Pharmacia's favor and dismiss Plaintiffs' cause of action in its entirety with prejudice.

Dated: January 30, 2017

PHARMACIA LLC, SOLUTIA INC.,
AND MONSANTO COMPANY

By its attorneys,

WHITE AND WILLIAMS LLP

/s/ Richard L. Campbell

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing was served upon all counsel of record via the ECF system on January 30, 2017.

/s/ Richard L. Campbell

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
New England Region
Five Post Office Square – Suite 100
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Via Electronic Mail: ccrbonifaz@gmail.com

November 8, 2022

Cristóbal Bonifaz, Esq.
Attorney for the Town of Lee Board of Health
Law Office of Cristóbal Bonifaz
180 Maple Street
Conway, Massachusetts 01341

Re: GE-Pittsfield/Housatonic River Site/Rest of River
Notice of Adjudicatory Hearing of the Town of Lee Board of Health

Dear Attorney Bonifaz:

EPA has received the Notice of Adjudicatory Hearing ("Notice") issued by the Town of Lee Board of Health ("BOH") regarding an adjudicatory hearing that the BOH will hold on November 19 to determine whether the Upland Disposal Facility ("UDF") to be constructed in the Town of Lee to facilitate the cleanup of the Housatonic River presents a health impact to Lee residents. I have also received your letter to me dated October 31, 2022 (the "Letter") primarily regarding transportation of material to the UDF, and your follow-up letter dated November 3. This letter responds to the Notice and your two letters to me.

As the Notice points out, EPA has previously referred the BOH to the Administrative Record that EPA established for the Revised Final Cleanup Permit that the Region made final in 2022 (the "Permit"). In my October 5 letter to you, I identified specific portions of the Administrative Record that are relevant to the protectiveness of the UDF. This letter clarifies and responds to certain misunderstandings contained in the Notice and in your Letter. Please forward this letter and the letter I previously sent you on October 5 to the BOH and add both letters to the Record that the BOH is creating for its decision. For ease of reference, I have attached my letter of October 5.

1. The Conclusions of the De Simone Report

As stated in our letter of October 5, EPA addressed the De Simone Report in one of our 2021 filings to EPA's Environmental Appeals Board. The relevant portion of EPA's filing is copied below, and the two pages from our filing are attached for your reference.

> [T]he primary finding [of the DeSimone Report] confirms what is already known and documented in the [Administrative Record]: there are permeable soils underlying the UDF location. EPA agrees that such soils are permeable and, based upon monitoring well elevation data, that the localized groundwater flows towards the River. EPA, however, has accounted for these facts and has determined that the UDF will be protective of human health and the environment. The report neither addresses nor rebuts these findings. At most, the Report expresses a mere difference of opinion. Dr. DeSimone does not address the low-level concentrations of the PCBs designated for the UDF; the chemical nature of PCBs that does not make them prone to migration in groundwater; or, based upon monitoring well data, the upwelling of groundwater near the UDF that would prevent any contamination from reaching the bedrock. (Footnotes and citations omitted.)

2. Health Impact from Truck Traffic for Sediment Disposal

The discussion of the trucking of PCBs to the UDF contained in the Notice and Letter is incorrect. First, based upon the cleanup criteria contained in the Permit and Housatonic River sampling data, it is estimated that approximately one million cubic yards of contaminated material will be disposed of at the UDF. Further, 100,000 cubic yards of the most highly contaminated material will be disposed of off-site. The total mass of PCBs estimated to be removed from the River is 50,500 pounds of PCBs, or 25.25 tons. See Table 2 of EPA's 2020 *Determination on Remand*. Because a minimum of 100,000 cubic yards of the most highly contaminated material will be sent off-site for disposal, the actual mass of PCBs to be disposed of in the UDF is estimated to be less than 25.25 tons.

The 2020 remedy involves an estimated 47,000 truck trips of excavated material to the UDF. The cleanup is estimated to take 13 years, so there will be approximately 3,800 truck trips per year over the estimated 13-year cleanup duration. The 2016 all off-site disposal remedy that does not use the UDF (alternative TD 1) would have involved 81,700 trips, nearly 35,000 more truck trips than the 2020 remedy. (For the 2016 remedy, truck trips would have been required to either a rail staging area, if rail were feasible, or directly to off-site facilities.) When considering the significant additional sediment to be removed from the River for the 2020 remedy (see footnote 5 of Table 13a described below), the use of the UDF will eliminate nearly 50,000 truck trips from the roads of Lee and Lenox due to its use of hydraulic pumping, if feasible, of excavated material directly to the UDF location. Based upon experience at other sites, EPA believes such pumping to be feasible. (Note that the above numbers of truck trips do not count truck trips for importing clean material for capping, backfilling, or for the construction of the UDF. They also do not account for return trips to the River after disposal at the UDF or trips taken by trucks to the River for disposal off-site.) The number of truck trips described above are based upon estimates as described in Tables 13a, 13b, and 13c of EPA's 2020 *Determination on Remand and Supplemental Comparative Analysis*. These tables are enclosed for your ease of reference.

Finally, with respect to the safety of PCB-material transport, the sediment will be drained of water prior to loading into trucks, and EPA expects that GE will use sealed trucks and tarps to minimize the potential for releases of liquids or air emissions, as it has done in other areas of the Site. This process was used successfully for the numerous response actions in Pittsfield, including at Silver Lake and the first two miles of the River, where the PCB concentrations in soil and sediment were much greater.

The Permit requires many actions by GE to address community impacts during remediation activities in submittals required under the Permit including the Quality-of-Life Compliance Plan and the Off-Site and On-Site Transportation Plan that will detail safety precautions for trucking. See the 2022 Permit, Section II.H.

For further details, see Section II.C. of EPA's 2020 *Response to Comments*.

3. Potential Leaking of the Double Liner System

The UDF will be designed according to the same engineering standards as those at permitted, long-term, hazardous waste landfills that accept waste with much higher PCB contamination levels. In addition to an impermeable top cover that cuts off rainwater infiltration, at the bottom of the landfill, to prevent leaks, the UDF will have an upper impervious liner with a leachate collection pipe above the upper liner, a backup liner located below the upper liner, with another leachate collection system between the liners that can detect leaks from the upper liner. As stated in the 2020 *Response to Comments*, "[w]hen two geomembrane liners are used in conjunction with a drainage layer designed to limit liquid head (water pressure) on the liner system, studies have demonstrated that the liner efficiency can be 99.9% or better. Assessment and Recommendations for Improving the Performance of Waste Containment Systems, EPA/600/R-02/099, 2002." 2020 *Response to Comments*, page 18. As further stated in the 2020 *Response to* Comments, "[t]he composite liner system is recognized as a best available liner technology to contain waste materials and has been shown to have a service life of 400-800 years. Technical Memo, URS, 2008; White Paper #6, GRI Institute, 2005 (updated 2011)." *Id.* These cover and liner systems have been used for many decades at landfills across the nation. *Id.*

Under the Permit, GE is required to operate, inspect, maintain, and, if necessary, repair the UDF. The Permit requires that GE install a groundwater monitoring network abutting and around the UDF. As described in EPA's 2020 *Response to Comments*, EPA believes that a leak from the UDF is extremely unlikely to occur. But, if the leachate collection or the groundwater monitoring systems did identify a leak, GE is required to take corrective actions.

The Notice also cites an EPA guidance for the proposition that the liner system will eventually leak. 53 Federal Register 33345 (August 30, 1988). This guidance, however, does not recommend against properly designed and monitored landfills with a low-permeable cover, double bottom liner, and leachate collection, such as the proposed UDF. The guidance actually recommends double bottom liners and groundwater monitoring longer than 30 years, which is what the Permit requires.

For further details, see pages 18 and 19 of EPA's 2020 *Response to Comments*.

4. Whether Potential Leaks from the Liner could Present a Health Risk

As stated above, given the design and monitoring of the UDF, EPA believes that a leak from the liners is extremely unlikely. If, for some reason, a leak occurs, however, the leak would be detected by the leachate collection system and the groundwater monitoring wells abutting and surrounding the UDF. Given the slow migration rate of PCBs in groundwater and the tendency of PCBs to sorb (attach) onto soil, these systems would detect elevated contaminant levels in groundwater years before a release to the Housatonic River would occur. 2020 *Response to Comments*, Pages 21 and 22.

Regarding the concerns that the UDF may adversely affect Lee's drinking water supplies, it is important to note that the UDF location is over one mile from the Town of Lee's public water supplies, and the groundwater at the UDF is approximately 150 feet lower in elevation and flows away from the Town's water supplies. 2020 *Response to Comments*, Page 20. Furthermore, the surface drainage from the UDF is generally away from the water supplies and towards the River, and the water supplies are at a much higher elevation than the proposed UDF. *Id.* at 21. Thus, in sum, groundwater and surface water near the UDF flows towards the River and away from the Town of Lee's water reservoirs.

Accordingly, the UDF is protective of human health and the environmental, and unexpected leaks from the liner system are extremely unlikely to present a risk to human health.

For further details, see Pages 20 through 22 of EPA's 2020 Response to Comments.

5. Power of EPA to Preempt Regulations of the Board of Health

EPA addressed this issue at length in its prior letter of October 5, and nothing in the Notice changes EPA's analysis that the BOH regulations do not preempt an on-going federal cleanup. Note that we did not state in our letter that the *Arthur D. Little* case only applied to the United States Department of Defense. Rather, the facts in that case have no bearing on whether the BOH can override an ongoing federal cleanup.

6. Your Follow-up Letter of November 3

We received your letter of November 3 that you describe as a follow-up to your letter of October 31. Regarding the November 3 letter, please note that Permit Section II.B.5, titled Upland Disposal Facility ("UDF"), limits the horizontal and vertical dimensions of the UDF. These limitations are contained in Permit Section II.B.5 (2)(a), (b), and (d). The Permit provisions have a direct bearing on size and height of the UDF and are copied immediately below.

> (2) The Upland Disposal Facility shall meet the following design Performance Standards:
>
> (a) The Upland Disposal Facility shall have a maximum design capacity of 1.3 million cubic yards.
>
> (b) The landfill consolidation area shall have a maximum footprint of 20 acres and a maximum elevation of 1,099 feet above mean sea level. If the seasonally high groundwater elevation is determined to be higher than 950 feet above mean sea level, the maximum elevation of the landfill consolidation area may be increased by the number of feet that is the difference between the seasonally high groundwater elevation and 950 feet above mean sea level in order for the Upland Disposal Facility to have a maximum capacity of 1.3 million cubic yards.
>
> (c) [Omitted for lack of relevancy to this issue.]
>
> (d) The bottom liner of the landfill will be installed a minimum of 15 feet above a conservative estimate of the seasonally high groundwater elevation. The seasonally high groundwater elevation will be projected using site-specific groundwater elevation data collected in the location of the Upland Disposal Facility, modified by an appropriate technical method that takes into account historic groundwater level fluctuations at similarly-sited off-site long-term monitoring wells in Massachusetts. The estimation of a seasonally high groundwater elevation will be performed pursuant to a methodology reviewed and approved by EPA. The estimate of seasonally high groundwater elevation shall then be used to support the design of the landfill relative to achieving the required minimum separation distance from the bottom of the liner system to the seasonally high groundwater elevation.

For your information, the current ground elevation of the UDF disposal area ranges from elevation 950 (at the open water areas) to 1048 above mean sea level. (See Figure 11 of EPA's Response to Comments for current elevations at the UDF disposal area.) Thus, if the seasonally high groundwater elevation is determined to be 950 feet above mean sea level, then based upon the Permit limitations cited above (including the UDF's height limitation of 1,099 above mean sea level), the maximum height of the UDF will be approximately 50 feet higher than the highest current elevation of the UDF area.

As stated previously, please refer to the Permit and its Administrative Record for more details regarding the UDF. Reference to these materials can avoid misunderstandings about the UDF and on-site disposal.

7. Conclusion and Summary

We appreciate the Board's concerns. It is important to reiterate, however, that the actual, ongoing threat to human health and the environment lies with the currently uncontrolled PCB contamination present in the River sediment and floodplain soil. Over 285,000 cubic yards of uncontrolled contaminated sediment is in Woods Pond and an additional 60,000 cubic yards is present in other River impoundments located downstream of Woods Pond in the Town of Lee. See Attachment 6 to the May 2014 *Comparative Analysis*. By safely removing, transporting, and disposing of contaminated material in the secure UDF and at off-site facilities, the remediation of the river and floodplain will result in decreased risks to the health of Lee residents.

In evaluating the UDF, we urge the BOH to review the Administrative Record for the 2022 Permit, especially EPA's *Response to Comments* dated December 2020, EPA's *Determination on Remand and Supplemental Comparative Analysis* dated July 2020, and EPA's *Statement of Basis for EPA's Proposed 2020 Revisions to the Remedial Action for the Housatonic River "Rest of River"* dated July 2020. These documents are word-searchable so that the BOH can reference particular topics. A review of the Record will hopefully avoid misperceptions and misunderstandings.

We remain committed to coordinating with all of the municipalities during the planning and implementation of the River cleanup. Please let me know if you have any further questions.

Sincerely,

JOHN KILBORN
Digitally signed by JOHN KILBORN
Date: 2022.11.08 16:37:37 -05'00'

John W. Kilborn
Senior Enforcement Counsel
Office of Regional Counsel
US EPA, Region 1

Attachments:
EPA letter to the BOH dated October 5, 2022
Pages 20 and 21 from EPA's 2021 *Response* filed with the EAB
Tables 13a, 13b, and 13c of EPA's 2020 *Determination on Remand*

Cc: Board of Selectmen, Lee
Board of Selectmen, Stockbridge
Board of Health of Lenox
Board of Health of Stockbridge
Board of Health of Sheffield
Board of Health of Great Barrington
Senator Elizabeth Warren
Senator Edward Markey
Congressman Richard Neal
Senator Adam G. Hinds
Representative Smitty Pignatelli
Administrator Michael S. Regan, EPA
Dean Tagliaferro, EPA
Bryan Olson, EPA
Andrew Silfer, GE
Chris Ferry, Superfund Records Center

DJ-16

SETTLEMENT AGREEMENT

The undersigned parties ("Parties") hereby jointly agree to resolve their disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site ("the 2016 Permit"), including those issues affirmed or remanded by the EPA Environmental Appeals Board (the "EAB"). This Settlement Agreement ("Settlement Agreement") shall be binding on and inure to the benefit of each Party and each Party's successors.

On October 27, 2000, a Consent Decree for the GE-Pittsfield/Housatonic River Site ("Site") was entered by the U.S. District Court for the District of Massachusetts (the "Decree"). Appendix G to the Decree, as reissued, is a RCRA Corrective Action Permit between EPA and the General Electric Company ("GE"), governing GE's investigation and alternative evaluation responsibilities with respect to the Rest of River ("the 2000 Permit"). Pursuant to the Decree and the 2000 Permit, EPA, in October 2016, issued the 2016 Permit, with concurrence from Massachusetts. Five parties challenged the 2016 Permit before the EAB, including the Berkshire Environmental Action Team, C. Jeffrey Cook, GE, the Housatonic Rest of River Municipal Committee ("Municipal Committee"), and the Housatonic River Initiative. The City of Pittsfield, Massachusetts Audubon Society ("Mass Audubon"), Connecticut and Massachusetts also participated in the EAB process. The EAB issued a decision in January 2018, denying the challengers' review in part and remanding to EPA on two issues challenged by GE.

The Parties have been engaged in mediated discussions concerning the 2016 Permit, pursuant to a mediation agreement executed in March 2019 ("Mediation Agreement"). The Parties entered into the Mediation Agreement with the objective of identifying whether there was one negotiated resolution of the permit dispute before the EAB that would result in a protective cleanup that is more comprehensive and faster, that minimizes the disputes and litigation going forward concerning the cleanup, and that is consistent with the overall Consent Decree for the Site.

The Parties have agreed on the following measures to achieve a cleanup that is protective, faster and more comprehensive, while minimizing disruption to affected parties, addressing community impacts, and promoting economic development. This Settlement Agreement is intended to address all disputes between the Parties regarding the 2016 Permit, including those raised in petitions to the EAB. The Parties recognize that the terms of this Settlement Agreement must be approved by each of the five towns making up the Municipal Committee (Great Barrington, Lee, Lenox, Sheffield and Stockbridge) ("the Towns"). The terms of the Settlement Agreement are not severable or modifiable other than with the consent of the affected Parties.

Agreements in this Settlement Agreement that relate to the provisions of the 2016 Permit will be set forth in EPA's proposed revision of the 2016 Permit ("the Revised Permit" or "Revision to the 2016 Permit"). The Revised Permit will be subject to a regulatory public comment process. This Settlement Agreement will become part of the public file for this matter upon execution by the Parties.

To promote the ability of this Settlement Agreement to expedite the Rest of River cleanup, the Parties agree not to challenge the Revised Permit unless it is inconsistent with the terms of this Settlement Agreement. Except as specified in Sections I, V.A.1, V.B.3, 5 and 6, and VI.D below, any agreements by any Party in the Settlement Agreement are contingent on the final issuance of a Revision to the 2016 Permit containing terms substantially similar to those in the 2016 Permit, revised as specified by the terms in Sections II and III below.

SETTLEMENT TERMS

I. Initiation of Rest of River Response Action Activities

In order to expedite response actions at the "Rest of River" portion of the Site, GE has agreed to commence and perform investigation and design work as contractual obligations effective upon the date on which all of the Parties including EPA have signed this Settlement Agreement. Specifically, GE must submit a schedule for the Rest of River Scope of Work (SOW), develop the SOW, and, subject to approval by EPA, implement the investigation and design components of the SOW and subsequent Work Plans to accelerate the commencement of the Rest of River cleanup. The obligation to perform this investigation and design work shall continue unless and until EPA issues a Revised Permit that does not contain terms substantially similar to those in the 2016 Permit, revised as specified by the terms in Sections II and III below.

II. Cleanup Enhancements

As part of this Settlement Agreement, GE agrees to enhance the cleanup in the following ways, to be required in the forthcoming Revised Permit.

A. GE shall implement all requirements of the 2016 Permit that are not explicitly modified in this Settlement Agreement, and all modifications of the 2016 Permit specified in Sections II and III of this Settlement Agreement.

B. For Reach 5A Floodplains in Pittsfield, GE shall remove soil from twenty-two (22) floodplain properties specified in Attachment A to meet the residential Performance Standards in the 2016 Permit. To the extent the Town of Lenox determines that any of the owners of the six properties identified in Attachment B consent to such removal, GE shall remove additional floodplain soil from any such properties to achieve the residential Performance Standards in the 2016 Permit. Allocation of costs for such additional work in Lenox is governed by Section V.A.4 of this Settlement Agreement.

C. For Reach 5A and 5B banks that do not otherwise require remediation pursuant to the 2016 Permit, GE shall evaluate the PCB data, erosion potential, the adjacent floodplain removal (if any), constructability issues, and the potential impact to PCB downstream transport should such banks erode and, based on these factors, consider supplemental bank removal.

D. For Reach 5C, GE shall excavate sediment to achieve an average PCB concentration of 1 mg/kg or less followed by the placement of six inches of suitable backfill across the Reach. This will eliminate approximately 57 acres of capping otherwise required by the 2016 Permit.

E. GE shall remove the sediments behind the Columbia Mill Dam in Reach 7 to achieve an average PCB level of 1 mg/kg or less, followed by the placement of a minimum of six inches of suitable backfill and additional material as necessary to maintain channel stability, and GE shall remove the Columbia Mill Dam, upon access being obtained to the property. The 2016 Permit will be revised to eliminate the option for any capping behind the dam. This will eliminate up to 10 acres of capping otherwise required by the 2016 Permit.

F. GE shall remove the sediments behind the former Eagle Mill Dam in Reach 7 to achieve an average PCB level of 1 mg/kg or less, followed by the placement of a minimum of six inches of suitable backfill and additional material as necessary to maintain channel stability, and GE shall remove the former Eagle Mill Dam, upon access being obtained to the property. The 2016 Permit will be revised to eliminate the option for any capping behind the dam. This will eliminate up to 8 acres of capping otherwise required by the 2016 Permit.

G. GE shall remove sufficient sediment to allow for a maximum of 3 acres of capping in the Willow Mill impoundment and 6.5 acres of capping in the Glendale impoundment, thus eliminating up to 10.5 acres of capping otherwise required by the 2016 Permit.

H. For Rising Pond (Reach 8), GE shall remove sufficient sediment to allow for a maximum of 31 acres of capping, thus eliminating up to 10 acres of capping otherwise required by the 2016 Permit.

I. All Legally Permissible Future Project or Work provisions in the 2016 Permit will be retained, but the related Corrective Measures provision of the Revised Permit will be modified to require that the specified "further response actions" will be (i) in accordance with and pursuant to the Consent Decree; (ii) consistent with the scope of the response actions selected in the Revised Permit; and (iii) that Permittee's responsibility for the costs of said further response actions will be limited to those costs solely related to the presence of PCBs.

J. For Vernal Pools, GE shall conduct a pilot study on not more than ten (10) Vernal Pools (none in Core Area 1 habitat) using either traditional excavation and restoration techniques, or amendments such as activated carbon. GE shall collect baseline data including water and soil chemistry and a range of taxa and shall submit a plan that proposes criteria for success. Following an appropriate monitoring period determined by EPA, GE agrees to implement the appropriate remediation, as determined by EPA, on the remainder of Vernal Pools as necessary to meet the Performance Standards in the 2016 Permit.

K. For the remediation of Reach 5C, Woods Pond and potentially in backwaters adjacent to Reach 5C and Woods Pond, GE shall implement, if feasible, a hydraulic dredging and/or hydraulic pumping approach with material from these areas pumped directly to the Upland Disposal Facility described below and depicted in Figure 1. To the extent that the hydraulic dredging and/or hydraulic pumping approach is not feasible, GE shall transport material from Reach 5C and Woods Pond to the Upland Disposal Facility via trucks while avoiding driving on public roads to the maximum extent practical. See attached Figure 2 for depiction of the potential pipeline location from these remediation areas to the Upland Disposal Facility and of potential truck routes. Although PCBs from Reach 5C, Woods Pond and potentially in backwaters adjacent to Reach 5C and Woods Pond at any concentration may be pumped or trucked to the Upland Disposal Facility (as described in this paragraph) for temporary processing, all material permanently disposed of at the Upland Disposal Facility shall meet the standard described below in Section III.A.

L. Quality of Life Plan: GE is required to submit to EPA, for review and approval, a Quality of Life Compliance Plan, which specifies five separate areas to be addressed during remediation: noise, air, odor, light; recreational activities; road use and transport - related impacts; coordination with impacted residents/landowners; and community health and safety. EPA will solicit input on this plan from local governments, impacted residents/landowners, neighborhoods in the vicinity of the cleanup, and other interested stakeholders. Section c of the Quality of Life Compliance Plan will include, among other requirements, consideration of methods to reduce residential impacts where practical, including remediation techniques that further restrict transport of waste material through residential areas. Examples of roads that would warrant such further restrictions include: Brunswick, Kenilworth, Warwick, Noblehurst, Chester, and Revilla Terrace; Shetland, Clydesdale, Pinto, and Palomino Drives; and Anita, Lucia, Quirco, Joseph, and Eric Drives. GE agrees to work with the City, the Towns and the landowners to take reasonable steps to minimize the adverse impact of the work activities by, among others, coordinating work activities, scheduling and traffic routing.

M. GE shall work cooperatively with the City of Pittsfield, the Towns of Great Barrington, Lee, Lenox and Stockbridge, and the State of Massachusetts to facilitate their enhancement of recreational activities, such as canoeing and other water activities, hiking, and bike trails in the Rest of River corridor. Such opportunities are possible on properties where remediation will occur and/or where temporary access roads are constructed.

N. GE shall coordinate as soon as practicable with municipal officials and affected landowners regarding work activities, schedules and traffic routes. GE's coordination with officials and landowners shall be described in the relevant work plans submitted to EPA.

O. Remediation of Mass Audubon Canoe Meadows Property:

In addition to the sampling and remediation described in the applicable Performance Standards in the 2016 Permit, GE will:

1. Expand the Exposure Area (EA) 10 boundary to the east so that the EA incorporates the area with PCBs greater than 1 ppm in the top foot of soil. This expansion would also allow evaluation of the trail in this area. The expanded EA is shown in Figure 6.
2. Include an additional subarea, beyond that included in the 2016 Permit, in the attached Figure 6 Mass Audubon Property Revised EA 10 Remediation and remediate additional floodplain soils to meet the applicable floodplain soil Performance Standards.

III. Disposal of Excavated Material in Rest of River Remedial Action

EPA's Revised Permit will include Performance Standards, corrective measures, and requirements for a Statement of Work and Work Plans, including for the disposal of excavated material. GE shall implement a hybrid disposal approach that includes the following;

A. Material disposed of at the Upland Disposal Facility pursuant to characterization and averaging method(s) approved and/or developed by EPA (Attachment C to this Settlement Agreement) shall not exceed the elevation, volume, and footprint limits described below. GE shall dispose of any material not placed in the Upland Disposal Facility in any out-of-state facility that is licensed/permitted to accept such waste and will accept it, including RCRA Subtitle C Landfills, so long as said facility is in compliance with EPA's Off-Site Rule (40 C.F.R. 300.440). Notwithstanding the first sentence of this paragraph, a minimum of 100,000 cubic yards of PCB-contaminated sediment, riverbank soils, and/or floodplain soils shall be disposed of out of State.

B. Transportation and disposal of other sediment, floodplain soils and other Waste Material (as defined in the Consent Decree) shall occur at a location depicted in Figure 1 and as described in Section III.D-G of this Settlement Agreement ("Upland Disposal Facility"). No material from the Rest of River Remedial Action will be disposed of at any other location in Berkshire County.

C. No one shall take any materials to the Upland Disposal Facility for disposal except those identified for the Upland Disposal Facility as set forth in this Section III and generated in the Rest of River Remedial Action. No materials from previously remediated sites in the Upper 2-Mile Reach of the Housatonic River cleanup nor any other materials associated with the other response actions conducted pursuant to the Site Consent Decree will be disposed of at the Upland Disposal Facility.

D. The Upland Disposal Facility shall have a maximum design capacity of 1.3 million cubic yards. The landfill consolidation area shall have a maximum footprint of 20 acres and a maximum elevation of 1,099 feet above mean sea level. If the seasonally high groundwater elevation determined pursuant to Section III.E is determined to be higher than 950 feet above mean sea level, the maximum elevation of the landfill consolidation area may be increased by the number of feet that is the difference between the seasonally high groundwater elevation and 950 feet above mean sea level in order for the Upland Disposal Facility to have a maximum capacity of 1.3 million cubic yards.

E. GE shall construct the Upland Disposal Facility landfill with a double liner and a leachate collection system and shall cap the Upland Disposal Facility with a low-permeability cap and vegetation. The liners shall have a permeability equal or less than 1×10^{-7} cm/sec, a minimum thickness of 30 mils and be chemically compatible with PCBs. The bottom liner of the landfill will be installed a minimum of 15 feet above a conservative estimate of the seasonally high groundwater elevation. The seasonally high groundwater elevation will be projected using site-specific groundwater elevation data collected in the location of the Upland Disposal Facility, modified by an appropriate technical method that takes into account historic groundwater level fluctuations at similarly-sited off-site long-term monitoring wells in Massachusetts. The estimation of a seasonally high groundwater elevation will be performed pursuant to a methodology reviewed and approved by the EPA. The estimate of seasonally high groundwater elevation shall then be used to support the design of the landfill relative to achieving the required minimum separation distance from the bottom of the liner system to the seasonally high groundwater elevation. The double liner system, separated by a drainage layer, shall incorporate primary and secondary leachate collection systems.

F. GE shall identify all non-community and private water supply wells currently within 500 feet of the Upland Disposal Facility consolidation area. Unless the well owner does not consent, GE shall pay the installation cost of a connection to public water. In the event any new water users (*e.g.*, new construction) move within 500 feet of the Upland Disposal Facility consolidation area during construction or operation and maintenance, GE shall pay the installation cost of a connection to public water.

G. Pursuant to EPA-approved or developed remedial design, remedial action, and operation and maintenance documents, and in accordance with the Consent Decree and the Revised Permit,

1. GE shall install a groundwater monitoring network around the Upland Disposal Facility to monitor for PCBs and other constituents identified in the groundwater monitoring plan as approved or modified by EPA. Groundwater monitoring shall include a sufficient number of monitoring wells to allow detection of groundwater impacts.
2. GE shall perform landfill inspections, maintenance, and groundwater sampling activities.
3. GE shall be responsible for the proper functioning of the Upland Disposal Facility landfill during landfill operations, and shall remain responsible for the proper operation and maintenance of the landfill thereafter. GE shall be responsible for the closure of the landfill including the installation of the impermeable cap and vegetative cover promptly upon EPA's determination that either of the following conditions has occurred: (1) the landfill is full (*e.g.*, when the maximum footprint, elevation and/or volume are reached), or (2) excavation and dredging activities conducted as part of the Rest of River Remedial Action are complete. GE shall be responsible for post-closure activities and monitoring thereafter.
4. Landfill design will include a stormwater management system to control surface runoff, to minimize the potential for surface erosion or stormwater contribution to leachate generation.

H. GE shall include in its landfill design submissions one or more proposals (based on GE's consultations with officials from the Town of Lee) describing how GE will prepare the Upland Disposal Facility for potential re-use once the landfill is capped if the Town of

Lee desires. Any such proposals shall be described in the final remedial design/remedial action work plans.

NON-PERMIT AGREEMENT(S)

IV. Other GE/EPA Agreements

A. GE and EPA's National Pollutant Discharge Elimination System permit program shall engage in good faith discussions regarding a renewal of the NPDES Permit for the former Pittsfield facility based on implementation of Best Management Practices to improve stormwater management, potentially including slip lining of damaged piping, pressure washing of other piping infrastructure, and removal of accumulated sediment from catch basins or other structures, as appropriate.

B. The EPA will facilitate opportunities for research and testing of innovative treatment and other technologies and approaches for reducing PCB toxicity and/or concentrations in excavated soil and/or sediment before, during, or after disposal in a landfill. These opportunities may include: (1) reviewing recent and new research; (2) identifying opportunities to apply existing and potential future research resources to PCB treatment technologies, through EPA and/or other Federal research programs; and (3) encouraging solicitations for research opportunities for research institutions and/or small businesses to target relevant technologies. The research may focus on soil and sediment removed (or to be removed) from the Housatonic River or similar sites to ensure potential applicability to the permit/selected remedy. GE and EPA will continue to explore current and future technology developments and, where appropriate, will collaborate on on-site technology demonstration efforts and pilot studies, and, consistent with the adaptive management requirements in the Final Permit together, will consider the applicability of promising research at the Housatonic Rest of River site.

V. Economic Development and Other Community Benefits

A. GE shall pay a total of $55 million, which the Towns of Lenox, Lee, Stockbridge, Great Barrington and Sheffield shall distribute among themselves.

1. GE agrees to establish an interest-bearing escrow account and to pay into that escrow account $55 million no later than 30 days after the Agreement is signed by the Parties. GE and the Towns of Lenox, Lee, Sheffield, Stockbridge, and Great Barrington agree to enter into a mutually acceptable escrow agreement regarding said escrow account, including instructions to the escrow agent, specifying the terms on which the $55 million deposited into said escrow account, and the interest, accrued, will be released.
2. GE shall donate the Rising Pond Site (parcel 113/005.0-0000.0008.0 listed as 149 acres) to the Town of Great Barrington or its designee to allow for conservation and/or development contingent on GE retaining necessary easements to conduct response actions at Rising Pond and to maintain the Rising Pond Dam.
3. GE shall release the use limitations currently effective at the adjacent Hazen Paper Mill Site subject to appropriate releases from future liability.
4. After Lenox determines whether any of the owners of the six properties identified in Attachment B seek additional floodplain soil removal to achieve the residential Performance Standards in the 2016 Permit pursuant to Section II.B of this Settlement

Agreement, Lenox and GE will share equally the cost of such additional removal for any such owners who request such additional removal.

B.

1. GE shall pay a total of $8 million to the City of Pittsfield within sixty (60) days of the final issuance of a Revision to the 2016 Permit containing terms substantially similar to those in the 2016 Permit, revised as specified by the terms in Sections II and III of this Settlement Agreement, with the understanding that the $8 million will be put into the Pittsfield Economic Development Fund.

2. Within sixty (60) days of the final issuance of a Revision to the 2016 Permit containing terms substantially similar to those in the 2016 Permit, revised as specified by the terms in Sections II and III of this Settlement Agreement, GE will donate, as is, the land and building that it owns on Woodlawn Avenue (Parcel ID I100005001) to the Pittsfield Economic Development Authority ("PEDA") or another entity agreeable to the City, GE and PEDA. Pittsfield reserves the right to decline the donation. Should Pittsfield elect to decline the donation it shall do so within 12 months of the date of this Settlement Agreement.

3. By December 31, 2020, unless EPA has proposed a Revised Permit that is not substantially similar to the 2016 Permit, revised as specified by the terms in Sections II and III of this Settlement Agreement, GE will remove the pavement, fencing and guard rails on three parking lots on Tyler Street (Parcel IDs J11000701, J110003013, and

J110010001)(the “Parking Lots”). To landscape the Parking Lots, GE shall plant grass, and shall, at a cost not to exceed $50,000, install appropriate shrubbery.

4. GE will also engage in good faith discussions with the City regarding the donation by GE of the Parking Lots to the City or another entity agreeable to the City and GE, which donation would occur within sixty (60) days of the later of the final issuance of a Revision to the 2016 Permit containing terms substantially similar to those in the 2016 Permit, revised as specified by the terms in Sections II and III of this Settlement Agreement, and completion of the landscaping of the Parking Lots.

5. GE will also agree to semi-annual meetings between the City and GE regarding GE’s plans for the maintenance, potential repurposing or eventual demolition of the structures located at 55 Merrill Road, Parcel J100009002: Building 12 complex including Buildings 12, 12X, and 12Y, Building 14 Complex including Buildings 14, 14A, 14D, 14E, 14H and any extensions, and the buildings and parcels south of East Street with the first semi-annual meeting to occur within 60 days of execution of the Settlement Agreement unless EPA proposes a Revision to the 2016 Permit that is not substantially similar to the terms of the 2016 Permit, revised as specified by the terms in Sections II and III of the Settlement Agreement.

6. Aesthetic Improvements on GE Owned Property in City of Pittsfield: Within 120 days of the execution of the Settlement Agreement, unless EPA proposes a Revision to the 2016 Permit that is not substantially similar to the terms of the 2016 Permit, revised as specified by the terms of Sections II and III of the Settlement Agreement, GE will commence the specified activities in this Section V.B.6 to aesthetically improve GE

owned property in the City of Pittsfield and will complete said specified activities within 12 months of the commencement of said specified actions.

a. GE Property South of East Street

   i. Remove barbed wire from fencing along East Street and remove former employee turnstile and associated infrastructure (if any) subject to concurrence by GE Corporate Security, to be discussed with the City.

   ii. Plant 24 White pines or equivalent subject to availability. (This is limited to areas east of the Woodlawn Avenue/East Street intersection due to lack of unpaved areas west of Woodlawn Avenue. Additional aesthetic improvement will be suggested by GE which can be installed west of Woodlawn Avenue to improve the appearance of the property running parallel to East St.).

   iii. Improve aesthetics of area currently being used as a storage area by WMECO.

b. GE property bounded by RR tracks/Merrill Road, New York Avenue, Tyler Street and PEDA property.

   i. Remove all barbed wire from fencing along Tyler Street subject to concurrence by GE Corporate Security, to be discussed with the City.

   ii. Remove pipe trestle extending from Building 12Y to the former 20s Complex (timing for removal subject to obtaining access and concurrence from CSX).

   iii. Remove guard rail north of Building 14E/14 Ext along Tyler Street subject to concurrence from the Pittsfield Department of Public Service.

iv. Remove 4 exterior vents/stacks that are on the outside wall of building 14/14-N and face Tyler Street.

c. Building 14 complex

   i. North side/facing Tyler Street; Paint rusted "columns" and "horizontal" facade near top of the building (excluding white siding) that faces Tyler Street.

   ii. In the high bays on the north, east and south side of 14/14E; replace broken windows, or fill all window panes, and/or paint with consistent solid material if such work can be performed safely.

   iii. Eastern side of Building 14/14E that faces south towards the SABIC parking lot; Remove, paint, refurbish or otherwise improve the rusted and/or peeling siding.

d. Building 12, facing west (toward PEDA property): paint perimeter façade of southern most garage door and rusted wall.

e. Building 12 complex

   i. Remove, paint, refurbish or otherwise improve the rusted and/or peeling siding that faces south toward East Street. (Siding is currently white.)

   ii. Remove, paint, refurbish or otherwise improve the rusted and/or peeling siding that faces southeast toward East Street/Merrill Road and siding on the west, south and east side of the upper building on 12 (Y). Portions of the upper building may be inaccessible and not subject to such aesthetic improvements due to lack of access/safety concerns. (Siding is currently red.)

f. Additional aesthetic improvements identified by the City will be discussed by the City and GE at the semi-annual meetings referenced above in Section V.B.5.

C. GE shall prioritize the use of local labor for the Rest of River Remedial Action to the extent feasible and economical.

D. Upon request, GE will provide any municipality with information relevant to GE's liability to that municipality for taxes on any real or personal property that is related to the Rest of River cleanup.

E. <u>Compensation and Access</u>:

1. Once Mass Audubon and GE execute an Access Agreement, GE agrees to pay Mass Audubon $500,000 for the placement and operation, for a period not to exceed 2 consecutive years, of a staging area of up to 3 acres (with appropriate access roads). Mass Audubon agrees that the staging area can be used to facilitate the remediation of Canoe Meadows Wildlife Sanctuary as well as other floodplain soils and Housatonic River sediments in Reach 5A. GE and Mass Audubon agree to execute an Access Agreement to provide additional details of the access that is consistent with the substance of Appendix R to the Consent Decree.

2. Such Access Agreement will include provisions relating to the restoration of Canoe Meadows Wildlife Sanctuary man-made infrastructure affected by the remediation, including but not limited to the boardwalk, walking trails, and public parking lot.

3. Such Access Agreement will include actions to be taken by GE to ensure continued recreational activities on walking trails and other areas of Canoe Meadows Wildlife Sanctuary that will not be affected by the remediation. This will include the provision of an alternate public parking lot and construction and maintenance of alternate connecting walking trails.

4. Such Access Agreement will not include additional monetary compensation.

F. Restoration of Canoe Meadows Staging Area:

Regarding ecological restoration of the staging area, GE agrees to comply with Section II.B.1.c of the 2016 Permit. Regarding all other restoration activities, GE agrees that when the remediation is complete and the staging area is no longer needed, GE will remove the staging area materials and plant appropriate vegetation based on a pre-construction survey of the area, replace any physical structures, trails, signs, public parking areas, and other improvements that are damaged or removed, and otherwise comply with the restoration provisions of the 2016 Permit.

VI. Coordination and Consultation

A. Coordination and Consultation with Stakeholders

1. EPA, in its 2016 Response to Comments on the Rest of River Permit, committed to soliciting input and working with all stakeholders as the cleanup design progresses. EPA reiterates that commitment in this Settlement Agreement. For example, during Remedial Design, EPA plans to engage with property owners, Native American tribes, local governments, communities and other stakeholders to ensure that their input is included in the design process. EPA will ensure that schedules for submissions and reviews take into account any necessary local government, property owner, and stakeholder reviews. At a

minimum, and not necessarily limited to the following, during remedial design EPA will provide an opportunity for input on key submittals required by the Permit, including the Quality of Life Compliance Plan and the design, construction and operation of the Upland Disposal Facility.

2. If in the course of remedial design, GE determines that it will encounter stormwater conveyances, GE will notify the municipality in which the stormwater conveyances are located. To the extent that said municipality wants to upgrade said conveyances, GE will coordinate with the municipality regarding said upgrade so long as it will not delay remedial action.

3. Prior to transporting any materials required for remediation or starting any work in the City of Pittsfield or in the towns of Great Barrington, Lee, Lenox, or Stockbridge, GE shall document the pre-existing condition of any municipal road to be used during remediation using 360 degree road imaging technology plus 3D road surface imaging technology. GE shall also photographically document the condition of other visible infrastructure associated with such roads, including bridges culverts and other exposed infrastructure that is not captured by the road scanning process and provide that documentation for review by the affected municipality. GE and the affected municipalities will meet and confer in good faith, and in consultation with experts, regarding the need for the use of Ground Penetrating Radar ("GPR") technology to assess subsurface conditions in particular areas where such GPR assessment may be warranted. The required Quality of Life Compliance Plan will include documentation showing how GE will repair any damage to the roads, other than normal wear and tear, caused by GE in order to allow safe public access during remediation activities. At the completion of

any remediation activities affecting a specific road, GE will document the then-existing condition of the road and associated exposed infrastructure using the same technology as set forth above and provide that documentation for review by the municipality; at that time, GE and the affected municipalities will meet and confer in good faith, and in consultation with experts, regarding the need for the use of GPR technology to assess subsurface conditions in particular areas where such GPR assessment may be warranted. GE shall repair or replace any damage caused by GE; any dispute under this Agreement between GE and a municipality regarding GE's responsibility for road and/or infrastructure repair, if the parties cannot resolve the matter through mediation, shall be determined by a single, neutral arbitrator with arbitration to occur in Massachusetts. The arbitration shall (unless the parties to the dispute agree otherwise) be administered by the Boston office of JAMS pursuant to the JAMS Streamlined Arbitration Rules and Procedures, effective July 1, 2014. Such repair or replacement shall meet current State or Federal standards and must be acceptable to the municipality, provided such acceptance is not unreasonably withheld. This provision does not affect any of EPA's authorities pursuant to the Consent Decree or the Revised Permit. GE and the affected municipalities agree to share relevant information regarding the usage of the roads during the remediation process.

4. EPA will coordinate with the affected municipality and interested stakeholders on the Vernal Pools to be remediated pursuant to this Settlement Agreement.

5. EPA also commits to coordinate closely with Connecticut and Massachusetts environmental agencies in implementing the Revised Permit.

B. Consultation with Public and Private Property Owners where Remediation is Required

EPA, in consultation with Connecticut and Massachusetts environmental agencies, commits to working closely with the affected property owner to obtain input prior to finalizing design submittals and other documents specifically related to property owners where remediation is required. These submittals/documents shall include but are not necessarily limited to the following:

- Floodplain Pre-Design Investigation Work Plans, which include:
  - Soil Sampling Plan
  - Potential Vernal Pool Certification Investigation Reports
  - Survey Report on Morphology, Habitat Characterization, and Accessibility
- Riverbed and bank Pre-Design Investigation Work Plans
- Pre-Design Investigation Summary Reports (summarizes investigation activities and sampling data, identifies additional data needs, if any)
- Baseline Restoration Assessment and Restoration Plans
- Cultural Resource Survey(s)
- Conceptual Remedial Design/Remedial Action ("RD/RA") Work Plan (Preliminary identification of excavation footprint and quantities, preliminary restoration activities, and preliminary plans and specifications.)
- Final RD/RA Work Plan (Final excavation footprint, detailed design details, plans and specifications, including potential access roads, staging areas, and restoration activities, long-term inspection, monitoring and maintenance requirements, and a preliminary schedule).

C. Coordination Among EPA, Mass Audubon, GE:

EPA, Mass Audubon, and GE recognize that, as envisioned in the 2016 Permit and this Settlement Agreement, the proposed remediation will affect Mass Audubon's Canoe Meadows property in Pittsfield.

1. Prior to submittal of the Conceptual RD/RA Work Plan relating to actions to be taken by GE at Canoe Meadows Wildlife Sanctuary, GE will meet with EPA and Mass Audubon at a mutually agreeable time to review the Revised Permit terms and discuss how these relate to: the actual areas of remediation on Canoe Meadows Wildlife Sanctuary; other areas on Canoe Meadows Wildlife Sanctuary that may be needed to facilitate the remediation; and applicable requirements of the Access Agreement between GE and Mass Audubon (including restoration requirements and actions to allow for continued recreational activities).
2. After executing an access agreement but prior to mobilization of the remediation at Canoe Meadows Wildlife Sanctuary or mobilization of activities to make a staging area at Canoe Meadows Wildlife Sanctuary, GE will meet with Mass Audubon and EPA to discuss concerns.
3. Prior to submittal of restoration plans for Canoe Meadows Wildlife Sanctuary (which typically are included in the Final RD/RA Work Plan), GE will meet with EPA and Mass Audubon at a mutually agreeable time to discuss restoration plans for the property.

D. Technical Assistance for Local Governments

EPA is providing contractor support to provide technical assistance to the City of

Pittsfield and the Towns of Lenox, Lee, Stockbridge, Great Barrington, and Sheffield.

The contractor is funded by EPA and can provide the following:

- Project planning,
- Communications/coordination with EPA, the States and other stakeholders,
- Technical review of Permit submittals and other documents,
- Preparing and presenting technical presentations to the local governments and the general public,
- Development of Fact Sheets,
- Development of community informational material for dissemination to the public that summarize technical information and technical issues in plain language,
- Technical presentations to community, and
- Provide support responding to questions raised by the public.

EPA has already committed $20,000 for this effort, effective on signature by all Parties to this Settlement Agreement. EPA intends, subject to the availability of funds, to further fund this effort during the design and implementation of the remedy.

VII. Effect of this Agreement

A. This Agreement is not a modification of and shall have no impact upon, the terms and conditions of the Consent Decree.

B. Nothing in this Agreement shall be construed to create any rights in, or grant any cause of action to, any person not a party to this Agreement.

C. This Settlement Agreement may be executed in multiple counterparts. The executed signature page(s) from each actual or electronic copy of a counterpart may be joined together and attached and will constitute one and the same Settlement Agreement.

LIST OF ATTACHMENTS

LIST OF FIGURES

(including figures referred to in Attachment C)

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the Town of Lenox:

Edward Lane

Name

2/5/2020

Date

CHAIR - LENOX BOARD of SELECTMEN

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the Town of Lee:

Thomas P Wickham

Name

Feb 5, 2020

Date

Chairman Board of Selectman

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the Town of Stockbridge:

Terence R. Flynn

Name

2/4/20

Date

Select Board Chair

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the Town of Great Barrington:

2/5/2020

Name Stephen Bannon

Date

Great Barrington Selectboard, Chair

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the Town of Sheffield:

Rene C Wood

Name

Feb 3, 2020

Date

Chair, Board of Selectmen

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the City of Pittsfield:

Linda M. Tyer

Name Linda M. Tyer

2/5/2020

Date

Mayor

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the State of Connecticut:

Lori D DiBella
Name Lori D. DiBella

2/5/2020
Date

Assistant Attorney General
Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For C. Jeffrey Cook:

CJ Cook

Name

2.6.20

Date

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For Berkshire Environmental Action Team:

Jane Winn
Name JANE WINN

February 6, 2020
Date

Executive DIRECTOR
Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For the United States Environmental Protection Agency:

2/6/2020

Name Date

REGIONAL ADMINISTRATOR

Title

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For Massachusetts Audubon Society:

Name Kathleen E. Connolly

02/07/2020
Date

Title Attorney

THE UNDERSIGNED PARTY enters into this Settlement Agreement to resolve disputes regarding EPA's October 2016 RCRA Corrective Action Permit Modification for the "Rest of River" portion of the GE-Pittsfield/Housatonic River Site

For General Electric Company:

B. [signature]

Name BUCKMASTER DEWOLF

2/10/20

Date

VP, ENVIRONMENT, HEALTH & SAFETY

Title

Attachment A
Reach 5A Floodplain Residential Properties Subject to Enhancement

Parcel ID
I6-1-42
I6-3-13
J6-2-3
J4-3-7
J4-3-8
J4-3-9
J4-3-10
J4-3-11
J3-1-10
J3-1-9
J3-1-8
J3-1-14
J3-1-13
J3-1-12
J3-1-11
J3-2-2
J3-2-3
J3-2-4
J3-2-5
J3-2-6
K3-1-2
K2-1-10

Attachment B
Reach 5C Floodplain Residential Properties Subject to Potential Enhancement

Parcel ID
24-6
24-5
24-4
24-3
24-2
24-1

Attachment C to Settlement Agreement

Criteria/Methods Applicable to
Disposal of Material Excavated in Rest of River Remedial Action

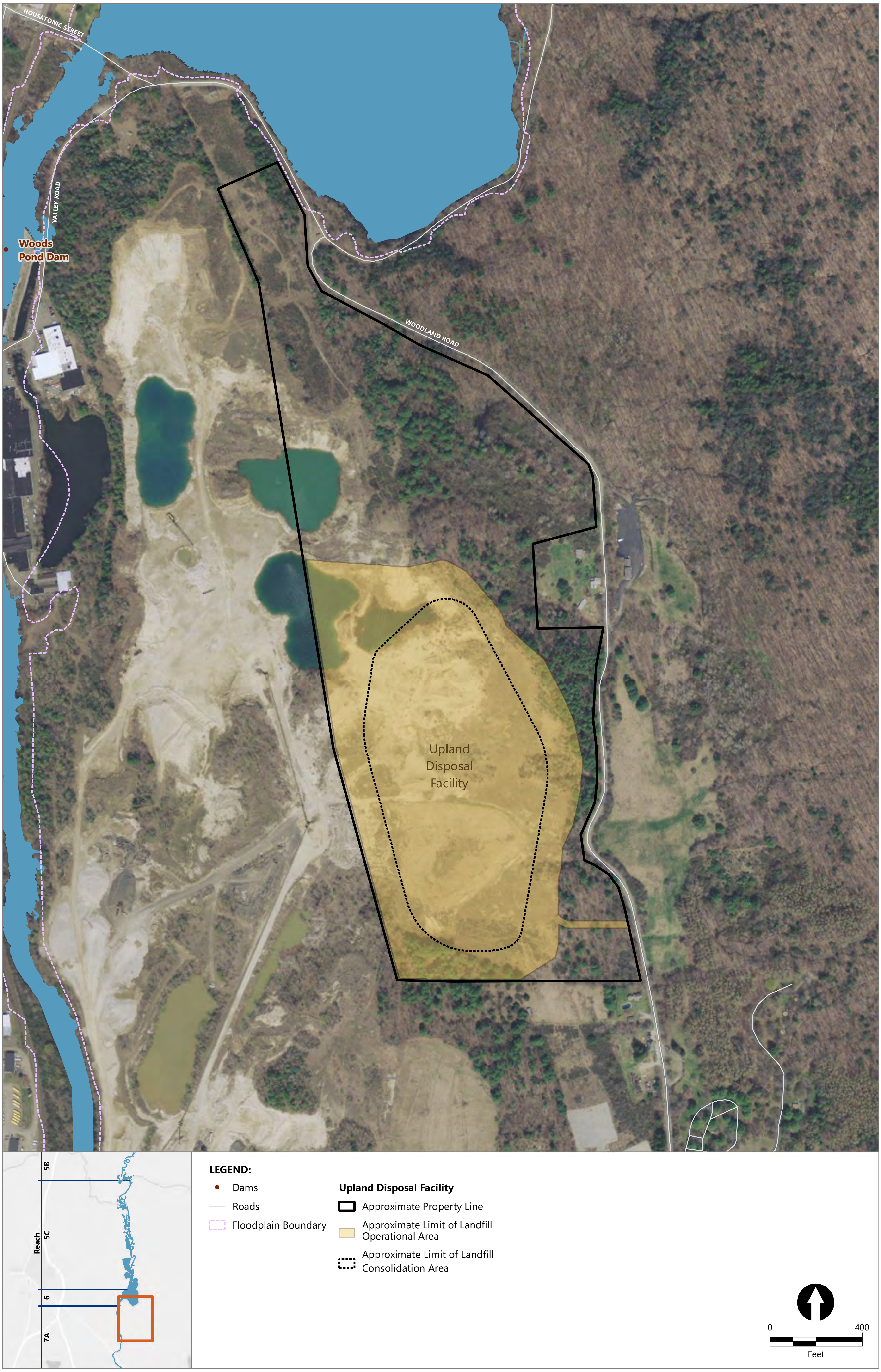
1. For floodplains in each of the 90 Exposure Areas shown in Figure 5, to the extent that remediation is required in any given Exposure Area, GE will segregate and dispose of off-site (out-of-state) soils containing high concentrations so that the remaining floodplain soil to be disposed of in the Upland Disposal Facility averages less than 50 mg/kg PCBs. The process is further described as follows:
   - After additional data collection required by the 2016 Permit, the horizontal footprint and vertical removal depth (the volume) of soil that needs to be removed in each Exposure Area will be determined.
   - The volume-weighted average PCB concentration of all soil to be removed from each Exposure Area will be calculated (using the same PCB data set used to delineate the soil to be removed).
   - If the volume-weighted average PCB concentration in the soil to be removed exceeds 50 mg/kg in an Exposure Area, the soil with the highest PCB concentrations (e.g., "hot spots") in the Exposure Area will be segregated, or separated out, for out-of-state disposal until the average concentration of the remainder of the soil to be removed in the Exposure Area decreases to less than 50 mg/kg for disposal at the Upland Disposal Facility.
2. For Reach 5A banks, GE will segregate and dispose of off-site (out-of-state) soils containing high concentrations so that the remaining Reach 5A bank soil to be disposed of in the Upland Disposal Facility has a volume-weighted average of less than 50 mg/kg PCBs. In calculating the volume-weighted average concentration of PCBs in Reach 5A riverbank soils for disposal purposes, the only soils that will be considered are soils to be removed from Reach 5A riverbanks.
3. GE will dispose of all riverbank and sediment from Reach 5B off-site (out-of- state), except in the following circumstances: If, pursuant to Section II.C of the agreement, GE removes additional riverbank soil with PCB concentrations less than 50 mg/kg, this material may be disposed of in the Upland Disposal Facility.
4. For all sediment except for Reach 5B, GE will segregate and dispose of off-site (out- of-state) sediments containing high concentrations so that the remaining sediment to be disposed of in the Upland Disposal Facility averages 25 mg/kg PCBs or less on a Reach or Subreach basis as described below.
   - The 25 mg/kg average applies individually to: Reach 5A, Reach 5C, Woods Pond, Backwaters, Reach 7 Subreaches (Subreach 7B [Columbia Mill Impoundment], Subreach 7C [Eagle Mill Impoundment], Subreach 7E [Willow Mill Impoundment], Subreach 7G [Glendale Impoundment], and Rising Pond. These Reaches/Sub- Reaches are depicted in Figures 3 and 4. The segregation of sediment for Reach 5B is described in item 3 above, which provides that all sediment removed from Reach 5B shall disposed of off-site (out-of-state).

- As described in the 2016 Permit, each Subreach, and in some cases each Reach, has its own Performance Standards to be achieved through sediment removal and capping or backfill. Following additional data collection, the area and amount of sediment to be removed to meet the Performance Standard will be determined. After the horizontal footprint and vertical removal depth are determined, the volume-weighted average PCB concentration of the sediment within that footprint will be calculated.
- If the volume-weighted average PCB concentration within a Reach or Subreach removal footprint exceeds 25 mg/kg, sediment with the highest PCB concentrations (e.g., “hot spots”) will be segregated for out-of-state disposal until the average concentration of the remaining sediment to be removed from the Reach or Subreach decreases to 25 mg/kg or less for disposal at the Upland Disposal Facility.
- Relevant data from the RCRA Facility Investigation (RFI) and data collected pursuant to the 2016 Permit or Revised Permit will be used in determining average concentrations for comparison to the 25-mg/kg criterion for placement in the Upland Disposal Facility.
- EPA agrees to work with GE to design an appropriate transition and hybrid disposal averaging area in the Woods Pond Headwaters area between Reach 5C and Woods Pond.

5. In addition, for all sediment in Reaches and Subreaches, including backwaters, except for Reach 5B, GE will segregate and dispose of off-site (out-of-state) sediment that is represented by a 3-dimensional polygon associated with a single vertical core that has an average concentration greater than or equal to 100 mg/kg PCBs, as further described below:
    - GE will compare the 100 mg/kg criterion to the average concentration in each individual vertical core.
    - Vertical core polygons will be generated by a Thiessen polygon method. Thiessen polygon mapping involves the use of computer software to draw perpendicular bisector lines between adjacent sample locations to create two-dimensional polygon areas. The two-dimensional Thiessen polygon will be extended vertically to the depth of sediment removal to create a three-dimensional polygon.
    - The data used in this evaluation will be limited to, and representative of, the depth intervals that correspond to depth of removal associated with the location where the core was collected.
    - If sampling data, at a given vertical core location, consists of data from different depth intervals, the vertical PCB average concentration will be calculated as a depth-weighted average at that location.
    - Vertical sediment cores will be of sufficient depth to characterize sediment PCB concentrations throughout the full vertical interval required to comply with the Performance Standards for each Reach, Subreach and backwater under the 2016 Permit or Revised Permit.
    - If the vertical depth-weighted PCB average in a polygon is equal to or greater than 100 mg/kg, then all sediment associated with the vertical core polygon will be segregated and disposed of off-site (out-of-state).

- For all reaches except Subreach 5A and 5C, relevant data from the RFI and additional data collected by GE pursuant to the 2016 Permit or Revised Permit, as applicable, will be used in determining these vertical depth-weighted core averages.
- Additional vertical core samples will be collected by GE pursuant to the 2016 Permit or Revised Permit, as applicable, in Reach 6 (Woods Pond) to supplement existing data and to fill in data gaps.
- For Reaches 5A and 5C, only data collected pursuant to the 2016 Permit or Revised Permit shall be used in this evaluation. Vertical core samples will be collected in six-inch increments. The sampling will consist of 3 vertical cores per transect (left, center and right of the channel) with transects performed at a linear spacing of 250 linear feet of the river channel.
- Additional vertical sediment cores may be collected to further refine the areas where average sediment concentrations exceed 100 mg/kg and/or to assist in achieving the relevant Performance Standards in all Reaches or sub Reaches.
- GE will submit sediment sampling plans to EPA for review and approval. These plans shall detail, at a minimum, the approach for collection of vertical sediment cores and the data analysis approach to determine compliance with the 100 mg/kg criterion.

6. GE will not dispose of material classified as federal RCRA hazardous waste, or free liquids, free product, or any intact drums, capacitors or containers, into the Upland Disposal Facility. GE can use relevant data from the RFI and apply the 20 times rule (i.e., dividing the concentration in the sample by 20 and comparing the result to certain threshold values described in 40 C.F.R. 261) to determine if there are compounds that could potentially exceed the Toxicity Characteristic Leaching Procedure (TCLP) testing requirements. GE can also use relevant data from EPA's 1.5- Mile Reach Removal Action (e.g., TCLP data and other RCRA Characteristic requirements including ignitability, corrosivity and reactivity). If existing data is not sufficient to demonstrate that material will not contain RCRA hazardous waste, then GE will propose additional sampling in the appropriate Work Plans. In any Subreach where RCRA hazardous waste may be present, GE will collect a reasonable number of composite samples for analysis (for example, TCLP sampling for metals). If any composite sample demonstrates the material is RCRA hazardous waste, then: a) the material can be treated until testing demonstrates that the material is non- hazardous, or b) the material can be disposed of at an off-site facility in compliance with EPA's off-site rule (40 C.F.R. § 300.440).
7. Any other materials to be disposed of not otherwise addressed above will be sampled prior to disposal and disposed of in the Upland Disposal Facility if they have less than 50 mg/kg PCBs. (This could apply to haul road materials, etc. that GE may need to dispose of as part of the overall remedy construction.)
8. GE will dispose of the segregated high concentration sediment, soil and waste materials, and any free liquids, free product, or intact drums, capacitors or containers, in any facility that is licensed/permitted to accept such waste and will accept it, including RCRA Subtitle C Landfills, so long as said facility is in compliance with EPA's off-site rule (40 C.F.R. § 300.440).



ANCHOR QEA

Figure 1
Upland Disposal Facility
Housatonic River – Rest of River

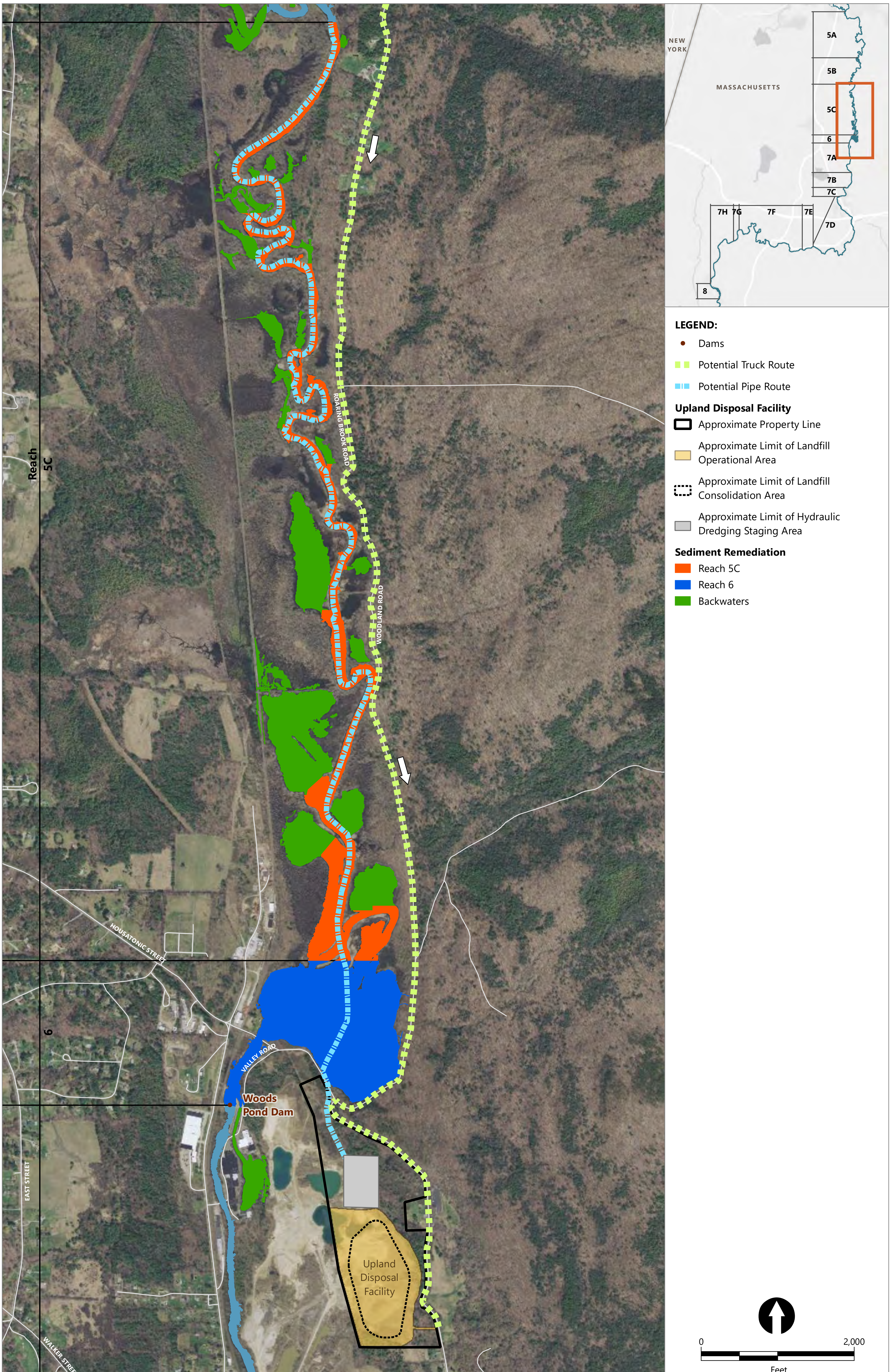


Figure 2

Potential Transport Routes for Reach 5C/Woods Pond Sediment to Upland Disposal Facility

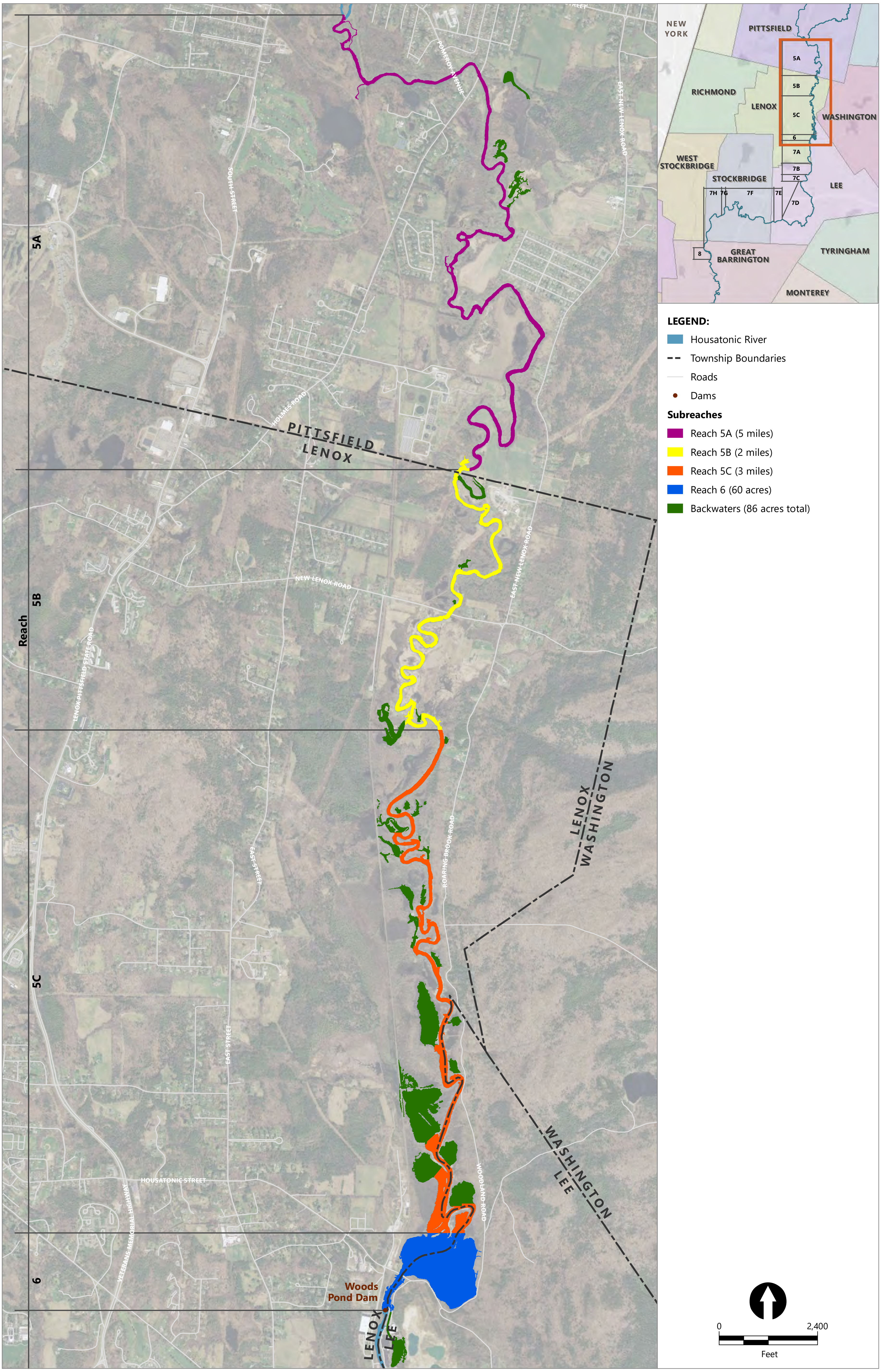
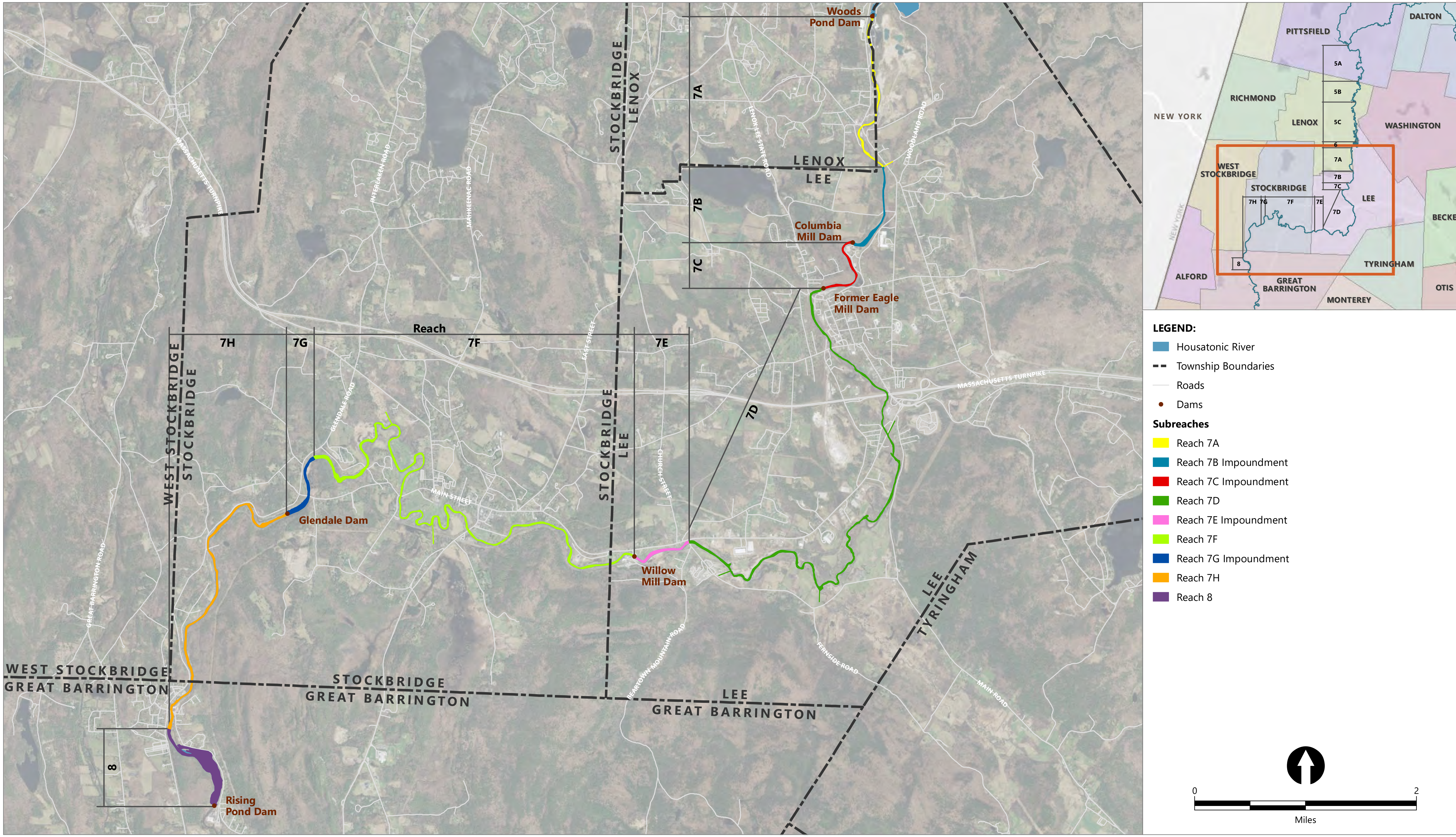
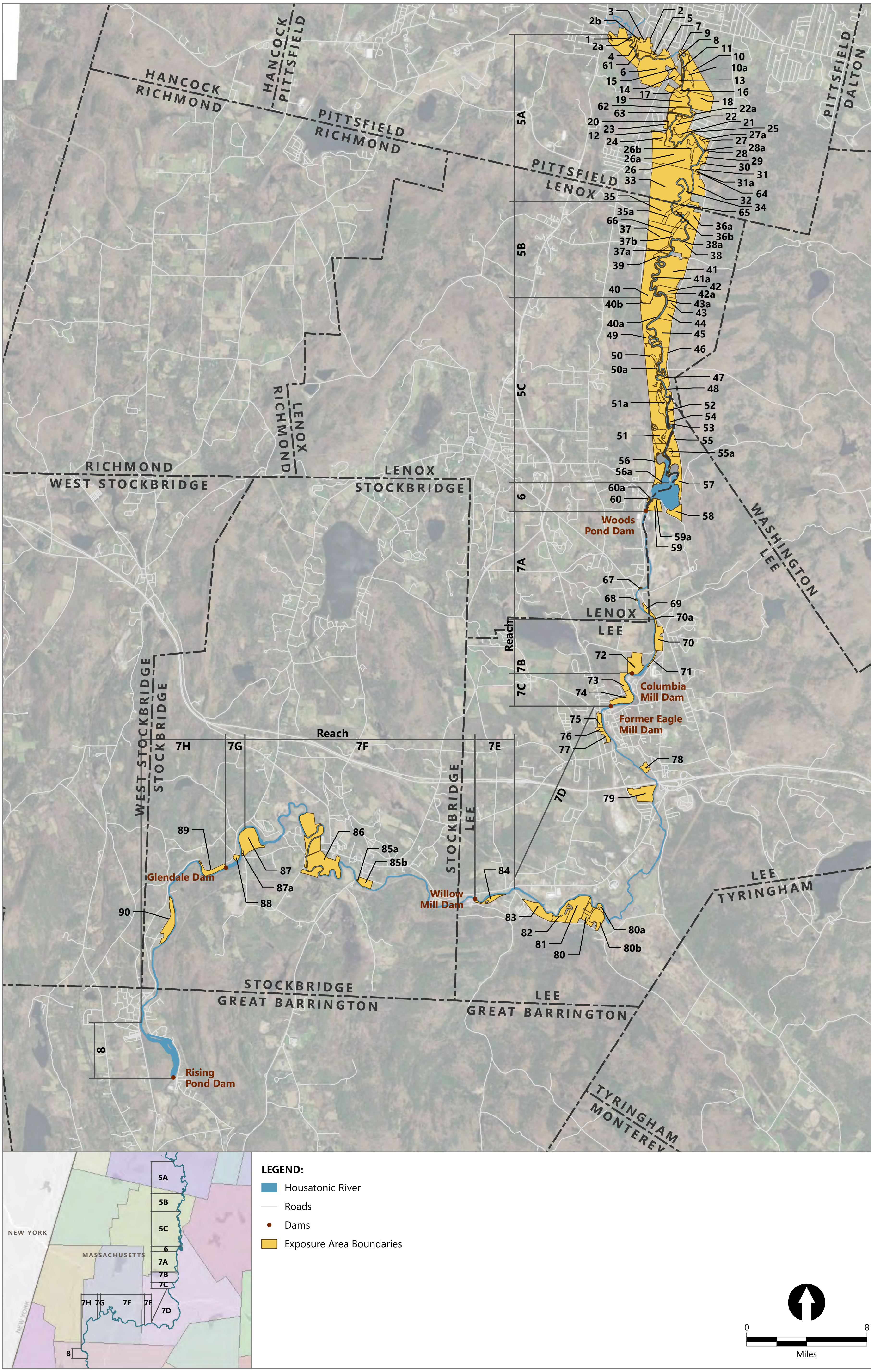


Figure 3
Subreaches in Reaches 5/6
Housatonic River – Rest of River



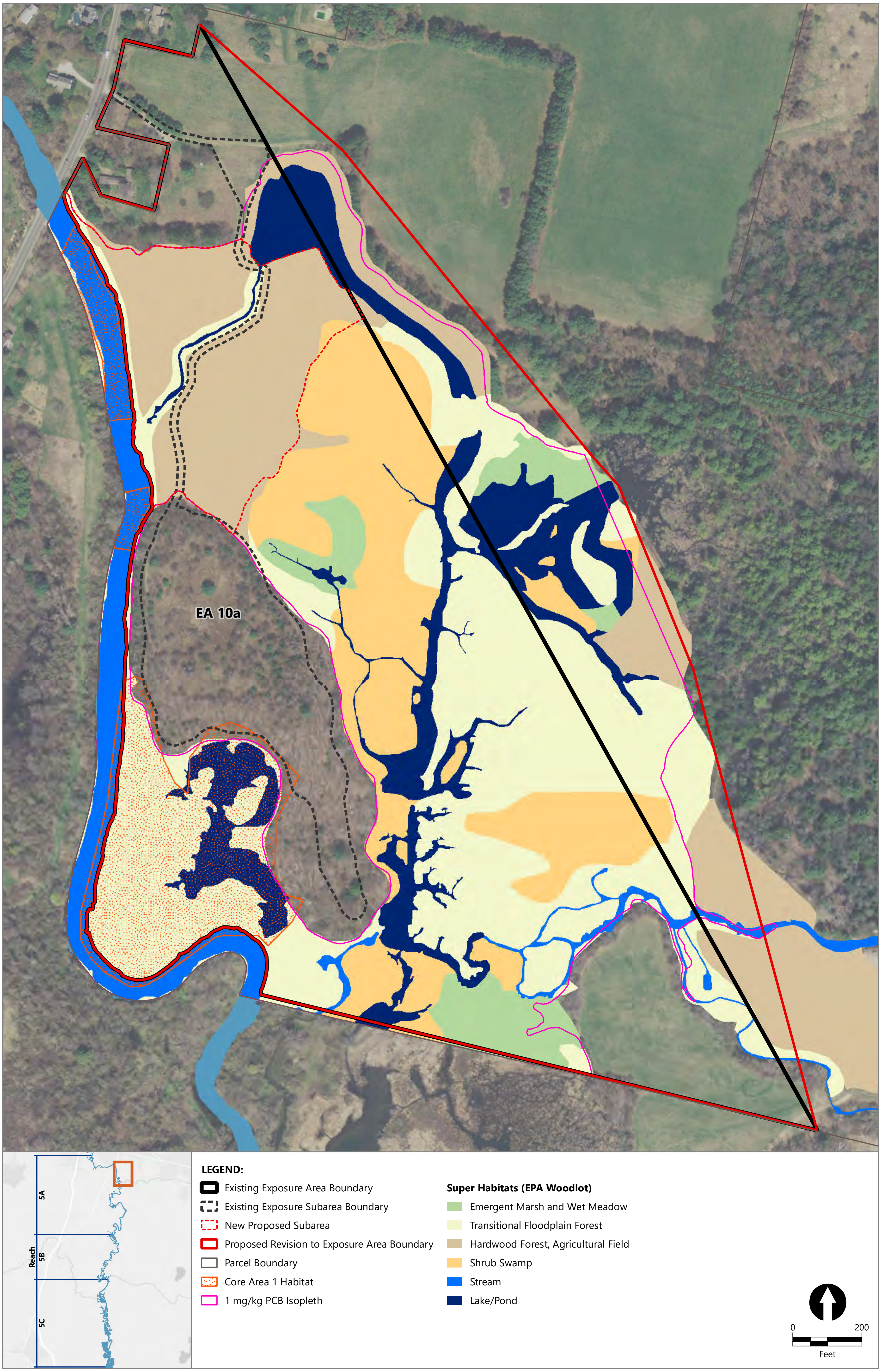
ANCHOR QEA

Figure 4
Subreaches in Reaches 7/8
Housatonic River – Rest of River



ANCHOR QEA

Figure 5
Exposure Areas in Reaches 5 to 8
Housatonic River – Rest of River



ANCHOR QEA

Figure 6
Mass Audubon Property Revised EA 10 Remediation
Housatonic River – Rest of River

DJ-17

From: **Cristobal Bonifaz** ccrbonifaz@gmail.com
Subject: Interdicipliaray Agreement
Date: February 8, 2023 at 10:51 PM
To: Cristobal Bonifaz ccrbonifaz@icloud.com, Cristobal Bonifaz ccrbonifaz@gmail.com

CB

From: **Christopher Brittain** CBrittain@town.lee.ma.us
Subject: RE: Settlement agreement
Date: February 2, 2023 at 5:38 PM
To: Cristobal Bonifaz ccrbonifaz@gmail.com

CB

Hi Cristobal,

The split is on page 4 of the Intermunicipal Agreement – highlighted below

Thanks!

3.
The Municipalities shall distribute any compensation received from GE, including interest thereon (the "Compensation"), in the following order and subject to the following provisions.

a.
The Compensation shall first be distributed to pay the full amount(s) of any costs incurred by any of the Municipalities to negotiate this Agreement.

b.
After the Compensation is distributed pursuant to subparagraph (a), any remaining Compensation shall be used to pay the full amount(s) of the fees or expenses of any escrow established pursuant to this Agreement for the deposit of the Compensation.

c.
After the Compensation is distributed pursuant to subparagraphs (a) and (b), any remaining Compensation shall be used to establish a reasonable monetary reserve, as determined by the COMMITTEE and administered by it or its successor, to pay for all legal, consulting and other expenses, fees or costs incurred in the administration, review and legal work related to any revised permit issued by EPA for the remedial work in the Housatonic River. If any funds shall remain in the monetary reserve following completion of the work under the revised permit, or if the Committee shall determine that such reserve is no longer required, such funds shall be paid to each of the Municipalities in accordance with the percentage of distribution to which each town is entitled as set forth in subparagraph (d), (1) and (2) below.

d.
Any Compensation remaining following the distribution of monies pursuant to subparagraphs (a), (b), and (c), shall be distributed as follows: (1) to each of Lenox and Lee, 45.90904% of the remaining Compensation; and (2) to each of Stockbridge, Great Barrington and Sheffield, 2.7273% of the remaining Compensation.

DJ-18

From: **Christopher Brittain** CBrittain@town.lee.ma.us
Subject: Lee Info
Date: July 11, 2023 at 4:32 PM
To: Cristobal Bonifaz ccrbonifaz@gmail.com

CB

Hi Cristobal,

See attached. The dump question was question 1 on the 2022 town election ballot 665 Yes, 390 No, 47 Blank– "Shall the town require the select board to rescind the town of Lee's approval of the Rest of River agreement".

Thanks,
Chris

may_16_2022_election...22.pdf

Press Release ROR C...p.docx

TOWN OF LEE, MASSACHUSETTS

Town Clerk's Office

Proceedings of the Town Elections
May 16, 2022

Rachael B. Armstrong, Town Clerk, declared the polls open at 7:00 am. Zero report was printed from the Image Cast tabulator and posted at 6:29:44am.

Election workers on staff throughout the day were Lucy Boldyga, Estella Ortiz Bodnar, Ann O'Brien, Jim Eithier, Sarah Navin, Elizabeth Mead, Caroline Calkins, Ann Mack, Sheila Viale, Marcia Slaminsky, Mary Swift, Sandy Cozzaglio, Dennis Forshee, Peter Waryoski, Ed Glickman, Jane Burns, Laura Page, Jean Monachina, Teresa Navin.

Police Officer Towne was there for 7:00AM and stayed until 4:00PM. Officer Wood took over from there and stayed until 9:15PM

Polls were declared closed at 8:00 pm. Results were printed from the Image Cast machine at 8:05:36pm. 1087 total ballots were cast on the image cast machine.

The following are the results of the election:

RACE	CANDIDATE	TOTAL
SELECT	BAILEY	576
	LANGLAIS	384
	R WRIGHT	128
	BLANK	4
QUES 1	YES	655
	NO	390
	BLANK	47

QUES 2	YES	633
	NO	418
	BLANK	41
QUES 3	YES	849
	NO	169
	BLANK	74
MODER	S WRIGHT	816
	BLANKS	269
	WRITE INS	7
PLAN	CARLINO	825
	BLANK	241
	WRITE INS	26
SCH 3 YR	LARMON	817
	BLANK	1340
	WRITE IN	26
	B STRICKLER	10
SCH 2 YR	NICHOLS	762
	BLANK	326
	WRITE IN	4
SCH 1 YR	KOSIOREK	763
	BLANK	325
	WRITE IN	4
DIST 1	DONOVAN	141
	FORREST	134
	TYER	143
	BLANK	228
	WRITE IN	2
DIST 2 (3)	BLUM	132
	DEVARENNES	168
	KENNEDY	136

	BLANK	171
	WRITE IN	4
		0
DIST 2 (2)	LANGLAIS	133
	BLANK	65
	WRITE	7
DIST 3 (3)	BORT	75
	MEAD	76
	BLANK	179
	WRITE	7
DIST 3 (2)	BLANK	102
	WRITE IN	11
		0
DIST 4	BAILEY	206
	BRUNNELL	183
	KALISCHER	144
	BLANK	255
	WRITE IN	7
DIST 5 (3)	ARMENT	75
	SORRENTINO	86
	BLANK	144
	WRITE IN	6
DIST 5 (1)	BLANK	99
	WRITE	5
DIST 6	HOFMAN	115
	TIERNEY	148
	BLANK	289
	WRITE IN	15

Total number of ballots used was 1092. This included:

37 Absentee Ballots
1 Provisional CAST (3 NOT cast)
3 Hand counted
1 UOCAVA

Total ballots cast was 1092 out of 4477 registered voters (24.39% voter turnout). There were 15 spoiled ballots.

Hand counts and write ins were tallied at the polling location. The used and unused ballots were sealed in separate containers and used ballots returned to Town Hall at 9:30 pm. Results were posted on the town website and sent to media outlets at 10:30pm

Rachael B Armstrong
Town Clerk

Records Request Reveals That BRPC Director Purposely Tried to Exclude and Mislead Lee's Rest of River Committee Members

Email records from BRPC Director Tom Matuszko shows a message to Attorney Matt Pawa stating "If you did want to discuss strategy with the Committee it might be better to do so closer to the May 4th date in case our Lee Committee member opponent gives those discussion comments to HRI's attorney (alternatively, and having watched way too much TV, you could provide misleading information to throw their attorneys off track.)"

In addition, when asked repeatedly by newly appointed Rest of River (RoR) member Josh Bloom, Mr. Matuszko is on record during a public meeting stating that he could not recall if any such conversations took place with Atty. Pawa prior to RoR meetings.

The Town of Lee and its residents have expressed numerous concerns over the Rest of River Committee's actions that have taken place over the past few months. In particular, the Rest of River Committee's vote to send counsel to the First Circuit Court to support GE's toxic waste dump in the Town of Lee and Pawa's statement at the First Circuit Court hearing where he stated that all 5 communities (including Lee) supported the controversial plan.

The Town of Lee filed a dispute on the vote to pay Attorney Pawa $15,000 to support GE's toxic waste dump in Lee. However, some Rest of River towns used delay tactics (such as filing objections to the selected mediator) to essentially deny Lee's request for mediation on the controversial vote.

Other related issues include an open meeting law violation that was up held by the Massachusetts Attorney General for an inaccurate and substandard agenda posting for the vote. Lee officials also have a pending record requests to BRPC to help determine if Mr. Matuszko may have shown intention to deceive the public on the agenda posting. BRPC has been unresponsive to these requests.

Furthermore, Mr. Matuszko refused to add public comment to meeting agendas following the controversial vote and subsequent open meeting law violations. Lee member Bob Jones made a plea to the other committee members from Lenox, Stockbridge, Great Barrington and Sheffield several times to allow public comment but no other members would even second his motion.

The Lee Select Board also reached out to the Lenox, Stockbridge, Great Barrington and Sheffield Select Boards to discuss the matter and all 4 boards refused to engage in a meeting.

Chair Bob Jones stated, "It's bad enough that Lee was sacrificed to house all of south county's toxic waste and it is even worse when our neighbors won't speak to us on the matter. Finding out the committee process has been corrupted, however, is reprehensible."

Board Member Sean Regnier stated that, "we always tried to view BRPC as an impartial facilitator but this is obviously not the case."

Member Gordon Baily said "It is tragic that there was an attempt by the BRPC Chair to request the attorney to deceive others. Lee is the town that will bear the brunt of this cleanup and will have the stigma of a pcb dump forever."

DJ-19

TOWN OF LEE BOARD OF HEALTH

Robert Wespiser, MD~ Chairperson~ Carisa Vincent, RN~ JoAnn Sullivan

DECISION
BOARD OF HEALTH OF LEE
ADJUDICATORY HEARING
ON THE MATTER OF THE PROJECTED UDF
April 27, 2023

The Housatonic River Initiative "HRI" petitioned the Lee Board of Health of Lee, Massachusetts "LBOH" to hold an adjudicatory hearing to establish whether a facility projected to be installed in Lee would be a risk of health to the residents of Lee and adjacent communities. HRI based its request on expert testimony supplied to LBOH by HRI, and implications of possible nefarious activity by EPA for granting the permit for the installation of the facility referred hereinafter as UDF.

HRI submitted to LBOH a report from David J. DeSimone which was very disturbing to the LBOH. In Expert DeSimone's words:

> "My primary concern for this site as a landfill is that a leak in the liner and leachate collection system will eventually occur; then, leachate will have no natural sediment barrier to flow in the subsurface." EPA has stated **"First, even the best liner and leachate collection systems will ultimately fail due to natural deterioration..."(53 Federal Register 33345, August 30, 1988).** "The sand and gravel aquifer will become contaminated, and leachate will easily infiltrate underlying bedrock. This is a poor site for a landfill" (emphasis added).
>
> **"The bottom line is the geology of the proposed PCB landfill location is very likely to result in leachate contamination of surficial and bedrock aquifers if leachate penetrates the landfill liners. Based upon site geology, PCB disposal in a landfill in this location is a very poor choice that may result in PCB contamination of the sand and gravel aquifer and the underlying Stockbridge marble aquifer**."(De Simone's Report found in EPA's administrative record.) (Emphasis in the original De Simone's Report Exhibit-1.

The implication that something nefarious might have occurred is described by HRI:

> "Let's be honest. What happened in this case is that, after the Board (Environmental Appeals Board) issued its remand decision, GE, the Region, and a number of other parties entered into closed-door settlement discussions that did not become part of the administrative record. GE threatened that, if the others did not agree to extensive on-site disposal of contaminated sediments, it would

> tie up the remediation of the river in court for decades, and the communities would end up with three, not one, on-site dumps. At the same time, GE offered that, if the communities would agree to one on-site dump and allow it to save $200 million (the difference in cost between on-site and off-site disposal), it would pay $55 million of that savings to the towns. Sadly, GE also offered large amounts of money to others, such as the Audubon Society, to agree to a deal. The Region, for its part, saw the deal to get a 23-year-old "monkey" off its back." (Reply Brief HRI in RCRA 21-01 at Page 1).

HRI is referring above to the 2016 EPA peer-reviewed decision of its scientists and engineers ordering GE to move all PCBs removed from the River, Pittsfield, Lee, Lenox, Great Barrington, Sheffield, and Stockbridge to a certified toxic dump site located outside the State of Massachusetts. This final decision was appealed by GE to the Environmental Appeals Board consisting of a triumvirate of administrative judges who overturned the part of its order requiring the PCBs to be buried at an out of state location. This GE win opens the door for the construction of the projected dump in Lee.

Given the seriousness of charges and the content of Expert DeSimone's Report, LBOH agreed to move ahead with the requested Adjudicatory Hearing.

Adjudicatory Hearings in Massachusetts are quasi-judicial proceedings governed by the Massachusetts Rules of Evidence.

LBOH made it clear to all participants that:

> LBOH will decide whether the UDF presents or does not present a risk to the health of residents of Lee and adjacent communities, based solely on expert testimony. LBOH requested all interested parties supporting or opposing the UDF to introduce such expert testimony either before the hearing or most preferably at the hearing so that members of LBOH can request further clarifications from the experts if needed. (Ex.- 1).

Notice of the projected adjudicatory hearing was sent to all interested parties on October 11, 2022. Between October 11, 2022, and November 8, 2022, LBOH sought and found independent of HRI, EPA or GE the projected engineering of the UDF. (Ex.-5) and raised with EPA specific questions addressing the issue of whether construction of the UDF might be a risk to the health to the residents of Lee and adjacent communities. EPA fully cooperated with LBOH in providing evidence EPA used in granting the permit for GE to construct and operate the UDF. (Exs. 1 to 4, and 6 to 12). All the aforementioned Exhibits were posted on November 8, 2022 on the web page of the Lee Board of Health through its website www.tritownhealth.org HRI was contacted and urged to make sure that the experts it intended to testify at the hearing read Exhibits 5 and 9 which deal directly with the engineering of the UDF.

The scheduled Adjudicatory Hearing took place on November 19, 2022. HRI introduced into the record the testimony of three experts. The first expert was Dr. David DeSimone; the same expert whose report was submitted by HRI in October of 2022 which also contained his qualifications. (Ex.-1).

Dr. DeSimone testified at the hearing that he had not read Exhibits 5 and 9 and that in fact he had not read anything related to the matter under consideration since 2020 (date of his report January 2020. Transcript at page 19). He offered no opinion as to whether the UDF as presently engineered as per Exhibits 5 (dated November 24, 2021) and 9 (dated November 8, 2022) presents a risk to the health of residents of Lee and adjacent communities. (Transcript at pages 21 and 22).

HRI then introduced the testimony of David Carpenter. Dr. Carpenter is the foremost expert on the dangers of PCBs in the United States. His expert qualifications were previously submitted by HRI to LBOH through Dr. Carpenter's sworn testimony in *American Kids et al. v. Sandra Lyon et al. Case No. 215-cv-02124-PA (AJWx)* partially quoted here.

> "My name is David O. Carpenter, and I am a public health physician, educated at Harvard College where I graduated magna cum laude in 1959 and at Harvard Medical School where I graduated cum laude in 1964. I have pursued a career in biomedical research and public health rather than patient care. I served as Director of the Wadsworth Center for Laboratories and Research of the New York State Department of Health from 1980-1985, then became the founding Dean of the School of Public Health of the University at Albany, a position I held until1998. My present position is Director of the Institute for Health and the Environment at the University at Albany. The Institute has been designated as a Collaborating Centre of the World Health Organization. I am also Professor in the Department of Environmental Health Sciences in the School of Public Health. I have over 400 peer-reviewed publications in the general fields of neuroscience and environmental health and am active in research and training. I teach graduate courses in environmental health, radiation biology and neurobiology/neurotoxicology."

Dr. Carpenter acknowledged he had not considered Exhibits 5 and 9 and offered no opinion as to whether the UDF as presently engineered would be a risk to the health of the residents of Lee. (Transcript pages 74-86).

HRI introduced the testimony of Clare Lahey describing her qualifications as an expert in statistics. Her qualifications and testimony have been posted on the web page of the Lee Board of Health. The content of her testimony is that EPA's decision in granting the permit for the UDF was arbitrary and capricious and an abuse of discretion. This issue is currently being litigated by HRI before the

Environmental Appeals Board. (*In Re: 2020 Revised pert etc. RCRA 21-01*). If the Environmental Appeals Board rules against HRI, they can appeal the issue to the First Circuit Court of Appeals. If they lose there, after a panel in the First Circuit Court of Appeals. If unsuccessful, then to an en-banc hearing in the same Court and eventually if it becomes necessary to the United States Supreme Court.

Her oral testimony mentioned that publications she had studied concluded that a percentage of the thousands of dumps across the United States leak and therefore the LBOH should evaluate the risk of leaks from the UDF based on this evidence. While she makes such a suggestion, the role of Boards of Health in Massachusetts is clear. Boards of Health in Massachusetts were established by MGL c. 111, §§ 31 and 143 in 1861 to safeguard the health of town residents and were granted power of issuing regulations to satisfy this end. Boards of Health are normally run by volunteers, have insignificant budgets and rely daily on expert testimony provided by State and Federal Agencies like The Massachusetts Departments of Health and Environmental Protection Agency the Federal Drug Administration. Boards of Health do not have the resources to hire scientists, engineers, physicians, or statisticians or take on lengthy studies on their own. There are rare occasions like this one in which the legal standard for reviewing the safety of an action by an agency is different from the legal standards to which Boards of Health must abide. (Ex.-2).

Ms. Lahey suggestion would involve locating all dumps in the United States engineered as the UDF, determine how many of these dumps have leaked, and whether the leaks contain PCBs and then evaluate the risk of the UDF leaking. This study is beyond the parameters set for this hearing and does not answer the question of whether the UDF as presently engineered presents a risk of health to the residents of Lee and adjacent communities.

HRI offered the testimony of its members all quoting different published articles about PCB dangers and dump leaks studied by others. LBOH took all these different publications under advisement and has posted them on its web site. LBOH is unable to consider all these publications as evidence in this hearing as all are hearsay testimony not admissible in an adjudicatory hearing under Massachusetts Rules of Evidence.

After November 19, 2022, BOH allowed introduction of additional testimony of Dr. David Carpenter. Dr. Carpenter submitted an Affidavit in which he stated his concern about evaporation of PCBs from the dump based on his studies of several toxic dumps located in the vicinity of the Hudson River that led to a concern that residents living within four miles of toxic dumps could be impacted by air carried PCBs. Dr. Carpenter's analysis suffers from the same flaws referred to above expressed by statistician Lahey described in the previous paragraph.

EPA agreed to participate in the adjudicatory hearing based on the premise stated in Exhibit-1, that BOH's judgment will be based "solely on expert testimony" and introduced into the record the opinions of its scientists and engineers who were forced by the EAB to oversee the dump to be located within the State of Massachusetts.

LBOH has evaluated all expert testimony introduced into the record by both parties and has concluded that based of all the expert testimony presented, LBOH was unable to conclude increased risk to health because the testimony introduced does not support that conclusion.

That said, LBOH would like to make some comments on the voluminous expert and non-expert testimony introduced into the record by residents of Lee who are understandably concerned about housing within its town border a toxic dump scheduled to introduce 2,000,000 tons of mud and soil containing 25-50 parts per million of PCBs for generations to come. (Ex.-9).

1. The Lee Board of Health is representing Lee, not the larger Housatonic region designated in the "rest of the river" agreement.

2. The dump, UDF, is only located in Lee.

3. PCB contaminated materials will be removed from their location in other towns, lessening those towns' total burden of exposure to PCB's.

4. The UDF brings additional PCBs to those already existing in Lee. Lee is the only town, including Pittsfield, in the entire GE/Housatonic cleanup, in which this increase in PCB burden occurs. The dump(s) in Pittsfield contain material collected only in Pittsfield.

5. In the long experience with landfills and liners, numerous examples of failure and eventual, environmental contamination have occurred. No technology appears to be foolproof.

6. Although the town of Lee's current water supply is at a higher elevation than the UDF, the aquifer is in a lower elevation. A containment breach may likely contaminate lower elevation water resources. Lee should not have to accept a "forever event" with more

PCB contamination and the accompanying increase in health risks. The possible future use of the aquifer should not be discounted.

7. Lee is the least economically advantaged town in the "rest of the river" group. Environmental injustice appears to be playing a role in the decision to locate the dump in the town of Lee. (Consideration should be given to involvement of well-established resources within the EPA and other organizations for examination of environmental justice concerns.)

8. Monitoring of the UDF is frequently mentioned as an important factor in maintaining safety. The responsibility for monitoring appears to be placed solely in the hands of GE's contractors. GE has a history of monitoring failures that have been documented in the public press. Utilizing GE as the responsible monitor does not appear to maximize the health of Lee residents given this history.

9. Concern has been raised regarding the lack of detail in the GE conceptual design plan provided to date. The EPA has responded that GE must submit a final design document with many more details. Many of these design and process details will have bearing on the risk to health of the residents of Lee. Given that these future details are not available, the Lee Board of Health is unable to fully assess the effect that many factors have on health. Many elements are not yet delineated, including but not limited to handling of PCBs, transportation, containment, contamination of equipment, and monitoring reliability.

10. The Lee Board of Health acknowledges that the overall focus of the EPA is to balance many different factors, including compromises in addressing cost and effects on human health. The Lee Board of Health, however, does, and should limit its interest to the risk to health concerning only the residents of Lee.

11. There appears to be a significant lack of data regarding the safety experience and other dumps in other similar situations across the US. Comparison of health risks in various remediation scenarios have not been available. Much of the analysis on both sides of the controversial issues appears to rely on speculation and extrapolation.

By taking these concerns into consideration, The Lee Board of Health hereby considers that the proposed UDF may pose an increased risk to the health of the residents in Lee.

Additionally, the LBOH will refer this matter and all evidence collected to the Town of Lee which has already taken legal action seeking a jury to award the Town sufficient funds outside the purview of GE and EPA to remove all the PCBs from the Town of Lee.

As voted and approved by the Lee Board of Health on April 27, 2023

Robert Wespiser MD, Chair Lee Board of Health

Robert Wespiser MD

Carisa Vincent

Cari Vincent

JoAnn Sullivan

JoAnn Sullivan

DJ-20

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

SPECIAL UNDERTAKING BY PURCHASERS OF POLYCHLORINATED BIPHENYLS

Monsanto Company ("Monsanto") manufactures certain polychlorinated biphenyl products ("PCB's") which General Electric Company ("Buyer") desires to purchase. While Buyer desires to purchase PCB's because of certain desirable flame resistant and insulator properties, Buyer acknowledges that it is aware and has been advised by Monsanto that PCB's tend to persist in the environment; that care is required in their handling, possession, use and disposition; that tolerance limits have been or are being established for PCB's in various food products.

Monsanto has therefore adopted certain restrictive policies with respect to its further production, sale and delivery of PCB's, including the receipt of undertakings from its customers as set forth below, and Buyer is willing to agree to such undertakings with respect to sales and/or deliveries of PCB's by Monsanto to Buyer.

Accordingly, Buyer hereby covenants and agrees that, with respect to any and all PCB's sold or delivered by or on behalf of Monsanto to Buyer on or after the date hereof and in consideration of any such sale or delivery, Buyer shall defend, indemnify and hold harmless Monsanto, its present, past and future directors, officers, employes and agents, from and against any and all liabilities, claims, damages, penalties, actions, suits, losses, costs and expenses arising out of or in connection with the receipt, purchase, possession, handling, use, sale or disposition of such PCB's by, through or under Buyer, whether alone or in combination with other substances, including, without implied limitation, any contamination of or adverse effect on humans, marine and wildlife, food, animal feed or the environment by reason of such PCB's.

0041818

All existing contracts for the sale of PCB's by Monsanto to Buyer are hereby amended to contain the provisions set forth above.

Nothing herein shall create or imply any duty or obligation of Monsanto to sell or deliver any PCB's to Buyer. No conditions, understandings or agreements purporting to modify or vary the terms hereof shall be binding unless hereafter made in writing specifically referring to this agreement and signed by the party to be bound and no modification or variance of the above undertaking shall be effected by the acknowledgment or acceptance of any sale document, purchase order, shipping instruction or other forms containing terms or conditions at variance herewith.

GENERAL ELECTRIC CO.
(Buyer)

BY: Walter A. Schlotterbeck

TITLE: Vice President and Corporate Counsel

DATE: January 21, 1972

MONSANTO COMPANY

BY: E. A. Putzell Jr.
Vice President

0041819

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4th Quart 1949	[redacted]	Everett - Powerhouse	Reticulum cell sarcoma of the neck.		D+2-10-50
4th Quart 1949	[redacted]	New York - Sales	Larynx		D-03-01-58
1st Quart 1949	[redacted]	Birmingham - Sales Mgr.	Thyroid		D-June '50
2nd Quart 1949	[redacted]	Gen. Mgr. St.Louis -Org. Chem. Div.	Lymphosarcoma of mediastinum & parotid		D-1st Quart 1951
3rd Quart 1950	[redacted]	St. Louis - Sales	Squamous cell carcinoma of esophagus. Explor. operation-July, 1950		D-4th Quart 1950
1st Quart 1950	[redacted]	Dayton, Unit I - Guard	Kidney		D
3rd Quart 1950	[redacted]	Dayton, Unit V -Accountant	Basal cell carcinoma, ri. post-auricular area		D-03-19-55
1947	[redacted]	Queeny Plt -Truck Driver	Multiple squamous cell epitheliomata, face & neck		D-12-28-50
2nd Quart 1950	[redacted]	Queeny Plt -Tractor Driver	Adenocarcinoma of submaxillary salivary gland		D-1952 D 9-8-82
2nd Quart 1950	[redacted]	Operator Phthalic Anhydride Queeny Plt	Squamous cell carcinoma of mediastinum (hilus, left lung,prob. arose in bronchus		D-1st Quar 1951 D-3-12-51
Fall 1947	[redacted]	Operator Queeny Plt-Sulfonamide Dept.	Bronchogenic carcinoma (with metastases)		D 4-26-48
2nd Quart 1950	[redacted]	Queeny Plt - Supervisory	Rt. temporal astrocytoma		D-06-12-51
Fall 1948	[redacted]	a man with this name at KK Queeny Plt -Chemical Eng.	Ewings Sarcoma - left ilium		D
3rd Quart 1950	[redacted]	Operating Record Queeny Plt -Clerk	Myoblastoma -ri. arm.		D-04-04-71
2nd Quart 1950	[redacted]	Everett - Mason	Adenocarcinoma of the stomach.		D-06-21-63
3rd Quart 1950	[redacted]	Janitor Everett -Locker Department	Prostate with osteoblastic & nodal metastasis		D-12/14/50
4th Quart 1950	[redacted]	Incinerator Queeny Plt-Operator	Lower lip		D-08-23-57
3rd Quart 1950	[redacted]	Locomotive Everett -Engineer	Carcinoma of lung with brain metastasis.		D[illegible]
3rd Quart 1950	[redacted]	Mason and Yard Everett -Sweeper	Obstruction due to carcinoma of rectum		D-12/26/50

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CANCER INDEX
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Per Dr. Binney's memo, 10/24/50, these people had neoplasms identified or known "during the past 3 yrs"

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4th Quart 1950	[redacted]	Carondelet	Skin		D-03-21-77
1949	[redacted]	Queeny Plt - Electrician	Basal cell carcinoma of the face just in front of rt. ear.	DD 7-7-?	Excised 2/51 with apparent cure
2nd Quart 1951	[redacted]	Everett	Carcinoma of head of pancreas with metastasis		D-4/3/51
3rd Quart 1951	[redacted]	Queeny Plt - Garage Mechanic	Bladder. Treated & presumably cured.	56 43	D-5/23/64
1949	[redacted]	Krummrich Plt	Carcinoma of Colon		D-9/23/51
1949	[redacted]	Everett	Malignant gastric ulcer	39	09-26-57 D-10/31/49
	[redacted]	Springfield - Saflex	Face		D 10-26-77
	[redacted]	Springfield - Styrene	Face, arm		D-02-25-62
	[redacted]	Springfield - Yard	Face		
	[redacted]	Springfield - Acetate, Nitrate	Leukemia		D-07-21-49
	[redacted]	Springfield - Acetates, Nitrates, Resins, Office	Colon		D-06-21-75
	[redacted]	Springfield - Steel wire mill elsewhere	Face, probable		
	[redacted]	Springfield - Payroll	Peritoneal metastases, ovaries(?)		D
	[redacted]	Springfield - Acetate, Nitrate	Face		D-11-24-66
	[redacted]	Springfield	Tumor of breast (non-malignant)		D-04-14-69
1st Quart 1950	[redacted]	Springfield - Secretary	Papillary adenocarcinoma of bladder (recurrance)		
1st Quart 1950	[redacted]	Mound Lab - Lab Director	Carcinoma of prostate	47	D-1/1/52
1st Quart 1950	[redacted]	Everett	Gen. carcinomatosis Carc. of Pancreas & gall bladder	60	EX P-0013 Page 31 of 32
1st Quart 1950	[redacted]	Anniston	Main cause of death, nephritis with uremia. Also had cancer of colon & diabetes.	64	D-5/27/52

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CANCER INDEX

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	Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
X	1952	[redacted]	Queeny Plt - Worker B-5 3/28/51 to 2/13/52 & 3/3/52 to 4/25/52	Prostate	47	D-6/22/52
X	1952	[redacted]	Shawinigan	Tumor of bowel		D-09-26-54
X	1952	[redacted]	Nitro	Bladder		D-7-23-85
X	1952	[redacted]	Springfield	Rectum	67	D-3/31/54
X	1952	[redacted]	Nitro	Throat (esophagus)	61	D-11/22/53
X	1952	[redacted]	Dayton (Mound)	Throat - midposition		8-28-59 D-~~[illegible]~~
X	1952	[redacted]	Shawinigan	Colon		D-09-26-54
	1952	[redacted]	Main Office	Leukemia	18	D-11/6/52
X	1952	[redacted]	Springfield	Oatcell carc. of lung, involve. of pericardium of esophagus & media-stinal nodes.	57	D-10/19/52
X	March, 1952	[redacted]	Nitro	Bladder		D-08-22-66
X	1952	[redacted]	Everett	Kidney		D-09-03-76
X	1952	[redacted]	r Nitro	Lungs	62	D-12/15/52
X	--	[redacted]	Camden	Bladder	72	D-1/5/53
X	--	[redacted]	Everett	Renal Cell		D-09-03-76
X	2/6/53	[redacted]	Krummrich Plant	Prostate	61	D-12-28-64
X	1953	[redacted]	Springfield	Prostate. Terminal stage of pelvic & bone metastasis on 4/28/53	64	D-09-25-53
X	1953	[redacted]	Queeny	Bile duct, Cirosis of liver	[illegible]	D-5/22/53
X	1953	[redacted]	Springfield	Right ll. of lung.	45	[illegible]
X	1953	[redacted]	Krummrich	Bronchogenic Carcinoma	45	D-7/15/53

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
1953	[redacted]	Queeny Plant	Rectum, metastatic Hydranephrosis	44	9/12/53-D
1953	[redacted]	Everett	(Brain) Gilobastoma multiforme	59	9/27/53-D
10/28/53	[redacted]	Anniston	Lung	48	D-07-03-66
10/29/53	[redacted]	Queeny	Rectum		
1953	[redacted]	Everett	Left lung, Epidermoid Carcinoma	60	10/22/53-D
3/54	[redacted]	Akron - Shipping Clerk	Lung. Lobectomy performed / Employed 33yrs 3/54		D-03-26-57
5/54	[redacted]	Tennessee	Lympho Carcinoma	52	D-5/16/54
8/54	[redacted]	Main Office - Invoice Clerk	Rectum		D-08-31-54
---	[redacted]	Queeny Plt - Salaried	Lung	44	D-8/12/54
9/54	[redacted]	Soda Springs, Idaho	Right kidney		D-11-14-54
12/54	[redacted]	Everett	Stomach	50	D-11/27/54
---	[redacted]	Queeny - wage employe	Lung		D-3/14/55
----	[redacted]	Krummrich Plant	Lung bronchogenic		D-6/27/55
----	[redacted]	Shawinigan	Malignant polyps of colon.		D-7/16/55
----	[redacted]	Springfield	Kidney	57	D-7/14/55
----	[redacted]	Krummrich Plant	Stomach	59	D-10/17/55
----	[redacted]	Everett	Rectum	58	D-3/21/56
----	[redacted]	Employed 25 years Night Supervisor - Everett	(metastasis Lip malignancy)	47	[illegible]
----	[redacted]	Everett- Operator in Bisulfite Dept.	Adeno carcinoma of rectum	56	

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
---	[redacted]	Employed 16 years Everett - Op. in DOP Dept.	Adenocarcinoma of the colon.	54	D-9/17/55
---	[redacted]	Everett	Liver	47	D-11-02-56
Feb. 1957	[redacted]	--	Reticulum Sarcoma Mediastenium	55	D-02-11-57
Feb. 1957	[redacted]	Krummrich - Hourly worker	Metastasis carcinoma carcinomatosis	50	D-02-24-57
---	[redacted]	(May be subject to Workmens Nitro . Compensation)	Liver, pancreas & spleen	53	D-03/13/57
---	[redacted]	Addyston - Lead man	Lung	64	10-3-57 D-[illegible]
1957	[redacted]	Monsanto, Tenn.	Lung	51	D-11-16-57
March 1958	[redacted]	Mound Laboratory	Malig. of prostate gland	58	D-09-04-62
April 1958	[redacted]	Krummrich Plant	Bronc. cancer carcinoma	52	D-07-04-58
April 1958	[redacted]	Queeny Plt	Bladder (?)		D-04-13-73
April 1958	[redacted]	Queeny Plt	Left lung	49	D-03-30-58
April 1958	[redacted]	Everett Plant	Larynx	66	D-03-13-66
April 1958	[redacted]	~~Everett~~ KR. on Mont	Lung		D-7/15/58
5/19/58	[redacted]	mont Monsanto, Tennessee	Liver	53	D-12-08-58
5/19/58	[redacted]	Trenton - wage employe	Left lung	58	D-10-19-58
1952	[redacted]	Nitro	Prostate	61	D-8/31/52
5/26/58	[redacted]	Springfield - wage employe	Left lung; exploratory thoracotomy, 3/27/58.	54	D- 10/[illegible]/57
6/6/58	[redacted]	Everett Plt	Cecum, metastasis	[illegible]	EX P-0013 Page [illegible]
6/16/58	[redacted]	Springfield, hourly	Carcinoma of pancreas	46	

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
6/24/58	[redacted]	Springfield - salaried	Carcinoma rectal sigmoid	45	D-05-01-61
6/27/58	[redacted]	Texas City -wage employe	Chin	52	D-02-26-70
8/58	[redacted]	Krummrich Plant	Tongue		D-09-25-58
8/58	[redacted]	Krummrich Plant	Bronchogenic sarcoma	52	D-8/28/58
8/58	[redacted]	Barton	Lip		D-08-06-70
9/23/58	[redacted]	Trenton	Lung	59	
9/23/58	[redacted]	Trenton	Lung	38	D-9/13/58
9/30/58	[redacted]	Springfield - wage employe	Pancreas	46	
9/30/58	[redacted]	(Mobay) New Martinsville -salaried	Cecum		D-02-20-63
10/3/58	[redacted]	Queeny Plant - hourly	Pancreas	64	D-11-27-58
10/10/58	[redacted]	(Dept. Mechanic) Queeny Plant - wage employe	Right colon	57	D-9/6/61
10/10/58	[redacted]	Texas City - hourly	Right eye	52	D-02-26-70
10/17/58	[redacted]	Lion Oil - El Dorado wage	Pancreas	54	D-10-29-58
10/58	[redacted]	Shawinigan - Springfield	Left mass facial fold	46	
11/58	[redacted]	Seattle	Stomach	[illegible]	D-11-11-58
12/11/58	[redacted]	Trenton	Bladder	58	D-07-29-65
2/13/59	[redacted]	(Chief Operator) Queeny Plant - hourly	Bladder	54	D-2/25/64
3/6/59	[redacted]	Mon., Tenn. - hourly	Carcinoma of descending colon	57	
3/11/59	[redacted]	St. Louis Office-salaried	Lung	63	D-05-02-61

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/12/59	[redacted]	El Dorado, Ark.-Wage	Generalized in lymphic system of the body	50	D-9/26/59
11/13/59		(Cafeteria - part-time) Queeny Plant-St. L.-Wage	Adenocarcinoma of Uterus	45	L - D 9-9-6
11/20/59		Krummrich-Hourly	Carcinoma of Lung	57	D-11/16/59
11/20/59		(Helper-Tech.Melamine) Everett - Hourly	Carcinoma of Bladder	52	~~L~~-D ~~9/60~~ 09-09-60
12/8/59		Everett - Salaried	Metaestatic Carcinoma	42	D-02-11-60
12/18/59		Everett - Hourly	Carcinoma of Colon	62	D-03-30-60
12/23/59		Krummrich - Hourly	Carcinoma of Bladder	48	L
12/23/59		Mound Lab - Hourly	Carcinoma of Cervix	40	L
1/22/60		(Mechanic) Queeny Plant - Hourly	Carcinoma of Bladder	44	L
1/22/60		(Chemical Operator) Krummrich - Hourly	Basal cell carcinoma of left lateral canthus	34	L
3/11/60		(Chem. Operator) El Dorado - Hourly	Carcinoma of Lung	50	D-01-07-61
3/29/60		(Helper & Laborer) Krummrich-Hourly	Carcinoma of Stomach	53	D-03-06-61
4/15/60		(Welder-1st class) El Dorado Ref.-Hourly	Carcinoma of Pancreas	59	D-07-29-60
6/17/60		(Mechanic) Queeny Plant - Hourly	Carcinoma of Colon	55	D-02-17-61
6/24/60		(Chief Operator) Texas City - Hourly	Cancer of the Lung	53	D-02-09-62
7/11/60,		Springfield (Office)	Cancer of the breast	43	D-02-21-61
7/18/60		(Foreman in Mftg.) Monsanto, Tenn.-Salaried	Carcinoma, left vocal cord	57	D-01-31-74
7/18/60		(Chemical Operator) Shawinigan Resins-Wage	Carcinoma of the thyroid	45	D-03-25-63
7/22/60		(Shift Engr.-Power Dept.) Texas City-Wage	Epidermoid carcinoma of left lung	44	D-01-25-61

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
3/11/59	[redacted]	St. Louis Office (Sal.)	Stomach	62	D=12/8/59
3/20/59		Spfld.(hourly) Chem. Op.	Metastatic Ca of Hip and pelvis, secondary to Ca. of Hip.	64	D-09-20-59
3/20/59		Texas City (hourly)	Ca. of the Scalp	37	L
6/8/59		Spfld. (hourly)	Basal Cell Ca of Rt. Lower Eyelid	56	L
6/19/59		Queeny (hourly)	Ca. of Lung	54	D-6/22/59
6/26/59		Mound Lab (Sal.)	Endometrial Ca of cervical invading the entire cervical canal probably the lower uterine segment and anterior lip of cervix	40	D-06-30-60
7/31/59		New York Ofc. (Sal.)	Ca., Rt. Breast	27	L
8/20/59		Dayton (Sal.)	Rt. Lung	63	D-12-18-59
8/21/59		El Dorado Chem. Plant (hourly)	Lower lip	52	L
8/31/59		Anniston (Hourly)	Rectosigmoid	58	D-07-07-63
9/17/59		Krummrich (Hourly)	Metastasis	49	D-9/9/59
10/16/59		Spfld. (Hourly)	Lung	55	D-~~11/10/59~~ 10-24-59
10/28/59		Krummrich (Hourly)	Lung	60	D-~~10/59~~ 10-07-59

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/29/60	[redacted]	Queeny (Pipefitter)	Urinary Bladder	51	D-09-21-61
8/26/60		Texas C. (Wage)(Operator)	Larynx	62	D-10-07-61
8/26/60		Texas C.-Wage (Operator)	Possible Ca Lungs	61	D-04-26-61
9/28/60		Spfld.-Salaried (Office)	Brain Tumor	30	D-08-17-60
10/13/60		T.C. (Machinist)	Metastatic Adenocar-cinoma	31	D-9/17/60
11/11/60		El Dorado - Sal. (Office)	Cervix	38	L
12/5/60		El Dorado - Sal. (Office)	Fallopian Tube	59	D-11-28-60
12/9/60		Queeny - Wage (Chem. Op.)	Bladder	45	D-01-21-70
1/3/61		Shawinigan, Spfld. - Wage	Basal Cell Cancer	37	L
5/8/61		Texas City(Painter-Leadman)	Squamous Cell Car-cinoma of left Mandible	54	D-02-26-70
5/23/61		Spfld.-Wage(Production)	Bronchogenic Ca.	59	D-06-05-61
10/24/61		Spfld.-Wage (Production)	Carcinoma of colon	63	D-09-12-62
2/23/62		Krummrich - Wage(Chem. Op.) (Dept. Mechanic)	Multiple myeloma] (NO TUMOR)	54	D-02-28-64
3/23/62		Queeny - Wage (PAB)	Carcinoma in situ Bladder	51	~~L~~ D 1-14-83
4/27/62		(Raw Materials Helper) Columbia, Tenn.	Prostate	56	D-07-19-63

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/13/62	[redacted]	Springfield - W (Production)	Head of pancreas	64	D-10-16-63
9/29/62		Queeny Plant (Chief Op.)	Carcinoma of Right Lung & mastitis		D-9/20/62
9/29/62		Queeny Plant(Dept.Mechanic)	Bronchogenic Cancer		D-8/9/62
10/2/62		Springfield (Production)	Metastatic Carcinoma	56	D-11-22-62
7/15/63		Texas City(Instrument man)	Carcinomatosis	63	D-~~1962~~ 08-01-62
"		Shawinigan (Clerk-Typist)	Cancer of Lungs	35	D-~~1962~~ 09-01-62
"		(Office) General Offices - St. Louis	Malignant meanoma of back	57	D-~~1962~~ 03-17-62
"		Krummrich (Maint.Foreman)	Cancer of Lung	61	D-~~1962~~ 04-23-62
"		Nitro (Maintenance Man)	Cancer of Lung	53	D-~~1962~~ 07-25-62
"		General Offices (Office)	Generalized cancer	45	D-~~1962~~ 06-17-62
"		(Night Superintendent) Texas City	Cancer of Liver	@50	D-~~1962~~ 06-19-62
"		General Offices (Sec'y.)	(Cancer of Liver, (Colon, Ovaries, Skull	42	D-~~1962~~ 06-10-62
"		Barton - Sr. Operator	Cirhossis of Liver	43	D-~~1962~~ 01-07-62
"		(Material Handler) New Martinsville	Cancer of Pancreas	50	D-~~1962~~ 06-25-62
"		~~Queeny~~	~~Cancer of Lung~~	~~61~~	~~D-1962~~
"		(Chief Clerk-Purch.) Texas City	Cirrhosis of liver	61	D-~~1963~~ 04-28-63
"		Carondelet (Utility Man - Production)	Cancer of bladder with metastasis to spine	45	D-~~1963~~ 04-08-63
"		(Plant Guard) New Martinsville	Cancer of Brain	54	D-~~1963~~ [illegible]-63

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/15/63	[redacted]	Texas City (Operator)	Brain	55	12-18-62 D-[illegible]
7/15/63		Queeny (Guard-Prev.Chem.Op.)	Lung	62	03-20-63 D-[illegible]
7/19/63		Monsanto, Tenn.	Prostate w/generalized bony metastasis	57	D-07-19-63
9/30/63		Mound Lab.-Fireman,Driver	Carcinomatosis Primary unknown at present.	60	D-02-17-64
11/25/63		Krummrich (Pipefitter)	Ca. Pancreas]	58	D-11/24/63
12/20/63		Krummrich (Blacksmith)	Metastic Ca. of Cervical Gland and Pleural effusion	60	D-01-12-64
12/20/63		Texas City (Pipefitte/ Leadman)	Rectum	56	D-12/4/63
1/31/64		Springfield(Production)	Rectum	63	D-1/23/64
2/5/64		G.O. (Admin)	Brain	42	D-1/20/64
2/5/66		Spfld- wage (Production (Chief Maintenance Man)	Lungs	50	D-1/22/64
2/10/64		Santa Clara-wage	Leiomyosarcoma of the jejunum with metastasis	59	D-2/1/64

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CANCER INDEX.

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/18/64	[redacted]	Queeny Plant (Porter)	Prostate	60	D-02-24-67
2/26/64	[redacted]	Spfld.,hourly (Production)	Lymphosarcoma	36	D-02-18-65
4/1/64	[redacted]	Nitro-Wage (Gate Attendant)	Abdomen	42	D-3/15/64
4/7/64	[redacted]	Salaried El Dorado (Office Worker)	Abdominal Cavity	56	D-2/11/64
4/9/64	[redacted]	Queeny Plant (Chem. Op.)	Bladder	52	L
5/12/64	[redacted]	Queeny (Packer)	Prostate	56	D-01-29-70
4/9/64	[redacted]	Springfield (Production)	Prostate	64	L
6/5/64	[redacted]	Everett (Op.-Tech.Melamine)	Esophagus]	63	D-05-31-64
7/10/64	[redacted]	Queeny (Chem. Op.)	Lung]	56	D-3/24/65
7/14/64	[redacted]	Everett	Bronchiogenic	60	D-12-04-64
7/17/64	[redacted]	Queeny (Chief Operator)	Pancreas	60	D-10-04-64
8/12/64	[redacted]	(Storeroom Attendant) Krummrich Plant	Rectum	62	D-08-29-71
8/17/64	[redacted]	Krummrich-hourly(Chem.Op.)	Lung	51	D-10-05-64
8/17/64	[redacted]	Lion Oil Distributor	Abdomen	63	D-09-27-64
11/6/64	[redacted]	Spfld.(Materials Clerk)	Bladder	62	D-03-21-73
11/18/64	[redacted]	Spfld.-hourly(stock Handler)	Liver	42	D-~~11/64~~ 10-30-64
11/24/64	[redacted]	(Stock Handler) Spfld.-Shawinigan	Colon Cecum	50	D-7/23/67

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
12/3/64	[redacted]	(Reduction Op. H-acid) Everett - hourly	Tongue	57	D-11/20/64
12/3/64		(Patent Atty.) St. Louis - G.O.	Right renal cell w/metastasis	43	D-10/1/64
12/22/64		(Chemical Laborer) Krummrich Plant	Lung	49	D-12/16/64
1/13/65		Nitro (Janitor)	Larynx	64	D-01-28-78
1/15/65		(Office Worker) El Dorado - hourly	Lung	59	D-12/31/64
1/22/65		(Rigger) Krummrich - hourly	Widespread cancer-primary site unknown	60	D-1/10/65
2/10/65		Queeny - wage (Chem. Op.)	Pancreas with metastasis to liver and lymph nodes.	54	D-3/31/65
2/17/65		(Office) Springfield - salary	Generalized carcinomatosis due to cancer of breast.	49	D-1/26/65
3/25/65		(Millwright) Queeny Plant - hourly	Stomach	54	D-5/2/65
3/29/65		(Powerhouse Ash Handler) Krummrich Plant -	Lung	52	D-06-27-65
4/29/65		(Finisher) Stonington - hourly	Stomach	55	L
5/3/65		Everett (Head Op.-bisulfite)	Nose	62	L
"		Queeny - hourly-Warehouseman	Rectum metastasis to liver	54	L D-8/2/65
"		Krummrich (Chem. Operator)	Larynx	56	L
"		Queeny (Chem. Operator)	Bronchogenic-left lobe	58	(D-9/12/65)
5/14/65		Everett (1/c Painter)	Lung	45	

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/18/65	[redacted]	MAC Station	right colon	47	D-12/27/65
6/2/65		Krummrich (Chem. Operator)	bronchogenic	56	D-8/10/66
6/9/65		Queeny (Pipefitter)	Hodgkins Disease rt. anterior chest wall lymph nodes rt. axilla and left groin.	43	D-08-26-76
6/21/65		Columbia, Tenn. (Elect.)	Lymphosarcoma	40	D-04-08-72
6/23/65		G.O. (Salaried - Admin.)	Lung	49	D-4/30/65
6/23/65		Janitor Port Plastics (wage)	Bronchiogenic with metastasis to brain	60	D-5/26/65
7/28/65		Krummrich (wage) [Painter]	Bronchiogenic w/ cerebral metastasis	58	D-7/10/65
8/17/65		Queeny (salaried) Project Planner Maintenance Dept.	Abdomen	47	D-7/23/65
9/3/65		Queeny Plant (wage) Chemical Operator	Bronchiogenic adeno-carcinoma - rt. upper lung.	56	D 12-22-85
9/28/65		(Finisher) Deep River-Hourly	Breast w/metastases to bones, skin, liver	44	D-9/13/65
9/21/65		Nitro (Pipefitter)	Squamous cell carcinoma - Recurrence	52	L
10/19/65		Krummrich (iron worker helper)	Sarcoma of bone and sclerosis of liver.	56	D-8/26/65

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
12/15/66	[redacted]	Columbia (hourly) Mechanic	Metastatic ca of abdomen. Primary site unknown.	51	L D-12/22/66
12/21/66	[redacted]	Deep River (wage) Mach. Op. B	Malignant lesion 8th vertebra (Widespread carcinomatosis)	49	D-1/13/67
12/22/66	[redacted]	ElDorado (hourly) (Station Engineer-pipeline sec.)	Liver (ca widespread)	61	D-2/1/67
12/23/66	[redacted]	Deep River (hourly) Maint. Mech. C)	Rectum	58	D-05-29-68
1/5/67	[redacted]	Mac Station Supervisor (Machinist)	Anoxia due to infiltration of lung by reticulum cell sarcoma	39	D-12/5/66
1/9/67	[redacted]	ElDorado Chem. Plnt.	Lung	50	D-06-11-67
1/19/67	[redacted]	Krummrich (Chemical Operator)	Lungs	57	D-12/13/66
2/9/67	[redacted]	Alvin (Sal) Analyt. Lab Asst.	~~Malig. Lymphoma~~ (Looks like Hodgkins)	28	D-1/28/67
3/13/67	[redacted]	(Mill Roll Operator) Springfield (hourly)	Lung	50	D-2/20/67
3/16/67	[redacted]	Columbia ("A" Elect.)	Lymphosarcoma w/blood stream involvement	42	D-04-08-72
3/17/67	[redacted]	Texas City (hourly) Operator	Facial skin ca.	56	D-08-30-72
3/17/67	[redacted]	Baxley (Filtered Resins)	Lung-left upper lobe	60	D-07-21-77
3/31/67	[redacted]	Pensacola (sal)	Brain tumor, metast.	49	D-2/25/67
4/13/67	[redacted]	Greenwood, S. C. (hourly) (Yarn process operator)	Reticulum cell sarcoma	42	D-3/13/67
4/27/67	[redacted]	Krummrich (Day Helper)	Skin	55	L
4/27/67	[redacted]	Sharonville (Finisher)	Breast (left)	29	L D - 5/24/70

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
6/9/66	[redacted]	(Garment Room Supervisor) Krummrich-Sal.	Lung with metastasis	56	D-4/30/66
9/2/66	[redacted]	pipefitter Queeny Plant (hourly)	Stomach	51	D-4/14/68
9/2/66	[redacted]	(Salt Cake Operator) Krummrich Plant (hourly)	Lung	54	D-04-29-68
9/ 6/66	[redacted]	Electrician Columbia (hourly)	Lymphosarcoma	41	D-04-08-72
9/26/66	[redacted]	Queeny (Research Porter)	Metastatic lesion	57	D 12-22-85
	[redacted]		Occipital Lobe		
9/26/66	[redacted]	Gehring	Metastatic ca primary site unknown	36	D-11/27/66
9/30/66	[redacted]	Welder Queeny (hourly)	Brain	45	D-9/11/66
9/30/66	[redacted]	Mound (sal.) Maint.Foreman	Astrocytoma rt. frontal lobe	53	D-9/9/66
10/5/66	[redacted]	Nitro (Production)	Ca bladder	63	D-8/22/66
10/10/66	[redacted]	Gering (hourly)	Ca bladder	56	D-12-27-75
10/10/66	[redacted]	(Boiler Fireman) Springfield (hourly)	Metastatic malignancy	45	D-11/20/66
10/24/66	[redacted]	Springfield (hourly) Engr.	Lung	55	D-9/24/66
10/24/66	[redacted]	(Supervisor-Res. Services) Shawinigan(Spfld) Sal.	Brain	59	D-10/5/66
10/24/66	[redacted]	Pensacola (Sal) (Projects & Standards) Mech.Engr.	Lung and Rectum	38	D-10/9/66
10/24/66	[redacted]	Fabric Services (Sal.)	Metastatic Ca.primary site un-determined.	57	D-9/15/66
12/5/66	[redacted]	Trenton (hourly) Millwright 1/c	Pancreas	43	D-11/26/66
~~12/6/66~~	[redacted]				
12/8/66	[redacted]	Columbia (Traffic Switchman)	Prostate	53	D-03-17-75

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/12/65	[redacted]	General Offices (admin)	Breast with metastasis.	52	D-11/5/65
12/8/65		Dept. 247 Operator Krummrich (wage)	Metastatic ca. generalized	40	D-12-22-65
12/17/65		Nitro (Serv. Bldg.Attendant)	Bladder Lining	58	D-11-20-68
12/17/65		Barton (Sr. Mechanic)	Melanoma on back	44	D-4/15/68
12/22/65		Spfld.(sal) Engrg. Supvr.	Malignant Melanoma	51	D-12/12/65
1/6/66		Queeny (Millwright)	Larynx	56	D-09-24-79
1/27/66		El Dorado Chem. Plant (operator - hourly)	Bronchiogenic	42	D-1/4/66
2/8/66		(Central Drumming Oper.) Queeny Plant	Fibrous sarcoma of left axillary	48	D-02-22-66
2/4/66		Interim Lead Operator Spfld.(hourly)	Stomach	48	D-1/20/66
4/28/66		Everett(hourly) Chem. Op.	Lung	60	D-4/15/66
4/28/66		Detroit Office (sal.)	Abdominal. Bilot ca. of Ovary	47	D-3/29/66
4/28/66		Trng. Mgr. Mound (salaried)Personnel	Left Kidney	51	D-3/23/66
5/6/66		(Leadman in Storeroom) Krummrich (hourly)	Carcinomatosis	52	D-4/19/66

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CANCER INDEX

	Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
X	4/28/67	[redacted]	Krummrich (Boilermaker)	Anus	57	D-09-22-67
X	4/28/67	[redacted]	Sharonville (Janitor-Prod.)	Tongue w/metastasis left cervical chain	48	D-02-19-68
X	5/15/67	[redacted]	Krummrich (Physician)	Abdominal	37	D-3/7/67
X	5/18/67	[redacted]	Stonington	Prostate (metastatic)	49	D-01-04-74
X	5/31/67	[redacted]	Springfield (Case maker-Shipping Dept)	Liver	60	L D 11/23/67
X	6/7/67	[redacted]	Spfld. (General Laborer)	Rt. Testicle	26	L D 8/4/68
X	6/22/67	[redacted]	Queeny Plant (Chemical Oper.)	Lung	52	D-09-11-68
	6/26/67	[redacted]	El Dorado (Sr. Operator Nitric Acid Plant)	Nose	50	L
X	6/30/67	[redacted]	Trenton (Chemical Worker)	Lung	51	D-8/12/67 L
X	7/19/67	[redacted]	Pensacola (1st class mechan.)	Metastatic Malignant Melanoma	29	D7/9/67
X	8/8/67	[redacted]	Decatur (sal.) (Sec'y.)	Metastatic ca ovaries tubes & peritoneum	51	D-7/17/67
X	9/1/67	[redacted]	Spfld. (	Metastatic ca.	47	D-8/28/67
X	10/9/67	[redacted]	Krummrich (Office Worker)	Lymphosarcoma	46	D8/31/67
X	10/16/67	[redacted]	Spfld. (hourly) Press Opr.	Lung	51	D9/24/67
X	10/16/67	[redacted]	ElDorado (Loader) Refinery (hourly)	Pancreas	62	D 10/1/67
	10/19/67	[redacted]	Queeny (Dept. 4 Operator)	Colon	51	L
X	11/2/67	[redacted]	Queeny (Millwright)	Bladder	48	D-04-13-73
X	11/9/67	[redacted]	Queeny (Leadman-Whse.)	Bladder	62	D-[illegible]-69
X	11/20/67	[redacted]	Texas City (Sal.)	Lungs (Maint. Foreman)	52	D-11/2/67

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/28/67	[redacted]	(operator-pelleting plant) El Dorado Plant	Neck	53	L
12/13/67	[redacted]	Krummrich (Bricklayer)	Bladder	55	L
1/8/68	[redacted]	Bridgeview (Sal.) (Plant Mgr)	Pancreas	49	D-10/18/67
1/8/68	[redacted]	(Operator) Texas City (hourly)	Lymphoma ~~xxxxxxx~~	35	D-12/6/67
~~2/5/68~~	[redacted]	~~Queeny~~	~~Abdomen (generalized)~~	~~52~~	~~L~~
2/5/68	[redacted]	Decatur (Spinning Operator) (hourly)	Alvcolar Cell Rhabdo-myosarcoma	23	D-1/11/68
2/8/68	[redacted]	Ligonier	Uterine	30	L
2/15/68	[redacted]	(Plant Guard) Carondelet (hourly)	Lung	61	L 2-20-68
4/4/68	[redacted]	Queeny (Electrician)	Left vocal cord	48	L
4/11/68	[redacted]	Ligonier (Factory Inspector)	Bladder	52	L 7-20-78
4/29/68	[redacted]	Nitro (hourly) (Operator Santoflex)	Bronchocarcinoma rt. upper lobe	54	D-4/15/68
5/2/68	[redacted]	(Electrical Foreman) Pensacola (sal.)	Stomach	68	D-4/17/68
5/12/68	[redacted]	(Truck Driver) Krummrich (hourly)	Malignant brain tumor	59	D-4/28/68
5/12/68	[redacted]	(Shift Helper) Krummrich (hourly)	ca. of lung	62	D-5/7/68
5/24/68	[redacted]	Luling (hourly) Guard	Lungs	55	D-4/30/68
6/8/68	[redacted]	(Maintenance-Lubrication) Deep River (hourly)	Rectum w/metastases	59	D-5/29/68
7/10/68	[redacted]	Krummrich (hourly)	Basal cell Ca.	56	~~L~~ D 10-6-83
7/15/68	[redacted]	T.C. (hourly) (Painter/Lead man)	Left Lung	61	L 2-?-70

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/10/69	[redacted]	Anniston (sal) (Mtls Hndlg supvr)	Pancreas	60	D-1/16/69
2/10/69		Krummrich (Porter-Laborer)	Adenocarcinoma-rectum	54	L 4-5-69
2/19/69		Krummrich (Pipefitter)	Right lung	57	L 10-16-69
3/6/69		El Dorado (Chem. Operator)	Face & Skin	58	L
3/20/69		Delaware River (Chem. Oper.)	Brain	45	L 4-9-70
3/21/69		Nitro (hrly) (head operator)	Pulmonary Embolus	58	D-12/25/68
~~3/21/69~~--			(due to op. ca of urinary bladder operation.		
3/21/69		El Dorado Refinery (hrly) (Operator)	left lung w/met.	57	D 2/18/69
3/28/69		Kenilworth (sal)(sales corrs.	Cirrhosis of liver	48	D-9/11/68
3/28/69		G.O. (engrg.)	Hypernephroma, met. to peritoneum, liver & tongue.	44	D-3/9/69
3/28/69		Texas City (hrly)(boiler-maker)	rt. lung	63	D-12/8/68
4/8/69		Queeny (Chemical Operator)	Lung	48	D-3/19/69
4/8/69		Columbia (slag foreman)	Lung	59	D-3/14/69
4/8/69		Texas City (operator)	Brain Tumor	49	D-2/14/69
4/15/69		Columbia (Electrician)	Lymphosarcoma with blood stream involvement	44	L 4-8-72
4/28/69		Nitro (hrly)(Gatehouse attendant)	Right Lung	53	D 4/22/69
4/30/69		Nitro (hrly) (Carpenter)	Right ear	59	L-

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/29/68	[redacted]	Trenton (hourly)	Gastric ca.	47	L 3-21-69
7/30/68	[redacted]	Texas City (hrly.) (Carpenter)	Papillary Ca. enlarged thyroid gland	49	L
8/20/68	[redacted]	Ligonier (Finisher)	Nose	52	L
8/22/68	[redacted]	Queeny (Cafeteria)	Ovaries	50	D-~~8/68~~ 8-12-68
8/22/68	[redacted]	Springfield(Empl.Serv.Mgr)	Pulmonary Atelectasis	64	D 7/27/68
9/12/68	[redacted]	Textiles N.Y. (Sales Rep.)	Testes	44	D 8/17/68
9/26/68	[redacted]	Kenilworth(hourly) Class A Mechanic	Lung	54	L 6-11-69
10/18/68	[redacted]	El Dorado Refinery (truck transport)	Anaplastic ca.	35	D-9/23/68
10/21/68	[redacted]	ElDorado Plant (Chem operator)	Mouth	61	D-6-20-80
11/14/68	[redacted]	Queeny (Chem. Operator)	Lung	47	L 3-19-69
11/21/68	[redacted]	Krummrich (Tractor Driver) (hourly)	Lung	58	D-10/23/68
11/22/68	[redacted]	Spfld.(Sal.)(Matl.Handling Engr)	Esophagus	49	D-11/1/68
12/9/68	[redacted]	Krummrich (hrly) (Electrician)	Colon	61	D-11/12/68
1/15/69	[redacted]	G.O.Research	Stomach	49	D-12/15/68
1/22/69	[redacted]	Pensacola (sal) (Managerial)	Malignant Lymphoma	49	D-1/1/69
1/30/69	[redacted]	Springfield (sal) (Maintenance Foreman)	Rectum	62	D-12/31/68
2/3/69	[redacted]	Nitro (hrly)	Bronchial ca.	53	L 4-22-69
2/5/69	[redacted]	New York (receptionist)	Brain Tumor -Ca.Colon	52	D-1/29/69

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/5/69	[redacted]	Yardville (hrly) (finisher)	Colon	42	L
5/7/69		MAC	Lymphosarcoma cell leukemia	43	D-5/3/69
5/19/69		Queeny (hrly) (Chem. Oper.)	Kidney	47	L 2-22-70
6/30/69		Kenilworth (Packer Film Dep	Multiple Myeloma	59	L
7/9/69		Kenilworth (hrly) (Sr. Mech.)	lung, w/metastasis to brain, liver, and left adrenal.	58	D-6/15/69
7/25/69		Nitro hrly. (Pipefitter)	lung	53	L 2-25-70
7/28/69		Greenwood, S. C. (Supt. Cost analysis)	Carcinomatosis of Kidney	55	D-6/13/69
7/29/69		Alvin (Chem. Operator)	Thyroid	33	
7/31/69		Queeny (Chem. Operator)	nose	62	D. 12-21-85
9/2/69		Queeny	Bladder		D-8-17-69
9/10/69		Krummrich (Chem. Operator)	Bladder	61	~~L~~ D 4-20-81
9/22/69		Spfld. (hrly) (Electrician)	Larynx	48	L
9/25/69		Gering (hrly)	Multiple Myloma	59	D-8/22/69
12/9/69		Akron, (secretary)	Ovarics	49	D-10/26/69
1/12/70		West Port (sal)	Ewings Sarcoma w/Metastases	29	D-11/27/69
1/27/70		Queeny (hrly) Garage Mech.	Bladder	49	D-1/18/70
2/26/70		Mound (maintenance foreman)	Colon	56	D-2/5/70

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See if these are on mortality file

CANCER INDEX

	Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
X	7/26/76	[redacted]	JFQ - rigger	ca. bladder	60	L D 2-27-85
X	11/9/76		Soda Spgs.-Gen'l. Acct. Super.	ca; Sigmoid	54	D- 9/19/76
X	11/9/76		Anniston-Chem. Operator	ca; Bronchogenic	41	D-10/2/76
X	11/18/76		Ligonier-Maintenance Laborer	ca: lung	62	D-10/23/76
X	11/24/76		Luling - Mfg.Foreman I Ag.	cancer metastatic	56	D-10/22/76
X	11/30/76		Deep . River - office worker	generalized carcinoma	47	D-11/30/76
X	3/25/77		Westport-Mech./Tool Crib	ca. left ala of nose & left cheek	60	L D 7-2-85

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/3/75	[redacted]	Ligonier (finisher)	Breast	42	L
3/21/75		Kearny (central control chemical operator)	Lung	62	D-3/2/75
3/25/75		FRP Co. (chemical operator)	bronchogenic		D
4/21/75		Spgfld. (plant service attendant)	to CA of colon gen. metastases/second	61	D-4/2/75
4/14/75		Alvin-Mech. Maintenance Tech.			L
9/22/75		Sand Mtn. - process tech.	undifferentiated mediastinum w compression lg. vessles	32	D-8/28/75
10/13/75		Trenton - Millright 1/C	carcinomatosis	52	D-9/14/75
12/5/75		Trenton - millright 2/C	ca. throat & tongue	53	L
1/26/76		Spgfld. - stenographer B	ca. rectum	54	D-1/8/76
1/26/76		Houston - secretary	ca: metastatic ovary	63	D-1/1/76
2/20/76		Bloomfield - Engr. Specialist	ca: stomach	54	D-2/2/76
2/3/76		Ligonier - finisher (factory)	carcinomatosis	54	D-1/15/76
4/14/76		G.O. - Gen. Engr.(elec. design)	carcinomatosis- adenaca. of pleura	61	D-3/16/76
3/22/76		Ligonier - Inspector	ca: bladder	60	L
3/25/76		Spgfld. -container clerk & rigger crane opr.	widespread anaplastic carcinoma	56	D-2/24/76
3/31/76		WGK. - chemical operator	metastatic melanoma	45	D ~~L~~ 3-2-84
4/5/76		Bircham Bend - pipefitter	ca: rt. lung met. to rt. scapula	47	L
6/11/76		Akron - Acct. Super. II	ca. Lung	50	D-2/[illegible]/76
6/15/76		Soda Spgs.-mechanic	ca. sigmoid ext. to bowel ~~wall & affecting colon~~	35	L

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PCB-ARCH0641333

CANCER INDEX

	Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
X	9/3/74	[redacted]	Columbia Traffic Operator	Prostate	60	L 3-17-75
X	9/5/74	[redacted]	Texas City (hrly) Boiler-maker	Lung	64	D-7/13/74
X	9/5/74	[redacted]	G.O.	Met. melanoma brain	54	D-8/6/74
X	9/11/74	[redacted]	Yardville (hrly) Finisher	Met. bronchogenic ca.	55	D-8/28/74
X	9/19/74	[redacted]	Alvin Maintenance Tech.	Respiratory failure due to met.ca of lung	44	D-9/5/74
X	9/20/74	[redacted]	Spfld. Still Operator	ca. bile ducts	41	L 12-14-74
X	9/20/74	[redacted]	G.O.	ca. bladder	56	D-8/30/74
X	10/22/74	[redacted]	Columbia Tapper Helper	bronchogenic ca.	49	D-9/28/74
X	10/22/74	[redacted]	Queeny Chem. Opr.	ca. colon w/met.	61	D-9/22/74
	11/15/74	[redacted]	Sharonville (finisher)	breast	44	L
X	11/27/74	[redacted]	Columbia Nodulizing Lead-man	left lung, met:to/ pleura	49	L 5-7-75
X	12/11/74	[redacted]	Shawinigan	sigmoid colon met to/ liver	63	D-11/29/74
X	12/23/74	[redacted]	Decatur Sr. Textile Tech.	stomach w/estens.Met.	60	D-12/2/74
X	12/23/74	[redacted]	Pensacola Spinnerette Tech	Met. ca. primary unkn.	43	D-12/18/74
X	1/7/75	[redacted]	Spfld. ~~[illegible]~~	infiltrating adenocarcinoma colon w/o met.	59	D 3-25-79
X	1/22/75	[redacted]	Springfield hrly	Stomach & liver	59	D-12/29/75
X	" "	[redacted]	Krummrich hrly (carpenter)	Met.adenocar. brain	57	D-1/11/75
~	" "	[redacted]	Columbia —	Lung	46	
X	2/24/75	[redacted]	Queeny (hrly) millwright - (1939-1975) [on PAB program]	Head of pancreas w/met ca of liver	64	D-2/11/75

CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/27/74	[redacted]	Yardville (hourly) Machine Opr.	Metastatic ca. Ca. testicles	22	D-2/2/74
"	[redacted]	Queeny (sal.) Chem. Opr. Prod. Foreman	Ca. Lung	56	D-2/4/74
"	[redacted]	Chicago (Secretary)	Carcinomatosis/breast, Pneumonia	59	D-5/20/73
"	[redacted]	Avon (hourly) Op. B Catalyst Plnt/	Ca rectum	58	D-1/23/74
"	[redacted]	Yardville (Finisher)	Bronchogenic ca. w/met & nephritis	55	L 8-28-74
2/26/74	[redacted]	Indian Orchard (Extrusion Process Att.)	mouth w/met. to neck	48	L 9-25-75
3/21/74	[redacted]	Queeny (Res. Porter)	Esophageal Ca.	60	L 3-21-74
"	[redacted]	Sharonville (Finisher)	Ca. in situ Cervix	40	L
"	[redacted]				
4/8/74	[redacted]	St. Peters (Bench Processor)	Ca. in situ	37	L
4/10/74	[redacted]	Lima, Ohio (B Inspector)	Ovary	40	L
4/18/74	[redacted]	Queeny (Engine Operator)	Ca Prostate w/met.	60	D-4/1/74
5/20/74	[redacted]	Nitro (Serv.Bldg.Attend)	Trans.cell ca prostate	49	D-4/29/74
6/7/74	[redacted]	Texas City (Pumper-Gauger	Bronchogenic carcinoma	61	L 10-4-74
7/1/74	[redacted]	New York (office)	Seminornia -metas.	41	D-5/29/74
7/1/74	[redacted]	Krummrich (Crane Hook-up)	Lung	62	D-6/9/74
7/1	[redacted]	Springfield (Blender Op.)	Ascending Colon	54	L
7/3	[redacted]	Queeny (Chief Operator)	Colon	57	L
8/5/74	[redacted]	Carondelet (Sec'y)	Met. ca to brain, liver, skeleton	46	EX P-0013 Page 4 of 32 [illegible]
8/12	[redacted]	Columbia [illegible] Dept 60-73 Analytical [illegible] 73 -	Ca. lung w/met.	45	D-7/6/74

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4/15/73	[redacted]	Queeny (48-72 Bricklayer (72-73 Shop Clerk	Bronchogenic ca.	47	D=3/19/73
5/2/73		(never actually worked for Monsanto) Leonard Construction Co.	Ca Bladder		10-19-73
5/16/73		Anniston	Distal mid-sigmoid Colon	59	L
6/6/73		Columbia ("B" mechanic)	Met. malignant melanoma of brain.	56	L 8-27-74
7/2/73		Texas City (Pumper Guager)	Met. ca. of rectum	61	D-6/20/73
7/9/73		Trenton (Pipefitter)	Trans. cell ca of bladder.	53	L 12-21-73
7/27/73		Krummrich (hrly) (Leadman) (Storeroom (Injection Molding)	Ca Liver	59	D-6/16/73
8/24/73		Kenilworth (Mach. Opr.)	Breast	47	L
9/5/73		Texas City (Chief Opcr.)	Left Lung	58	L D 12/2/73
10/1/73		Spfld. (stock cont.-Resimines	Prostate	58	L 7-6-77
1/22/74		G.O.	Ca.Lung (death due to acute myocardial infarct.)	64	D-12/24/73
1/22/74		Trenton (hourly) (Pipefitter)	Ca. Bladder	53	D-12/21/73
1/29 /74		Krummrich (Porter)	Ca. sigmoid colon	59	D 4-22-85
1/29/74		Nitro (sal.) (Utilities Foreman	Ca. lung	62	D-1/17/74
1/29/74		Bircham Bend (Lab analyst)	Reticulum cell ca. left femoral.	29	L
2/27/74		Pensacola Hourly (Misc. Opr.)	Pulmonary ca, wide-spread metastasis to brain bone.	52	D-1/26/74

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
3/10/72	[redacted]	Texas City (Chem. Op.)	Lip (lower)	57	L
3/17/72	[redacted]	Pensacola (Electrical Mech.)	Carcinomatoses Bronchogenic ca.	55	D-3/1/72
3/23/72	[redacted]	Addyston (Office)	Metastatic ca.Brain	50	D-1/13/72
4/20/72	[redacted]	Stonington (Finisher)	Prob. Metastatic Disease, liver. Old ca of breast.	39	L D-6/2/72
5/24/72	[redacted]	Queeny (Mechanic)	Adenocarcinoma lung	63	D-5/13/72
8/23/72	[redacted]	Nitro (Auto Mechanic)	Rectal ca.	49	L 12-8-72
10/3/72	[redacted]	Texas City (Operator)	Metastatic cerebral hepatic carcinoma	62	D=8/30/72
10/30/72	[redacted]	Texas City (Painter)	Adenocarcinoma of prostate metastatic to bone	50	L 1-25-76
11/13/72	[redacted]	El Dorado (Machinist)	left upper lobe-lung	63	L
11/13/72	[redacted]	Ligonier	Abdominal ca	57	D-10/30/72
1/2/73	[redacted]	Greenwood (Plant Security Guard)	Ca of liver-metastatic	61	D-12/2/72
2/73	[redacted]	Springfield (hrly) (Mason)	Ca of lung	56	D=1/8/73
2/73	[redacted]	Bircham Bend (Chem. Opr.)	Ca left lung with metastasis to bones and liver	59	D-1/11/73
2/26/73	[redacted]	Krummrich	Ca of gallbladder	48	D-2/13/73
2/28/73	[redacted]	Krummrich (Yard Laborer)	Ca rt. lung	59	1/25/73

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
9/9/71	[redacted]	Queeny (Shop Clerk)	Lung	63	D 9-6-71
9/9/71	[redacted]	Queeny (Cafeteria attend.)	Breast	43	L
9/9/71	[redacted]	(Safety & Sec. Inspector El Dorado Plant	Prostate gland	62	D-8/1/71
9/20/71	[redacted]	Alvin (I&E Technician)	Basal cell ca rt. cheek	35	L
9/23/71	[redacted]	Bircham Bend (Welder)	Adenocarcinoma	44	L
10/18/71	[redacted]	Krummrich (sal) Lab Analyst	Malignant lymphoma, mixed cell type	47	D-9/28/71
10/21/71	[redacted]	Ligonier (hrly) Finisher	Uterus	53	D-10/20/71
11/1/71	[redacted]	G.O. Off. Mach. Maint.	Metastatic ca. of kidney	51	D-9/17/71
11/23/71	[redacted]	Decatur (hrly)Janitor	Carcinomatosis	61	D-11/5/71
11/23/71	[redacted]	Queeny ?	Prostate	57	L
12/20/71	[redacted]	G.O.	Pancreas (adenocarcinoma)	559	D-11/21/71
1/4/72	[redacted]	Spfld. Lift truck repairman	lower 1/3 esophagus	58	D-10-4-72
1/5/72	[redacted]	Queeny (hrly) Chem. Opr.	urinary bladder (met)	56	D-12/7/71
1/5/72	[redacted]	Ligonier (Maint. Foreman)	Stomach	53	D-12/15/71
1/7/72	[redacted]	Mound (hrly) (Welder)	Carcinomatous from metastatic ca of colon	54	D-11/3/71
1/10/72	[redacted]	Nitro (Yard Laborer)	basal cell ca face & Squamous cell ca of lip	54	D-5-28-72
2/4/72	[redacted]	Gehring (	prostate, met. to bone	53	L
2/4/72	[redacted]	Ligonier (Office Worker)	Cervix w/metastasis	42	D-[illegible]
3/1/72	[redacted]	Addyston (Chem. Op)	Colon	35	[illegible]

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PCB ARCH0641228

CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4/5/71	[redacted]	Krummrich (Machinist)	Lung	52	L 6-5-71
4/13/71		El Dorado	Metastatic malignant melanoma from lesion of back	35	L 10-8-71
5/6/71		(ator/spinner Tire Yarn Dept.) Pensacola (hrly)	Ca of testis with met.	25	D-4/9/71
6/11/71		Texas City (Chief Oper.)	Bronchogenic Ca. w/ Cerebral metastasis	47	L 6-6-71
6/11/71		Krummrich (sal) Office	Bronchogenic	50	D-5/18/71
6/16/71		Krummrich (hrly) (Machinist)	Lung	52	D-6/5/71
6/18/71		West Port (Shift Mech. C Crew)	Malignant Nevi	38	L
7/1/71		Texas City (hrly) (Chief Opr.)	Brain tumor, secondary to lung ca.	48	D-6/6/71
7/6/71		Pensacola - Mechanic	Exanguinating hemorrhage due to bronchogenic ca.	57	D-6/12/71
7/20/71		G.O. (Cafeteria)	Metastatic Disease w/ bilateral uretreal obstruction	39	D-7/4/71
7/28/71		Columbia (Bulldozer Oper)	Massive abdominal tumor probably metastatic from old testicle ca	46	L 12-19-74
8/13/71		Ligonier (Inspector)	Transurethral ca	55	L [illegible]

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
9/8/70	[redacted]	Everett (Autoclave Opr. Santocel Dept.)	Parkinson's Disease	55	L 9-17-78
9/8/70	[redacted]	Queeny (Whse. Clerk, Shop Laborer)	Rectum	59	L 3-11-78
10/23/70	[redacted]	G.O. (Sec'y)	Breast w/metastasis	54	D-9/18/70
10/15/70	[redacted]	Columbia (Furnace Tapper)	Rt. Upper Lobe	53	L 7-5-72
10/19/70	[redacted]	St. Peters (Bench Processor Clean & Insp.)	Breast	33	D 10/8/70
11/25/70	[redacted]	Texas City (Chief Operator)	Liver	62	L 12-13-70
12/7/70	[redacted]	Queeny (Dept. Mechanic)	Bladder	55	L
12/10/70	[redacted]	Trenton (Maint.MechanicI)	Hodgkins	33	L 7-9-72
1/26/71	[redacted]	Anniston (Millwright)	Bronchogenic Ca.	59	D-1/5/71
2/5/71	[redacted]	Texas City (Painter)	Respiratory paralysis, secondary to spinal cord metastatic ca. due to ca of rt adrenal poss. secondary to ca of lung.	54	D-12/30/70
XXXXXXXX	[redacted]	XXXXXXX			
	[redacted]				
2/5/71	[redacted]	El Dorado (Field Gauger)	Adenocarcinoma of Pancreas	64	D-1/29/71
	[redacted]				
2/8/71	[redacted]	Queeny (Coppersmith & ~~Tinner~~)	Lung	57	~~L~~ D 12-10-85
3/10/71	[redacted]	G.O.	Carcinomatosis-primary ~~bronchiogenic ca.~~	63	D-2/23/71
3/10/71	[redacted]	Everett (Carpenter 1/c)	Larynx	42	L
3/12/71	[redacted]	Carondelet (Chem. Oper.)	Ca. left ear & neck	43	L
4/1/71	[redacted]	Springfield (Nurse)	Ca. of Ovary	47	D-3/17/71

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EX P-0013
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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/26/70	[redacted]	Spfld.(hrly) Pkg. Operator	Sarcoma of lung	50	D-2/12/70
3/2/70	[redacted]	Baxley	Lung	61	L 7-21-77
3/5/70	[redacted]	Queeny (Chem. Operator)	Bronchiogenic ca.	54	L 11-6-70
3/12/70	[redacted]	W. Caldwell (Wiring & Soldering Opr.)	Breast	34	L
3/30/70	[redacted]	Spfd. (sal) (Res. Tech.)	Colon	61	D-3/11/70
4/27/70	[redacted]	Everett (Sal) (Mfg.Special-ist)	Metastatic seminoma to liver and heart 1	59	D-4/4/70
4/27/70	[redacted]	G.O. (sal)	Brain Tumor-lung ca.	53	D-3/31/70
4/30/70	[redacted]	Ligonier (Chief Polyflex Inspector)	Cervix	46	L
5/4/70	[redacted]	enilworth (Benchworker)	Cervix	46	L
6/4/70	[redacted]	renton (Drum Dryer Operator)	Medullary ca of thy-roid	40	L
6/25/70	[redacted]	haronville(hrly) Finisher	Breast-metastatic	32	D-5/24/70
7/10/70	[redacted]	enilworth (Benchworker	Endometrial ca.	41	L
7/13/70	[redacted]	ircham Bend (Shift Supvr.)	Bronchogenic Ca.	55	D=5/31/70
7/20/70	[redacted]	ED	Lymphosarcoma	50	D 7/3/70
7/22/70	[redacted]	ensacola (sal) Maint.Supv. Intermediates and Power	Lymphosarcoma	49	D-7/17/70
8/14/70	[redacted]	El Dorado Plant(Chem.Oper.)	Left Kidney	58	L 6-29-72
8/25/70	[redacted]	Sharonville (Mach. Oper. Blow Molding)	Tetratoma left test.	28	D EX P-0013 Page [illegible] of 32
9/8/70	[redacted]	Queeny hourly	Liver	56	D-8/14/70

0665798

PCB-ARCH0641341

DJ-22

LAW OFFICES OF CRISTÓBAL BONIFAZ
180 Maple Street
Conway, Massachusetts 01341
Telephone: 413-369-4263
Electronic Mail ccrbonifaz@gmail.com

November 10, 2023

Mike Holston, Esq.
Senior Vice President, General Counsel
General Electric Company
5 Necco Street
Boston, Massachusetts 02210

This office represents the Town of Lee, Massachusetts.

The purpose of this letter and attachments is to make GE aware it has a claim worth millions of dollars against Monsanto for expenses incurred– and to be incurred by GE— for removal of PCBs from the Housatonic and Hudson Rivers. The statute of limitations of this claim begins to run on the day GE receives this letter.

GE accepted responsibility, and is in the process of carrying out an EPA-CERCLA Order issued in 2022 for dredging the Housatonic River to remove mud containing PCBs from the River. GE and EPA have not made efforts to hold third parties accountable for PCB contamination of the River.

DDT discovered in 1939 saved millions of lives worldwide. In 1962 it was established that DDT damaged the egg shells of raptors a discovery that gave birth to hundreds of scientific studies worldwide of the impacts on the environment of similar halogen substituted hydrocarbons such as PCBs.

Monsanto learned in the 1950s and 60s from internal studies and published scientific papers that PCBs were toxic to humans and the environment. *(See ¶s 38 to 43 of the Attached Draft Complaint for Declaratory Judgment supported by exhibits DJ-4 to DJ-14).*

Monsanto's marketed PCBs Aroclors 1254 and 1262 as plasticizers for a variety of applications including caulk, cement, asphalt, paint, fluorescent light fixtures and similar applications. Aroclors 1254 and 1262 were also sold by Monsanto to GE in much smaller quantities for usage in electrical transformers. *(Id.)*

Monsanto' Plasticizer's Group sent a letter on February 27, 1970 to its 661 plasticizers' customers of Aroclors 1254 and 1260 stating that recent published articles indicate that these chemicals have been discovered in some marine, aquatic and wildlife environments urging its 661 customers to take all possible care to prevent PCBS from becoming environmental contaminants. The letter included as attachments a Chemical Week article dated October 29, 1969 and a detailed listing of then insignificant state regulations concerning disposal of chemicals in water ways. *(Id. ¶s 44 to 49).*

Monsanto's Chemical Week attachment to its letter February 27, 1970 relates how industrial manufacturing plants were located next to rivers to allow for chemicals to be dumped into rivers to flow into oceans. *(DJ-4 Chemical Week Article attached to the February 27, 1970 letter).*

Monsanto's Plasticizer Group's letter of February 27, 1970 was a post facto attempt to protect itself from liability as six months later it stopped marketing PCBs as plasticizers. Monsanto continued sales of Aroclors 1254 and 1262 for usage in electrical transformers. *(id. ¶s 44 to 50).*

Monsanto in 1968 learned through an unforeseen, unplanned , and negligent event—as per Monsanto's admission—that a discharge of 1 to 3 gallons of Aroclors 1254 and/or 1262 into the Escambia River that Aroclors 1254 and 1262 did not flow with the River to the ocean as expected for all other chemicals but instead stayed forever imbedded in the sediments of the River. This fact was never conveyed to any of its customers. (*Id. ¶s 51 to 71).*

Monsanto does not have a statute of limitations defense for recovery actions GE choses to make against Monsanto for the costs of dredging the Hudson and Housatonic Rivers since GE is learning through this letter for the first time the critical knowledge Monsanto withheld from GE from 1968 to the present.

Congress enacted in 1980 the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and began to enforce The Toxic Substances Control Act of 1976 forcing manufacturing plants to remove chemical wastes present in rivers. GE assumed responsibility for the contamination with PCBs of the Hudson and Housatonic Rivers ignorant of the fact that Monsanto had known in 1968 that PCBs dumped in the Hudson and Housatonic remained in the sediments of the rivers forever or until physically removed by dredging.

The Town of Lee is communicating this information to GE since as a result of litigation GE was able to secure a ruling from the Environmental Appeals Board to build a 15 story PCB dump in Lee on a 20 acre base. GE saved itself the cost of moving dredged PCBs from the Housatonic River to an off-site location. (*Id. ¶s 1-13 and 71 -80 supported by Exhibits DJ and DJ-3).*

The projected PCCB dump in Lee will result in recoverable property value losses for Lee's residents. (id. *¶s 8-13).* The millions of dollars recoverable by GE from Monsanto for dredging the Hudson and Housatonic Rivers far exceed the cost of moving the Housatonic sediments to an off-site location as ordered by EPA in 2016. The Town of Lee suggests that since Lee has generated all information necessary for GE to overcome a statute of limitations defense against Monsanto, GE in turn should reconsider its current plans to build the dump in Lee and instead move the dredged PCBs to an **off-site** location as originally ordered by EPA in 2016. *(Id. ¶s 1 to 8 and 70 to 80).*

GE has a claim against Monsanto for recovery of costs incurred—and to be incurred in the future by GE— for dredging the Housatonic and Hudson Rivers under CERCLA Orders. GE's claim is identical to the claims filed by the Commonwealth of Pennsylvania and the State of Oregon against Monsanto for removal of PCBs from water ways. These actions resulted in settlements for the States of 100 and 691 million respectively. *(DJ-20, DJ-21, DJ-22, and DJ-23).*

Sincerely,

Cristóbal Bonifaz, Esq.
Enclosures: Hard Copy of Drafted Complaint and Microchip containing digital copies of the Complaint and Exhibits DJ-1 to DJ-23.

DJ-23

TOWN OF LEE
32 Main Street, Lee, MA 01238
www.lee.ma.us

Select Board

January 2, 2024

His Excellency Joseph Biden, President of the United States
The Honorable Edward Markey, U.S. Senate
The Honorable Elizabeth Warren, U.S. Senate
The Honorable Richard Neal, U.S. House of Representatives
Her Excellency Maura Healey, Governor of Massachusetts
The Honorable Andrea Campbell, Attorney General of Massachusetts
The Honorable Paul Mark, State Senator
The Honorable Smitty Pignatelli, State Representative, 3rd Berkshire
EPA Region 1 Administrator David Cash
EPA Administrator Michael S. Regan
H. Lawrence Culp, Jr., President of General Electric

RE: Housatonic Rest of River – General Electric/EPA PCB Cleanup

The Lee Select Board recently obtained several General Electric (GE) and Monsanto documents that are cause for great concern related to the GE/EPA Housatonic Rest of River Cleanup remedy. Namely, the attached documents show that GE signed an agreement releasing Monsanto of liability for PCB contamination. To our knowledge, this was not disclosed to the EPA or the First Circuit Court of Appeals. In addition, the EPA failed to adequately investigate this relationship between GE and Monsanto. Also attached, is an internal Monsanto document (cancer index) outlining each employee diagnosed with cancer from PCB's to as far back as 1949 (over 2 decades prior to the release with GE). David Carpenter, the foremost expert on the human health impacts of PCBs, testified to the Lee Board of Health in an Affidavit stating that the current location of the projected PCB dump in Lee would be catastrophic to the residents of Lee. His affidavit is attached.

In 1968 Monsanto learned that PCBs were discharged into rivers, and unlike other chemicals, were not carried by the river currents to the sea. Instead, they became imbedded into the settlements of the rivers.

On February 21, 1970, Monsanto's plasticizer department wrote a letter to all its 661 plasticizers customers warning them about contamination to waterways. Monsanto attached information in this letter stating that chemical and industrial plants were located next to rivers and disposed of chemical waste via river discharges. Monsanto also included information in this letter stating that the Commonwealth of Massachusetts only had regulations concerning river discharges for radioactive chemicals.

In August of 1970, Monsanto halted all production of Aroclors 1254 and 1262 due to overwhelming evidence it had that PCBs were toxic and harmful to humans and the environment. By that date, Monsanto had sold more than 1.4 billion pounds of the Aroclors.

On January 21, 1971, Monsanto entered into a contract with GE to continue selling Aroclors 1254 and 1262 for usage in electrical equipment. Monsanto conveyed to GE under the terms of the contract that PCBs were severely harmful to humans and the environment. GE executed this contract assuming all responsibility for any damages Monsanto might have to pay to others for PCB exposures.

In the opinion of the Town of Lee, the January 21, 1971 contract between Monsanto and GE violates Massachusetts Civil Conspiracy Law. The Town is currently planning to file charges against Monsanto this month, and related claims, including a public nuisance claim.

Since the time of the amended EPA permit in 2020, the Town of Lee has continued to express its overall discontent with the cleanup project as a whole. The Town, through numerous elections and public meetings, has objected to almost every aspect of the cleanup including, but not limited to, the toxic waste dump proposed for the Town of Lee, the lack of any alternative technologies for the cleanup remedy, and the potential impact on our infrastructure and human health.

The Town of Lee played no part in the contamination of the river and considers this an environmental injustice that the residents of Lee (with the lowest income of all towns in the river cleanup area) be subject to 13 years of disruption and risk to human health followed by centuries of potential issues from a toxic waste dump in our Town.

Based on the information presented in this letter, the Town of Lee will continue to pursue all avenues for a cleanup remedy where all involved parties are held responsible and all contaminated sediment is removed from Lee and the Berkshires. We look forward to your support in this mission and welcome the opportunity to discuss this situation further. Feel free to contact us through the Town Administrator, Christopher Brittain, at cbrittain@town.lee.ma.us or (413) 409-5976 to discuss this matter further.

Sincerely,

Bob Jones, *Chair* | Gordon D. Bailey | Sean Regnier

Gordon D Bailey
Sean Regnier

Attachments: Internal GE/Monsanto Documents (Exhibit A), Mickey Friedman 3 Part Series (Exhibit B), Dr. Carpenter Affidavit (Exhibit C).

cc:
Berkshire Eagle
Berkshire Edge
Stockbridge Updates
Boston Globe
Springfield Republican
New England Public Radio
New York Times
Washington Post
ABC, CBS, NPR, Fox, CNN

EXHIBIT A

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

SPECIAL UNDERTAKING BY PURCHASERS OF POLYCHLORINATED BIPHENYLS

Monsanto Company ("Monsanto") manufactures certain polychlorinated biphenyl products ("PCB's") which General Electric Company ("Buyer") desires to purchase. While Buyer desires to purchase PCB's because of certain desirable flame resistant and insulator properties, Buyer acknowledges that it is aware and has been advised by Monsanto that PCB's tend to persist in the environment; that care is required in their handling, possession, use and disposition; that tolerance limits have been or are being established for PCB's in various food products.

Monsanto has therefore adopted certain restrictive policies with respect to its further production, sale and delivery of PCB's, including the receipt of undertakings from its customers as set forth below, and Buyer is willing to agree to such undertakings with respect to sales and/or deliveries of PCB's by Monsanto to Buyer.

Accordingly, Buyer hereby covenants and agrees that, with respect to any and all PCB's sold or delivered by or on behalf of Monsanto to Buyer on or after the date hereof and in consideration of any such sale or delivery, Buyer shall defend, indemnify and hold harmless Monsanto, its present, past and future directors, officers, employes and agents, from and against any and all liabilities, claims, damages, penalties, actions, suits, losses, costs and expenses arising out of or in connection with the receipt, purchase, possession, handling, use, sale or disposition of such PCB's by, through or under Buyer, whether alone or in combination with other substances, including, without implied limitation, any contamination of or adverse effect on humans, marine and wildlife, food, animal feed or the environment by reason of such PCB's.

All existing contracts for the sale of PCB's by Monsanto to Buyer are hereby amended to contain the provisions set forth above.

Nothing herein shall create or imply any duty or obligation of Monsanto to sell or deliver any PCB's to Buyer. No conditions, understandings or agreements purporting to modify or vary the terms hereof shall be binding unless hereafter made in writing specifically referring to this agreement and signed by the party to be bound and no modification or variance of the above undertaking shall be effected by the acknowledgment or acceptance of any sale document, purchase order, shipping instruction or other forms containing terms or conditions at variance herewith.

GENERAL ELECTRIC CO.
(Buyer)

BY: Walter A. Schlotterbeck

TITLE: Vice President and Corporate Counsel

DATE: January 21, 1972

MONSANTO COMPANY

BY: [signature]
Vice President

0041819

SPQR

Service Performance Quality Reliability

April 18, 1972

RECEIVED
AU...
EDWARD L. DOBBINS

Information Letter - MT-166

MTD SPOT
To: Holders of SPOT ✓
File this under
Information Letter Tab of Section I

SUBJECT: SUPPLY PYRANOL

TO: FIELD SALES DISTRICT MANAGERS
FIELD SALES ENGINEERS
PLUS SELECTED PRODUCT DEPARTMENT SALES MANAGERS, INTERNATIONAL SALES DIVISION, FASO, I&SE & SERVICE SHOP PERSONNEL

Since early 1970, Monsanto Chemical Company, sole supplier of Pyranol, has advised that this material, under the generic term askarel, contains polychlorinated biphenyls (PCB). Polychlorinated biphenyls are highly stable compounds and are not readily biodegradeable. Therefore, when placed in the environment, they may be considered contaminants and may adversely affect some species of animal and marine life.

At that time all customers were advised through Sales Channels to take every precaution to prevent any entry of this material into the environment through spills, usage, leakage, disposal, vaporization or otherwise.

In the past we have supplied Pyranol to transformer repair shops, and to companies requiring these products for top-up of existing transformers. Pyranol was also available from Monsanto under GE Specification A13B3B without restriction regarding its usage.

These sales have been discontinued by Monsanto as of January 15, 1972, except to those who have entered into special agreement to indemnify Monsanto with respect to this product for use in transformers.

General Electric has agreed to indemnify Monsanto for this use, as have several other major manufacturers. Some manufacturers have chosen not to indemnify Monsanto and have decided to discontinue manufacturing askarel-filled transformers.

The Medium Transformer Products Department will be the only supplier of GE transformer Pyranol effective immediately. This is further defined as follows:

1. All orders for supplying Pyranol for all General Electric Company Pyranol transformers will be placed on the Medium Transformer Products Department, Rome, Georgia.

2. MTPD, Rome, may ship direct to customer or from Monsanto Chemical Company when circumstances warrant such shipment, but orders will always be placed on Rome.

PLAINTIFF'S EXHIBIT 1100

736592

GENP 001842

3. Sales by Rome are only for use in askarel-filled transformers including repair and maintenance of any askarel-filled transformer, and for use in any new GE-manufactured transformer.

4. Bulk sales for askarel-filled transformers only will be made to the following customer classes:

   a) Utilities.
   b) Industrial and other customers for their own use.
   c) Service shops for transformer use only.

5. Sales will not be made to:

   a) External OEM's for their own use.
   b) Distributors for resale.
   c) Other external customers for resale, except for an independent Service Shop to fulfill a service contract on their customer's transformer.

6. All bulk orders to MTPD, Rome, from external customers must be acknowledged with the attached statement.

All Sales Departments must not only include this Indemnification Clause but state on the customer's purchase order and the GE requisition that the material is for transformer use only, before the order will be fulfilled by the Medium Transformer Products Department.

Other fluids for transformer use are presently under study which exhibit a higher degree of environmental compatibility. Studies indicate that some of these are feasible for use in transformers. However, until these materials have been proven suitable for transformer use, the above policy will remain in effect.

In the meantime, Handbook Section 5713, pages 1, 2, and 3 have been withdrawn and are being reviewed by the Medium Transformer Products Department, Rome, Georgia.

Please refer all requests for quotations on supplying Pyranol to:

H. J. Pinson
Specialist - Product Service
Medium Transformer Products Department
Rome, Georgia 30161

R. W. Frahm

R. W. FRAHM
MANAGER-MARKETING

:hs
Attach.

736593

Add to terms and conditions of sale on acknowledgment form which will be sent to the Purchaser in each instance, the following:

This material is sold on the understanding that it is for use in transformers only.

Pyranol® contains polychlorinated byphenyls (PCB's) which tend to persist in the environment and, therefore, care is required in its handling, possession, use and disposition. Accordingly, Buyer agrees that it shall defend, indemnify and hold harmless Seller, its directors, officers, employees and agents from and against any and all liability or expense whatsoever arising out of, or in connection with, the possession, handling, use, sale or disposition of such Pyranol® purchased by Buyer on this order which relates in any way to contamination of, or adverse effect on, any part of the environment including but not limited to humans, all other animal life, plant life or food by reason of such Pyranol®.

736594

GENP 001844

DISTRIBUTION:

List	Tabs
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1.11B	1A, 1C, 1E, 2D, 2E, 3B, 3E, 4B, 5E
1.12A	2B, 2C, 6A, 7A
1.14	3E, 4A
1.18	1B, 2A, 2C, 2D
1.20	1B, 1D, 9D, 2D, 4B, 3A, 3C, 5B, 5C, 6E, 8D, 8E
1.21	1B, 1C, 2E, 5A, 5C, 6E, 7A
1.22A	8B, 10B, 10C, 1A, 2A, 4A, 5A, 7B, 10E
1.23	1B
1.24	1A
1.25	1A, 1D, 1E, 2A, 2C, 2D
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GENP 001845

BCC: J. MASON - JMASO
H. S. BERGEN
E. P. WHEELER - EWHEE
J. D. EARLY - WASHINGTON
W. S. CLARK - WCLAR

February 10, 1971

Mr. Lowell E. Miller, Director
Pesticide Regulation Division
Environmental Protection Agency
South Agricultural Building
Washington, D.C. 20250

Dear Mr. Miller:

I recently noted in United States Department of Agriculture PR Notice 70-25 dated October 29, 1970 that polychlorinated biphenyls must be eliminated from economic poisons. We at Monsanto understand and are in complete agreement with this action as indicated in correspondence Dr. R. E. Kelly, Monsanto's Medical Director, had with Dr. Harry W. Hayes and Dr. C. Cueto, Jr. when the Pesticide Regulation Division was part of the U.S. Department of Agriculture.

I am deeply concerned, however, to note that this elimination has been extended to include the polychlorinated terphenyls. We have thoroughly searched all available literature and communicated with many laboratories, industrial, academic and regulatory, and been unable to find evidence that would indicate the polychlorinated terphenyls are contaminating the environment or that they are responsible for adverse effects on fish or wildlife.

We realize the importance of preventing the contamination of the environment but seriously question whether the polychlorinated terphenyls can be properly classified as contaminants. Does your division have available any information or data which would justify the elimination of these materials from economic poisons?

Sincerely,

W. B. Papageorge
Manager
Environmental Control

/lee

NEV 012520

PLAINTIFF'S EXHIBIT 1103

711772

BCC: J. MASON - JMASO
H. S. BERGEN
E. P. WHEELER - EWHEE
J. D. EARLY - WASHINGTON
W. S. CLARK - WCLAR

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Sincerely,

W. B. Papageorge
Manager
Environmental Control

/lso

PLAINTIFF'S
EXHIBIT
1103

NEV 012520

711772

CANCER INDEX

Page 1

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4th Quart 1949	[redacted]	Everett - Powerhouse	Reticulum cell sarcoma of the neck.		D+2-10-50
4th Quart 1949	[redacted]	New York - Sales	Larynx		D-03-01-58
1st Quart 1949	[redacted]	Birmingham - Sales Mgr.	Thyroid		D-June '50
2nd Quart 1949	[redacted]	Gen. Mgr. St.Louis -Org. Chem. Div.	Lymphosarcoma of mediastinum & parotid		D-1st Quart 1951
3rd Quart 1950	[redacted]	St. Louis - Sales	Squamous cell carcinoma of esophagus. Explor. operation-July, 1950.		D-4th Quart 1950
1st Quart 1950	[redacted]	Dayton, Unit I - Guard	Kidney		D
3rd Quart 1950	[redacted]	Dayton, Unit V -Accountant	Basal cell carcinoma, rt. post-auricular area		D-03-19-55
1947	[redacted]	Queeny Plt -Truck Driver	Multiple squamous cell epitheliomata, face & neck		D-12-28-50
2nd Quart 1950	[redacted]	Queeny Plt -Tractor Driver	Adenocarcinoma of submaxillary salivary gland		D-1952 D 9-8-82
2nd Quart 1950	[redacted]	Operator Phthalic Anhydride Queeny Plt	Squamous cell carcinoma of mediastinum thilus. left lung, prob. arose in bronchus		D-1st Quar 1951 D-3-2-51
Fall 1947	[redacted]	Operator Queeny Plt-Sulfonamide Dept.	Bronchogenic carcinoma (with metastases)		D 4-26-48
2nd Quart 1950	[redacted]	Queeny Plt - Supervisory	Rt. temporal astrocytoma		D-06-12-51
Fall 1948	[redacted]	no man with this name at KK Queeny Plt -Chemical Eng.	Ewings Sarcoma - left ilium		D
3rd Quart 1950	[redacted]	Operating Record Queeny Plt -Clerk	Myoblastoma -rt. arm.		D-04-04-71
2nd Quart 1950	[redacted]	Everett - Mason	Adenocarcinoma of the stomach.		D-06-21-63
3rd Quart 1950	[redacted]	Janitor Everett -Locker Department	Prostate with osteoblastic & nodal metastasis		D-12/14/50
4th Quart 1950	[redacted]	Incinerator Queeny Plt-Operator	Lower lip		D-08-23-57
3rd Quart 1950	[redacted]	Locomotive Everett -Engineer	Carcinoma of lung with brain metastasis.		D EX.P-0013
3rd Quart 1950	[redacted]	Mason and Yard Everett -Sweeper	Obstruction due to carcinoma of rectum		Page 32 of 32 D-12/28/50

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For Dr. [illegible]'s memo, 10/24/50, these people had neoplasms identified or known "during the past 3 yrs"

CANCER INDEX
Page 2

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4th Quart 1950	[redacted]	Carondelet	Skin		D-03-21-77
1949		Queeny Plt - Electrician	Basal cell carcinoma of the face just in front of rt. ear.	DD 7-27-?	Excised 2/51 with apparent cure
2nd Quart 1951		Everett	Carcinoma of head of Pancreas with metastasis		D-4/3/51
3rd Quart 1951		Garage Queeny Plt -Mechanic	Bladder. Treated & presumably cured.	56 43	D-5/23/64
1949		Krummrich Plt	Carcinoma of Colon		D-9/28/51
~~1949~~		Everett	Malignant gastric ulcer	39	09-26-57 D-~~10/[illegible]~~
		Springfield - Saflex	Face		D 10-26-77
		Springfield - Styrene	Face, arm		D-02-25-62
		Springfield - Yard	Face		
		Springfield - Acetate, Nitrate	Leukemia		D-07-21-49
		Springfield - Acetates, Nitrates, Resins, Office	Colon		D-06-21-75
		Springfield- Steel wire mill elsewhere	Face, probable		
		Springfield - Payroll	Peritoneal metastases, ovaries(?)		D
		Springfield - Acetate, Nitrate	Face		D-11-24-66
		Springfield	Tumor of breast (non-malignant)		D-04-14-69
1st Quart 1950		Springfield - Secretary	Papillary adenocarcinoma of bladder (recurrance)		
1st Quart 1950		Mound Lab - Lab Director	Carcinoma of prostate	57	D-1/1/52
1st Quart 1950		Everett	Gen. carcinomatosis Carc. of Pancreas & gall bladder	60	
1st Quart 1950		Anniston	Main cause of death, nephritis with uremia. Also had cancer of colon & diabetes.	64	D-5/27/52

EX P-0013
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CANCER INDEX

Page 3

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
1952	[redacted]	Queeny Plt - Worker B-5 3/28/51 to 2/13/52 & 3/3/52 to 4/25/52	Prostate	47	D-6/22/52
1952	[redacted]	Shawinigan	Tumor of bowel		D-09-26-54
1952	[redacted]	Nitro	Bladder		D-7-23-85
1952	[redacted]	Springfield	Rectum	67	D-3/31/54
1952	[redacted]	Nitro	Throat (esophagus)	61	D-11/22/53
1952	[redacted]	Dayton (Mound)	Throat - midposition		D 8-28-52
1952	[redacted]	Shawinigan	Colon		D-09-26-54
1952	[redacted]	Main Office	Leukemia	18	D-11/6/52
1952	[redacted]	Springfield	Oatcell carc. of lung, involve. of pericardium of esophagus & media-stinal nodes.	57	D-10/19/52
March, 1952	[redacted]	Nitro	Bladder		D-08-22-66
1952	[redacted]	Everett	Kidney		D-09-03-76
1952	[redacted]	r Nitro	Lungs	62	D-12/15/52
--	[redacted]	Camden	Bladder	72	D-1/5/53
--	[redacted]	Everett	Renal Cell		D-09-03-76
2/6/53	[redacted]	Krummrich Plant	Prostate	61	D-12-28-64
1953	[redacted]	Springfield	Prostate. Terminal stage of pelvic & bone metastasis on 4/22/53	64	D-09-25-53
1953	[redacted]	Queeny	Bile duct, Cirosis of liver	[illegible]	D-5/28/53
1953	[redacted]	Springfield	Right ll. of lung.	43	D-5/30/53
1953	[redacted]	Krummrich	Bronchogenic Carcinoma	45	D-7/15/53

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PCB-ARCH0641361

CANCER INDEX

Page 4

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
1953	[redacted]	Queeny Plant	Rectum, metastatic Hydranephrosis	44	9/12/53-D
1953	[redacted]	Everett	(Brain) Gilobastoma multiforme	59	9/27/53-D
10/28/53	[redacted]	Anniston	Lung	48	D-07-03-66
10/29/53	[redacted]	Queeny	Rectum		
1953	[redacted]	Everett	Left lung, Epidermoid Carcinoma	60	10/22/53-D
3/54	[redacted]	Akron - Shipping Clerk	Lung. Lobectomy performed 3/54 / Employed 33yrs		D-03-26-57
5/54	[redacted]	Tennessee	Lympho Carcinoma	52	D-5/16/54
8/54	[redacted]	Main Office - Invoice Clerk	Rectum		D-08-31-54
---	[redacted]	Queeny Plt - Salaried	Lung	44	D-8/12/54
9/54	[redacted]	Soda Springs, Idaho	Right kidney		D-11-14-54
12/54	[redacted]	Everett	Stomach	60	D-11/27/54
---	[redacted]	Queeny - wage employe	Lung		D-3/14/55
----	[redacted]	Krummrich Plant	Lung bronchogenic		D-6/27/55
----	[redacted]	Shawinigan	Malignant polyps of colon.		D-7/16/55
----	[redacted]	Springfield	Kidney	57	D-7/14/55
----	[redacted]	Krummrich Plant	Stomach	59	D-10/17/55
----	[redacted]	Everett	Rectum	53	D-3/21/56
----	[redacted]	Employed 25 years Night Supervisor - Everett	Lip malignancy (metastasis)	47	D-[illegible]
----	[redacted]	Everett- Operator in Bisulfite Dept.	Adeno carcinoma of rectum	56	

EX P-0013 Page 20 of 32

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CANCER INDEX

Page 5

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
---	[redacted]	Employed 16 years Everett - Op. in DOP Dept.	Adenocarcinoma of the colon.	5[illegible]	D-9/17/[illegible]
---		Everett	Liver	47	D-11-02-56
Feb. 1957		--	Reticulum Sarcoma Mediastenium	55	D-02-11-57
Feb. 1957		Krummrich - Hourly worker	Metastasis carcinoma carcinomatosis	50	D-02-24-57
---		(May be subject to Workmens Nitro . Compensation)	Liver, pancreas & spleen	53	D-03/13/57
---		Addyston - Lead man	Lung	64	10-3-57 D-~~[illegible]~~
1957		Monsanto, Tenn.	Lung	51	D-11-16-57
March 1958		Mound Laboratory	Malig. of prostate gland	58	D-09-04-62
April 1958		Krummrich Plant	Bronc. cancer carcinoma	52	D-07-04-58
April 1958		Queeny Plt	Bladder (?)		D-04-13-73
April 1958		Queeny Plt	Left lung	49	D-03-30-58
April 1958		Everett Plant	Larynx	66	D-03-17-66
April 1958		~~Everett~~ KR on Mont	Lung		D-7/15/58
5/19/58		~~mont~~ Monsanto, Tennessee	Liver	53	D-12-08-58
5/19/58		Trenton - wage employe	Left lung	58	D-10-19-58
1952		Nitro	Prostate	61	D-8/31/5[illegible]
5/26/58		Springfield - wage employe	Left lung; exploratory thoracotomy, 3/27/58.	54	D- [illegible]
6/5/58		Everett Plt	Cecum, metastasis	[illegible]	EX P-0013 Page [illegible]
6/16/58		Springfield, hourly	Carcinoma of pancreas	46	

0665816

CANCER INDEX

Page 6

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
6/24/58	[redacted]	Springfield - salaried	Carcinoma rectal sigmoid	45	D-05-01-61
6/27/58	[redacted]	Texas City -wage employe	Chin	52	D-02-26-70
8/58	[redacted]	Krummrich Plant	Tongue		D-09-25-58
8/58	[redacted]	Krummrich Plant	Bronchogenic sarcoma	52	D-8/28/58
8/58	[redacted]	Barton	Lip		D-08-06-70
9/23/58	[redacted]	Trenton	Lung	59	
9/23/58	[redacted]	Trenton	Lung	38	D-9/13/58
9/30/58	[redacted]	Springfield - wage employe	Pancreas	46	
9/30/58	[redacted]	(Mobay) New Martinsville -salaried	Cecum		D-02-20-63
10/3/58	[redacted]	Queeny Plant - hourly	Pancreas	64	D-11-27-58
10/10/58	[redacted]	(Dept. Mechanic) Queeny Plant - wage employe	Right colon	57	D-9/6/61
10/10/58	[redacted]	Texas City - hourly	Right eye	52	D-02-26-70
10/17/58	[redacted]	Lion Oil - El Dorado wage	Pancreas	54	D-10-29-58
10/58	[redacted]	Shawinigan - Springfield	Left mass facial fold	46	
11/58	[redacted]	Seattle	Stomach	[illegible]	D-11-11-58
12/11/58	[redacted]	Trenton	Bladder	58	D-07-29-65
2/13/59	[redacted]	(Chief Operator) Queeny Plant - hourly	Bladder	54	D-2/25/64
3/6/59	[redacted]	Mon., Tenn. - hourly	Carcinoma of descending colon	57	
3/11/59	[redacted]	St. Louis Office-salaried	Lung	63	D-05-02-61

CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/12/59	[redacted]	El Dorado, Ark.-Wage	Generalized in lymphic system of the body	50	D-9/26/59
11/13/59	[redacted]	(Cafeteria - part-time) Queeny Plant-St. L.-Wage	Adenocarcinoma of Uterus	45	L - D [illegible]
11/20/59	[redacted]	Krummrich-Hourly	Carcinoma of Lung	57	D-11/16/59
11/20/59	[redacted]	(Helper-Tech.Melamine) Everett - Hourly	Carcinoma of Bladder	52	09-09-60 ~~L~~-D ~~9/60~~
12/8/59	[redacted]	Everett - Salaried	Metaestatic Carcinoma	42	D-02-11-60
12/18/59	[redacted]	Everett - Hourly	Carcinoma of Colon	62	D-03-30-60
12/23/59	[redacted]	Krummrich - Hourly	Carcinoma of Bladder	48	L
12/23/59	[redacted]	Mound Lab - Hourly	Carcinoma of Cervix	40	L
1/22/60	[redacted]	(Mechanic) Queeny Plant - Hourly	Carcinoma of Bladder	44	L
1/22/60	[redacted]	(Chemical Operator) Krummrich - Hourly	Basal cell carcinoma of left lateral canthus	34	L
3/11/60	[redacted]	(Chem. Operator) El Dorado - Hourly	Carcinoma of Lung	50	D-01-07-61
3/29/60	[redacted]	(Helper & Laborer) Krummrich-Hourly	Carcinoma of Stomach	53	D-03-06-61
4/15/60	[redacted]	(Welder-1st class) El Dorado Ref.-Hourly	Carcinoma of Pancreas	59	D-07-29-60
6/17/60	[redacted]	(Mechanic) Queeny Plant - Hourly	Carcinoma of Colon	55	D-02-17-61
6/24/60	[redacted]	(Chief Operator) Texas City - Hourly	Cancer of the Lung	53	D-02-09-62
7/11/60,	[redacted]	Springfield (Office)	Cancer of the breast	43	D-02-21-61
7/18/60	[redacted]	(Foreman in Mftg.) Monsanto, Tenn.-Salaried	Carcinoma, left vocal cord	57	D-01-31-74
7/18/60	[redacted]	(Chemical Operator) Shawinigan Resins-Wage	Carcinoma of the thyroid	45	D-05-25-63
7/22/60	[redacted]	(Shift Engr.-Power Dept.) Texas City-Wage	Epidermoid carcinoma of left lung	44	D-01-25-61

0665813

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CANCER INDEX

Page 7

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
3/11/59	[redacted]	St. Louis Office (Sal.)	Stomach	62	D=12/8/59
3/20/59	[redacted]	Spfld. (hourly) Chem. Op.	Metastatic Ca of Hip and pelvis, secondary to Ca. of Hip.	64	D-09-20-59
3/20/59	[redacted]	Texas City (hourly)	Ca. of the Scalp	37	L
6/8/59	[redacted]	Spfld. (hourly)	Basal Cell Ca of Rt. Lower Eyelid	56	L
6/19/59	[redacted]	Queeny (hourly)	Ca. of Lung	54	D-6/22/59
6/26/59	[redacted]	Mound Lab (Sal.)	Endometrial Ca of cervical invading the entire cervical canal probably the lower uterine segment and anterior lip of cervix	40	D-06-30-60
7/31/59	[redacted]	New York Ofc. (Sal.)	Ca., Rt. Breast	27	L
8/20/59	[redacted]	Dayton (Sal.)	Rt. Lung	63	D-12-18-59
8/21/59	[redacted]	El Dorado Chem. Plant (hourly)	Lower lip	52	L
8/31/59	[redacted]	Anniston (Hourly)	Rectosigmoid	58	D-07-07-63
9/17/59	[redacted]	Krummrich (Hourly)	Metastasis	49	D-9/9/59
10/16/59	[redacted]	Spfld. (Hourly)	Lung	55	D-~~11/10/59~~ 10-24-59
10/28/59	[redacted]	Krummrich (Hourly)	Lung	60	D-~~10/59~~ 10-07-59

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/29/60	[redacted]	Queeny (Pipefitter)	Urinary Bladder	51	D-09-21-61
8/26/60		Texas C. (Wage)(Operator)	Larynx	62	D-10-07-61
8/26/60		Texas C.-Wage (Operator)	Possible Ca Lungs	61	D-04-26-61
9/28/60		Spfld.-Salaried (Office)	Brain Tumor	30	D-08-17-60
10/13/60		T.C. (Machinist)	Metastatic Adenocarcinoma	31	D-9/17/60
11/11/60		El Dorado - Sal. (Office)	Cervix	38	L
12/5/60		El Dorado - Sal. (Office)	Fallopian Tube	59	D-11-28-60
12/9/60		Queeny - Wage (Chem. Op.)	Bladder	45	D-01-21-70
1/3/61		Shawinigan, Spfld. - Wage	Basal Cell Cancer	37	L
5/8/61		Texas City(Painter-Leadman)	Squamous Cell Carcinoma of left Mandible	54	D-02-26-70
5/23/61		Spfld.-Wage(Production)	Bronchogenic Ca.	59	D-06-05-61
10/24/61		Spfld.-Wage (Production)	Carcinoma of colon	63	D-09-12-62
2/23/62		Krummrich - Wage(Chem. Op.)	Multiple myeloma]	54	D-02-28-64
3/23/62		Queeny - Wage (PAB) (Dept. Mechanic)	(NO TUMOR) Carcinoma in situ Bladder	51	D 1-14-83
4/27/62		(Raw Materials Helper) Columbia, Tenn.	Prostate	56	D-07-19-63

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/13/62	[redacted]	Springfield - W (Production)	Head of pancreas	64	D-10-16-63
9/29/62		Queeny Plant (Chief Op.)	Carcinoma of Right Lung & mastitis		D-9/20/62
9/29/62		Queeny Plant (Dept. Mechanic)	Bronchogenic Cancer		D-8/9/62
10/2/62		Springfield (Production)	Metastatic Carcinoma	56	D-11-22-62
7/15/63		Texas City (Instrument man)	Carcinomatosis	63	D-~~1962~~ 08-01-62
"		Shawinigan (Clerk-Typist)	Cancer of Lungs	35	D-~~1962~~ 09-01-62
"		(Office) General Offices - St. Louis	Malignant meanoma of back	57	D-~~1962~~ 03-17-62
"		Krummrich (Maint. Foreman)	Cancer of Lung	61	D-~~1962~~ 04-03-62
"		Nitro (Maintenance Man)	Cancer of Lung	53	D-~~1962~~ 07-25-62
"		General Offices (Office)	Generalized cancer	45	D-~~1962~~ 06-17-62
"		(Night Superintendent) Texas City	Cancer of Liver	@50	D-~~1962~~ 06-19-62
"		General Offices (Sec'y.)	(Cancer of Liver, (Colon, Ovaries, Skull	42	D-~~1962~~ 06-10-62
"		Barton - Sr. Operator	Cirhossis of Liver	43	D-~~1962~~ 01-07-62
"		(Material Handler) New Martinsville	Cancer of Pancreas	50	D-~~1962~~ 06-25-62
"		~~Queeny~~	~~Cancer of Lung~~	~~61~~	~~D-1962~~ Dual
"		(Chief Clerk-Purch.) Texas City	Cirrhosis of liver	61	D-~~1963~~ 04-28-63
"		Carondelet (Utility Man - Production)	Cancer of bladder with metastasis to spine	45	D-~~1963~~ 04-08-63
"		(Plant Guard) New Martinsville	Cancer of Brain	54	D-~~1963~~ [illegible]-63

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/15/63	[redacted]	Texas City (Operator)	Brain	55	12-18-62 D-[redacted]
7/15/63		Queeny (Guard-Prev.Chem.Op.)	Lung	62	03-20-63 D-[redacted]
7/19/63		Monsanto, Tenn.	Prostate w/generalized bony metastasis	57	D-07-19-63
9/30/63		Mound Lab.-Fireman, Driver	Carcinomatosis Primary unknown at present.	60	D-02-17-64
11/25/63		Krummrich (Pipefitter)	Ca. Pancreas]	58	D-11/24/63
12/20/63		Krummrich (Blacksmith)	Metastic Ca. of Cervical Gland and Pleural effusion	60	D-01-12-64
12/20/63		Texas City (Pipefitte/ Leadman)	Rectum	56	D-12/4/63
1/31/64		Springfield(Production)	Rectum	63	D-1/23/64
2/5/64		G.O. (Admin)	Brain	42	D-1/20/64
2/5/66		Spfld- wage (Production	Lungs	50	D-1/22/64
2/10/64		(Chief Maintenance Man) Santa Clara-wage	Leiomyosarcoma of the jejunum with metastasis	59	D-2/1/64

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/18/64	[redacted]	Queeny Plant (Porter)	Prostate	60	D-02-24-67
2/26/64		Spfld.,hourly (Production)	Lymphosarcoma	36	D-02-18-65
4/1/64		Nitro-Wage (Gate Attendant)	Abdomen	42	D-3/15/64
4/7/64		Salaried El Dorado (Office Worker)	Abdominal Cavity	56	D-2/11/64
4/9/64		Queeny Plant (Chem. Op.)	Bladder	52	L
5/12/64		Queeny (Packer)	Prostate	56	D-01-29-70
4/9/64		Springfield (Production)	Prostate	64	L
6/5/64		Everett (Op.-Tech.Melamine)	Esophagus]	63	D-05-31-64
7/10/64		Queeny (Chem. Op.)	Lung]	56	D-3/24/65
7/14/64		Everett	Bronchiogenic	60	D-12-04-64
7/17/64		Queeny (Chief Operator)	Pancreas	60	D-10-04-64
8/12/64		(Storeroom Attendant) Krummrich Plant	Rectum	62	D-08-29-71
8/17/64		Krummrich-hourly(Chem.Op.)	Lung	51	D-10-05-64
8/17/64		Lion Oil Distributor	Abdomen	63	D-09-27-64
11/6/64		Spfld.(Materials Clerk)	Bladder	62	D-03-21-73
11/18/64		Spfld.-hourly(stock Handler)	Liver	42	D-~~11/64~~ 10-30-64
11/24/64		(Stock Handler) Spfld.-Shawinigan	Colon Cecum	50	D-7/23/67
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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
12/3/64	[redacted]	(Reduction Op. H-acid) Everett - hourly	Tongue	57	D-11/20/64
12/3/64		(Patent Atty.) St. Louis - G.O.	Right renal cell w/metastasis	43	D-10/1/64
12/22/64		(Chemical Laborer) Krummrich Plant	Lung	49	D-12/16/64
1/13/65		Nitro (Janitor)	Larynx	64	D-01-28-78
1/15/65		(Office Worker) El Dorado - hourly	Lung	59	D-12/31/64
1/22/65		(Rigger) Krummrich - hourly	Widespread cancer-primary site unknown	60	D-1/10/65
2/10/65		Queeny - wage (Chem. Op.)	Pancreas with metastasis to liver and lymph nodes.	54	D-3/31/65
2/17/65		(Office) Springfield - salary	Generalized carcinomatosis due to cancer of breast.	49	D-1/26/65
3/25/65		(Millwright) Queeny Plant - hourly	Stomach	54	D-5/2/65
3/29/65		(Powerhouse Ash Handler) Krummrich Plant -	Lung	52	D-06-27-65
4/29/65		(Finisher) Stonington - hourly	Stomach	55	L
5/3/65		Everett (Head Op.-bisulfite)	Nose	62	L
"		Queeny - hourly-Warehouseman	Rectum metastasis to liver	54	L D-8/2/65
"		Krummrich (Chem. Operator)	Larynx	56	L
"		Queeny (Chem. Operator)	Bronchogenic-left lobe	58	L (D-9/12/65)
5/14/65		Everett (1/c Painter)	Lung	45	

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/18/65	[redacted]	MAC Station	right colon	47	D-12/27/65
6/2/65		Krummrich (Chem. Operator)	bronchogenic	56	D-8/10/66
6/9/65		Queeny (Pipefitter)	Hodgkins Disease rt. anterior chest wall lymph nodes rt. axilla and left groin.	43	D-08-26-76
6/21/65		Columbia, Tenn. (Elect.)	Lymphosarcoma	40	D-04-08-72
6/23/65		G.O. (Salaried - Admin.)	Lung	49	D-4/30/65
6/23/65		Janitor Port Plastics (wage)	Bronchiogenic with metastasis to brain	60	D-5/26/65
7/28/65		Krummrich (wage) [Painter]	Bronchiogenic w/ cerebral metastasis	58	D-7/10/65
8/17/65		Queeny (salaried) Project Planner Maintenance Dept.	Abdomen	47	D-7/23/65
9/3/65		Queeny Plant (wage) Chemical Operator	Bronchiogenic adeno-carcinoma - rt. upper lung.	56	D 12-22-85
9/28/65		(Finisher) Deep River-Hourly	Breast w/metastases to bones, skin, liver	44	D-9/13/65
9/21/65		Nitro (Pipefitter)	Squamous cell carci-noma - Recurrence	52	L
10/19/65		Krummrich (iron worker helper)	Sarcoma of bone and sclerosis of liver.	56	D-8/26/65

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
12/15/66	[redacted]	Columbia (hourly) Mechanic	Metastatic ca of abdomen. Primary site unknown.	51	L D-12/22/66
12/21/66		Deep River (wage) Mach. Op. B	Malignant lesion 8th vertebra (Widespread carcinomatosis)	49	D-1/13/67
12/22/66		ElDorado (hourly) (Station Engineer-pipeline sec.)	Liver (ca widespread)	61	D-2/1/67
12/23/66		Deep River (hourly) Maint. Mech. C)	Rectum	58	D-05-29-68
1/5/67		Mac Station Supervisor	Anoxia due to infiltration of lung by reticulum cell sarcoma	39	D-12/5/66
1/9/67		(Machinist) ElDorado Chem. Plnt.	Lung	50	D-06-11-67
1/19/67		Krummrich (Chemical Operator)	Lungs	57	D-12/13/66
2/9/67		Alvin (Sal) Analyt. Lab Asst.	Malig. Lymphoma (Looks like Hodgkins)	28	D-1/28/67
3/13/67		(Mill Roll Operator) Springfield (hourly)	Lung	50	D-2/20/67
3/16/67		Columbia ("A" Elect.)	Lymphosarcoma w/blood stream involvement	42	D-04-08-72
3/17/67		Texas City (hourly) Operator	Facial skin ca.	56	D-08-30-72
3/17/67		Baxley (Filtered Resins)	Lung-left upper lobe	60	D-07-21-77
3/31/67		Pensacola (sal)	Brain tumor, metast.	49	D-2/25/67
4/13/67		Greenwood, S. C. (hourly)	(Yarn process operator) Reticulum cell sarcoma	42	D-3/13/67
4/27/67		Krummrich (Day Helper)	Skin	55	L
4/27/67		Sharonville (Finisher)	Breast (left)	29	L D-5/24/70

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
6/9/66	[redacted]	(Garment Room Supervisor) Krummrich-Sal.	Lung with metastasis	56	D-4/30/66
9/2/66	[redacted]	pipefitter Queeny Plant (hourly)	Stomach	51	D-4/14/68
9/2/66	[redacted]	(Salt Cake Operator) Krummrich Plant (hourly)	Lung	54	D-04-29-68
9/ 6/66	[redacted]	Electrician Columbia (hourly)	Lymphosarcoma	41	D-04-08-72
9/26/66	[redacted]	Queeny (Research Porter)	Metastatic lesion Occipital Lobe	57	D 12-22-85
9/26/66	[redacted]	Gehring	Metastatic ca primary site unknown	36	D-11/27/66
9/30/66	[redacted]	Welder Queeny (hourly)	Brain	45	D-9/11/66
9/30/66	[redacted]	Mound (sal.) Maint.Foreman	Astrocytoma rt. frontal lobe	53	D-9/9/66
10/5/66	[redacted]	Nitro (Production)	Ca bladder	63	D-8/22/66
10/10/66	[redacted]	Gering (hourly)	Ca bladder	56	D-12-27-75
10/10/66	[redacted]	(Boiler Fireman) Springfield (hourly)	Metastatic malignancy	45	D-11/20/66
10/24/66	[redacted]	Springfield (hourly) Engr.	Lung	55	D-9/24/66
10/24/66	[redacted]	(Supervisor-Res. Services) Shawinigan(Spfld) Sal.	Brain	59	D-10/5/66
10/24/66	[redacted]	Pensacola (Sal) (Projects & Standards) Mech.Engr.	Lung and Rectum	38	D-10/9/66
10/24/66	[redacted]	Fabric Services (Sal.)	Metastatic Ca.primary site undetermined.	57	D-9/15/66
12/5/66	[redacted]	Trenton (hourly) Millwright 1/c	Pancreas	43	D-11/26/66
~~12/6/66~~	[redacted]				
12/8/66	[redacted]	Columbia (Traffic Switchman)	Prostate	53	D-03-17-75

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CANCER INDEX

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Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/12/65	[redacted]	General Offices (admin)	Breast with metastasis.	52	D-11/5/65
12/8/65	[redacted]	Dept. 247 Operator Krummrich (wage)	Metastatic ca. generalized	40	D-12-22-65
12/17/65	[redacted]	Nitro (Serv. Bldg. Attendant)	Bladder Lining	58	D-11-20-68
12/17/65	[redacted]	Barton (Sr. Mechanic)	Melanoma on back	44	D-4/15/68
12/22/65	[redacted]	Spfld. (sal) Engrg. Supvr.	Malignant Melanoma	51	D-12/12/65
1/6/66	[redacted]	Queeny (Millwright)	Larynx	56	D-09-24-79
1/27/66	[redacted]	El Dorado Chem. Plant (Operator - hourly)	Bronchiogenic	42	D-1/4/66
2/8/66	[redacted]	(Central Drumming Oper.) Queeny Plant	Fibrous sarcoma of left axillary	48	D-02-22-66
2/4/66	[redacted]	Interim Lead Operator Spfld. (hourly)	Stomach	48	D-1/20/66
4/28/66	[redacted]	Everett (hourly) Chem. Op.	Lung	60	D-4/15/66
4/28/66	[redacted]	Detroit Office (sal.)	Abdominal. Bilot ca. of Ovary	47	D-3/29/66
4/28/66	[redacted]	Mound (salaried) Personnel Trng. Mgr.	Left Kidney	51	D-3/23/66
5/6/66	[redacted]	(Leadman in Storeroom) Krummrich (hourly)	Carcinomatosis	52	D-4/19/66

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4/28/67	[redacted]	Krummrich (Boilermaker)	Anus	57	D-09-22-67
4/28/67	[redacted]	Sharonville (Janitor-Prod.)	Tongue w/metastasis left cervical chain	48	D-02-19-68
5/15/67	[redacted]	Krummrich (Physician)	Abdominal	37	D-3/7/67
5/18/67	[redacted]	Stonington	Prostate (metastatic)	49	D-01-04-74
5/31/67	[redacted]	Springfield (Case maker-Shipping Dept)	Liver	60	L D 11/23/67
6/7/67	[redacted]	Spfld. (General Laborer)	Rt. Testicle	26	L D 8/4/68
6/22/67	[redacted]	Queeny Plant (Chemical Oper.)	Lung	52	D-09-11-68
6/26/67	[redacted]	El Dorado (Sr. Operator Nitric Acid Plant)	Nose	50	L
6/30/67	[redacted]	Trenton (Chemical Worker)	Lung	51	D-8/12/67 L
7/19/67	[redacted]	Pensacola (1st class mechan.)	Metastatic Malignant Melanoma	29	D7/9/67
8/8/67	[redacted]	Decatur (sal.) (Sec'y.)	Metastatic ca ovaries tubes & peritoneum	51	D-7/17/67
9/1/67	[redacted]	Spfld. (	Metastatic ca.	47	D-8/28/67
10/9/67	[redacted]	Krummrich (Office Worker)	Lymphosarcoma	46	D8/31/67
10/16/67	[redacted]	Spfld. (hourly) Press Opr.	Lung	51	D9/24/67
10/16/67	[redacted]	ElDorado (Loader) Refinery (hourly)	Pancreas	62	D 10/1/67
10/19/67	[redacted]	Queeny (Dept. 4 Operator)	Colon	51	L
11/2/67	[redacted]	Queeny (Millwright)	Bladder	48	D-04-13-73
11/9/67	[redacted]	Queeny (Leadman-Whse.)	Bladder	62	EX P-0013 Page 15 of 32 D-08-[illegible]-69
11/20/67	[redacted]	Texas City (Sal.)	Lungs (Maint. Foreman)	52	D-11/2/67

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
11/28/67	[redacted]	(operator-pelleting plant) El Dorado Plant	Neck	53	L
12/13/67	[redacted]	Krummrich (Bricklayer)	Bladder	55	L
+ 1/8/68	[redacted]	Bridgeview (Sal.) (Plant Mgr)	Pancreas	49	D-10/18/67
+ 1/8/68	[redacted]	(Operator) Texas City (hourly)	Lymphoma xxxxxxx	35	D-12/6/67
~~2/5/68~~	[redacted]	~~Queeny~~	~~Abdomen (generalized)~~	~~52~~	~~L~~
+ 2/5/68	[redacted]	(Spinning Operator) Decatur (hourly)	Alvcolar Cell Rhabdo-myosarcoma	23	D-1/11/68
2/8/68	[redacted]	Ligonier	Uterine	30	L
+ 2/15/68	[redacted]	(Plant Guard) Carondelet (hourly)	Lung	61	L 2-20-68
4/4/68	[redacted]	Queeny (Electrician)	Left vocal cord	48	L
+ 4/11/68	[redacted]	Ligonier (Factory Inspector)	Bladder	52	L 7-20-78
+ 4/29/68	[redacted]	Nitro (hourly) (Operator Santoflex)	Bronchocarcinoma rt. upper lobe	54	D-4/15/68
+ 5/2/68	[redacted]	(Electrical Foreman) Pensacola (sal.)	Stomach	68	D-4/17/68
+ 5/1?/68	[redacted]	(Truck Driver) Krummrich (hourly)	Malignant brain tumor	59	D-4/28/68
+ 5/1?/68	[redacted]	(Shift Helper) Krummrich (hourly)	ca. of lung	62	D-5/7/68
+ 5/24/68	[redacted]	Luling (hourly) Guard	Lungs	55	D-4/30/68
+ 6/8/68	[redacted]	(Maintenance-Lubrication) Deep River (hourly)	Rectum w/metastases	59	D-5/29/68
X 7/10/68	[redacted]	Krummrich (hourly)	Basal cell Ca.	56	~~L~~ D 10-6-83
X 7/15/68	[redacted]	T.C. (hourly) (Painter/Lead man)	Left Lung	61	L [illegible]

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/10/69	[redacted]	Anniston (sal) (Mtls Hndlg supvr)	Pancreas	60	D-1/16/69
2/10/69	[redacted]	Krummrich (Porter-Laborer)	Adenocarcinoma-rectum	54	L 4-5-69
2/19/69	[redacted]	Krummrich (Pipefitter)	Right lung	57	L 10-16-69
3/6/69	[redacted]	El Dorado (Chem. Operator)	Face & Skin	58	L
3/20/69	[redacted]	Delaware River (Chem. Oper.)	Brain	45	L 4-9-70
3/21/69	[redacted]	Nitro (hrly) (head operator)	Pulmonary Embolus	58	D-12/25/68
~~3/21/69~~--	[redacted]		(due to op. ca of urinary bladder operation.		
3/21/69	[redacted]	El Dorado Refinery (hrly) (Operator)	left lung w/met.	57	D 2/18/69
3/28/69	[redacted]	Kenilworth (sal)(sales corrs)	Cirrhosis of liver	48	D-9/11/68
3/28/69	[redacted]	G.O. (engrg.)	Hypernephroma,met. to peritoneum, liver & tongue.	44	D-3/9/69
3/28/69	[redacted]	Texas City (hrly)(boiler-maker)	rt. lung	63	D-12/8/68
4/8/69	[redacted]	Queeny (Chemical Operator)	Lung	48	D-3/19/69
4/8/69	[redacted]	Columbia (slag foreman)	Lung	59	D-3/14/69
4/8/69	[redacted]	Texas City (operator)	Brain Tmmor	49	D-2/14/69
4/15/69	[redacted]	Columbia (Electrician)	Lymphosarcoma with blood stream involvement	44	L 4-8-72
4/28/69	[redacted]	Nitro (hrly)(Gatehouse ~~attendant)~~	Right Lung	53	D-4/22/69
4/30/69	[redacted]	Nitro (hrly) (Carpenter)	Right ear	59	L-

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
7/29/68	[redacted]	Trenton (hourly)	Gastric ca.	47	L 3-21-69
7/30/68	[redacted]	Texas City (hrly.) (Carpenter)	Papillary Ca. enlarged thyroid gland	49	L
8/20/68	[redacted]	Ligonier (Finisher)	Nose	52	L
8/22/68	[redacted]	Queeny (Cafeteria)	Ovaries	50	D-~~8/68~~ 8-12-68
8/22/68	[redacted]	Springfield(Empl.Serv.Mgr)	Pulmonary Atelectasis	64	D 7/27/68
9/12/68	[redacted]	Textiles N.Y. (Sales Rep.)	Testes	44	D 8/17/68
9/26/68	[redacted]	Kenilworhh(hourly) Class A Mechanic	Lung	54	L 6-11-69
10/18/68	[redacted]	El Dorado Refinery (truck transport)	Anaplastic ca.	35	D-9/23/68
10/21/68	[redacted]	ElDorado Plant (Chem operator)	Mouth	61	D-6-20-80
11/14/68	[redacted]	Queeny (Chem. Operator)	Lung	47	L 3-19-69
11/21/68	[redacted]	Krummrich (Tractor Driver) (hourly)	Lung	58	D-10/23/68
11/22/68	[redacted]	Spfld.(Sal.)(Matl.Handling Engr)	Esophagus	49	D-11/1/68
12/9/68	[redacted]	Krummrich (hrly) (Electrician)	Colon	61	D-11/12/68
1/15/69	[redacted]	G.O.Research	Stomach	49	D-12/15/68
1/22/69	[redacted]	Pensacola (sal) (Managerial)	Malignant Lymphoma	49	D-1/1/69
1/30/69	[redacted]	Springfield (sal) (Maintenance Foreman)	Rectum	62	D-12/31/68
2/3/69	[redacted]	Nitro (hrly)	Bronchial ca.	53	L 4-22-69
2/5/69	[redacted]	New York (receptionist)	Brain Tumor -Ca.Colon	52	D-1/29/69

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
5/5/69	[redacted]	Yardville (hrly) (finisher)	Colon	42	L
5/7/69	[redacted]	MAC	Lymphosarcoma cell leukemia	43	D-5/3/69
5/19/69	[redacted]	Queeny (hrly) (Chem. Oper.)	Kidney	47	L 2-22-70
6/30/69	[redacted]	Kenilworth (Packer Film Dep	Multiple Myeloma	59	L
7/9/69	[redacted]	Kenilworth (hrly) (Sr. Mech.)	lung, w/metastasis to brain, liver, and left adrenal.	58	D-6/15/69
7/25/69	[redacted]	Nitro hrly. (Pipefitter)	lung	53	L 2-25-70
7/28/69	[redacted]	Greenwood, S. C. (Supt. Cost analysis)	Carcinomatosis of Kidney	55	D-6/13/69
7/29/69	[redacted]	Alvin (Chem. Operator)	Thyroid	33	
7/31/69	[redacted]	Queeny (Chem. Operator)	nose	62	D 12-21-85
9/2/69	[redacted]	Queeny	Bladder		D-8-17-69
9/10/69	[redacted]	Krummrich (Chem. Operator)	Bladder	61	~~L~~ D 4-20-81
9/22/69	[redacted]	Spfld. (hrly) (Electrician)	Larynx	48	L
9/25/69	[redacted]	Gering (hrly)	Multiple Myloma	59	D-8/22/69
12/9/69	[redacted]	Akron, (secretary)	Ovarics	49	D-10/26/69
1/12/70	[redacted]	West Port (sal)	Ewings Sarcoma w/Metastases	29	D-11/27/69
1/27/70	[redacted]	Queeny (hrly) Garage Mech.	Bladder	49	D-1/18/70
2/26/70	[redacted]	Mound (maintenance foreman)	Colon	56	D-2/5/70

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See if these are on mortality file

CANCER INDEX

	Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
X	7/26/76	[redacted]	JFQ - rigger	ca. bladder	60	D 2-27-85
X	11/9/76		Soda Spgs.-Gen'l. Acct. Super.	ca; Sigmoid	54	D- 9/19/76
X	11/9/76		Anniston-Chem. Operator	ca; Bronchogenic	41	D-10/2/76
X	11/18/76		Ligonier-Maintenance Laborer	ca: lung	62	D-10/23/76
X	11/24/76		Luling - Mfg.Foreman I Ag.	cancer metastatic	56	D-10/22/76
X	11/30/76		Deep . River - office worker	generalized carcinoma	47	D-11/30/76
X	3/25/77		Westport-Mech./Tool Crib	ca. left ala of nose & left cheek	60	D 7-2-85

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/3/75	[redacted]	Ligonier (finisher)	Breast	42	L
3/21/75		Kearny (central control chemical operator)	Lung	62	D-3/2/75
3/25/75		FRP Co. (chemical operator attendant)	bronchogenic		D
4/21/75		Spgfld. (plant service	to CA of colon gen. metastases/second	61	D-4/2/75
4/14/75		Alvin-Mech. Maintenance Tech.			L
9/22/75		Sand Mtn. - process tech.	undifferentiated mediastinum w compression lg. vessles	32	D-8/28/75
10/13/75		Trenton - Millright 1/C	carcinomatosis	52	D-9/14/75
12/5/75		Trenton - millright 2/C	ca. throat & tongue	53	L
1/26/76		Spgfld. - stenographer B	ca. rectum	54	D-1/8/76
1/26/76		Houston - secretary	ca: metastatic ovary	63	D-1/1/75
2/20/76		Bloomfield - Engr. Specialist	ca: stomach	54	D-2/2/76
2/3/76		Ligonier - finisher (factory)	carcinomatosis	54	D-1/15/76
4/14/76		G.O. - Gen. Engr.(elec. design)	carcinomatosis-adenaca. of pleura	61	D-3/16/76
3/22/76		Ligonier - Inspector	ca: bladder	60	L
3/25/76		Spgfld. -container clerk & rigger crane opr.	widespread anaplastic carcinoma	56	D-2/24/76
3/31/76		WGK. - chemical operator	metastatic melanoma	45	D ~~L~~ 3-2-84
4/5/76		Bircham Bend - pipefitter	ca: rt. lung met. to rt. scapula	47	L
6/11/76		Akron - Acct. Super. II	ca. Lung	50	D-2/20/76
6/15/76		Soda Spgs.-mechanic	ca. sigmoid ext. to bowel ~~wall & affecting colon~~	35	L

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
9/3/74	[redacted]	Columbia Traffic Operato	Prostate	60	L 3-17-75
9/5/74	[redacted]	Texas City (hrly) Boiler-maker	Lung	64	D-7/13/74
9/5/74	[redacted]	G.O.	Met. melanoma brain	54	D-8/6/74
9/11/74	[redacted]	Yardville(hrly) Finisher	Met.bronchogenic ca.	55	D-8/28/74
9/19/74	[redacted]	Alvin Maintenance Tech.	Respiratory failure due to met.ca of lung	44	D-9/5/74
9/20/74	[redacted]	Spfld. Still Operator	ca. bile ducts	41	L 12-14-74
9/20/74	[redacted]	G.O.	ca. bladder	56	D-8/30/74
10/22/74	[redacted]	Columbia Tapper Helper	bronchogenic ca.	49	D-9/28/74
10/22/74	[redacted]	Queeny Chem. Opr.	ca. colon w/met.	61	D-9/22/74
11/15/74	[redacted]	Sharonville (finisher)	breast	44	L
11/27/74	[redacted]	Columbia Nodulizing Lead-man	left lung, met.to/ pleura	49	L 5-7-75
12/11/74	[redacted]	Shawinigan	sigmoid colon met to/ liver	63	D-11/29/74
12/23/74	[redacted]	Decatur Sr. Textile Tech.	stomach w/estens.Met.	60	D-12/2/74
12/23/74	[redacted]	Pensacola Spinnerette Tech	Met. ca. primary unkn.	43	D-12/18/74
1/7/75	[redacted]	Spfld. ~~[illegible]~~	infiltrating adenocarcinoma colon w/o met.	59	D-3-25-79
1/22/75	[redacted]	Springfield hrly	Stomach & liver	59	D-12/29/75
" "	[redacted]	Krummrich hrly (carpenter)	Met.adenocar. brain	57	D-1/11/75
" "	[redacted]	Columbia —	Lung	46	
2/24/75	[redacted]	Queeny (hrly)millwright - (1939-1975) (on PAB program)	Head of pancreas w/met ca of liver	64	D-2/11/75

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/27/74	[redacted]	Yardville (hourly) Machine Opr.	Metastatic ca. Ca. testicles	22	D-2/2/74
"	[redacted]	Queeny (sal.) Chem. Opr. Prod. Foreman	Ca. Lung	56	D-2/4/74
"	[redacted]	Chicago (Secretary)	Carcinomatosis/breast, Pneumonia	59	D-5/20/73
"	[redacted]	Avon (hourly) Op. B Catalyst Plnt/	Ca rectum	58	D-1/23/74
"	[redacted]	Yardville (Finisher)	Bronchogenic ca. w/met & nephritis	55	L 8-28-74
2/26/74	[redacted]	Indian Orchard (Extrusion Process Att.)	mouth w/met. to neck	48	L 9-25-75
3/21/74	[redacted]	Queeny (Res. Porter)	Esophageal Ca.	60	L 3-21-74
"	[redacted]	Sharonville (Finisher)	Ca. in situ Cervix	40	L
"	[redacted]				
4/8/74	[redacted]	St. Peters (Bench Processor)	Ca. in situ	37	L
4/10/74	[redacted]	Lima, Ohio (B Inspector)	Ovary	40	L
4/18/74	[redacted]	Queeny (Engine Operator)	Ca Prostate w/met.	60	D-4/1/74
5/20/74 6/7/74	[redacted]	Nitro (Serv.Bldg.Attend) Texas City (Pumper-Gauger	Trans.cell ca prostate Bronchogenic carcinoma	49 61	D-4/29/74 L 10-4-74
7/1/74	[redacted]	New York (office)	Seminornia -metas.	41	D-5/29/74
7/1/74	[redacted]	Krummrich (Crane Hook-up)	Lung	62	D-6/9/74
7/1	[redacted]	Springfield (Blender Op.)	Ascending Colon	54	L
7/3	[redacted]	Queeny (Chief Operator)	Colon	57	L
8/5/74	[redacted]	Carondelet (Sec'y)	Met. ca to brain, liver, skeleton	46	D-7/[illegible]/74
8/12	[redacted]	Columbia Quincy Dept 60-73 Analytical 73 -	Ca. lung w/met.	45	D-7/6/74

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4/15/73	[redacted]	Queeny (48-72 Bricklayer (72-73 Shop Clerk	Bronchogenic ca.	47	D=3/19/73
5/2/73		(never actually worked for Monsanto) Leonard Construction Co.	Ca Bladder		10-19-73
5/16/72		Anniston	Distal mid-sigmoid Colon	59	L
6/6/73		Columbia ("B" mechanic)	Met. malignant melanoma of brain.	56	L 8-27-74
7/2/73		Texas City (Pumper Guager)	Met. ca. of rectum	61	D-6/20/73
7/9/73		Trenton (Pipefitter)	Trans. cell ca of bladder.	53	L 12-21-73
7/27/73		Krummrich (hrly) (Storeroom (Leadman)	Ca Liver	59	D-6/16/73
8/24/73		(Injection Molding) Kenilworth (Mach. Opr.)	Breast	47	L
9/5/73		Texas City (Chief Oper.)	Left Lung	58	L D 12/2/73
10/1/73		Spfld. (stock cont.-Resimine	Prostate	58	L 7-6-77
1/22/74		G.O.	Ca.Lung (death due to acute myocardial infarct.)	64	D-12/24/73
1/22/74		Trenton (hourly) (Pipefitter)	Ca. Bladder	53	D-12/21/73
1/29 /74		Krummrich (Porter)	Ca. sigmoid colon	59	L 4-22-85
1/29/74		Nitro(sal.) (Utilities Foreman	Ca. lung	62	D-1/17/74
1/29/74		Bircham Bend (Lab Analyst)	Reticulum cell ca.	29	L
2/27/74		Pensacola Hourly (Misc. Opr.)	left femoral. Pulmonary ca, wide-spread metastasis to brain bone.	52	D-1/26/74

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
3/10/72	[redacted]	Texas City (Chem. Op.)	Lip (lower)	57	L
3/17/72		Pensacola (Electrical Mech.)	Carcinomatoses Bronchogenic ca.	55	D-3/1/72
3/23/72		Addyston (Office)	Metastatic ca.Brain	50	D-1/13/72
4/20/72		Stonington (Finisher)	Prob. Metastatic Disease, liver. Old ca of breast.	39	L D-6/2/72
5/24/72		Queeny (Mechanic)	Adenocarcinoma lung	63	D-5/13/72
8/23/72		Nitro (Auto Mechanic)	Rectal ca.	49	L 12-8-72
10/3/72		Texas City (Operator)	Metastatic cerebral hepatic carcinoma	62	D-8/30/72
10/30/72		Texas City (Painter)	Adenocarcinoma of prostate metastatic to bone	50	L 1-25-76
11/13/72		El Dorado (Machinist)	left upper lobe-lung	63	L
11/13/72		Ligonier	Abdominal ca	57	D-10/30/72
1/2/73		Greenwood (Plant Security Guard)	Ca of liver-metastatic	61	D-12/2/72
2/73		Springfield (hrly) (Mason)	Ca of lung	56	D-1/8/73
2/73		Bircham Bend (Chem. Opr.)	Ca left lung with metastasis to bones and liver	59	D-1/11/73
2/26/73		Krummrich	Ca of gallbladder	48	D-2/13/73
2/28/73		Krummrich (Yard Laborer)	Ca rt. lung	59	1/25/73

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
9/9/71	[redacted]	Queeny (Shop Clerk)	Lung	63	D 9-6-71
9/9/71		Queeny (Cafeteria attend.)	Breast	43	L
9/9/71		(Safety & Sec. Inspector El Dorado Plant	Prostate gland	62	D-8/1/71
9/20/71		Alvin (I&E Technician)	Basal cell ca rt. cheek	35	L
9/23/71		Bircham Bend (Welder)	Adenocarcinoma	44	L
10/18/71		Krummrich (sal) Lab Analyst	Malignant lymphoma, mixed cell type	47	D-9/28/71
10/21/71		Ligonier (hrly) Finisher	Uterus	53	D-10/20/71
11/1/71		G.O. Off. Mach. Maint.	Metastatic ca. of kidney	51	D-9/17/71
11/23/71		Decatur (hrly)Janitor	Carcinomatosis	61	D-11/5/71
11/23/71		Queeny ?	Prostate	57	L
12/20/71		G.O.	Pancreas (adenocarcinoma)	59	D-11/21/71
1/4/72		Spfld. Lift truck repairman	lower 1/3 esophagus	58	D-10-4-72
1/5/72		Queeny (hrly) Chem. Opr.	urinary bladder (met)	56	D-12/7/71
1/5/72		Ligonier (Maint. Foreman)	Stomach	53	D-12/15/71
1/7/72		Mound (hrly) (Welder)	Carcinomatous from metastatic ca of colon	54	D-11/3/71
1/10/72		Nitro (Yard Laborer)	basal cell ca face & Squamous cell ca of lip	54	D-5-28-72
2/4/72		Gehring (	prostate, met. to bone	53	L
2/4/72		Ligonier (Office Worker)	Cervix w/metastasis	42	D-[illegible]
3/1/72		Addyston (Chem. Op)	Colon	35	

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CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
4/5/71	[redacted]	Krummrich (Machinist)	Lung	52	L 6-5-71
4/13/71	[redacted]	El Dorado	Metastatic malignant melanoma from lesion of back	35	L 10-8-71
5/6/71	[redacted]	ator/spinner Tire Yarn Dept) Pensacola (hrly)	Ca of testis with met.	25	D-4/9/71
6/11/71	[redacted]	Texas City (Chief Oper.)	Bronchogenic Ca. w/ Cerebral metastasis	47	L 6-6-71
6/11/71	[redacted]	Krummrich (sal) Office	Bronchogenic	50	D-5/18/71
6/16/71	[redacted]	Krummrich (Machinist) (hrly)	Lung	52	D-6/5/71=
6/18/71	[redacted]	West Port (Shift Mech. C Crew)	Malignant Nevi	38	L
7/1/71	[redacted]	Texas City (Chief Opr.) (hrly)	Brain tumor, secondary to lung ca.	48	D-6/6/71
7/6/71	[redacted]	Pensacola - Mechanic	Exanguinating hemorrhage due to bronchogenic ca.	57	D-6/12/71
7/20/71	[redacted]	G.O. (Cafeteria)	Metastatic Disease w/ bilateral uretreal obstruction	39	D-7/4/71
7/28/71	[redacted]	Columbia (Bulldozer Oper)	Massive abdominal tumor probably metastatic from old testicle ca	46	L 12-19-74
8/13/71	[redacted]	Ligonier (Inspector)	Transurethral ca	55	L 8-2-78

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BCR ARCH0641339

CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
9/8/70	[redacted]	Everett (Autoclave Opr. Santocel Dept.)	Parkinson's Disease	55	L 9-17-78
9/8/70		Queeny (Whse. Clerk, Shop Laborer)	Rectum	59	L 3-11-78
10/23/70		G.O. (Sec'y)	Breast w/metastasis	54	D-9/18/70
10/15/70		Columbia (Furnace Tapper)	Rt. Upper Lobe	53	L 7-5-72
10/19/70		St. Peters	Breast (Bench Processor Clean & Insp.)	33	D 10/8/70
11/25/70		Texas City (Chief Operator)	Liver	62	L 12-13-70
12/7/70		Queeny (Dept. Mechanic)	Bladder	55	L
12/10/70		Trenton (Maint.MechanicI)	Hodgkins	33	L 7-9-72
1/26/71		Anniston (Millwright)	Bronchogenic Ca.	59	D-1/5/71
2/5/71		Texas City (Painter)	Respiratory paralysis, secondary to spinal	54	D-12/30/70
~~XXXXXXX~~		~~XXXXXX~~	cord metastatic ca. due to ca of rt adrenal		
			poss. secondary to ca of lung.		
2/5/71		El Dorado (Field Gauger)	Adenocarcinoma of ~~Pancreas~~	64	D-1/29/71
2/8/71		Queeny (Coppersmith & ~~Tinner)~~	Lung	57	~~L~~ D 12-10-85
3/10/71		G.O.	Carcinomatosis-primary ~~bronchiogenic ca.~~	63	D-2/23/71
3/10/71		Everett (Carpenter 1/c)	Larynx	42	L
3/12/71		Carondelet (Chem. Oper.)	Ca. left ear & neck	43	L
4/1/71		Springfield (Nurse)	Ca. of Ovary	47	D-3/17/71

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BCP ARCH0641340

CANCER INDEX

Date Reported	Name	Location & Job	Cancer of:	Age	Living Deceased
2/26/70	[redacted]	Spfld.(hrly) Pkg. Operator	Sarcoma of lung	50	D-2/12/70
3/2/70		Baxley	Lung	61	L 7-21-77
3/5/70		Queeny (Chem. Operator)	Bronchiogenic ca.	54	L 11-6-70
3/12/70		W. Caldwell (Wiring & Soldering Opr.)	Breast	34	L
3/30/70		Spfd. (sal) (Res. Tech.)	Colon	61	D-3/11/70
4/27/70		Everett (Sal) (Mfg.Specialist)	Metastatic seminoma to liver and heart 1	59	D-4/4/70
4/27/70		G.O. (sal)	Brain Tumor-lung ca.	53	D-3/31/70
4/30/70		Ligonier (Chief Polyflex Inspector)	Cervix	46	L
5/4/70		Kenilworth (Benchworker)	Cervix	46	L
6/4/70		Trenton (Drum Dryer Operator)	Medulary ca of thyroid	40	L
6/25/70		Sharonville (hrly) Finisher	Breast-metastatic	32	D-5/24/70
7/10/70		Kenilworth (Benchworker	Endometrial ca.	41	L
7/13/70		Bircham Bend (Shift Supvr.)	Bronchogenic Ca.	55	D-5/31/70
7/20/70		ED	Lymphosarcoma	50	D 7/3/70
7/22/70		Pensacola (sal) Maint.Supv. Intermediates and Power	Lymphosarcoma	49	D-7/17/70
8/14/70	[redacted]	El Dorado Plant (Chem.Oper.)	Left Kidney	58	L 6-29-72
8/25/70		Sharonville (Mach. Oper. Blow Molding)	Tetratoma left test.	28	D
9/8/70		Queeny hourly	Liver	56	D-8/14/70

EX P-0013

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PCB-ARCH0641341

EXHIBIT B

A sign by Woods Pond warning of PCB-contaminated fish. Photo courtesy of the EPA.

IN FOCUS

THE OTHER SIDE: Sue Monsanto, save Lee — a modest proposal in three parts (Part One)

While recent events may preclude legal action against GE, that is not the case when it comes to pursuing claims against the Monsanto Company, the ultimate responsible party for the widespread PCB contamination in the Commonwealth.

BY MICKEY FRIEDMAN
POSTED ON DECEMBER 10, 2023

I am not an attorney, but for more than 40 years, I have been writing, filming, and organizing about General Electric's (GE's) misuse of polychlorinated biphenyls (PCBs) and how it has affected GE workers, contaminated homes in Pittsfield, a children's playground, a local schoolyard, and, of course, the Housatonic River.

I have learned over these years how we have all been injured, and how our public health and our environment has suffered. All of us in Berkshire County who have lost the use of our Housatonic River, who have breathed in Monsanto's Aroclors, who will have to endure thousands of trucks filled with PCB-contaminated material rumbling through our streets, and especially the citizens of Lee who, for generations to come, will have to live next to a massive PCB dump have suffered an enormous public nuisance.

GE's significant economic, social, and political power, not only in Berkshire County but extending throughout the Commonwealth, coupled with a variety of political pressures on the United States Environmental Protection Agency (EPA), has resulted in a compromised cleanup which will leave large amounts of PCBs in the Housatonic River system and burden the citizens of Lee with the Upland Disposal Facility (UDF). This contamination is—and will be for generations to come—a continuing assault on the public health and the environment of Berkshire County.

I have recently written about all of this for The Berkshire Edge, in case you have time for some research: Read "Whose Housatonic?"; "Housatonic Hypocrisy"; and, most recently, "Massachusetts' Massive PCB Mistake."

Many believe that this imperfect settlement is a done deal. In fact, as part of a series of confidential negotiations, the Massachusetts towns of Lee, Lenox, Stockbridge, Great Barrington, and Sheffield entered into a settlement agreement under which those towns agreed not to appeal the terms of the 2022 CERCLA Order in exchange for a GE payment of $62 million.

Nonetheless, other parties, including the Housatonic River Initiative (HRI) and HEAL of Connecticut, unsuccessfully intervened before the EPA's own Environmental Appeals Board (EAB), urging a more comprehensive cleanup and the use of innovative treatment technologies instead of landfilling. EAB, with minor modifications, including the request for a more comprehensive explanation for why EPA wouldn't award a TSCA exemption for a GE on-site landfill, affirmed the EPA-revised permit. The EAB decision prompted confidential negotiations that resulted in the critical change from off-site disposal to mandate the Lee UDF. Meanwhile, two parties went to the United States Court of Appeals for the First Circuit, but the court dismissed their appeal on July 25, 2023.

Clearly, the ramifications for Lee are highly significant. Even though a majority of Lee residents were/are opposed, the agreement was indeed signed onto by Lee officials, who have since been repudiated by the voters and are no longer serving. Question 1 on the 2022 Lee Town Meeting Warrant read, "Shall the town require the Select Board to rescind the town of Lee's approval of the rest of River Agreement?" 665 residents voted in favor, while 390 opposed. The negotiated settlement precludes any action by local officials and, with the result of the Court of Appeals decision, any action by the courts to challenge this agreement.

I am hoping there might be a new way to address this dilemma and find the money needed to spare the innocent citizens of Lee the massive PCB dump that GE and EPA have foolishly sited near an aquifer in a geologically suspect location.

Sue Monsanto, and save Lee. It is not a coincidence that Lee is the poorest of the Housatonic River communities with the least robust tourist economy—and that the other towns opted to protect themselves and receive financial compensation for agreeing to the dump for Lee that they had previously vigilantly fought against for their own communities.

No lawyer here, but I am hoping that, if successful, this proposed legal action will address the critical public nuisance the UDF would impose and restore some well-deserved environmental justice. And the financial damages can simultaneously be used to pay for the transportation of PCB-contaminated waste out of state to a TSCA-approved landfill, while financing additional remediation of some of the remaining toxic soils and sediments from this and other PCB-contaminated Commonwealth waterways, like New Bedford Harbor. This will reduce threats to public health and the environment, better protect Commonwealth-owned lands that border the Housatonic River, and restore protection for the Housatonic ACEC.

It is important to remember that there were many compelling reasons, including the Commonwealth's repeated and strongly expressed preference in its official comments, for previous EPA decisions that mandated off-site disposal. Here are two persuasive selections from EPA's February 29, 2016 "Statement of Position in Support of Intended Final Decision":

i. EPA's selection of off-site disposal is supported by the nine permit criteria and the administrative record.

GE claims that EPA concedes that off-site disposal would be no more protective to human health and the environment than on-site disposal. GE SOP at 6. On the contrary, EPA does favor off-site disposal in terms of protectiveness. In addition, and even more significantly, GE treats cost and protectiveness as the sole criteria for decision-making, when they are only two of the nine Permit criteria that EPA evaluated. When viewed in that context, off-site disposal is clearly the best suited disposal option.

One of the Permit factors EPA considered in selecting the remedy is its implementability, including coordination with other agencies, regulatory and zoning restrictions, and availability of suitable facilities. Long-standing and active opposition to on-site disposal threatens the Rest of River remedy with lengthy litigation and community resistance. By proposing off-site disposal, EPA avoids these road-blocks, rendering the entire remedy more likely to be promptly implemented and in that respect more protective of human health and the environment. EPA acted in a manner consistent with the Decree in considering public and governmental objections to on-site disposal because these objections are relevant to the implementability criterion listed in the Permit. In addition, the Decree allows EPA to consider any relevant evidence in the administrative record, including the overwhelming number of public comments opposing on-site disposal. Moreover, the Decree offers multiple public participation opportunities, and these would be meaningless if EPA could not consider the views of the public in remedy selection.

Apart from implementability, EPA also considered the other relevant Permit criteria, including cost. For example, in evaluating long-term reliability and effectiveness, EPA evaluated the suitability of the proposed on-site landfill locations, considering the fact that GE did not establish that the proposed locations were suitable in light of soil permeability, hydrology, and proximity to potential drinking water sources and the Housatonic River. Similarly, EPA recognized that the Woods Pond and Forest Street locations would require the waiver of ARARs designed to protect an ACEC and/or wetlands habitat. EPA further considered the suitability of a pre-existing licensed off-site disposal location in comparison

EPA's February 29, 2016 "Statement of Position in Support of Intended Final Decision." Highlighting added.

The EPA then emphasized its belief that GE was less concerned with environmental science or the suitability of their proposed landfill location than with how much they would have to spend if they were forced to transport the contaminated soils and sediment to an off-site TSCA landfill.

EPA has used its scientific and technical expertise to thoroughly consider GE's technical positions at multiple points in the Rest of River decision-making process. Moreover, EPA has subjected its own analyses to further scrutiny, including review by experienced EPA scientists and engineers nationally, and independent scientific peer review. Furthermore, EPA has afforded GE and the public with an extraordinary degree of participation and input on the Rest of River cleanup decision. Based on that substantive expertise and multiple process opportunities, EPA proposed a remedy that is best suited for the Rest of River.

GE challenges EPA's Intended Final Decision for one reason – to reduce its costs in cleaning up its PCBs. GE attempts to justify its challenge with three main claims: (1) GE allegedly knows better than EPA how to select a remedy in the public interest; (2) GE is allegedly entitled to virtually total certainty and finality in the cleanup, with uncertainties and additional costs all to be borne by the public; (3) EPA allegedly misinterpreted the Decree in requiring restoration of natural resources; and (4) EPA inappropriately applies ARARs. None of these claims are

EPA's February 29, 2016 "Statement of Position in Support of Intended Final Decision." Highlighting added.

In 2016, as well as resounding public support for the Housatonic ACEC, there was large-scale public disapproval of GE's plans to construct another PCB landfill in Berkshire County. GE was previously allowed in 2000 to dump PCB contamination from its cleanup of the first two miles of the Housatonic to two GE landfills, one lined and one unlined, across from the Allendale Elementary School in Pittsfield.

Not surprisingly, as EPA pointed out in 2016 with this latest compromise mandating the Lee UDF, GE will save close to $200 million in transportation costs. With that one decision, GE accomplished a major task and EPA and the Commonwealth failed to adequately protect the citizens of Lee. GE, one of the most profitable corporations in the world, could easily afford the added transportation costs. After all, the citizens of Lee, along with the citizens of Berkshire County, never profited from the multi-billion dollar manufacture, sales, or use of PCBs, and have only paid a sometimes lethal price for the incompetence and irresponsibility of GE and Monsanto, who together allowed their toxic chemicals to contaminate one of New England's most beautiful rivers.

So, while recent events may preclude legal action against GE, that is not the case when it comes to pursuing claims against the Monsanto Company, the ultimate responsible party for the widespread PCB contamination in the Commonwealth. It is time to see whether the courts will determine that this was criminal negligence.

Money—we discover once again—was always the strongest motivating factor. As internal documents reveal, even as the Monsanto Company—and General Electric and Westinghouse, two of the largest consistent users of Monsanto's PCBs—became aware that the product was toxic, the profit involved in selling PCB-dependent electrical equipment overwhelmed any responsible concern for workers, end-users, local communities, the nation, even the world.

A short bit of history: GE began to manufacture electrical capacitors and transformers at its Pittsfield plant beginning in 1903. PCBs are a group of distinct chemical compounds, none of which occur naturally. While first synthesized in 1881, they were produced commercially by Swann Chemical Company beginning in 1929 in its plant in Anniston, Ala. Monsanto, in its 1969 "PCB Environmental Abatement Plan," notes, "Monsanto entered the Aroclor market in 1930 by acquiring Swann Electrical Company or known today as our Anniston, Alabama plant. Our first load of Aroclor which incidentally was Aroclor 1254 went out of Anniston, Alabama to GE in 1931."

Monsanto produced PCBs at plants in Sauget, Ill. and Anniston, Ala. until 1978. PCBs were used in capacitors, transformers, hydraulic fluids, lubricants, carbonless copy paper, inks, pesticide extenders, sealants, flame retardants, and building materials like caulk. Monsanto used the trademark "Aroclor" for its PCBs, while GE used the trade name "Pyranol." Monsanto was the sole producer of PCBs in the United States. [See 116 Cong. Record 11695, 91st Congress, (April 14, 1970) ("Insofar as the Monsanto Co., the sole manufacturer of PCB's is concerned ...").]

Both GE and Westinghouse used massive amounts of Monsanto's PCBs as a flame retardant dielectric fluid in transformers and capacitors. It has been estimated that, between 1929 and 1977, about 1.1 billion pounds of PCBs were produced in the United States. And Monsanto's domestic production reached a peak volume of 86 million pounds in 1970. 17.9 percent of Monsanto's sales were of Aroclor 1254. A large amount of Monsanto's Aroclors went into the production of plasticizers.

The EPA details the commercial products that may contain PCBs:

- Transformers and capacitors
- Electrical equipment including voltage regulators, switches, re-closers, bushings, and electromagnets
- Oil used in motors and hydraulic systems
- Old electrical devices or appliances containing PCB capacitors
- Fluorescent light ballasts
- Cable insulation
- Thermal insulation material including fiberglass, felt, foam and cork
- Adhesives and tapes
- Oil-based paint
- Caulking
- Plastics
- Carbonless copy paper
- Floor finish

The Pittsfield Transformer Manufacturing Division of GE manufactured large and medium-sized AC and DC power transformers. Pyranol was used by GE from 1932 until 1977, when they stopped due to the EPA's proposed regulations banning the manufacture of PCBs.

For several decades, GE controlled our understanding of the parameters of our PCB problem, asserting that there was a total of anywhere from 22,000 to 39,400 pounds of PCB that had migrated into the entire Housatonic River system. It was my interviews in "Good Things To Life: GE, PCBs and Our Town" with Edward Bates, the manager of tests at GE Power Transformer, and his assistant, Charles Fessenden, supervisor of calculations, and former Pittsfield Mayor Remo DelGallo that provided a far more accurate portrait of the truly massive extent of the PCB contamination.

From my August 15, 1997 interview with former Pittsfield Mayor Remo DelGallo:

> ***Unfortunately for the City of Pittsfield in many ways the General Electric Company property is located practically in the center of town. And they had many, many drains in the General Electric Company – and they dumped a voluminous amount of oil in those drains. Nobody even knew where those drains went. Some leeched into Silver Lake. A good number of them went into the Housatonic River ...***
>
> *And when I say disposed we're talking about thousands and thousands and thousands of gallons of oil.* ***We're not talking about crank case oil, 150 gallons, we're talking about thousands and thousands of gallons of oil, including that oil tank that they had up on top of what is known as Peck's Bridge, 550,000 gallons of oil. That's how much — it held that capacity and it leaked for years and years and years before 1964 and after 1964.*** (*Emphasis added.*)

From my September 12, 1990 interview with Ed Bates:

[P]eople don't realize that Pyranol is twice as heavy as water. You put a gallon of Pyranol in water and it sinks right to the bottom. Within that twelve and a half pounds of Pyranol weighs, seven pounds of every gallon is PCBs. ***We used to use an average of 20,000 gallons of Pyranol a week. And this is, if you did simple mathematics, this is 140,000 pounds of Pyranol, of PCBs a week that we were handling. And we had a loss rate, spillage, over-filling of about three percent so this says that every week, we would lose between 4,000 and 5,000 pounds of PCBs that would go down the drain and into the river. ... In the meantime about a million and a half pounds of PCBs have been plowed into that river. I imagine a good 30 percent is left.*** (Emphasis *added.*)

It wasn't just the liquid Pyranol that was escaping from the factory. Ed Bates explained that there were continuing spills of the oil when filling or putting the transformers through their tests:

Well, Fuller's Earth — it was a substance like sawdust, that if you had a spill of oil or Pyranol, you'd throw it on and take it and shovel it in drums. Then the drums would be unloaded, but I don't know where they were unloaded. Uh it turns out that some of them probably were unloaded up at the Rose Property in Lanesboro from the sound of it, some were unloaded uh where the Allendale School is. Others were unloaded in the big pond in back of Plastics over in Building 59 over there ... every day as part of their cleanup the fellows would put this stuff on the floor and then sweep it up and throw it in the drums and every day they'd be thrown out ... to me there must have been four or five hundred pounds a day thrown out. And if you take that over a period of forty years or thirty years when we were using Pyranol you're talking uh maybe 2,000 pounds a week or a hundred thousand pounds a year or three million pounds over 30 years. It's just mind-boggling if you go into that too ... (*Emphasis added.*)

This contaminated fill was trucked throughout the county, to the city landfill, and given away to GE employees to use to fill in their front and backyards. MassDEP investigated hundreds of suspected fill properties in the Lakewood area, and 175 residential properties had to be cleaned up and restored.

To get some idea about the scale of GE's miscalculation, here is an accounting by EPA of the amount of PCB-contaminated soil and sediment remediated so far:

Cleanup is complete at all 20 contaminated areas outside the River ... Approximately 186,000 cubic yards (cy) of soil and sediment have been removed from these 20 cleanup areas ... Cleanup is complete for the Upper ½-Mile Reach. 18,700 cy of contaminated material was removed from river sediment and bank soils ... Cleanup is complete for the 1.5 Mile Reach. 91,700 cy of contaminated material was removed from river sediment and bank soils.

That is a total of 296,400 cubic yards.

As for the anticipated total removal of contaminated soils and sediments from the Rest of River, the EPA estimates:

GE will excavate PCB contamination from 45 acres of floodplain and 300 acres of river sediment, resulting in removal of over one-million cubic yards of PCB-contaminated material. Most of the sediment and floodplain cleanup will happen within the first 11 miles of the Rest of River in the City of Pittsfield and the towns of Lee and Lenox.

When asked if he knew if the PCBs he was working with were dangerous, Ed Bates answered:

No ... Uh the U.S. government ... uh, neither of us blame the GE for that. Any fluid or anything that you used in those days, you'd run a two-week test on it and if you didn't break out in welts or your eyes didn't water too bad, they would use it. And uh it turns out that Charlie and I feel, from our observation, that the latency period of Pyranol, PCB Pyranol is around fifteen to twenty years. You really got to be exposed to it, and you did get itching out of it and you got sore eyes out of it ... and this we would heat up to 55 degrees C or around 120 degrees when we were running tests on transformers. And the odor of it was unbelievable. It'd choke you but, you know, there was nothing published ... It wasn't until 1969 that it became noted, and it was noted by the GE in a document, that it was a real problem ... but it wasn't until 1975 and 76 that they started to use silicon and phase out Pyranol.

Reginald Meunier began working for GE in 1946:

They never forewarned us of any dangers of handling any liquids there ... And you know they never gave us anything to protect ourselves which was ridiculous. They never told anyone there was any dangers with any of the oil we used or anything ... If you would have seen some of these rashes on my legs that I developed from having the oil drop on my legs you wouldn't believe it. Even developed on my back — my wife would keep saying where did you get all these terrible rashes and sores on your back ...

But they never told us wear any special clothing, which they should have done. When we complained that the oil was dripping all over our clothes, they got us some rubber aprons which was great for the front but it would run down and oil would seep into our shoes and at the end of the day you'd walk around and hear this squooshing going on ... But as far as being forewarned or forearmed, never. They never divulged to us what we were working with. Never told us the hazards. Never put any signs around. The only signs that we saw were hazards against electrical shock or — that was it ...

The Environmental Working Group (EWG) has aggregated important internal Monsanto documents. Monsanto claimed again and again that, until the 1960s, the company didn't know PCBs were harmful to human health or even that they persisted in the environment: "And the truth is that in 1966 when we found out that PCBs were in the environment, we started an investigation journey and we tried to gather information and we acted responsibly." (Trial Transcript, Owens v. Monsanto CV-96-J-440-E, (N.D. Alabama April 4, 2001), pg. 454, line 6.)

In fact, Monsanto and GE knew from the very beginning that the PCBs they were manufacturing and using were toxic. The Washington Post reveals that after purchasing the Swann Anniston plant, "the company learned that PCBs, in the double negative of one company memo, 'cannot be considered non-toxic.'"

By 1936, there were already reports of serious health effects amongst workers who were exposed to these chemicals. United States Public Health Service Senior Surgeon Dr. Louis Schwartz wrote an article in the American Journal of Public Health, in which he discussed treating not only workers who had been contaminated but a wife and child who had developed chloracne, a severe skin rash, from contact with work clothes. Dr. Schwartz wrote:

> **In addition to these skin lesions, symptoms of systemic poisoning have occurred among workers inhaling these fumes. Those working with the chloro diphenyls have complained of digestive disturbances, burning of the eyes, impotence and hematuria. The latter symptom developed among a number of men making amino diphenyl, which is used in the manufacture of a rubber antioxidant. Cases of death from yellow atrophy of the liver have been reported among workers exposed to the fumes of the chloro naphthalenes.**

Louis Schwartz, "Dermatitis from Synthetic Resins and Waxes," June 1936. Highlighting added.

Schwartz urged that a series of preventative measures be taken, including isolating the areas the chemicals were used in, or if that wasn't possible, utilizing suction exhaust systems to vent the fumes. Floors and walls needed to be washed often, and he proposed lockers for all the workers so that they could change out of their street clothes and into work clothes, then reverse the process with available showers. He wrote: "It has been estimated at one point that 6 cents a day per worker will take care of furnishing clean clothes each day." Most importantly, he wrote:

> *There should be periodic medical examination of workers to detect cases of dermatitis and* ***workers in chlorinated napthalenes and diphenyls should be periodically examined for symptoms of systemic poisoning. Laws should be passed making it compulsory for factories where there are skin hazards to adopt these measures.*** (pp. 591-592) (*Emphasis added.*)

And in a second 1936 article, "Skin Hazards in American Industry Part II, "Schwartz reiterated: **"Workers in chlorinated naphthalenes and diphenyls should be periodically examined for symptoms of systematic poisoning."** (p. 10) (*Emphasis added.*)

Dr. Cecil Drinker of Harvard University had been hired by the Halowax Corporation to investigate mounting health problems among its workers exposed to chlorinated napthalenes and diphenyl. Halowax used these chemicals to coat electric wire. GE began using Halowax's products. In September 1937, Dr. Drinker, MF Warren, and GA Bennett, published an article entitled "The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons." The authors wrote:

> *For years it has been known that many of these compounds cause a troublesome acne, and there is a large literature upon this phase of the subject.* ***Our investigations have not been concerned with chloracne but with the possibility of systemic effects following ingestion or inhalation of such products.*** *In the spring of 1936, the Halowax Corporation, a division of the Bakelite Corporation, called our attention to three fatal cases of jaundice in workmen using chlorinated naphthalenes and chlorinated diphenyl, and requested that the subject be investigated as rapidly and thoroughly as possible.* (*Emphasis added.*)

Drinker's article quoted extensively from a conference held by the Harvard School of Public Health attended by representatives from Halowax, Monsanto, GE, and the U.S. Public Health Service. Dr. Drinker wrote: "the chlorinated diphenyl is certainly capable of doing harm in very low concentrations and is probably the most dangerous ... **These experiments leave no doubt as to the possibility of systemic effects from the chlorinated napthalenes and chlorinated diphenyls."** (*Emphasis added.*)

According to Drinker, Mr. F.R. Kaimer, the assistant manager of GE's York, Penn. Wireworks factory recounted:

> *It is only 1 1/2 years ago that we had in the neighborhood of 50 to 60 men afflicted with various degrees of this acne about which you all know. Eight or ten of them were very severely afflicted — horrible specimens as far as their skin conditions was concerned.* ***One man died and the diagnosis may have attributed his death to halowax vapors, but we are not sure of that ...*** (*Emphasis added.*)

R. Emmett Kelly, who represented Monsanto, described the results of their human experiments: "A more or less extensive series of skin eruptions which we were never able to attribute as to cause, whether it was impurity in the benzene we were using or to the chlorinated diphenyl."

A Monsanto memo, dated October 13, 1937, by L.A. Watt acknowledges:

> ***Experimental work in animals shows that prolonged exposure to Aroclor vapors involved at high temperatures or by repeated ingestion will lead to systemic toxic effects.*** *Repeated bodily contact with the liquid Aroclors may lead to an acne-form skin eruption. Suitable draft ventilation to control the vapors, as well as protect by suitable garments from extensive bodily contact with the liquid Aroclors, should protect any untoward effect.* (*Emphasis added.*)

Workers told me that none of these protections were ever implemented by GE in Pittsfield.

Problems with chlorinated hydrocarbons were well known by users. A July 18, 1939 document marked "Confidential, Not for Publication" was issued by the National Paint Varnish and Lacquer Association to its members: "Chlorinated Hydrocarbons. Carbon tetrachloride, trichlor ethylene, tetrachlorethane, ethylene dichloride, and similar chlorinated aliphatic hydrocarbons **are said to be very dangerous toxics** ... some chlorinated aromatics are frequently the source of skin troubles." *(Emphasis added.)* They reminded members of the Manufacturing Chemists' Association Legal Principles: **"A manufacturer who puts out a dangerous article or substance without accompanying it with a warning as to its dangerous properties is ordinarily liable for any damage which results from such failure to warn."** (*Emphasis added.*)

Monsanto's October 1944 "Salesmen's Manual for Aroclor" stated clearly: **"All chlorinated hydrocarbons have measurable degrees of toxicity" and that Aroclor poisoning could result in atrophy of the liver ..."** (*Emphasis added.*)

10-1-44

MONSANTO CHEMICAL COMPANY

2. Acute yellow atrophy of the liver in which the liver cells show swelling, hypergranulation, hyaline inclusions and vacuolation as a result of extensive exposure over long periods of time.

Monsanto's October 1, 1944 "Manual for Salesmen of Aroclor." Highlighting added.

A 1947 article in The Chemist Analyst by Robert M. Brown, chief of the industrial hygiene section of the Health Department of St. Louis, Mo., acknowledged the toxicity of the Aroclors and the dangers of coming in contact with the liquid, as well as breathing the vapors:

The Chemist Analyst, Vol. 36, No. 2, page 33,
J. T. Baker Chemical Co., Phillipsburg, N. J.
September 1947

ON THE TOXICITY OF THE "AROCHLORS" (sic)

Robert M. Brown, Chief
Industrial Hygiene Section, Division of Health
Dept. of Public Welfare, City of St.Louis, Mo.

A recently published article (Maglio, M. Martin, Chemist Analyst, 35 94 (1946)), has recommended the substitution of one of the "Arochlors" as the melting-point bath liquid in preference to the customary sulphuric acid. As stated in that article "Arochlors" are a group of chlorinated diphenyls produced by the Monsanto Chemical Company.

There is need therefore to give warning. For the toxicity of these compounds has been repeatedly demonstrated, both from the standpoints of their absorption from the inspired air, as well as from their effects in producing a serious and disfiguring dermatitis when allowed to remain in contact with the skin. Since these effects have been repeatedly observed, industrial hygienists have taken care to see that the proper controls have been established wherever these products are used. For example, the maximum allowable concentration of chlorinated diphenyl for an 8-hour working day is 1 milligram per cubic meter of air.

"On the Toxicity of the Aroclors," September 1947. Highlighting added.

The Environmental Working Group adds:

> *In response to a 1947 inquiry from one of its Aroclor customers about possible liver damage, Monsanto referred the customer to Dr. Drinker's published work, promoting it as the best information available on the subject: 'The best published information about the toxicity of Aroclor vapors with reference to possible damage to the liver is in a series of three articles written for the Journal of Industrial Hygiene and Toxicology ...'*

EWG continues:

> *At the conclusion of this letter highlighting Drinker's findings and praising it as the most accurate available science on PCBs, Monsanto wrote to a customer that:*

'Based on our practical experience in the manufacture and sale of millions of pounds of Aroclors annually, the point that we would emphasize is that workers should not be exposed to Aroclor vapors and that the men working with Aroclors should observe "good housekeeping" rules about keeping their clothing and skins free of the material and avoid ingestion of it.' [Monsanto to Celanese; December 30, 1947.]

A 1952 memo refers to Monsanto's and other manufacturers' agreement with United States Public Health System about labelling:

> ***Since the wording of the label was formulated and put into use, skin patch tests run under competent medical supervision indicated that Aroclors are neither skin irritants nor skin sensitizers. This is indicated in our literature, but of course is not intended to mean that people should bathe in Aroclor.*** *There are instances in the commercial use of Aroclor where people have immersed their arms up to the elbow, day in and day out, in the liquid Aroclors, and of course we do not approve of this, and to avoid such misuse of Aroclor, the wording on our label, to avoid repeated contact with the skin seems highly significant. Back in 1938 or thereabouts, when the Aroclor applications were relatively few and the customers about equally few, there was indeed the prize application of using Aroclor 1254 as a chewing gun plasticizer. The wording of our label would not be compatible with this sort of thing.*
>
> ***Since so many of the new Aroclors involve their use at elevated temperatures, the wording of the warning label to avoid inhalation of fumes is especially significant. We constantly keep this factor in mind in our development work, and emphasize it in direct contacts as well as indirect contacts such as our literature. While the toxicity hazard of Aroclor's fumes is well established and should be thoroughly understood by all, yet as we go along we find that we are always confronted with violations in one degree or another, and indeed, regard keeping in touch with these things to a major responsibility in the promotion of Aroclors.*** (*Emphasis added.*)

A simple site visit to GE Power Transformer would have immediately revealed how grievously Monsanto was failing in its responsibilities to safely promote its Aroclors.

On September 1, 1953, Monsanto Medical Director Dr. Emmet Kelly responded to Mr. Lewis W. Spoiler, director of the Division of Industrial Health at the Indiana State Board of Health. Dr. Kelly balanced Monsanto's admission that Aroclors couldn't be classified as "non-toxic" with a denial that Aroclors had caused long-standing health problems:

From MONSANTO CHEMICAL COMPANY
At St. Louis

- 4 SEP 1953

Date September 1, 1953

cc Mr. T.K. Smith - 7
Mr. A.T. Beauregard - 7
Mr. F. O. Benignus - 7
Dr. J.W. Barrett - London
Dr. J.A. Gardner, - Fulmer
Mr. J.F. Stickley - KXOK
Dr. N.B. Dyson - Newport

To Mr. E. Mather
At Rueben

Reference Your memo to ATB - 8/11/53
Subject AROCLORS: TOXICITY

Mr. Beauregard has asked the Medical Department to comment on your letter referred to above.

As I am sure you know, Aroclors cannot be considered nontoxic. The interpretation of the toxic properties of a compound, however, determine whether or not there is any hazard associated with the specific use of a compound. To my knowledge, there is no hazard involved in the use of transformers containing Aroclors as a substitute for other materials. To my understanding, in the United States this application of Aroclors is widely accepted and has not resulted in any difficulty from a toxicological standpoint.

September 1, 1953 letter regarding Aroclors and toxicity. Highlighting added.

These denials were very often contradicted by further study. The Environmental Working Group published this 1954 acknowledgment that one of Monsanto's customers had recently discovered that seven of its workers had health problems after working with Aroclor:

> *Lesions of chloracne developed in seven workers employed in an organic acid manufacturing plant when Aroclor was used.* ***An unusual feature of this outbreak of dermatitis was the long period of exposure before any cases were recognised.*** *Sudden recognition of seven cases after 19 months was a result of the especially careful examination of the exposed employees after discovery of the first case. Of 14 exposed or potentially exposed, seven developed chloracne.* ***The fact that air tests, even in the presence of vapors, showed only negligible amounts of chlorinated hydrocarbons indicates that this type of intermittent but fairly long continued mild exposure is not innocuous.*** (*Emphasis added.*)

An April 1955 document, "Process for the Production of Aroclors, Pyranols, Etc. at the Anniston and at the WM. G. Krummrich Plant," notes:

> *There are many literature references to harmful effects of the type of 'chlor acne' resulting from exposure to chlorinated diphenyls, especially in cases where people working with small electrical components have been exposed to the fumes of hot, highly chlorinated Aroclors. Chloracne is sometimes accompanied by gastric troubles, and there are literature references to liver troubles.*
>
> *From the start of Aroclor manufacture at the Krummrich plant the operators have been supplied a clean change of clothes every day, and time has been allowed at the end of the shift for bathing. Operators are advised to wash hands and face before eating. The Anniston operators do not have the same issue of clean clothes. At Anniston, no special protective clothing is provided for the Diphenyl and Aroclors operators. A daily change of clothing was provided in the past but this practice ceased before the war ... the men are expected to take a bath, in their own time, at the end of the shift.*

In September 1955, Dr. J. Emmet Kelly wrote Dr. J. W. Barret in London to discuss "Aroclor Toxicity," suggesting that the company had already invested a lot of money in testing its Aroclors and urging that more tests weren't really necessary. But most important of all, Dr. Kelly acknowledged the toxicity of Aroclors and advised that, should these issues come to trial, a jury wouldn't particularly be interested in the details of "Maximum Allowable Concentrations":

> I don't know how you would get any particular advantage in doing more work. What is it that you want to prove? I believe your work should be directed towards finding out what the concentrations are of Aroclor during different operations whether it is industrial or painting. The reports you have seen from Kettering Laboratory are the result of approximately $15,000 to $20,000 expenditure by MCC.
>
> MCC's position can be summarized in this fashion. We know Aroclors are toxic but the actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an individual developes any type of liver disease and gives a history of Aroclor exposure. I am sure the juries would not pay a great deal of attention to MACs.

Dr. Kelly to Dr. Barret, September 20, 1955. Highlighting added.

As the Environmental Working Group explains, Monsanto's history with the U.S. Navy is instructive:

> *In 1956, the U.S. Navy considered using one of Monsanto's products which contained PCBs, called Pydraul 150, as a hydraulic fluid in Navy submarines. But after conducting their own toxicity tests, which showed that skin applications of Pydraul 150 killed all rabbits tested and that a statistical model on inhalation of Pydraul 150 indicated 'definite liver damage,' the Navy decided not to use Monsanto's product due to its potentially harmful effects. In Dr. Kelly's own words: 'No matter how we discussed the situation, it was impossible to change their thinking that Pydraul 150 is just too toxic for use in a submarine.'*

The Environmental Working Group adds:

> *The Navy's decision to do its own toxicity tests, despite having been supplied Monsanto's tests, greatly bothered a member of Monsanto's Medical Department, Elmer Wheeler, who wrote on December 26, 1956 to a Monsanto colleague in Washington, D.C.: 'Out of all of this it appears quite certain that in the future we will not spend one nickel to develop toxicity data on hydraulic fluids for the Navy. We will continue to get information to satisfy ourselves that the use of our fluids is safe under any normal foreseeable conditions. This is generally enough to satisfy non-military customers. If the Navy has interest in any of these fluids and wishes to accept them toxicity wise on the information available, they are welcome to do so. If the fluids are not acceptable toxicity wise on the basis of such data, then perhaps we can save a lot of time and effort by advising the Navy to look elsewhere for their requirements.*
>
> *In spite of the tone of the above memo, Emmet [Dr. Kelly] and I wish you the happiest of New Years!' [Wheeler to Sido; December 26, 1956] ...*
>
> *Despite all the company knew of the toxic effects of PCBs, Monsanto consistently failed to adequately disclose its full knowledge to its customers. Most customers didn't take the initiative to run their own tests as the Navy had, and therefore, remained in the dark about the potential danger of exposure to PCBs.*

Despite these medical studies and Monsanto's acknowledgment that animal tests revealed "prolonged exposure to Aroclor vapors involved at high temperatures or by repeated ingestion will lead to systemic toxic effects," GE workers spoke in "Good Things To Life," of inadequate ventilation and constant contact with PCB-contaminated oil without protective gear. Those working with transformers and capacitors often put their arms in PCB oil up to their elbows to tighten bolts by hand. They explained that they couldn't do the job while wearing gloves. Crane operators talked about the clouds of vapor that extended to the extraordinarily high ceiling of Building 100. Other workers talked about the puddles of PCB oil that covered the floors, slowly eating through the rubber soles of their boots, and the coupons GE offered them for replacement boots. Everyone I interviewed worked in their street clothes and brought their oil-soaked shirts and pants home to be washed with the family's other clothes.

Monsanto assured the United States Public Health System in 1952 that it regarded inhalation of fumes as highly significant. Perhaps Monsanto failed to deliver the message because GE obviously never got the message or they disregarded it. And GE workers in Berkshire County and the rest of have paid the price.

Smoke billows from GE's PCB-contaminated-oil-burning thermal oxidizer, which was affectionately known by workers as "Puff the Magic Dragon." Still courtesy of Mickey Friedman.

IN FOCUS

THE OTHER SIDE: Sue Monsanto, save Lee — a modest proposal (Part Two)

Thanks to our share of Aroclor, we in Berkshire County have been victims of GE and Monsanto's gross incompetence, remarkable negligence, and their unrelenting impulse to put profit before worker safety, and the public health and our environment.

BY MICKEY FRIEDMAN

Despite the repeated concern of medical authorities with the vaporization and inhalation of PCBs—realities Monsanto and GE were well aware of—for 22 years, beginning in 1973, GE's thermal oxidizer continuously burned PCB-contaminated oil. Crane operator Al Bertelli told me they used to refer to the oxidizer as "Puff the Magic Dragon." Puff stood adjacent to the Newell Street/Lakewood residential neighborhood. And as Ron Desgroseilliers of GE's Area Environmental and Facility Operations admitted to Pittsfield residents, most of the toxic oil GE burned came from out of town.

On April 14, 1993, Desgroseilliers revealed that 20 percent of the PCB-contaminated oil burned in the thermal oxidizer came from GE Pittsfield, another 40 percent from other GE plants, and 40 percent from other companies across the United States. Plumes of smoke and vapor would infiltrate the entire surrounding area where many of the GE workers lived and many small businesses were located. As Ed Bates told me:

> "They say that it's 99 percent—you know, 99.5 percent effective, which is fine, but we just got word, we got some figures in there from The Advocate, the North Adams paper, where last year they burned a million, 800,000 pounds of PCBs. Well if, uh, that's good, but if you're losing two tenths of one percent, it isn't much, but it adds up to about 3,600 pounds. Where does it go? Is it left in the ash? Does it go in the air?"

Joe Carr, who worked for 30 years at GE, told me:

> "[Puff] burned a lot of materials which were hazardous, and it was supposed to be regulated by the Environmental Protection Agency and several other agencies, even our local agencies with GE. And they had rods in there which were called sensors. I mean that thing was a hundred some-odd feet tall, and there must have been two, three hundred rods in there that would measure what was coming out for smoke ... It tells exactly how hot you can burn that fire, and then I had a person I know from a government agency go in there and go up to the top and there was no rods in there. They were all burned out. They used to burn it so hot. And there were no rods to determine what the hell is all over Lakewood."

When it came to the human costs of the continuing use of Aroclor, one of the great frustrations experienced by Ed Bates was the great gap between the rhetoric of safety from GE and Monsanto and the reality of sickness. He felt responsible for the medical problems and premature deaths of those who worked under him at Power Transformer. And after much pressure, GE hired Dr. Wegman of Harvard to do an occupational health study. When Ed Bates and Charles Fessenden examined the data Wegman was working with, they found numerous instances where researchers misidentified where some GE workers had worked, and made errors with their death certificates and cause of death:

> "Charles and I've been very close since we were in school, and it would seem to me that every other week Charlie would say, 'OK we got to go to a funeral ... a wake' ... And it wasn't just the Tests where we worked, the building itself where we used to mix the Pyranol, and deliver it out through a series, a system of pipes. There was a Shipping group. There was a Maintenance group. There was an Assembly group. There was a Test group. All these people were in the same building, and it seemed to me that we were—you know, it started to get on you. Charlie and I had reached the age of 40 and 50 and say, gee, why come all these people are dying, but we didn't do anything about it. Maybe we were wrong."

As Reginald Meunier put it:

As for the rhetoric, in 1962, then-Director of the Monsanto Medical Department Dr. R. Emmet Kelly wrote Dr. Marcus Key at the Division of Occupational Health of the United States Public Health Service:

> "As I told you on the telephone, **our experience and the experience of our customers over a period of nearly 25 years, has been singularly free of difficulties. To our knowledge, there have been only three instances where chloracne has occurred. In view of the millions of pounds which have been produced and used in many and varied applications, the low frequency of any difficulties has been gratifying.**" (*Emphasis added.*)

GE, the EPA, and the towns who allied themselves with the Rest of River Committee have crafted a compromise that "will excavate PCB contamination from 45 acres of floodplain and 300 acres of river sediment, resulting in removal of over one-million cubic yards of PCB-contaminated material." But the crucial question that remains for us is: How much PCB contamination will be left in the river sediments and bank soils? And what about the massive amounts that will be transferred from one part of our environment to another, to a lined dump the authorities swear will be safe from the likely increasing threats of the climate crisis? All of which remains a continuing and constant threat to the public health and the environment. And while the negotiated settlement crafted by GE and the EPA and the river towns, coupled with the decision of the court, have preempted us from taking action against them, the toxic Aroclors from Monsanto remain.

Upon publication of "Sue Monsanto, save Lee — a modest proposal in three parts (Part One)," a source reached out and sent me Monsanto documents I had never seen before. I learned I was off by several years and several significant symptoms. Yes, Dr. Louis Schwartz of the United States Public Health Service had warned in 1936 about the systemic effects—including chloracne, hematuria, and impotence—from working with and inhaling PCBs. But the Swann Company, which Monsanto had purchased in 1930, had already acknowledged the dangers of Aroclor's vapors. Of course, there is always a however:

VAPORIZATION LOSS	The clear resins have rather low vaporization losses. At 65.6°C (150°F) these losses are less than 0.04 g. per square inch of surface per month.
TOXICITY	The Aroclors, so far as is known, have no harmful physiological action. When they are applied to the skin, there is no evidence that they are vesicants. The vapors, however, will irritate the membranes of the nose and throat.

"Monsanto: A Brief Description of Aroclors," February 20, 1931. Highlighting added.

In fact, GE workers in Pittsfield were experiencing the very real "physiological" consequences daily. Bill Kowalcyzck shared his experience:

> "I was a group leader as a crane operator, I overseen most of the moving operations of not only the transformers and their core units ... GE is constantly saying there's no health effects, ill effects with this PCBs or anything attributed with the PCBs. In my own case, I have chloracne on my legs. I have 21 ppb PCBs in my blood. My wife has health conditions. My daughter has tumors ... There are my friends that I have worked with over the years that I have noticed now they are dying. Pancreatic explosions ... seven of my friends right now that have a blood vessel disorder, which is a collapsing of blood vessels. It seems awful strange that we all worked together and we all have the same problem. ... Too many instances of my friends dying over the last, you know, five, six years. I'll be 55 in

"[W]hen the transformer blew for whatever reason or failed Test, they would pull it out, take the iron off, which was covered with that Pyranol, bring it back upstairs, and we had to re-lace it into a new coil. And we couldn't wear gloves—we had to put it in bare-handed because the oil, you couldn't pick the iron up … in the Tank it was even worse … [Y]ou drop the transformer down into the tank, it's full of Pyranol, or oil whatever they were going to use, and it would set on two pins, and you had to reach down into that oil and put two nuts and a washer, a lock washer, so you're up to about here in it, putting it in … And the stuff wasn't bad when they first put it through. It's when it blew up—it would come back, and you lace one in the morning, you'd pick up the first leg of iron, and I'd have a headache the whole day …"

In public, Monsanto would routinely deny its Aroclors were harmful. In fact, those working in the Monsanto factory in Anniston, Ala. were suffering greatly. Thanks to the series of court battles that began in 1996, Walter Owns v. Monsanto and Abernathy v. Monsanto, many internal Monsanto documents, some of which I have already referenced, some marked "Confidential: Read and Destroy," were produced in discovery.

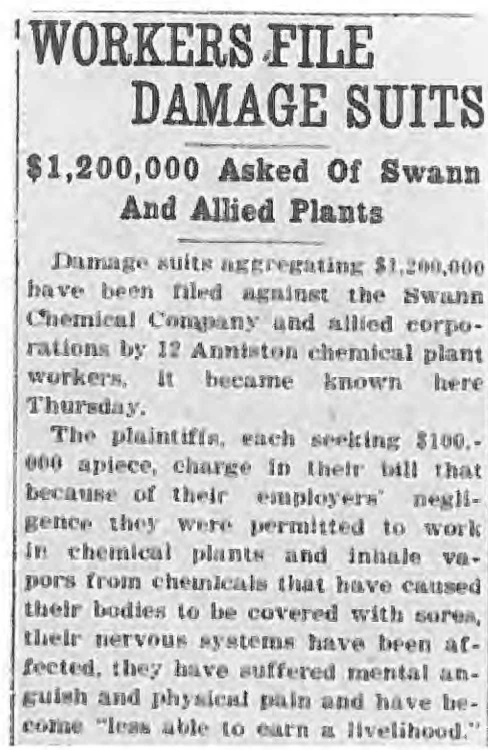
During his opening statement in the Owens v. Monsanto trial, on April 4, 2001, Monsanto's counsel claimed:

"The truth is that PCBs are everywhere. They are in meat, they are in everyone in the courtroom, they are everywhere and they have been for a long time … **The truth is that the men and women who have worked around PCBs the most over forty, fifty, sixty years, people in our plant, people in the electrical industry, have not experienced any significant health problems which can be associated or tied into or caused by PCBs other than a serious skin condition called chloracne, which is easily treatable."** (*Emphasis added.*) (Trial Transcript, Owens v. Monsanto CV-96-J-440-E, [N.D. Alabama April 4, 2001], pg. 453, line 16.)

With the release of the documents, the extent of Monsanto's knowledge of PCB toxicity was revealed. As The Washington Post wrote on January 1, 2002: "Monsanto Hid Decades Of Pollution."

The workers demanded a jury trial before the Seventh Judicial Circuit Court of Alabama:

"The plaintiff avers that as a proximate result of defendant's negligence and his subjection to said fumes and dust, he has sustained the following injuries: He has been made sick, his body has become covered with sores, the skin of his whole body has deteriorated, his digestion has become impaired, his nervously system has been disordered, and other organs of his body have become affected and he has been caused to suffer physical pain and mental anguish and to lose sleep. He has become impotent and has lost his vigor and vitality. He has become less able to earn a livelihood and plaintiff avers that he has been permanently injured." (*Emphasis added.*)



WORKERS FILE DAMAGE SUITS

$1,200,000 Asked Of Swann And Allied Plants

Damage suits aggregating $1,200,000 have been filed against the Swann Chemical Company and allied corporations by 12 Anniston chemical plant workers, it became known here Thursday.

The plaintiffs, each seeking $100,000 apiece, charge in their bill that because of their employers' negligence they were permitted to work in chemical plants and inhale vapors from chemicals that have caused their bodies to be covered with sores, their nervous systems have been affected, they have suffered mental anguish and physical pain and have become "less able to earn a livelihood."

Symptoms far beyond chloracne. Having known of this worker's complaint, and the dangers to the nervous system caused by

Instead, in 1935, E.H. Buford of Monsanto wrote a report entitled "Diphenyl and Chlorinated Diphenyl Derivatives." Buford acknowledged that in 1933, thanks to inadequate ventilation, workers exposed to dust and fumes from heated Aroclors began to develop "a severe type of dermatitis." Bur explained that, simultaneously, the "electrical properties of the distilled Aroclors began to fall below specifications" which led them to conclude there was some impurity in the solution, and that styrene dichloride entered the pores of the workers along with the Aroclor dust and fumes causing irritation and an infection. In the face of worker litigation, Monsanto's solution was to replace the workers most readily susceptible to the fumes and contact with Aroclors and swap them with workers they hoped were more hardy.

Skin specialists were consulted, but cure of the disease was found to be slow and difficult. The company became involved in an expensive litigation since suit was entered by the majority of the men affected.

As a result of this trouble the following precautionary measures were taken.

1. All affected men were removed from the operation and new men substituted as rapidly as they could be trained.

2. Adequate ventilation facilities were installed. DSW 001398

Monsanto's 1935 "Diphenyl and Chlorinated Diphenyl Derivatives." Highlighting added.

Then they implemented a set of protocols we know never lasted: a change of clothes, towels, soap, and cold cream which resulted in "no recurrence of dermatitis among the operators."

And yet the problems persisted. On March 16, 1936, the Commonwealth of Pennsylvania published "A Preliminary Report on the Dermatological and Systemic Effects of Exposure to Hexachloro-Napthalene and Chloro-Diphenyl":

> "The relatively high percentage of these individuals affected … in a group of one hundred and twenty-six persons examined, indicates a need for preventive measures … In those processes where the compounds are heated to a temperature sufficient to cause volatilization and subsequent condensation in air, either closed methods, operating under partial vacuum or exhaust ventilation should be instituted."

In 1936, Dr. Jones and Dr. Alden published "An Acneform Dermatergosis":

REPORT OF A CASE

History.—O. D., a Negro aged 26, began work in the distillation of chlorinated di-phenyl in April 1930 and worked regularly until the latter part of the year 1933. About May of 1933, he noticed the appearance of blackheads on his face, neck, arms and legs. These areas itched slightly. In a short time blackheads began to appear on the chest, back and lower part of the abdomen, around the navel and on the scrotum and penis. Many of these blackheads swelled and became infected, discharging thick pus. The areas healed with difficulty and often left scars. The condition seemed to be progressive until November 1933. When seen in December 1933 the patient complained of lassitude, loss of appetite and loss of libido and said that his cutaneous condition seemed to be improving.

Physical Examination.—On examination he seemed in good general health. His complaint of lassitude was not borne out by anything more than the usual temperament of the Negro toward work. On the forehead, extending within the hair line, and on the cheeks, chin, nose and neck were numerous small, very black, tenacious comedones, their distribution best described as being "peppered" within the skin. Many of the comedones surmounted firm shotlike cysts, which in some areas contained viscid yellow pus. The pustular elements were more noticeable on the neck. Similar shotlike comedones and cysts had appeared on the shoulders, midportion of the back and chest, with an occasional large cyst. A peculiar peppering of the skin with tenacious carbon-colored comedones was apparent around the umbilicus and lower portion of the abdomen. The scrotum and penis were involved in a similar process, the former being given more to the formation of cysts. The outer surfaces of the forearms and anterior thighs showed similar but fewer comedones. The whole eruption was acneform but differed from

"An Acneform Dermatergosis," 1936. Highlighting added.

Sadly, there is the egregious racism of these doctors: "His complaint of lassitude was not born out by anything more than the usual temperament of the Negro toward work." But far more relevant to the issue at hand is the evidence of yet another case of someone who worked with PCBs as early as 1930 to 1933 experiencing a wide range of systemic effects.

And as Monsanto endangered its workers, so too did it expose those who lived adjacent to its Anniston, Ala. factory. As The Washington Post explained:

> "[F]or nearly 40 years … Monsanto Co. routinely discharged toxic waste into a west Anniston creek and dumped millions of pounds of PCBs into oozing open-pit landfills … In 1966, Monsanto managers discovered that fish submerged in that creek turned belly-up within 10 seconds, spurting blood and shedding skin as if dunked into boiling water. They told no one. **In 1969, they found fish in another creek with 7,500 times the legal PCB levels. They decided 'there is little object in going to expensive extremes in limiting discharges.' In 1975, a company study found that PCBs caused tumors in rats. They ordered its conclusion changed from 'slightly tumorigenic' to 'does not appear to be carcinogenic.'** Monsanto enjoyed a lucrative four-decade monopoly on PCB production in the United States, and battled to protect that monopoly long after PCBs were confirmed as a global pollutant. 'We can't afford to lose one dollar of business,' one internal memo concluded." (*Emphasis added.*)

In its January 1, 2002 story "In Dirt, Water and Hogs, Town Got Its Fill of PCBs," The Post focused on one of the plaintiffs:

The first time the man from Monsanto Co. knocked on Ruth Mims's door, he announced that her hogs were trespassing on company property. "We'll give y'all 24 hours to move those hogs," he warned her. She panicked. She had no room for hogs in her little yard.

But the man knocked again a few minutes later. Tell you what, he told Mims. We'll buy the hogs for $25 a head, plus a pint of white corn liquor. Mims didn't drink, but Christmas was coming and she was short on cash, so she said yes.

That was in December 1970. It wasn't until Mims told that story in federal court last April that she saw Monsanto's secret "Hog Analysis Results" from 30 years earlier. The company had dissected some hogs from the west Anniston area and found PCB levels as high as 19,000 parts per million. There were no legal limits then, because the idea that PCBs could end up in hogs was pretty new, but that would be more than 90,000 times the legal maximum in some states today.

The Washington Post, Jan. 1, 2002. Highlighting added.

On December 15, 1966, London's New Scientist journal published a brief notice of the work of Swedish scientist Sören Jensen, "Report of a New Chemical Hazard":

> "A Swedish research worker has expressed concern over the increased evidence of polychlorinated biphenyl (PCB) entering the air, presumable from industrial smoke and rubbish dump smoke and being absorbed by water and taken up by fish and later humans. PCB which is related to and as poisonous as DDT was detected by Mr. Sören Jensen of the Institute of Analytical Chemistry, University of Stockholm, in 200 pike taken from different parts of Sweden, fish and fish-spawn throughout the country, an eagle which was found dead in the Stockholm Archipelago, and in his own, his wife, and his baby daughter's hair. As the baby is only five months old her father concludes she got her dose of PCB with her mother's milk."

Then, in 1968, more than 1,300 people got sick in Yusho, Japan after consuming rice bran oil that had been contaminated with more than 2,000 parts per million (ppm) of PCB oil. "Among males, excess mortality was observed for all cancers ... Among females, increased mortality was observed for liver cancer ..."

On December 14, 1968, Nature magazine published "Polychlorinated Biphenyls in the Global Ecosystem," by R. W. Risebrough et al, citing research that showed the dangerous effects of PCBs on the thickness of the eggs of raptorial and fish-eating birds in America and Great Britain:

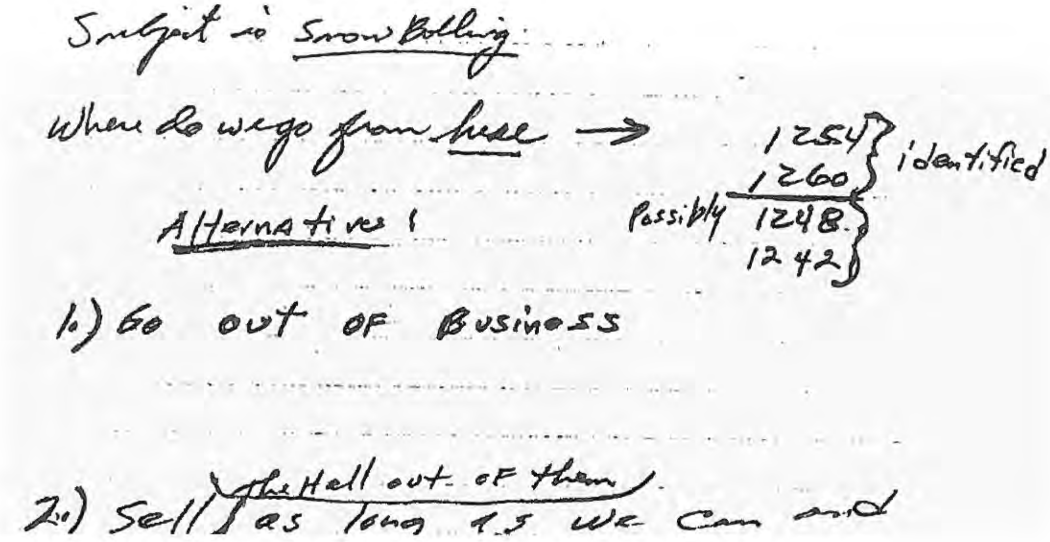
> "A widespread change in the chemical environment which affected the calcium physiology of these species evidently occurred at that time. The chlorinated hydrocarbons, which came into general use in the 1940s may now be the most abundant synthetic pollutants present in the global environment." (*Emphasis added.*)

It seems that, by April 1969, Monsanto was aware of studies being done on shrimp and oysters in the Escambia River and Pensacola Bay, Fla. The results of this research, "A Polychlorinated Biphenyl (Aroclor 125) in the Water, Sediment, and Biota of Escamhia Bay," Florida was published in the Bulletin of Environmental Contamination and Toxicology in March–April 1970:

> "We have detected a polychlorinated biphenyl (PCB), Aroclor 1254, in the biota, sediment, and water of estuarine area near Pensacola, Florida. **Only one source of the chemical, an industrial plant on the Escambia River, has been located. However, the chemical occurs in tissues of pelagic and sessile organisms that are widely distributed within the estuary. This distribution of Aroclor 1254 could be due to dispersion of the chemical from the river by currents and biota to other parts of the system ...**
>
> "**Our laboratory studies showed that Juvenile shrimp were the most sensitive, and were killed when exposed to 5.0 ppb of Aroclor 1254 in flowing sea water.** The Aroclor content in water from Escambia Bay, even near the mouth of the river, contained less than 1 ppb. Shrimp collected from the bay contained a maximum of 2.5 ppm. Thus, the shrimp in Escambia Bay probably were not exposed to lethal levels of the chemical during the sampling period.
>
> "**This study demonstrates the urgent need for continued surveillance of our estuaries in order to preserve these nursery grounds for our valuable fishery resources. Also, the study shows a need for conducting long-term tests on the effect of sub-lethal concentrations of Aroclor 1254 on estuarine organisms in sensitive stages of their life history.**" (*Emphasis added.*)

By the way, "5 ppb" is five parts per billion—a very small amount. And so what had been kept private all along—the knowledge of the systemic toxicity of Monsanto's PCB Aroclors and, beginning with even small doses, their tendency to bioaccumulate—was now becoming public, and impossible to ignore. Monsanto began a public relations campaign to respond.

Here is a handwritten note from a meeting of Monsanto's PCB Committee on August 25, 1969, which gathered to weigh strategies to deal with the ever-increasing appreciation of the dangers of PCBs. They posed two alternatives: Go out of business, or sell the living hell out of their Aroclors as long as they can.


Subject is Snow Balling:

Where do we go from here →

1254 } identified
1260 }
Possibly 1248 }
1242 }

Alternatives!

1.) Go out of Business

2.) Sell the Hell out of them as long as we can and

Here are some notes from Monsanto's September 5, 1969 first meeting of its "Aroclor Ad Hoc Committee":

> *Objectives: (Agreed to by the Committee) Submit recommendations for action which will:*
>
> ***1. Permit continued sales and profits, of Aroclors and Terphenyls.***
>
> ***2. Permit continued development of uses and sales.***
>
> ***3. Protect image of Organic Division and of the Corporation …***
>
> *Background Discussion of Problem:*
>
> ***2. PCB has been found in:***
>
> ***a. Fish, oysters, shrimp, birds.***
>
> ***b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries. Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant.***
>
> ***3. PCB has been tied to DDT in effects on disappearance of wild birds which have fish diets.*** *Ratio of PCB to DDT has been about 40-50:1 generally. Dr. Reisboro reported almost 1:1 ratio.* ***PCB may be contributing to or exaggerating the effects of other chlorinated aromatics.*** (Emphasis added.)

Then, close to home, there was the Escambia River problem:

6. Escambia River Problem:

For a clearer understanding of the general problem, the situation at Pensacola was reviewed. From a relatively negligible discharge of 1-3 gal/day into a large river, 1/4 mile downstream levels of 42 ppb in water and 476 ppm in mud were found. Although use of Aroclor was halted immediately, we can expect the water contamination to continue for a lengthy period by leaching from the contaminated mud. No downstream samples have yet been taken to measure the decrease in contamination (as of 9/5/69).

September 5, 1969, first meeting of the "Aroclor Ad Hoc Committee." Highlighting added.

Monsanto acknowledges—but most probably underestimates—the loss of Aroclor (one to three gallons a day) from its factory to the surrounding waterway. It then explains that preventing such losses from continuing probably wasn't worth the money it would cost:

> "The question of exactly how far to reduce (how much money to spend) is not yet clear and expenditures to date have been comparatively small. It was agreed that, until the problems of gross environmental contamination by our customers have been alleviated, there is little object in going to expensive extremes in limiting discharges from the plants." (*Emphasis added.*)

On March 3, 1969, Monsanto issued this statement:

> "On February 24, the San Francisco Chronicle carried a major feature about 'a menacing new pollutant' found in the San Francisco Bay area. The article was based on marine life research carried out by Dr. Robert Risebrough of the University of California. It stated that residues of polychlorinated biphenyl (PCB) were killing certain birds and implied a long-term threat to humans. Monsanto manufactures polychlorinated biphenyl and markets it under our

"Dr. Risebrough's more recent work reports the identification of PCB, along with DDT and DDE pesticides, in the tissues of birds and fish on the West Coast. The conclusions of these scientists are puzzling from several aspects. Polychlorinated biphenyls are stable chemical compounds which are essentially insoluble in, water. Their use does not make them easily released into the natural environment ... It has also been implied that polychlorinated biphenyls are 'highly toxic' chemicals. This is not true. The toxicity of any material, whether it be chemicals, drugs, natural plants or even foods, is relative. Just like other industrial chemicals and home products now in widespread use, PCBs are not hazardous when properly handled and used." (*Emphasis added.*)

On October 2, 1969, Monsanto issued its confidential "Report of 'Aroclor' Ad Hoc Committee," and it is interesting to see how they rephrased one of their objectives to make it more eco-friendly: "Protect the image of the Organic Division and the Corporation as members of the business community recognizing their responsibilities to prevent and/or control contamination of the global ecosystem." (*Emphasis added.*)

But, most significantly, the committee counseled the development of a strategy to maintain Monsanto's profitability. With little likelihood that Monsanto could control the growing realization of the risks of their Aroclors throughout the world, it was most critical that they continue sales.

PROBABILITY OF SUCCESS

The committee believes there is little probability ~~[illegible]~~ that any action that can be taken will prevent the growing incrimination of specific polychlorinated biphenyls (the higher chlorinated--e.g. Aroclors 1254 and 1260) as nearly global environmental contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp), and the possible extinction of several species of fish eating birds.

Secondly, the committee believes that there is no ~~possible~~ practical course of action that can so effectively police the uses of these products as to prevent completely some environmental contamination.

There are, however, a number of ~~possible~~ actions which must be undertaken in order to prolong the manufacture, sale and use of these particular Aroclors as well as to protect the continued use of other members of the Aroclor series.

The ultimate that can be expected is the continued use of the lower chlorinated biphenyls (Less than 5 Chlorines) and the chlorinated terphenyls in applications amenable to such control that there is practically zero losses to the environment. In the interim we would hope to establish by appropriate research efforts "tolerance" or safe levels for particular Aroclors in the environment.

Monsanto's confidential October 2, 1969 "Report of 'Aroclor' Ad Hoc Committee." Highlighting added.

They are, however, keenly aware of their liability:

BASIS FOR RECOMMENDATIONS (Continued)

As the alarm concerning the contamination of the environment grows it is almost certain that a number of our customers or their products will be incriminated. The company could be considered derelict, morally if not legally, if it fails to notify all customers of the potential implication.

A case in point is the recent determination (mid-~~August~~ sept.) that milk to be marketed by the Maryland Cooperative Milk Producers, Inc. in Baltimore was contaminated with polychlorinated biphenyls. The source of the PCB's was isolated to six dairy herds in Martinsburg, West Virginia. Investigation by the Producers Association is continuing but to our knowledge the specific source of the PCB has not been pin-pointed.

Monsanto's confidential October 2, 1969 "Report of 'Aroclor' Ad Hoc Committee." Highlighting added.

This is a critically significant document: While Monsanto acknowledges the growing tendency to regard its Aroclors as "nearly global contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp), and the possible extinction of several species of fish eating birds," it claims there is no practical way to effectively police the use of their Aroclors or prevent environmental contamination. There are, however, ways to prolong sales.

Considering the many billions of dollars Monsanto had made marketing Aroclors, the claim they couldn't actively protect the environment seems palpably false. Unsurprisingly, the actions the Aroclor Ad Hoc Committee doesn't contemplate is to make a public admission of their liability along with a pledge to finance immediate remediation of contaminated waterways.

Rather, Monsanto acted to protect itself from claims that "it was derelict morally if not legally." How? By reaching out in an almost ex post facto fashion to notify customers to take steps to prevent their Aroclors from entering the environment. The confidential October 2, 1969 "Report of 'Aroclor' Ad Hoc Committee" refers to the letters they sent:

On September 24, 1969 the San Francisco Chronicle published a "scare" story following an interview with Dr. Robert Risebrough of the University of California. The latter had recently published in Nature the finding of polychlorinated biphenyls in fish, birds and eggs in the California coastal areas.

On March 3, 1969, the Functional Fluids group sent a letter to the 31 major Aroclor customers in the transformer and capacitor applications. The letter included a copy of the Chronicle story and a Monsanto statement concerning the situation. This was intended to announce to these customers that the polychlorinated biphenyls might be in trouble and implied that the customers should make every effort to prevent loss of these materials to the environment. There has been subsequently some follow-up with at least General Electric and Westinghouse.

It has been recognized from the beginning that other functional fluid uses could lead to losses of the Aroclors to liquid waste streams from the customers' plants. Losses could occur from spills, unusual leakage of large volumes and daily losses of smaller volumes.

It has also been recognized that there could be vapor losses but it has been felt that these were perhaps of less significance than the vapor losses in plasticizer applications. The concern for vapor losses rises from the published proposed theory that even minute quantities of vapors are eventually transferred to the water environment and accumulated therein.

Monsanto's confidential October 2, 1969 "Report of 'Aroclor' Ad Hoc Committee." Highlighting added.

On November 17, 1969, Monsanto made a "PCB Presentation to Corporate Development Committee." The presentation first acknowledged, "Certain PCB's have recently been identified by various scientists along with DDT in fish, birds, and other wildlife. From the standpoint of reproduction, the PCB's are highly toxic to birds," then moved to secure guidance and approval on "a recommended plan of action."

This is a serious matter, not only from the pollution viewpoint, but also because of the $22 M worldwide customer business involved with resultant gross profits of $10 M and a net investment of approximately $9 M. In addition, there could be possible adverse legal and public relations problems leveled against Monsanto.

Monsanto's Nov. 17, 1969 "PCB Presentation to Corporate Development Committee." Highlighting added.

Three alternative strategies were offered:

Alternative 2: Go out of total Aroclor business was considered unacceptable from a Divisional viewpoint, but from a Corporate viewpoint may be necessary. Only-you-can-make-that-decision. ***All Aroclor products are not serious pollutants – many degrade, there is too much customer/market need and selfishly too much Monsanto profit to go out …***

Alternative 3: Go out of Aroclor 1254 and 1260. This was seriously considered and may eventually occur by our actions and customer actions, nevertheless, we feel that segments of this business are defensible or are so confined in use that specific plans of action arc called for this portion … (Emphasis added.)

Not only were Aroclors contaminating our environment, but when Monsanto hired Industrial Bio-Test Laboratories (IBT) in 1969 to undertake toxicity studies of its products, it began a decade-and-a-half-long joint effort to falsify test results. In "Ashamed to Put His Name to It: Monsanto, Industrial Bio-Test Laboratories, and the Use of Fraudulent Science, 1969–1985," David Rosner and Gerald Markowitz tell the story of how Monsanto and IBT tried to falsely reassure customers and the regulatory agencies that their Aroclors were safe.

Here is an excerpt from Monsanto's notes of a January 21 and 22, 1970 meeting in St. Louis with GE:

D. Status of Aroclor Studies At Industrial Bio-Test. Table 2.

In essence results reported by Mr. Wheeler on chronic animal toxicity tests and animal reproducibility studies underway are not as favorable as we had hoped or anticipated. Particularly alarming is evidence of effect on hatchability and production of thin egg shells regards white leghorn chickens. The studies involved Aroclor 1242, 1254 and 1260. Some of the studies will be repeated to arrive at better conclusions.

Excerpt from Monsanto's "The PCB-Pollution Problem." Highlighting added.

Rosner and Markowitz explain:

"Monsanto sent IBT new samples that they claimed were 'clean[ed] up' and told IBT they hoped to 'find a higher "no effect level," a potential "safe" level below which the experimental animals would not show symptoms of damage.' **Indeed, their collaboration with IBT to downplay the hazards of PCBs appears to have been successful. By 1973, they claimed that 'the most important data which has led the government agencies to permit the continued but constricted use of polychlorinated biphenyl are the extensive animal toxicity studies which we have completed in the last two years.'"** (*Emphasis added.*)

Except that the most important data was the falsified study data.

Then, in the meeting with GE, Monsanto emphasized the critical need for transformers and the Aroclor fluid:

"[W]ithout availability of askarel transformers large cities like New York would be shut down with no power … **Without Aroclor capacitors most of the lights across our country would go out and motors in air conditioners and many industrial applications would not run."** (*Emphasis added.*)

And we learned from Monsanto that, while expressing the continuing need for Aroclor, GE refused Monsanto's wish that GE accept sole liability for its use:

L. What GE Desires

1. GE seeks that Monsanto take no precipitous reaction to the PCB problem that would result in withdrawing supply of Aroclor 1254 or 1260 to GE.

2. The consensus is that no suitable replacement for transformer askarel fluid is foreseen.

3. In event of development of a suitable fire-resistant fluid replacement for askarel, Mr. Raab emphasized that a minimum of 2 years testing work would be required before commercial use could be adopted.

4. In reply to Monsanto's legal question whether with continued use of Aroclor 1254 and 1260 GE would assume sole and complete liability -- Mr. Raab answered, No! To substantiate his reply, Mr. Raab cited case examples involving GE where damages were sought and collected, even though GE was only the third party. He further stated that any arrangement seeking to delegate and confine liability to GE relative to the PCB problem would be worthless.

Excerpt from Monsanto's "The PCB-Pollution Problem." Highlighting added.

GE needed Monsanto's Aroclors. As we will see soon, some things are not what they seem. As for the IBT studies, Rosner and Markowitz explain:

"[T]he reliability of those studies was belied by two facts: first, the actual conditions in the IBT labs that tested PCBs for Monsanto were soon found to be compromised, and second, data were found to be fabricated and sent to the government as ostensible 'proof of their chemicals' safety ... Central to these activities was Paul Wright, who was the link between IBT and Monsanto. Wright was employed at Monsanto beginning in 1965 as a senior research chemist and from 1968 until 1970 as a research group leader. In 1970, as IBT began its two-year chronic testing of PCBs for Monsanto, Wright moved to IBT, where he directed the toxicology lab that oversaw these studies. In late 1972, he returned to Monsanto as the toxicology manager and stayed at Monsanto until 1984 ... Philip Smith, the lab assistant in the IBT PCB studies, gave vivid descriptions of how Wright had falsified data that ended up in the report sent to the government ..."

Rosner and Markowitz continue.

"On May 4,1981, a federal grand jury handed down an indictment ... [and] detailed that Monsanto's Wright made 'false, fictitious and fraudulent statements and representations ... In August 1983, Paul Wright, Moreno L. Keplinger, and James B. Plank, former assistant toxicology manager, were convicted of fraud and sentenced to jail. But even following conviction, Monsanto gave Wright a 'golden parachute,' providing him with full retirement benefits, accrued vacation time, one month's severance, and the services of a recruitment specialist to help him find future jobs when he was released from prison."

According to the EPA, the Monsanto plant in Anniston, Ala. "produced Aroclors between 1929 and 1971... [EPA] estimated that the amount of Aroclors produced at the Anniston plant was about 680 million pounds."

Monsanto poisoned the shrimp of Escambia. GE poisoned the fish and ducks of the Housatonic. The EPA revealed in 1999:

"Waterfowl samples collected last summer on the Housatonic River in western Massachusetts show elevated

3,700 parts per million adjusted for fat—were found in the breast tissue of a six-month old wood duck." (*Emphasis added.*)

Thanks to our share of Aroclor, we in Berkshire County have been victims of GE and Monsanto's gross incompetence, remarkable negligence, and their unrelenting impulse to put profit before worker safety, and the public health and our environment. GE and Monsanto have made us pay a fearsome price, and they are determined to leave us all, but especially Lee with a toxic legacy. Hopefully we can find a possible solution.

Woods Pond in Lee in the late afternoon. Photo by Mickey Friedman.

IN FOCUS

THE OTHER SIDE: Sue Monsanto, save Lee — a modest proposal (Part Three)

I have read too many words, written too many. For me, there is always the reality of a poisoned Rising Pond, but the enduring dream of a fishable, swimmable river.

BY MICKEY FRIEDMAN
POSTED ON DECEMBER 26, 2023

For a moment, I want to go back to what turns out to be a very important year: 1970. The scientific reality that hydrocarbons like Aroclor were poisoning the global environment began to overwhelm Monsanto's rhetoric, and environmental regulators were slowly beginning to take notice. Monsanto reached out to its customers in a coordinated attempt to maintain its profits and buy some time. Elmer Wheeler of Monsanto met with GE on January 21 and 22, 1970:

A. Presentation and Discussion of Published Articles About Chlorinated Aromatic Hydrocarbon Insecticides, (DDT etc.) and PCBs

Mr. Wheeler presented to Mr. Raab a booklet containing most of the pertinent publications, to date, and indicated that additional articles will appear shortly.

He mentioned that manufacturers of DDT and chlorinated aromatic hydrocarbon insecticides will tend to emphasize the finding and interference of PCBs as the Government hearings limiting or banning use of the insecticides are held.

This lead GE to seek understanding of the scope, reproducibility, reliability and validity of the analytical procedures used by various investigators who reported finding PCB in concentrations as low as parts per billion.

B. The Analytical Procedures

Drs. Keller and Tucker presented details of Monsanto's GLC - Mass Spectrometric analytical capability and apparatus, as portrayed in Table 1. The sophistication of our analytical capability was emphasized to assure that our approach is the ultimate and is not surpassed. On this basis our views of the validity of results given in various publications are indicated in the attachments to Table 1.

General Electric were impressed and completely satisfied with the scope of our analytical capability and work.

"The PCB-Pollution Problem," the Monsanto-GE meeting of January 21–22, 1970. Highlighting added.

Monsanto states:

> *In essence results reported by Mr. Wheeler on* **chronic animal toxicity tests and animal reproducibility studies underway are not as favorable as we had hoped or anticipated.** *Particularly alarming is evidence of effect on hatchability and production of thin egg shells regards white leghorn chickens. The studies involved Aroclor 1242, 1254 and 1260. Some of the studies will be repeated to arrive at better conclusions.* (Emphasis added.)

If these notes are accurate, and if GE was completely satisfied, it appears that Monsanto never fully shared with GE its knowledge of—and GE never fully appreciated—the reliability of several studies showing why its Aroclor (Pyranol) needed to be kept from leaving their factories, or the details of what actually happened with the PCBs that made it to the environment.

On February 18, 1970, Donald A. Olson, director of sales at the Monsanto Functional Fluids Group, wrote to other customers:

> *It is claimed that the PCBs found strongly resemble chlorinated biphenyls containing 54 [percent] and 60 [percent] chlorine by weight. Products which are sold by Monsanto under the trade names of Aroclor® 1254 and 1260 do contain chlorinated biphenyls ... As your supplier of Aroclor® 1254 and 1260 and formulated products containing*

We feel that all possible care should be taken in the application, processing and effluent disposal of these products to prevent them becoming environmental contaminants. Of interest to you may be an article in Chemical Week, October 29, 1969, regarding water pollution standards set by each state in the Union. It is attached. This article reflects that good manufacturing practice in the future may require that no product used by any company should find their way into waterways.

We realize that you have marketed or may now market transformers and other electrical equipment containing dielectric fluids which include Aroclor® 1254 and 1260. Although these fluids are sealed into such equipment it is recognized that occasionally the fluid may be lost through leaks resulting from equipment misuse or equipment repair necessitating replacement of the fluid. Since the dielectric fluid contained in this equipment is only an incidental part of the over-all unit manufactured by you, we are not notifying the purchasers of such equipment of the potential environmental contamination problem described in this letter. We do recommend, however, that you notify such equipment users of this problem.

Monsanto's February 18, 1970 letter to its customers. Highlighting added.

As always, Monsanto parsed its words and actual environmental contamination became potential. Here is Chemical Weekly's 1969 listing of water quality standards for Massachusetts:

Radioactivity: None in concentrations harmful to human, animal or aquatic life. Turbidity, Color, Taste and Odor: None in concentrations that would impair industrial use. Solids: None allowed except that which may result from the discharge from waste-treatment-facilities providing appropriate treatment. Toxic Substances: None in concentrations or combinations harmful to human, animal or aquatic life.

"For the first time, a summary of water quality standards set by all 50 states," Chemical Weekly, October 29, 1969. Highlighting added.

No toxic substances should be released in Massachusetts that would prove harmful to human, animal, or aquatic life.

Monsanto was trying to have it both ways: acknowledging the PCB problem to some while denying it to others. After all, almost all this guidance to be extra careful had been advocated by Dr. Schwartz in June 1936—then rigorously disregarded. That same day, Papageorge wrote Dr. Continelli at the Buffalo Children's Hospital asserting that Monsanto had no knowledge of the harmful effects of their Aroclor:

August 31, 1970

Dr. Basil M. Continelli
Drug Information Center
Buffalo Children's Hospital
125 Hodge-Street
Buffalo, New York 14222

Dear Dr. Continelli:

Your letter to Monsanto Company dated August 24, 1970 was forwarded to me for response since I have been assigned the responsibility for studying the total PCB environmental problem.

I appreciate the concern you have regarding the possible toxic effects of PCB.

Monsanto has manufactured Aroclors for about 40 years and throughout the period we have not observed any harmful effects on our employees or our customer's employees. Extensive animal testing being conducted for Monsanto has not revealed any evidence of deformity in the usual laboratory animals. We are therefore disturbed by the article's reference to birth defects in animals. To our knowledge no laboratory has evidence to confirm this statement.

W. B. Papageorge to Dr. Basil M. Continelli, August 31, 1970. Highlighting added.

Meanwhile, the February 1971 "Conference in the Matter of Pollution of the Interstate Waters of Escambia River Basin" named the Monsanto Chemical Plant as the source for PCBs in Escambia:

> *Our first transect was about two miles above the Monsanto Plant and we found no Aroclor 1254 in the surface or bottom water sediments. At the Monsanto weir in Escambia River we found 0.4 of a part per billion in the surface water and 0.2 in the bottom water. Fifty yards below this point, 0.5 parts per billion on the surface and it was not detectable in the bottom.*

The document continues:

> *… it does appear from these first samples that Aroclor is contained in sediments a little deeper than the surface … At zero to 2 inches from the surface we had 78.0 parts per million at the weir, 2 to 4 inches 30.0 parts per million, 4 to 6 inches, 6.1, and 6 to 8 inches 0.4.*
>
> *MR. REED: Mr. Chairman, may I interrupt?*
>
> *MR. WHITE: Yes, Mr. Reed.*
>
> *MR. REED: Tom, this doesn't sound like a short-term leak to me if we are getting stratification levels like this. This sounds like a long and continued discharge into the bay to build up. Admitted, these are preliminary figures, but this is not — this is a stratification that is deep.* (Emphasis added.)

With Escambia, two realities became crystal clear: Monsanto's Aroclors had made it to the waterway, and while levels let the Aroclors make their way to water. But what they didn't make clear was that the Aroclors weren't moving through the water column and out to sea—as most might have assumed—but were congregating in the sediments and bank soils where they contaminated the living things that came in contact with them.

It is also clear that, despite this now undeniable knowledge, Monsanto never did anything to take effective action to remediate this problem—a problem they had caused for decades and continue to cause as long as their toxic Aroclors remain present.

A revelatory 1972 interview with Elmer Wheeler provides insight into what was going on within Monsanto:

> *[W]e were told—that the material that the Swedes had identified was specifically polychlorinated biphenyl in probably March or April 1967 ... Initially, we ignored the significance of the Swedish work. We just couldn't believe that based on the uses of the Aroclor, based on the stability of it and based on the lack of solubility, that these things could conceivably begin to show up in the environment as did the chlorinated pesticides ... Almost a year following April 1967 the British published information that tended to confirm the Swedish work—again, however, without being so specific in their analytical techniques that true identification was without question. I guess it was late February 1969 that the you-know-what hit the fan when Professor Risebrough out at Berkeley published his paper indicating that he had found PCB's in birds and fish on the California coast ...*

Wheeler also talks about the new understanding that came with the 1968 acquisition and use of "a gas liquid and spectrophotometer ... able to detect the presence of PCBs in all types of samples at low levels ..."

Here is an excerpt from that interview:

> ***INTERVIEWER:*** *So, as I understand it, he took water, things of that sort, and then tested them to see if he could determine if PCBs were present in them?*
>
> ***WHEELER:*** *Yes. And in order to do that, he deliberately contaminated them and then ran them through the instrument to see if his numbers matched the input ...*
>
> ***INTERVIEWER:*** *Did he do any analysis on material that he hadn't contaminated deliberately with PCBs? ...*
>
> ***WHEELER:*** *... They did go out and get some soil samples around the plants, soil near the operation and so on.*
>
> ***INTERVIEWER:*** *And did they find that these soils had PCBs in them?*
>
> ***WHEELER:*** *Yes ... [and] they were able to feel more confident of the numbers ...*
>
> ***INTERVIEWER:*** *Was he surprised that there were PCBs in the environment?*
>
> ***WHEELER:*** *Oh, yes ...*
>
> ***INTERVIEWER:*** *So as I understand your answer, Dr. Keller's surprise was with respect to the extent that the PCBs had migrated from the factories? ...*
>
> ***WHEELER:*** *That was one of the surprises.*
>
> ***INTERVIEWER:*** *What other surprises did he have?*

Wheeler described a 1969 pesticide symposium at Oregon State University:

> *[S]ome of Risebrough's more vocal adherents were there ... Real hippy types with long hair, clean but raggedy jeans, sandals or bare feet and any time Risebrough would take a crack at industry, they would applaud and of course the local TV and press were just swarming around these activists every opportunity they had ...*
>
> *The upshot of this meeting was that, on the evening of the first day, Marsh and I were having a drink before we went to dinner and Marsh said, 'Elmer, these people are going to put Monsanto out of the PCB business' and I said 'I'm beginning to think you are right.' Fancher had the same reaction. We came back from that meeting and sat down with ... the people that were involved in what was going on in the PCB area at that time and out of that came a task force of 5 or 6 of us to put together the then current status of our knowledge about PCB's and predictions as to the future. We issued a report which was intended to be a preliminary draft of the deliberations of that group. That was about October 15. It got fairly wide distribution and subsequently we got a call from one of Dick Stohr's counterparts in the Law Department which said, 'call back all of those reports and burn them.' It was redistributed to some 12 people with the legend on the front 'ATTORNEY CLIENT PRIVILEGE.' This led to a review in November of the whole situation before the Corporate Management Committee which was the agency of the Board ...*

Yes, of course, burn all reference to the inconvenient reports or acknowledgment of what was really happening with Monsanto's Aroclors. But Monsanto didn't exactly have to worry yet about the EPA. The U.S. Interdepartmental Task Force on PCBs submitted its report "Polychlorinated Biphenyls and The Environment" in May 1972. It was clear U.S. regulatory agencies still didn't fully appreciate what Monsanto knew. And it is evident they still hadn't adequately done their own definitive tests or accurately extrapolated all the medical and scientific data available from the late 1930s on up. The EPA was still underestimating the severe risks that PCBs posed to human health and the environment:

> *PCBs should be restricted to essential or non-replaceable uses which involve minimal direct human exposure since they can have adverse effects on human health.* ***There currently are no toxicological or ecological data available to indicate that the levels of PCBs currently known to be in the environment constitute a threat to human health, but additional experiments are underway to evaluate the impact of low level, long-term exposure to PCBs.***
>
> *EPA then made a series of statements based as much on politics and economics as on environmental science: "PCBs have been used so widely over such a long period that they are ubiquitous. Even a total cessation of manufacturing and use of PCBs would not result in the rapid disappearance of the material, and ultimate disappearance from the environment will take many years ... Prohibition of PCB discharges into water will result in the reduction of such residues ...*
>
> ***The use of PCBs should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCBs in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCBs to all except manufacturers of electrical transformers and capacitors.*** (Emphasis added.)

Several developments affected us in Berkshire County. As the world better understood the growing devastation of PCB contamination on the environment, corporate lawyers focused on issues of liability. As Monsanto contemplated withdrawing from the manufacture and sale of its Aroclors, GE still had a thriving business and still depended on Aroclor 1254. Monsanto decided to leverage that dependency. While GE had earlier refused Monsanto's request to accept all liability, it now relented. An April 18, 1972 Monsanto document explains:

Since early 1970, Monsanto Chemical Company, sole supplier of Pyranol, has advised that this material, under the generic term askarel, contains polychlorinated biphenyls (PCB). Polychlorinated biphenyls are highly stable compounds and are not readily biodegradeable. Therefore, when placed in the environment, they may be considered contaminants and may adversely affect some species of animal and marine life.

At that time all customers were advised through Sales Channels to take every precaution to prevent any entry of this material into the environment through spills, usage, leakage, disposal, vaporization or otherwise.

In the past we have supplied Pyranol to transformer repair shops, and to companies requiring these products for top-up of existing transformers. Pyranol was also available from Monsanto under GE Specification A13B3B without restriction regarding its usage.

These sales have been discontinued by Monsanto as of January 15, 1972, except to those who have entered into special agreement to indemnify Monsanto with respect to this product for use in transformers.

General Electric has agreed to indemnify Monsanto for this use, as have several other major manufacturers. Some manufacturers have chosen not to indemnify Monsanto and have decided to discontinue manufacturing askarel-filled transformers.

Monsanto's April 18, 1972 letter to customers. Highlighting added.

As Monsanto put it:

These sales have been discontinued by Monsanto as of January 15, 1972, except to those who have entered into special agreement to indemnify Monsanto with respect to this product in transformers … General Electric has agreed to indemnify Monsanto for this use …

Not surprisingly GE passed on the indemnification requirement to its customers:

Mr. A. P. Engel LPD Erie Works	Mr. J. K. McCall TSPD Erie Works

Consistent with our prior discussions you are aware of the considerable concern that has been expressed over the effects of polychlorinated biphengls (PCB) on the environment. In an effort to protect the General Electric Company from unreasonable risks in this area, we are forwarding the attached information. This information must be communicated to your customers which have purchased Pyranol®-filled transformers as part of your equipment.

The first attachment is an indemnification clause which we suggest you use with your ultimate customer on all new proposals. This indemnification clause will be included in all new Power Transformer Products Department proposals for Pyranol® transformers. The second attachment is a

GE's October 1973 document discussing Pyranol indemnification agreements. Highlighting added.

This incinerator was designed, and was demonstrated, to destroy PCB wastes at 99.9998 percent efficiency. By September, 1971, this unit was in continuous operation and was destroying both waste from our production and PCBs returned by customers as they converted to non-PCB replacements. When phaseout from nonelectrical applications was complete, the incinerator was used to destroy waste PCB which was collected from ongoing dielectric use.

GE built Puff and burned its own Pittsfield Pyranol and Pyranol from other GE plants and then charged others to burn their PCB oil. According to a deposition with Monsanto's Papageorge on April 27, 1999, by the middle of 1977, "the amount of material being returned had reduced to the point where it was perceived not to be needed any longer because there were commercial units available …"

In its "PCBs: A Report on Uses, Environmental and Health Effects and Disposal," Monsanto offers itself the benefit of every doubt as it explains its last years in the PCB business:

At least as late as a 1975 press conference, the EPA reiterated it would not ask Monsanto to stop production because that would shut down the electrical power industry and the railroads in short order. The EPA objective was to find a way to proceed without shutting down the country. That was precisely the objective to which Monsanto had been committed since 1970 …

Because PCBs were reported in the environment and tests indicated they could accumulate in the food chain, Monsanto voluntarily decided to terminate sales of chlorinated biphenyls to open applications — those which could result in losses to the environment. Plasticizer and carbonless paper applications fell into this category … High operating pressures cause hydraulic systems to leak. Monsanto therefore alerted users to manage wastes to eliminate PCB discharge to the environment. As new hydraulic fluids were developed in 1971, we terminated sales of those containing PCBs …

Although a variety of effects of PCBs has been postulated from research of widely varying quality, ***there is no evidence of environmental levels of PCBs being a major human health hazard. However, it became apparent that the public perceived risks associated with continued PCB dielectric use and preferred to forego its undoubted functional benefits. Therefore, in October of 1976, we advised dielectric customers that it was our intent, consistent with their progress with substitute products, to terminate chlorinated biphenyl production and sale by October, 1977 … Monsanto's decision to withdraw from the PCB business was based on concerns about environmental presence rather than health effects*** … (Emphasis added.)

Monsanto, all those years ago, seemed to have come to the conclusion that Mother Earth couldn't sue them, that the shrimp, oysters and eagles wouldn't ever be able to hold the company accountable. I am, I must remind you, a journalist and a story-teller, not an attorney, but I wonder if an indemnification agreement signed by a party ignorant of all the relevant facts still prevails. Or might GE have a case that Monsanto hadn't been completely forthcoming about what it had learned at Escambia, about what would happen if/when its Aroclors had left GE's factories and made it to the Hudson and Housatonic Rivers. Would GE have agreed to indemnification if it had known Monsanto's Aroclors could move through the water column then gather in the bank soils and river sediments and with modest amounts poison fish, mink, eagles and ducks?

In December 1996, EPA issued a Unilateral Administrative Order under the Superfund law to GE to remove highly contaminated sediment and bank soil in the area adjacent to GE's Building 68, which is on the banks of the River in the Upper ½ Mile Reach ... in 1997 and 1998 GE excavated and disposed of 5,000 cubic yards of heavily contaminated sediment (average PCB concentration of approximately 1,534 parts per million, or 'ppm') from a 550-foot section of the river and 2,230 cubic yards of heavily contaminated bank soil (average concentration of surficial soil of 720 ppm and average concentration of subsurface soil of 5,896 ppm) from a 170-foot stretch of the river bank.

At Escambia, researchers found contamination levels of 78.0 parts per million. Here in Pittsfield, the Building 68 site had average levels of 1,534 ppm.

Having sat across from and engaged with some of them, I know how very talented GE's attorneys are. Perhaps because it was Monsanto's Aroclors that settled in the sediments and bank soils, they might argue that Monsanto reimburse GE for some of the many hundreds of millions of dollars the company has already spent remediating the first two miles of the Housatonic and for what the EPA estimates will be $576 million to clean up the next installment of 1.13 million cubic yards of contaminated soil and sediment from the Rest of River. Couldn't GE divert some of that money to underwrite the costs of shipping Housatonic River PCBs out of state?

As for us, the ordinary citizens of Berkshire County, there is a growing understanding of PCB exposure. As the World Health Organizations' 2016 "Assessment of Polychlorinated Biphenyls and Polybrominated Biphenyls" explains:

The reason that PCB and PBB mixtures in the environment today differ from the original commercial products is that after release into the environment, the congener composition changes through partitioning, chemical transformation, and bioaccumulation. ***Partitioning refers to processes by which different congeners separate into air, water, sediment, and soil. Some congeners tend to volatilize or disperse as aerosols, providing an effective vehicle for long-range transport.*** *Congeners with low chlorine or bromine content tend to be more volatile, and also somewhat soluble in water.* (Emphasis added.)

And, in fact, previous epidemiological studies of PCB exposure focused on workers "exposed to the 'fresh' product, by inhalation or dermal contact, while studies in the general population assessed individuals exposed primarily through intake of contaminated food, for which the exposure profile is difficult to assess." But as time went on, we have learned so much more about bioaccumulation and volatilization.

Today, and this is particularly relevant to those living near the Housatonic River and other PCB-contaminated waterways in the Commonwealth, "exposure is to complex mixtures originating from commercial products that have been altered by environmental processes (i.e. weathering, transport, and bioaccumulation)."

And WHO notes: **"Harrad et al. (2006) have suggested that inhalation may account for 4-63 [percent] (median, 15 [percent]) of overall exposure in humans."** (Emphasis added.)

Dr. David Carpenter of the Institute for Health and the Environment at the University of Albany was an invited specialist consultant for the WHO Assessment and testified as well for the plaintiffs in the Monsanto Anniston, Ala. cases. Dr. Carpenter's recent research has focused on the volatilization of PCBs and the marked increase in disease shown in those who live near PCB-contaminated waterways like the Hudson River and toxic-waste sites.

In previous studies, PCB exposure in Mohawk adults has been associated with an increased risk of thyroid disease, reproductive abnormalities in both men and women, diabetes, hypertension, obesity, hyperlipidemia, and metabolic syndrome [9]. While earlier studies monitored total PCBs in blood, more recent studies investigated the effects of different PCB congener groups. This is important because high-chlorinated congeners are more persistent in both the environment and the human body, and their primary route of exposure is from the ingestion of animal fats, especially contaminated fish [10]. However, lower chlorinated congeners are more easily metabolized and, therefore, are less persistent and more volatile, leading to inhalation as a major route of exposure. We found that for some diseases, such as diabetes [11] and the abnormalities of menstruation and ovulation [12,13], the biological effects were primarily due to the low-chlorinated congeners. However, for other outcomes, such as hyperlipidemia and obesity, high-chlorinated congeners are more strongly associated, implicating ingestion as the major route of exposure [9].

PCB exposure also adversely affects cognitive function. Mohawk adolescents at Akwesasne were studied in an investigation of the adverse effects of PCB exposure on cognition, and it was found that the elevated concentrations of total PCBs were negatively associated with delayed recall, long-term retrieval, and comprehension knowledge scores [14]. Dioxin-like, non-dioxin-like, persistent, and low-persistent PCB congener groupings were all associated with reduced long-term memory [15]. Auditory processing was associated only with the persistent congener group, while the non-persistent congener group was associated with the scores of delayed recall, long-term retrieval, and comprehension knowledge [15]. Therefore, Mohawk adolescents who were highly exposed to PCBs showed significant detriments to cognitive skills.

Excerpt from Dr. Carpenter's "Study of PCBs and their Effect on Cognitive Function in Mohawk Adults at Akwesasne." Highlighting added.

Remember Monsanto's surprise in the late 1960s when their newly sophisticated testing regimes revealed that "the composition of that PCB would change, indicating that something was affecting the lower chlorinated PCBs."

Here is another study written by Dr. Carpenter and his colleagues: "Exocrine pancreatic cancer and living near to waste sites containing hazardous organic chemicals, New York State, USA – an 18-year population-based study." And here is a selection where Dr. David Carpenter highlights the health risks of volatilization and its impact on cancer, heart disease, hypertension, and diabetes:

> *[T]hese studies provide support for the conclusion that inhalation of PCBs is the major cause of the elevated rates of hospitalization. The implications of these studies are significant for several reasons. First, these results suggest that living near a PCB-contaminated waste site poses risk to health, and by extrapolation this applies also to attending a school with elevated PCBs in the air ...* (Emphasis added.)

Close to home, Dr. Carpenter and his team conducted indoor air testing coupled with PCB blood testing in Pittsfield:

> *Pittsfield still has large landfills with PCBs, and air, soil and water still contain high concentrations of PCBs. While most monitoring of PCBs levels in environmental and human samples have focused on the more persistent congeners,* ***our group has increasingly become concerned about vapor phase PCBs and with inhalation of PCBs as being a significant route of exposure.*** *While many of the more volatile congeners are not persistent in the human body,* ***if PCBs are present in air, especially indoor air, the exposure will be continuous and may pose health hazards that are not adequately identified by measurement of more persistent congeners in blood.*** (Emphasis added.)

Most Berkshire residents are unaware that they and their families may very well have paid—and continue to pay—a

Let's revisit the troubling results of the 1997 Housatonic River Area PCB Exposure Assessment Study conducted by the Massachusetts Department of Public Health. A quick note: While PCB levels in fish tissue and river sediments are often measured in parts per million (ppm), PCB levels in human blood is measured in parts per billion (ppb).

Sixty-nine of 1,529 participants agreed to blood testing.

> *Total serum PCBs, which were classified as Aroclor 1260, ranged from non-detectable to 35.81 ppb, with a mean of 5.44 ppb and a median of 3.93 ppb ... In addition, residents who were not chosen for the study but who were concerned about exposure to PCBs were offered the opportunity to volunteer to participate in a separate effort ...*

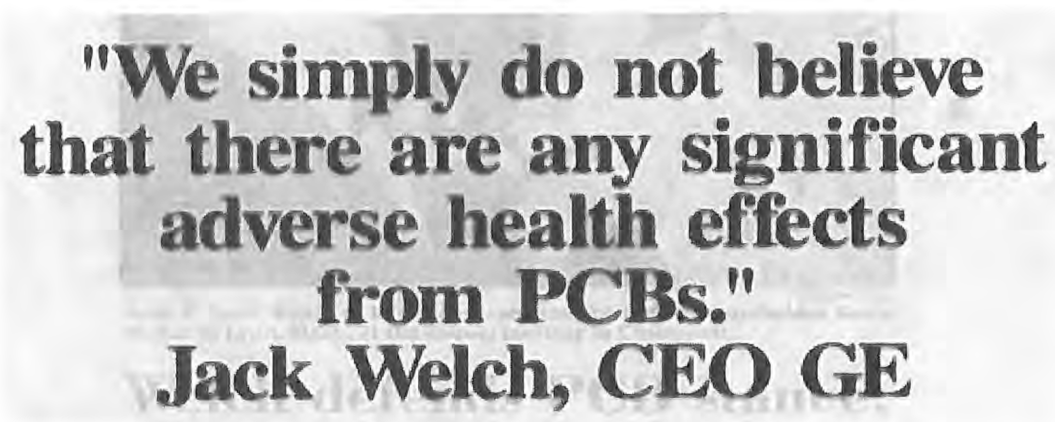
The mean PCB blood level for Pittsfield adults aged 18 to 64 was 4.22 ppb, and for those older than 65, it was 10.56 ppb. The mean PCB blood levels for those aged 18 to 64 living nearby the Housatonic was 3.56 ppb, and for those 65 and older, it was 5.78 ppb.

MDPH stated:

> *The serum PCB levels found among participants of both studies were generally within typical background estimates for a non-occupationally exposed U.S. population. ATSDR reports that, for U.S. populations without occupational exposure, mean serum PCB levels were usually between 4 and 8 ppb, with 95 [percent] of the individuals having concentrations less than 20 ppb. Since the results of this study represented individuals with the highest risk of exposure, it is reasonable to assume that serum PCB levels of most non-occupationally exposed residents in the HRA communities are within the US background range, though individual differences may likely occur.* (Page 2, emphasis added.)

But, in fact, MDPH misstated the national background level for serum PCBs. Soon after the report, James Cogliano, former chief of the EPA's Quantitative Risk Methods Group, told a Pittsfield audience that the accurate figure for the national background level of PCBs in the blood was actually 0.9 to 1.5 ppb. So, in fact, those 18 to 64 years old in Pittsfield had more than three to four times the national background level of PCBs in their blood, while those in Pittsfield 65 and older had more like seven to 10 times the levels of PCBs in their blood. So, contrary to what MDPH and GE were telling them, there were many reasons to be concerned.

This inaccuracy has provided false comfort for too many. And GE took immediate advantage, publishing a series of full-page ads in The Berkshire Eagle, including this patently false assertion by GE CEO Jack Welch that there was absolutely no reason to be concerned about PCBs.



Recently, a Berkshire Eagle article (dated Tuesday, April 25) declared the Allendale School 'safe' from PCBs ... While it is true that the most likely way to become exposed to PCBs is through our food supply (and that probably holds true even for those of us who live next to a PCB contaminated site), those who live or go to school next to a PCB hazardous waste site face an additional threat from airborne PCBs. This may occur from breathing PCBs, both in the form of suspended particles in the air (dust) and as an invisible vapor (volatilized).

Average 'background' PCB air levels in uncontaminated regions are about 1 nanogram/m3. A number of PCB air levels measured at GE's On Plant Consolidation Areas have been substantially higher than that. The EPA claims that PCB air levels less than 50 nanograms/m3 (that is 50 times higher than background) do not expose children to excessive health risk. We do not share their comfort level. We feel that the EPA's risk assessments are based on limited data. This data does not consider the latent health effects of endocrine disruption nor the fact that children will be exposed to additional PCBs through their food. In addition, no safe PCB exposure level has yet been determined for children ... (Emphasis added.)

As for "Sue Monsanto," the issue of volatilization came to a head in November 2023:

Three schoolteachers in Washington state who sued the chemical company Monsanto over exposure to materials in fluorescent lights have been awarded $185m ... The teachers, who worked at the Sky Valley education center in Monroe, Washington, said they suffered brain damage from exposure to polychlorinated biphenyls, or PCBs, in the fluorescent lighting at the school. 'This is a big step in holding Monsanto accountable,' the teachers' attorney, Rick Friedman, said in a statement.

Law firm Friedman Rubin wrote:

... the Washington State jury found Pharmacia LLC liable for selling polychlorinated biphenyls (PCBs) without providing adequate warnings, resulting in neurological injuries, endocrine disruption and cognitive impairment to the plaintiffs, which included five teachers, a librarian and a custodian. All seven plaintiffs recovered damages including two of the teachers who developed rare cancers ... The verdict comes after nearly two months of trial and two weeks of deliberations. Of the $165 million verdict, $49.8 million is for compensatory damages, while $115.3 million is for punitive damages.

They noted that in July "Friedman Rubin and PCVA were instrumental in securing a $72 million verdict on behalf of another set of former Sky Valley employees who also sustained life-long injuries from PCB exposure at the school."

According to Courtroom View Network:

The teachers blamed their health problems, which include severe fatigue and cognitive difficulties, on exposure to PCBs from 2011 to 2015. They claim Monsanto, the sole company to manufacture PCBs, did so despite knowing they posed a risk to the public prior to being banned in the 1970's [sic].

As for other successful legal actions against Monsanto, the state of Washington filed a complaint in 2016 alleging that there was a long list "of water bodies within the state of Washington that are contaminated with Monsanto's PCBs, as measured in fish tissue or sediment PCBs in the environment."

3. Monsanto Company was the sole manufacturer of PCBs in the United States from 1935 to 1979, and trademarked the name "Aroclor" for certain PCB compounds. Although Monsanto knew for decades that PCBs were toxic and knew that they were widely contaminating all natural resources and living organisms, Monsanto concealed these facts and continued producing PCBs until Congress enacted the Toxic Substances Control Act ("TSCA"), which banned the manufacture of PCBs by January 1, 1979.

4. PCBs were used in many industrial and commercial applications such as paint, caulking, transformers, capacitors, coolants, hydraulic fluids, plasticizers, sealants, inks, lubricants, and other uses. PCBs regularly leach, leak, off-gas, and escape their intended applications, contaminating runoff during naturally occurring storm and rain events.

5. As a result, PCBs contaminate waterways, waterbodies, sediment, fish, and other land, water, and wildlife throughout the state of Washington. PCBs bioaccumulate in fish and humans, causing PCB levels hazardous to human health.

State of Washington v. Monsanto. Highlighting added.

The complaint continued to list the many waterways, large and small, whose fish and river sediment are now contaminated by Monsanto's PCBs.

8. Monsanto's PCBs have caused and will continue to cause direct injury to Washington's public natural resources.

9. The State of Washington has incurred significant costs to identify and reduce sources of Monsanto's PCBs entering and contaminating public natural resources. The State has also incurred significant costs towards monitoring, investigation, analysis, and remediation of Monsanto's PCBs in the environment. The State's residents have borne costs of treating and managing PCB-contaminated water.

10. The State incurs and will continue to incur significant costs into the future due to the presence of Monsanto's PCBs.

State of Washington v. Monsanto. Highlighting added.

The following claims of Washington are particularly relevant to the contamination of the Housatonic River, along with the extensive lands owned by the Commonwealth, including the 874 acres of the George Darey Housatonic Valley Wildlife Management Area that borders the Housatonic, and our interests in protecting the Housatonic ACEC:

16. Monsanto's PCB contamination constitutes injury to the State's public natural resources and to other property and waters of the State, for which the State seeks damages, including on behalf of itself and on behalf of its residents in its parens patriae capacity.

17. The State has a quasi-sovereign interest in and trustee obligation to protect the State's public natural

18. The State has a proprietary interest in protecting all property owned by the State and has an interest in remediating the contamination of its exclusive property and in preventing future contamination …

20. Injury to public natural resources caused by Monsanto's PCBs has resulted in loss of public use and enjoyment of those resources. The economic value of these natural resources, as well as the cost of restoring them, is substantial.

Washington explains: "The State brings this suit pursuant to RCW 7.48.010, et seq. and any other applicable codes or forms of relief available for monetary damages and removal of the public nuisance caused by Monsanto's PCBs."

Washington also makes clear that as "trustee of certain public natural resources, including certain lands, aquatic lands, wildlife, and state waters within state boundaries including but not limited to 3 million acres of state trust lands and 2.6 million acres of state-owned aquatic lands in public trust," they have "standing to bring this lawsuit as trustee of all aforementioned public natural resources."

As the state of Washington maintained, so too is our Commonwealth's property contaminated by Monsanto's PCBs and located throughout the state, including in Berkshire County. And yes, Monsanto's products containing PCBs were sold and used in Berkshire County.

Utilizing some of the internal memos I have referred to previously, the state of Washington asserted that Monsanto's interest was not in adequately addressing the ramifications of its careless distribution of PCBs but in maintaining the market they had come to rely upon. On June 24, 2020, the state of Washington announced that they had won a judgment of $95 million dollars.

In January 2018, the state of Oregon sued Monsanto for damages related to PCB contamination of Oregon's land, waters, fish, and wildlife. They stated:

Between 1929 and 1977, Monsanto was the only company in the United States to manufacture PCBs for widespread commercial use. Monsanto distributed PCBs widely, including throughout Oregon, for use in a broad array of products ranging from electrical equipment to lighting ballasts, from paint to caulking.

Oregon Attorney General Ellen Rosenblum won "a historic $698 million dollar settlement with the Monsanto Company (Monsanto) for their role in polluting Oregon with PCBs (polychlorinated biphenyls) for the past 90 + years …" The statement on the Oregon Department of Justice's website reads:

'This is a huge win for our state,' said AG Rosenblum. 'PCBs are still present throughout Oregon — especially in our landfills and riverbeds — and they are exceedingly difficult to remove, because they 'bioaccumulate' in fish and wildlife.

You can read the Consent Judgment here.

Pennsylvania filed suit in December 30, 2021 claiming:

Despite that Monsanto knew early on of dangers associated with PCBs, and/or knew or should have known that PCBs 'substantially persist in the natural environment rather than break down over time'; … that they 'would inevitably volatilize and leach, leak, and escape their intended applications, contaminating runoff during naturally *soils, and plants, as well as fish and other wildlife'; and 'that PCBs bio-accumulate and bio-magnify in animal tissue, including in fish tissue and human tissue, and [pose] an increasingly hazardous threat to the health of the Commonwealth's residents ... Monsanto nevertheless continued to market and sell its products containing PCBs ...'*

As the Pennsylvania Pressroom reports:

The Shapiro Administration has secured $100 million through a consent agreement with the Monsanto Company, Solutia INC., and Pharmacia LLC to resolve claims related to their production of products containing polychlorinated biphenyls (PCBs), which damaged waterways and other natural resources across Pennsylvania ...

In Virginia, on September 12, 2023, WRIC-TV reported, "Attorney General Miyares has announced an $80 million settlement with Monsanto ..."

On June 16, 2023, the state of Vermont sued Monsanto, with the legal help of Attorney Matthew Pawa, who represented our Rest of River Committee and managed to give the U.S. Court of Appeals for the First Circuit quite the false impression that the citizens of Lee still supported the confidential agreement he negotiated. Having worked hard to deny the Housatonic River Initiative's desire for a more extensive cleanup and to pressure GE and the EPA to opt for transporting PCB-contaminated waste off site rather than burden Lee with a massive PCB dump, Pawa now seems to be as interested in helping Vermont as he was in thwarting Lee.

Vermont's suit claims:

All ten sections of Lake Champlain and the entire 7-mile reach of the Hoosic River is considered impaired for PCBs on Vermont's most current 303(d) Impaired Waters List. Because of this, Vermont has a fish consumption advisory for all of Lake Champlain and the Hoosic River. The accumulation of PCBs in natural resources, and fish in particular, poses a public health threat to the citizens of Vermont ...

Monsanto never advised the State or the public that Old Monsanto's PCB mixtures or products would inevitably leach, leak, off-gas, emit, discharge, and release PCBs from their ordinary and intended applications and from disposal sites, regardless of the nature of the application, to contaminate Vermont's waters, sediments, soils, lands, air, fish, and wildlife. Monsanto issued no public warning or instruction about such issues or the health and environmental hazards presented and, indeed, as alleged above, denied that such hazards exist in their communications with public entities and the public more generally ...

Causes of Action – Count 1 – Public Nuisance: Defendants or their predecessors intentionally designed, manufactured, distributed, marketed, and sold PCBs and PCB-containing products with the knowledge that they inevitably and foreseeably caused or created environmental contamination, indoor air contamination, property damage, and unreasonable health risks when used as intended ...

Defendants' or their predecessors' conduct causes and continues to cause harm to Plaintiff. Plaintiff has suffered and will continue to suffer damage from Defendants' PCBs and PCB-containing products. This harm is severe and greater than Plaintiff should be required to bear without compensation ...

Defendants are under a continuing duty to act to correct and remediate the injuries their conduct, or that of their predecessors, has introduced, and to warn Plaintiff and the public about the human health risks posed by their

Attorney General Andrea Joy Campbell's Office is an advocate and resource for the people of Massachusetts in many ways, including protecting consumers, combating fraud and corruption, investigating and prosecuting crime, and protecting the environment, workers, and civil rights.

The citizens of Berkshire County have suffered for decades from the irresponsible misuse of PCBs. These PCBs were manufactured by Monsanto and then irresponsibly used by GE. Monsanto and GE lied about the ongoing threats to public health and the environment posed by their toxic Aroclors. Clearly, both GE and Monsanto share responsibility for our PCB contamination.

Meanwhile, many citizens of Berkshire County regard the revised CERCLA order as insufficient. GE will save $200 million in transportation costs with the decision to force Lee to host the UDF, a massive PCB landfill. Now, in addition to the ongoing public nuisance posed by the continuing dislocation of the proposed remediation, and with constant volatilization of the remaining PCBs, we will all suffer again because of GE's insistence on transporting PCB-contaminated soils and sediments through our towns and city streets by truck to the UDF. These realities will continue to present a continuing and imminent danger to our health. A continuing public nuisance, an environmental trespass.

While many of us in Berkshire County might not have fully appreciated the price we were paying all the years GE was misusing Monsanto's Aroclors, we know now, thanks to studies by Dr. David Carpenter, that we suffer and will suffer from a continuing imminent danger.

Is it too much to imagine that the attorney general—taking into account all we have learned about the continuing public health threat of PCBs from the Housatonic—will act on our behalf.

Is it too much to imagine that the attorney general will act to enforce the following provision of Mass Law Chapter 21E and its provision, Section 142A, Pollution or contamination of atmosphere; prevention; regulations; violation; enforcement:

"Whoever violates any such regulation or any permit or plan approval or order issued thereunder: (a) shall be punished for each violation by a fine of not more than twenty-five thousand dollars, or by imprisonment for not more than one year, or both such fine and imprisonment; or (b) shall be subject to a civil penalty of not more than twenty-five thousand dollars for each violation. Each day or part thereof that such violation occurs or continues shall be a separate violation. The civil penalty may be assessed in an action brought on behalf of the commonwealth in the superior court. The commonwealth may also bring an action for injunctive relief in the superior court for any such violation, and the superior court shall have jurisdiction to enjoin such violation and to grant such further relief as it may deem appropriate.

Certainly, the residents of Lee will suffer the greatest nuisance as a result of Monsanto's negligence as their property values decline at the very same time their public health is threatened more than most.

I have attended dozens and dozens of public meetings beginning in the early 1980s with the Massachusetts Department of Environmental Quality Engineering (DEQE), then its successor agency, the Massachusetts Departmental of Environmental Protection (DEP), and, of course, the EPA, and I have never heard them address Monsanto's significant responsibility. These agencies spent decades negotiating with GE but not Monsanto. And while GE is removing a portion of the PCBs that contaminated the Housatonic River, too many will remain. As GE acts to fulfill its

I have read too many words, written too many. For me, there is always the reality of a poisoned Rising Pond, but the enduring dream of a fishable, swimmable river.

Isn't it time for Massachusetts Attorney General Andrea Joy Campbell and her staff of fine lawyers to follow the lead of other states? Isn't it time for the Commonwealth to Sue Monsanto and Save Lee?

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EXHIBIT C

IN RE THE NOVEMBER 19, 2022
LEE BOARD OF HEALTH
ADJUDICATORY HEARING

Affidavit of David O. Carpenter, M.D.

1. I, David O. Carpenter, M.D., am an expert in the field of Environmental Medicine. One of my subspecialities is the health effects caused by human exposure to PCBs.[1] My Curriculum Vitae is attached herewith as **Exhibit A**.

2. I have written extensively on the serious and long-lasting adverse health effects caused to humans from exposure to unsafe levels of PCBs. These health effects include cancer, reproductive health as well as many other diseases which are listed and discussed in my published article entitled "*Exposure to and Health Effects of Volatile PCBs*" dated May 31, 2015 report attached here as **Exhibit B**.[2]

3. I testified at the November 19, 2022 Lee Board of Health Adjudicary Hearing ("11/19/22 LBOH") via Zoom. However, there was some difficulty with internet connection during my testimony that day. I would like to supplement my expert testimony with this affidavit.

4. I am familiar with General Electric Company's proposed Upland Disposal Facility ("UDF") at Woodland Road Location in Lee, MA.

5. I have reviewed the relevant aspects of the Settlement Agreement between General Electric Company ("GE") and the Town of Lee, et al. which provide specific information about the UDF. The Settlement Agreement ("SA") indicates that the UDF will be located two miles from downtown Main Street in Lee, MA. As to the

[1] Polychlorinated biphenyl
[2] The findings of the adverse health effects of PCBs as described in the article remain current and relevant today.

size of the UDF, the SA states that the UDF will have a capacity of 1.3 million cubic yards with a footprint of 20 acres and an elevation of 1,099 feet above mean sea level. Placing a PCB-contaminated disposal facility of this magnitude in a location so close to the heart of the Town of Lee and residential areas is a dangerous plan. It will threaten the health of the residents who live up to a four-mile radius of the PCB landfill. My research team has numerous publications showing that people who live within a four-mile radius of a PCB-contaminated waste site in New York State are more likely to be hospitalized with a number of different diseases (including diabetes, hypertension, heart disease, asthma, COPD and other diseases) than those who do not. The route of their exposure to PCBs is through the inhalation of vapor-base PCBs coming off the PCB waste site.

6. Landfills, such as the UDF, do not prevent PCBs from passing through the cover of the landfill and into the air. PCBs will escape into the air from even an enclosed and dormant landfill.

7. The SA states that the soil dredged from the Housatonic River with concentration levels of PCBs between 20 to 25 parts per million and lower will be dumped and stored at the UDF. It leaves open the possibility that GE could dump PCB-contaminated soil with concentration levels of PCBs as high as 25 to 49 parts per million at the UDF.[3] Our studies, referenced in Paragraph 5 above, show that for some diseases, especially diabetes and hypertension, it is the lower-chlorinated PCBs congeners that are more volatile and responsible for the elevated risk of disease.

8. While there may be good intentions behind the language in the SA promising to only store the PCB-contaminated soil with the lower-concentration levels of PCBs, this does little to control the risk of dangerous exposure to PCBs to those living within a four-mile radius of the UDF. The important distinction lies between lower *concentration* levels of PCBs verses lower-*chlorinated* PCBs. The soil with the lower-concentration levels of PCBs between 20 and 25 parts per million will still

[3] The Toxic Substance Control Act requires that contaminated soil with concentration level of PCBs at levels of 50 parts per million or more must be transported to a designated facility out of state.

contain PCBs with fewer chlorines. It is the PCBs with lower amounts of chorine that volatize more quickly into the air and increase the risk of exposure. The SA does not reference this important fact nor does it mention any plan to test for of the PCB-contaminated soil stored at the UPD for its chlorine content which is critical to understanding the likelihood of the risk of exposure to airborne PCBs coming from the UDF.

9. I understand that the UDF project includes a thirteen-year plan to transport the PCB-contaminated soil and sediments from various points of removal along the Housatonic River to the UDF. All of the PCB-contaminated soil and sediments dredged from the river will contain some lower-chlorinated PCBs. The constant movement of these lower-chlorinated PCBs and their continual exposure to the air will cause those PCBs to volatized, become airborne and inhaled. Breathing in airborne PCBs is the primary way in which human beings are exposed to dangerous levels of PCB. The thirteen-year plan to transport the PCB-contaminated soil from the Housatonic River to the UDF will logistically involve a minimum of four steps. Each step of the process will cause the lower-chlorinated PCBs in the soil to volatilize again and again. For example, the opportunity for the lower-chlorinated PCBs to volatilize will occur at each of the following points of transport:
    a. Every time the PCB-contaminated soil is dredged from the Housatonic River to the open air;
    b. Every time the PCB-contaminated soil is loaded on to the trucks for transport to the UDF;
    c. Every time the PCB-contaminated soil is transported from the point of removal to the UDF on public roads;
    d. Every time the PCB-contaminated soil is unloaded from the trucks and dumped into the UDF: and
    e. The lower-chlorinated PCBs will volatize even more quickly when wet as the soil and sediments will be wet when its first dredged from the Housatonic River for transport to the UDF. As the soil containing the lower-chlorinated PCBs dries out, those PCBs will rapidly evaporate and become airborne.

10. The SA states that the UDF will have "*a double liner and a leachate collection system with a low permeability cap and vegetation. The liners shall have permeability equal or less than 1 x 10 (minus 7) cm/sec with a minimum thickness of 30 mils and be chemically compatible with PCBs.*" These liners, whether there is one liner or two, will eventually leak. All of the known data on the life of the liners used in toxic

landfills, such as the UDF, support this conclusion. The location of the UDF is 1,000 feet from the Housatonic River as the crow flies and only 15 feet above the Town of Lee's water table (as stated in the SA). Given the location of the UDF, it is more likely than not that when the liners in the UDF do leak, the PCB contaminates stored at the UDF will eventually run back into the Housatonic River and contaminate the ground water and water table for the Town of Lee. This conclusion is supported by Dr. David DeSimone's findings in his report submitted as Exhibit 6 in the online public record for the 11/19/22 LBOH.[4]

11. Given the likelihood of exposure to potentially dangerous levels of airborne PCBs to the residents of Town of Lee living within a four-mile radius of the UDF, if the water table for Town of Lee was also contaminated with PCBs, it would be catastrophic to the long-term health of these residents.

12. Based on the above factual information, it is my expert opinion, to a degree of medical certainty, that the location and size of the UDF, as well as the thirteen-year plan to transport the PCB-contaminated soil from the Housatonic River to the UDF, will cause the residents in the Town of Lee living within a four-mile radius of the UDF an array of serious and long-lasting adverse health effects as referenced in this affidavit and its attachments which are incorporated herein by reference.

[4] Dr. DeSimone states, in relevant part, that the ground underneath the UDF is quite porous and will provide little, if no, retention base for the PCB-contaminates that leak from the UDF. Specifically, he describes the ground underneath the UDF as being "underlain by Stockbridge Foundation carbonate rock which primarily consists of dolomite marble and that the marble naturally contains fractures and joints which allow ground water and any contaminates to flow through" to the ground water below.

Dated: February 14, 2023

SIGNED UNDER PENALTIES OF PERJURY

DAVID O. CARPENTER, M.D.

STE[illegible] HOUT
Notary Public, State of New York
Qualified in Albany County
Reg. No. 01HO6288676
My Commission Expires Oct. 7, 2025

2/14/2023

David O. Carpenter*

Exposure to and health effects of volatile PCBs

Abstract

Introduction: Polychlorinated biphenyls (PCBs) are persistent, lipophilic contaminants that are known to increase risk of a number of human diseases. Although ingestion of animal fats is a major route of exposure, there is increasing evidence that inhalation of vapor-phase PCBs is also important and may be as or even more important than ingestion under some circumstances.
Methods: The evidence that inhalation of PCBs may cause cancer, heart disease, hypertension, and diabetes is reviewed and presented in this report.
Results: PCBs are known human carcinogens. A husband and wife, occupationally required to 'smell' PCB-containing oils, both developed thyroid cancer, malignant melanoma/severely melanocytic dysplastic nevus (a precursor to malignant melanoma) and the husband, a non-smoker, developed and died of lung cancer. The serum of both had highly elevated concentrations of lower chlorinated, volatile PCB congeners. In other studies, residents living near PCB-containing hazardous waste sites, and thus breathing PCB-contaminated air, have elevated rates of hospitalization for cardiovascular disease, hypertension, diabetes and reduced cognitive performance, whereas other studies in defined populations show that there is an elevated risk of all of these diseases in individuals with elevated serum PCBs.
Conclusions: These results are consistent with the conclusion that inhaled PCBs can increase risk of cancer, cardiovascular disease, hypertension, diabetes and reduce cognitive function.

Keywords: cancer; cardiovascular disease; diabetes; hypertension; PCB exposure; volatile PCBs.

DOI 10.1515/reveh-2014-0074
Received December 17, 2014; accepted February 12, 2015

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Introduction

Polychlorinated biphenyls (PCBs) were manufactured in many countries from the late 1920s until they were found to be persistent and toxic in the late 1970s, when their manufacture and use was stopped in most developed countries. It is reported, however, that they are still being manufactured in North Korea, and even in the US, many transformers and capacitors that are still being used contain PCBs.

PCBs consist of mixtures of up to 209 individual congeners, which vary depending on how many chlorines are on the biphenyl rings and where they are located on the molecule. Figure 1 shows the PCB molecule and the convention for identifying different congeners based on the location of chlorines. PCBs were manufactured in many countries as commercial mixtures through the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst, usually iron. The duration of the reaction determined the average degree of chlorination. In the US, almost all PCBs were manufactured by Monsanto, who sold commercial mixtures under the trade name 'Aroclor'. Aroclor 1242 was 42% chlorine by weight, whereas Aroclor 1260 was 60% chlorine. However, all commercial products contained a variety of PCB congeners, with the exception of Aroclor 1271, which was pure PCB 209 that contained chlorine groups at all 10 sites.

Most widely used commercial PCB mixtures are oils, and the greater the degree of chlorination, the more viscous the oil. They had many useful purposes. However, they had major uses in capacitors and light ballasts given because they are relatively nonflammable and nonconductive. They were widely used as hydraulic fluids, as solvents for paints or caulking, in carbonless copy paper, and in other products requiring a lipophilic solvent.

Although all PCB congeners have some common properties, they also have significant differences in physical properties and routes of exposure to humans. In general, PCBs have low water solubility and volatility. However, those congeners containing fewer chlorines are more water soluble and more volatile than those with more chlorines (1, 2). Table 1 (3) shows vapor pressure, water solubility, log octanol/water partition coefficient (log K_{ow}), and approximate evaporation rates as a function of the number of chlorines on the PCB molecule.

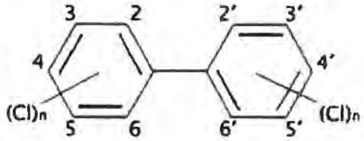

Figure 1: The structure of PCBs. There can be any number of chlorines around the biphenyl ring between one and ten. The convention for labelling the position is shown by the numbers, where the 2 and 6 positions are *ortho*, the 3 and 5 positions are *meta*, and the 4 position is *para*. The prime sign distinguishes in which ring the chlorines are located.

Table 1: Physical characteristics of PCBs by homologue groups at 25°.

PCB homologue group	Vapor pressure, Pa	Water solubility, g/m^3	Log octanol/ Water coefficient	Evaporation rate, $g/m^2/h$
Monochloro	1.1	4.0	4.7	0.25
Dichloro	0.24	1.6	5.1	0.065
Tetrachloro	0.012	0.26	5.9	4.2×10^{-3}
Hexachloro	5.8×10^{-4}	0.038	6.7	2.5×10^{-4}
Octachloro	2.8×10^{-5}	5.5×10^{-4}	7.5	1.5×10^{-5}
Decachloro	1.4×10^{-6}	7.6×10^{-4}	8.3	8.5×10^{-7}

Data from Ref (3).

Even commercial mixtures with primarily highly chlorinated congeners contain lower chlorinated congeners at low concentrations. Figure 2 shows the congener pattern of Aroclor 1260 (60% chlorine by weight) and that of PCBs in the vapor phase, resulting from blowing air over the commercial mixture. Clearly, even this highly chlorinated mixture contains lower chlorinated PCBs that volatize. There is also some volatilization of moderately chlorinated congeners, but the overall profile in the vapor phase shifts markedly to the left, indicating that lower chlorinated congeners are more volatile.

PCBs can volatilize from a variety of sources, including commercial mixtures, water, landfills, and commercial products. As lower chlorinated PCBs are more water soluble and more volatile (Table 1) they will selectively dissolve in water and then move from a soluble aqueous phase into the air. PCBs evaporate along with the water (4, 5), and this process is very temperature dependent (6). Volatile loss of PCBs from Lake Superior was calculated to be about 1900 kg per year (7). Outdoor air concentrations of PCBs near New Bedford Harbor, a highly contaminated body of water, ranged from 0.4 to 53 ng/m³ (8); these are significantly higher than those at a comparison site. PCB fluxes to air along the contaminated Hudson River ranged from 0.5 to 13 µg/m²/day (9).

The greater water solubility of lower chlorinated PCBs has implications for drinking water quality. The majority of the higher chlorinated congeners will be bound to particulates in water and then removed by standard drinking water treatments. However, those that are dissolved are more difficult to remove and may be an important route of human exposure, especially if contaminated surface water is used for municipal drinking water.

PCBs will also volatilize from contaminated soils and sediments. As from water, the PCBs volatize with water, and dry sediments lose fewer PCBs to the air as compared with wet sediments or soils (4). PCBs can also volatilize from landfills, depending upon how tightly they are covered (10). Hermanson et al. (11) studied air PCB concentrations near a Monsanto landfill in Anniston, Alabama, the site of a PCB synthesis factory, and compared results to those from a nearby site that had superficial soil PCB contamination. They found less dependence on surface temperature for PCB release to air from the landfill, and suggested that most of the sources of PCBs from the landfill site were materials buried within the landfill.

In addition to the differences in physical properties, congeners have both differences in rates of metabolism in the human body and major differences in mechanisms of action and health effects in humans. PCBs, like most chlorinated compounds, are poorly metabolized and are thus persistent. In general the half-life increases with number of chlorines but other factors like location of the chlorines around the ring also influence rates of metabolism. The half-lives in humans of several individual PCB congeners are shown in Table 2 (12). *Ortho* chlorine substitution usually increases the half-life relative to that of a PCB with the same number of chlorines but with none in the *ortho* position (13).

Many of the volatile mono-, di-, and tri-chloro congeners are metabolized within hours in rats (14). Hu et al. (15) found that labeled PCB 11 (3,3′-dichloro biphenyl) had a half-life of 12 h in male rats. Although human metabolism is generally not as rapid as in rodents, it is sufficiently rapid such that lower chlorinated congeners are rarely found at significant concentrations in human blood. Long half-life makes it convenient to determine the exposure of a person to PCBs in the past, but there is often the assumption that long half-life is indicative of greater health effect. This assumption is not necessary correct. This is because even those congeners that are more rapidly metabolized may have significant toxicity, especially if there is prolonged exposure, as would be the case if they were inhaled on a daily basis.

The major metabolism of PCBs is through cytochrome P450s in the liver and other organs (13). This results in

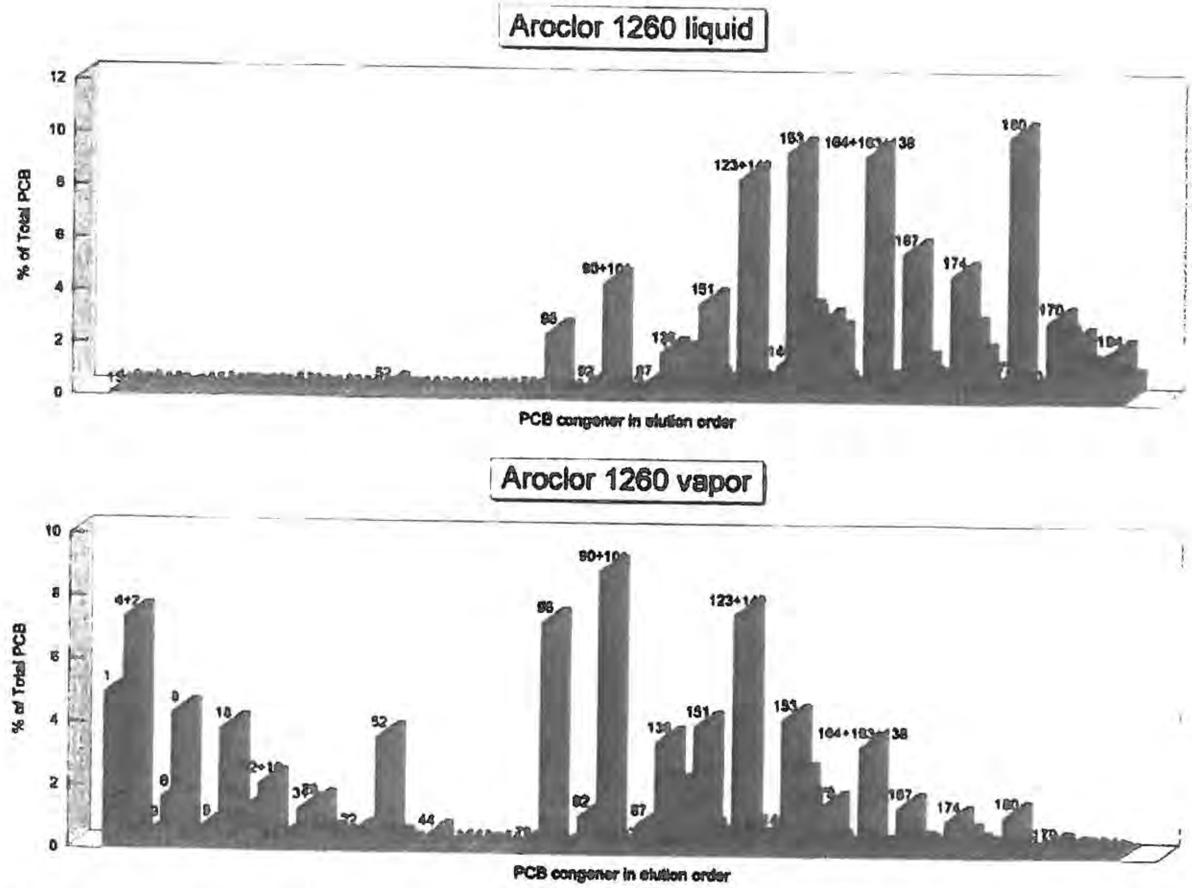

Figure 2: The congener patterns in Aroclor 1260 liquid (top) and the congener pattern seen when passing air over the liquid and collecting and analyzing the vapor-phase PCBs.
Peaks are shown in the order they elute from the column. The numbers above the peaks identify individual congeners or groups of congeners. Those peaks to the left have fewer chlorines.

Table 2: Half-lives of single PCB congeners in the human adult body.

PCB number	PCB structure	Half-life, years
28	2,4,4′ Trichlorobiphenyl	5.5
52	2,2′,5,5′ Tetrachlorobiphenyl	2.6
105	2,3,3′4,4′ Pentachlorobiphenyl	5.2
118	2,3′4,4′,5 Pentachlorobiphenyl	9.3
138	2,2′,3,4,4′,5′ Hexahlorobiphenyl	10.8
153	2,2′,4,4′,5,5′ Hexachlorobiphenyl	14.4
170	2,2′,3,3′,4,4′,5 Heptachlororbiphenyl	15.5
180	2,2′,3,4,4′,5,5′ Heptachlorobiphenyl	11.5

Data from Ref (4).

introduction of oxygen onto the molecule, which then allows for further metabolism by other transferases. Many of the hydroxylated or methyl sulfonated metabolites are somewhat persistent and have biologic activity (16). The position of the chlorines around the PCB molecule influences the rate of metabolism (17). This is why different PCB congeners with the same number of chlorines have different half-lives, as shown in Table 2. In addition, different congeners are targets of different P450s. Many studies have focused on PCB congeners that have dioxin-like activity as well as those that bind to the aryl hydrocarbon receptor, induce P4501A and then induce many different genes (18). Other congeners induce different P450s and many genes, but with a different pattern (19). To make matters even more complex, the profile of genes that are induced may vary from one tissue to another (20). Many of the adverse health effects reported in humans are likely a consequence of different patterns of gene induction.

Despite the more rapid metabolism of lower chlorinated PCBs, evidence for inhalation exposure can be obtained from serum samples. Our group has studied PCB exposure in a Native American population for many years. Many older adults have a pattern of congeners dominated by a few highly chlorinated and persistent congeners like PCBs 138, 153, 170, and 180. However, we have been able to identify a pattern of lower chlorinated PCBs in the serum of younger Mohawks, which matched closely to the pattern of the PCB profile in air over a contaminated site (21) Figure 3. The pattern could not be observed clearly in older individuals because serum levels increase with age and the PCBs from ingestion obscure those more readily metabolized PCBs.

Herrick et al. (22) measured serum PCB levels in teachers working in a school that had elevated PCBs in indoor air, and found significantly higher concentrations of lower

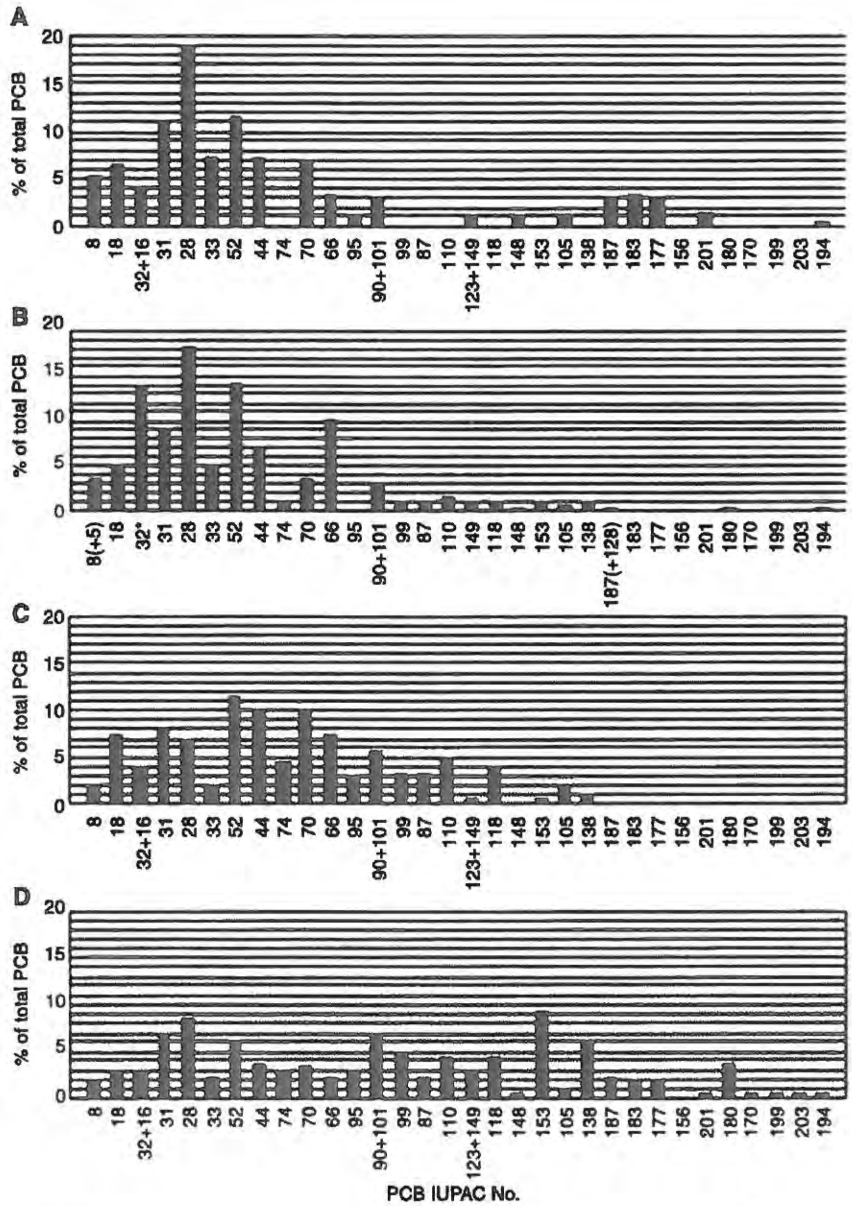

Figure 3: Congener compositions of (A) End-member (EM)-1 as determined by polytopic vector analysis (PVA) of serum PCB congener data for 702 adult Mohawks, (B) air sampled above "Contaminant Cove" at the western boundary of Akwesasne in summer 1993,[17] (C) native commercial A1248 liquid, and (D) serum from the subject with the highest proportion (46.2%) of EM-1. For profiles not generated in the authors' laboratory (i.e., B), the same congener elution order as that in the other samples is presented to facilitate comparisons. Differences in congener coelutions between samples are indicated by brackets; congeners analyzed in the authors' laboratory but not by others are shown in italics. For brevity, CB 138 is listed alone although it coelutes with CBs 163 and 164 for all samples. In addition, CB 32 coelutes with CBs 11, 12, and 13 for the sample shown in (B). *Reprinted from DeCaprio et al.[21] with permission from Elsevier B.V.*

chlorinated congeners (PCBs 6–74) than those found in unexposed teachers. Meyer et al. (23) obtained serum PCB measurements from 134 residents of a flat with high concentrations of PCBs in the indoor air, and compared levels to those of 139 unexposed persons. Levels of 27 congeners, especially lower chlorinated congeners, were found to be four times higher in the serum of the exposed individuals.

The goal of this paper is to review the evidence that the inhalation of PCBs can lead to adverse health effects in humans. The paper will focus on a few specific diseases for which evidence exists to support the conclusion that inhalation is an important route of exposure. The problem is that most scientists who are investigating health effects of PCBs use serum PCB concentration as their exposure assessment measure. Given that most of the more volatile congeners are rapidly metabolized, they are not present in high concentrations in serum samples and, thus, they are usually not considered. However, the typical source of inhaled PCBs is indoor air in homes, schools and offices, places where people spend many hours a day. Under these circumstances, people may be more or less continuously exposed and affected by the lower chlorinated congeners.

Cancer

PCBs have been identified as Group 1, known human carcinogens, by the International Agency for Research on Cancer (24). The specific cancer with the strongest evidence is malignant melanoma. There are, however, many of types of cancer for which strong associations with serum PCB levels have been found (25). However, there is little direct evidence for cancer in humans resulting from inhalation exposure to PCBs.

Until the recent IARC identification of all PCBs being carcinogenic, there was a widespread belief that only dioxin-like PCBs had carcinogenic activity. This is despite clear evidence presented by van der Plas et al. (26). They reported that majority (about 80%) of the tumor-promoting activity of PCBs can be found the in 2–4 *ortho*-substituted congener groups, which have little or no dioxin-like activity. Sandal et al. (27) compared the genotoxic activities of PCB 52 (2,2′,5,5′tetrachloro biphenyl, a non-dioxin-like congener) and PCB 77 (3,3′,4,4′ tetrachlorobiphenyl, a dioxin-like congener) on cultured human lymphocytes. They found that both congeners caused DNA damage as monitored by the comet assay, but that PCB 52 is significantly more potent. Both PCB 9 (2,5 dichlorobiphenyl) (28) and PCB 11 (29) generate reactive oxygen species, known to be a risk factor for cell damage and death. Ludewig et al. (30) found that PCB 3 (4-monochlorobiphenyl) and/or its metabolites increase mutations in rat liver. Tan et al. (31) found that PCBs 8 (2,4 dichlorobiphenyl), 28, 47 (2,2′4,4′-tetrachlorobiphenyl), and 52 are cytotoxic to both neurons and thymocytes, but the dioxin-like congeners PCBs 77, 80 (3,3′,5,5′-tetrachlorobiphenyl) and 81 (3,4,4′,5-tetrachlorobiphenyl) are not. Although not all of these effects are necessarily directly related to cancer, they clearly demonstrate toxicity of lower chlorinated, non-dioxin-like congeners.

Case study

Company X was an analytic services laboratory that provided analysis of fluids from electric transformers. Up until 1977, when their manufacture and new use was outlawed by the US Environmental Protection Agency (EPA) due to their persistence and toxicity, most electric transformers were filled with commercial mixtures of PCBs. However, old transformers that have not been serviced still contain PCBs. Now EPA requires that the fluid from transformers being serviced or discarded be tested to determine whether PCBs are present; if they are, then the EPA requires that the fluid be removed and the transformer cleaned and filled with a non-toxic substitute. All PCB-containing fluids at concentrations <50 ppm are to be treated as hazardous waste, and rules have been established to regulate disposal of oils containing PCBs at concentrations between 2 and 50 ppm.

JM, a relatively dark-skinned Hispanic, was employed by company X between 1994 and 2003 as a laboratory technician. His job was to analyze 100–150 transformer oil samples per day to determine whether they contained PCBs. It was known that 10%–20% of those samples would have PCBs at concentrations ranging from 50 to 499 ppm, and another 10% would have even higher concentrations, some being 100% commercial PCBs. JM was told to smell the fluid to determine whether or not it contained high concentrations of PCBs. PCBs have a subtle but distinctive odor. The reason for smelling the fluids before analyzing them was that running a sample with a high PCB concentration in the gas chromatograph would result in contamination that would then take time to wash out. Thus, if samples with high concentrations could be identified before being run, they could be serially diluted to the point that they would not require extra time to be taken to wash out the gas chromatograph.

JM was born in 1967 and did not smoke nor drink to excess. His medical history was unremarkable except for hypertension, and elevated LDL with a slightly low HDL. On December 14, 2001 he was found to have a greatly reduced thyroid stimulating hormone (TSH) level, and highly elevated thyroxine (T4) level. On February 28, 2003 he was treated with radioactive ^{131}I, which resulted in a decrease in his TSH level. On March 3, 2003 a large papillary thyroid carcinoma was removed in a subtotal thyroidectomy. The tumor surrounded the vagus nerve and it was difficult to remove. On August 26, 2003 he was found to still have an abnormally elevated uptake of ^{131}I, which was suggestive of recurrent disease. Although he continued to work at company X after his surgery, he was no longer required to analyze for PCBs. In March, 2011 JM had a malignant melanoma removed from his back. In March, 2013 JM was diagnosed with lung cancer, which on biopsy, proved to be a poorly differentiated adenocarcinoma, not a metastasis from the melanoma. JM died later in 2013 with massive hemorrhagic brain metastases.

GM, wife of JM, was born in 1968 and hired by company X in 1996. Her job was to dump oils that were in the GC sampling vials that had been analyzed into 55 gallon drums, separating those with and without high concentrations of PCBs, and ensure that any liquids containing PCBs were not allowed down the drain. She also was required to wash the glassware. She worked in a 50 sq ft room with a hood and waste basin but without windows or air conditioning, and was told to keep the door closed. When the oils were to be dumped, she was told to sniff each sample in order to determine which 55 gallon drum the material should be placed in. If it smelled like PCBs, it would go into one drum, but if not then it should go into the other. The glassware contaminated with PCBs was to be washed with toluene and acetone, followed by soap and water. She was never provided with a lab coat, gloves, or a mask.

GM was also diagnosed with thyroid cancer in May of 2003, after which she stopped working at company X. She had a total thyroidectomy in July, 2003. She completed a course of 100 mC ^{131}I on September, 2003. She had some abnormal uptake of the isotope on August 26, 2003, but there was no evidence of recurrent disease by March, 2004. In 2011, she was diagnosed with a compound melanocytic dysplastic nevus, a highly dangerous mole that is a precursor to melanoma. This was removed. She also had abnormal liver function tests, perhaps a fatty liver, diabetes, and hypertension. She does not drink and does not have hepatitis.

Serum samples were obtained in the late summer and fall of 2005 for measurement of PCBs, and analysis was done by ERGO Forschungsgesellschaft mbH in Hamburg, Germany. The results for six PCB congeners are shown in Table 3.

Table 3: PCB concentrations (μg/kg or ppb wet weight) in serum samples from JM and GM.

PCB congener	JM	GM
28	1.82	3.47
52	1.22	1.60
101	nd	0.33
138	nd	0.22
153	0.17	0.23
180	0.16	0.44
Sum	3.37	6.28

nd, not detected.

There are several remarkable findings in this tragic story. For two persons who are not blood relatives to both develop two relatively rare cancers of the same type (thyroid and melanoma) by chance is extraordinarily unlikely. Malignant melanoma is the cancer for which there is the strongest evidence for causation by PCBs. This is reflected in the recent report from the International Agency for Research on Cancer, which declared PCBs to be Group 1, known human carcinogen, based primarily of occupational studies (24). Although the route of occupational exposure is uncertain in these reports, inhalation is certainly a major component.

Thyroid cancer has been reported in rats exposed to commercial PCB mixtures (32, 33). An elevation in lung cancer has been reported in one occupational cohort after control for other factors (34). Animal studies have shown that exposure of mice to Kanechlor-400 (a Japanese PCB product) resulted in various kinds of lung neoplasms (35). JM was a non-smoker living in an area where radon is not a major problem, and it is likely that his lung cancer was also a consequence of inhaling PCBs.

The pattern of PCB congeners found in the serum sample is striking. In the general population, PCB 153, 138, and 180 are found at much higher concentrations than PCBs 28 and 52. However because PCBs 28 and 52 have fewer chlorines, are much more volatile. In the 2003–04 NHANES, mean concentrations of PCB 28 in adults over 20 was 0.031 and the 95th percentile was 0.067 ppb. For PCB 52, the mean concentration was 0.016 and the 95th percentile was 0.043 ppb. Hence, the concentrations of both congeners are two orders of magnitude higher in both JM and GM. For PCB 153, the levels in both JM and GM are within the background concentrations found among the individuals in the 2003–2004 NHANES (mean, 0.148 ppb, 95th percentile, 0.671 ppb). This pattern of PCBs in serum alone is convincing evidence that the major route of exposure for both JM and GM was inhalation of volatile PCBs.

There is other evidence consistent with the conclusion that lower chlorinated, more volatile PCBs are carcinogenic. Although those congeners with fewer chlorines are more rapidly metabolized, they generate hydroxylated and other metabolic progeny that exhibit genotoxicity (36) and oxidative stress (29). Maddox et al. (37) demonstrated a non-significant two-fold increase in spontaneous mutations induced by PCB 3 (4 monochloro biphenyl) and 4-OH-PCB 3 in rat lung. Xie et al. (38) showed that PCB 3 is converted to quinones which are very efficient in inducing gene mutations and chromosomal breaks.

Studies using hospitalization diagnoses to assess diseases from inhalation of PCBs

My colleagues and I have performed a series of studies using New York State (NYS) hospitalization data to examine residences near hazardous waste sites containing identified chemicals, particularly PCBs. In NYS, the diseases diagnosed in every patient admitted as an inpatient to a state-regulated hospital (all except federal hospitals like Veterans' Administration and Indian Health Services) must be reported to the Department of Health upon discharge. The data available to us include sex, age, race, method of payment and zip code of residence, as well as up to 15 different disease diagnoses. The data are limited in that we do not know names or street addresses, and do not have any information about personal habits. We do have access to behavioral characteristics by county from the Behavioral Risk Factor Surveillance System (BRFSS), and we have information on median household income and population density by zip code from the US Census. We have matched rates of hospitalization for specific diseases to residence in zip codes that either contain or do not contain a hazardous waste site. The Department of Environmental Conservation lists 814 such sites in NYS and identifies those containing PCBs. Our hypothesis behind these studies is that living near a PCB-contaminated site increases exposure, and that such exposure must be primarily by inhalation. There is no reason to assume that dietary exposure would be different depending upon where you live, and it is unlikely that most people are going to have significant dermal exposure.

There are some important limitations in ecologic studies of this sort, particularly with regards socioeconomic status (SES). Poverty is well known to be an important risk for disease, but we adjust for this the best we can using the BRFSS, which provides some information on personal habits in the locale and census data, from which we can obtain median household income in the zip code. The exposure assessment is also very limited, being only the zip code of residence. We cannot distinguish multiple hospitalizations by one person from those of different individuals. However, despite these limitations, there are some other major strengths. For example, there are 2.5 million hospitalizations each year in NYS, and we have data from 1993 through 2008. We have used results of these studies to generate hypotheses, which we then tested in smaller populations wherein we have better exposure assessment.

Cardiovascular disease

Sergeev and Carpenter (39) examined rates of hospitalization for coronary heart disease and myocardial infarction in NYS residents living in a zip code wherein a PCB hazardous waste site was located, and compared these rates with those living in a zip code without any hazardous waste site after adjustment for age, sex, race, income, and health insurance coverage. They found an odds ratio (OR) of 1.15 (95% confidence interval=1.03–1.29) for coronary heart disease and an OR of 1.20 (1.03–1.39) for myocardial infarction. They then examined a sub-set of the PCB zip codes, that being those along the 200 miles of the contaminated Hudson River. Average income is higher in these zip codes, and BRFSS data show more exercise, less smoking, and greater consumption of fruits and vegetables in these counties than in the rest of NYS. Despite living a healthier life style, the ORs for coronary heart disease and myocardial infarction in these zip codes were 1.36 (1.19–1.56) and OR=1.39 (1.19–1.63), respectively. Thus, living in a zip code containing a PCB hazardous waste site (either a landfill or a contaminated body of water) is associated with an increased risk of coronary heart disease and myocardial infarction, and this is unlikely due to inadequate adjustment for socio-economic status because the elevations in ORs are even higher along the Hudson.

Strokes ('brain attacks') are closely related to myocardial infarctions ('heart attacks'). Shcherbatykh et al. (40) used the same hospitalization records for stroke. They found significant elevations for ischemic stroke for individuals living in PCB-contaminated zip code (OR=1.17, 1.04–1.39) and a slightly greater elevation for individuals living along the Hudson River (OR=1.20, 1.10–1.32) as compared with zip codes without any hazardous waste site.

The above ecologic studies support the hypothesis that exposure to PCBs increases the risk of cardiovascular disease. In order to test this hypothesis, we performed studies in two PCB-exposed populations where we have measured serum PCB concentrations. We suspect that the route of exposure for those individuals living near PCB hazardous waste sites is inhalation of lower chlorine congeners which are not very persistent. Hence, it is not clear whether the associations seen with measurement of total serum PCBs will give exactly the same results.

Goncharov et al. (41) determined self-reported rates of cardiovascular disease among the Mohawks at Akwesasne, a Native American group living at the US-Canadian border, in relation to measured serum PCBs and serum lipids. They found significantly elevated risk of self-reported cardiovascular disease, but found this to be an indirect effect via an elevation in serum cholesterol and triglycerides. Aminov et al. (42) investigated these same relationships in 575 residents of Anniston, Alabama who live near the Monsanto plant that manufactured PCBs. They also found that increased total serum PCB concentrations was significantly associated with elevated concentrations of total cholesterol and triglycerides, but found no effect on HDL or LDL cholesterol. Thus, there is a clear association between elevation in serum lipids, a major risk factor for cardiovascular disease, and more highly chlorinated PCBs, whereas the ecologic results support the conclusion that the lower chlorinated congeners are also important. At present, the relative importance of lower and higher chlorinated congeners on cardiovascular disease remains to be fully determined. Hennig et al. (43) have demonstrated pro-inflammatory changes induced by PCBs on endothelial cells, which may combine with elevations in serum lipids to increase the risk of cardiovascular disease. Ha et al. (44) have reported that there is a dose-dependent relationship between serum PCB concentrations and cardiovascular disease using data from the National Health and Nutrition Examination Survey (NHANES).

Hypertension

Hypertension is not usually considered to be an environmental disease. However, using the hospitalization data set, Huang et al. (45) reported a significantly elevated OR=1.19 (1.09–1.31) for hospitalization diagnosis of hypertension among individuals living in a zip code with a PCB hazardous waste site. They also found elevated hospitalization for hypertension (OR=1.14; 1.05–1.23) for residents living along the Hudson River.

We have determined the associations between serum PCB levels and blood pressure in 351 residents of Anniston who were not on anti-hypertensive medication. Three measurements of blood pressure were taken in individuals where serum PCBs levels had been measured. We found striking associations between rates of hypertension and serum PCB concentrations (46). After adjustment was age, sex, BMI, serum lipids, smoking and exercise the OR for lowest to highest tertile of PCB concentration was 4.09 (1.3–12.7) for clinical hypertension and 5.28 (1.0–25.8) for both systolic and diastolic hypertension. Even within the normotensive range of blood pressure, there were significant associations with total PCB concentration (47). Serum PCB concentration showed a stronger association than any other factor but age, including BMI, total lipids, sex, race, smoking, and exercise. Associations between serum PCBs and hypertension have also been reported using NHANES data (48, 49).

Diabetes

Kouznetsova et al. (50) analyzed NYS hospitalization data for adult inpatient admissions for diabetes in relation to residence in a zip code containing a PCB-contaminated waste site. Living in a PCB-contaminated zip code was associated with a 23% elevated chance of hospitalization for diabetes as compared with rates for individuals living in a zip code that did not contain a hazardous waste site (OR=1.23; 1.15–1.32), after adjustment for age, race, sex, median household income, and urban/rural residence. Living along the Hudson River was associated with an even greater elevation (OR=1.36; 1.25–1.42). As with the above diseases, the most likely exposure must have come from inhalation.

We have examined rates of physician-diagnosed diabetes in relation to serum PCB concentrations in the Mohawk population at Akwesasne. In a preliminary study, Codru et al. (51) reported that after adjustment for sex, age, BMI and smoking, individuals in the top tertile PCB concentration had a significant 3.9-fold elevated risk of diabetes (95% CI=1.5–10.6). Only two individual congeners were reported, PCBs 74 (2,4,4',5-tetrachlorobiphenyl) and 153. When adjusted for all other contaminants in addition to the factors listed above, only PCB 74 showed a significant association. We have followed-up on this study (52) with a more complete single congener analysis and with adjustment for all other contaminants but the one under investigation. These results indicate that the only significant association with diabetes is with non- or mono-*ortho* PCB congeners that do not have dioxin-like activity. This is an important observation because these are the lower-chlorinated, volatile congeners. This provides strong support for the hypothesis developed from the hospitalization studies (50), which concluded that the association between diabetes and living near a PCB-contaminated site is secondary to inhalation of lower chlorinated PCBs.

Discussion and conclusions

These results are consistent with the conclusion that inhalation of PCBs is not only an important route of exposure, but that it can also result in serious disease. PCB exposure is well documented to increase the risk of the diseases reviewed here, namely, cancer, cardiovascular disease, hypertension and diabetes, based on documentation that incidence of these diseases increased with serum concentrations of PCBs. However, the majority of the PCBs found in serum are the more persistent congeners, often with half-lives of a decade or more. These are the congeners found in the higher chlorinated commercial mixtures, and are the ones commonly found in animal fats, which is an important route of exposure to humans. From the point of view of research, the persistence of these higher chlorinated congeners is helpful for establishing associations because a blood sample will provide information about PCB exposure after many years have passed.

This review has focused on only four diseases, chosen because of at least some evidence for elevated risk coming from inhalation exposure. However, these are certainly not the only diseases for which exposure to PCBs is known to increase risk. PCBs are known to cause deficits in learning and memory (53, 54), and there is evidence from animal studies indicating that lowered chlorinated congeners are more neurotoxic than more highly chlorinated congeners (55). Fitzgerald et al. (56) reported decrements of verbal learning and an increase in depressive symptoms in adults living near the contaminated Hudson River, but serum concentrations are not significantly different from those in a comparison population (57). This finding is consistent with inhalation of lower chlorinated, more rapidly metabolized PCBs as the critical factor. PCBs are structurally somewhat similar to T4, and exposure has been shown to suppress thyroid function (58). PCBs also alter sex hormone function, with many congeners and hydroxylated metabolites having estrogenic activity (59). Elevated PCB exposure results in earlier puberty in girls (60) and a reduction in testosterone levels in men and boys (61, 62). PCBs suppress the immune system, leading to increased respiratory infections in children (63, 64) and elevations in cases of asthma (64, 65). PCB exposure to mothers is associated with lower birth weight of infants (66, 67). The relative role of inhalation of lower chlorinated PCBs, to date, has not been studied with regards these diseases and effects.

The PCB congeners that volatilize easily are less highly chlorinated, and most of them are much more rapidly metabolized in the human body. Some, like PCBs 28 and 52, are somewhat more persistent than others, and are frequently found at low concentrations in human serum, although the majority of those congeners with four of fewer chlorines are often not present at detectable concentrations. However, just because they are more rapidly metabolized and do not accumulate does not mean that they do not have adverse health effects. This is particularly the case if the concentrations of these lower chlorinated congeners in air are significant in places where people spend long periods of time (e.g., at home, school, or work). Under these circumstances exposure can be almost continuous, but would not be reflected in high levels of PCBs. Although the specific mechanisms whereby serum PCBs cause neurotoxicity are still uncertain, animal studies have shown that PCB, like lead, are effective in reducing long-term potentiation, an electrophysiologic marker of learning and memory (68).

The most extreme demonstration of the hazards of inhalation of PCBs is the cases of JM and GM, workers occupationally instructed to inhale PCB vapors. Both developed multiple cancers of the same type, and JM died of cancer. Their serum contained elevated concentrations of the lower chlorinated, more volatile PCBs, and only background concentrations of more highly chlorinated congeners that are less volatile.

The ecologic studies showing elevations of cardiovascular disease, hypertension, and diabetes in relation to residences near PCB-contaminated waste sites strongly suggest that inhalation is the route of exposure. However, there are significant limitations to ecologic studies, and they must be viewed as being hypothesis generating. Therefore, we have performed other investigations in defined populations where we have good exposure assessment (albeit with the limitations discussed above for lower chlorinated congeners), as well as access to medical and clinical chemistry information. These studies confirm the hypothesis that PCB exposure is associated with elevated risks of all three diseases. Thus, these studies provide support for the conclusion that inhalation of PCBs is the major cause of the elevated rates of hospitalization.

The implications of these studies are significant for several reasons. First, these results suggest that living near a PCB-contaminated waste site poses risk to health, and by extrapolation this applies also to attending a school with elevated PCBs in the air due to PCB-containing light ballasts or caulk (69–73), working in a contaminated building

(74, 75), working as a fireman around certain house fires (76), and living downwind of sewage sludge drying plants (77). Lower chlorinated PCBs are found in current retail paints, and would be expected to volatilize into room air (78). Urban areas are likely to have more hot spots with higher concentrations than in rural areas, as has been demonstrated in Chicago and Cleveland (79). Thus, many people are being unknowingly exposed to these sources via inhalation. Scientists from the USEPA have recently published a report calling for greater evaluation of health risks from inhaled PCBs (80).

PCBs are dangerous chemicals, but the danger is not restricted to dioxin-like congeners or persistent congeners. These findings reinforce the conclusion that it is imperative to find ways of removing these contaminants from the environment. Furthermore, it is important that risk assessment methodologies no longer rely only on measurement of serum PCB levels and their associations with various diseases, but rather consider air concentrations and the evidence that even low concentrations of PCBs in air constitute an important route of exposure and disease, especially if the exposure is prolonged.

References

1. Hansen LG. The ortho side of PCBs: occurrence and disposition. Boston, MA: Kluwer Academic Publishers, 1999.
2. Carpenter DO, Welfinger-Smith G. The Hudson River: a case study of PCB contamination. In: Selendy JM, editor. Water and sanitation-related diseases and the environment: challenges, interventions and preventive measures. Hoboken, NJ: Wiley-Blackwell, 2011:303–27.
3. Erickson MD. Introduction: PCB properties, uses, occurrence, and regulatory history. In: Robertson LW, Hansen LG, editors. PCBs: recent advances in environmental toxicology and health effects. Lexington, Kentucky: The University Press of Kentucky, 2001:xi–xxx.
4. Chiarenzelli J, Scrudato R, Arnold G, Wunderlich M, Rafferty D. Volatilization of polychlorinated biphenyls from sediment during drying at ambient conditions. Chemosphere 1996;33:899–911.
5. Chiarenzelli J, Scrudato RJ, Wunderlich ML. Volatile loss of PCB aroclors from subaqueous sand. Environ Sci Technol 1997;31:597–602.
6. Chiarenzelli J, Bush B, Casey A, Barnard E, Smith B, et al. Defining the sources of airborne polychlorinated biphenyls: evidence for the influence of microbially dechlorinated congeners from river sediment? Can J Fish Aquat Sci 2000;57:86–94.
7. Jeremiason JD, Hornbuckle KC, Eisenreich SJ. PCBs in Lake Superior, 1978–1992: decreases in water concentrations reflect loss by volatilization. Environ Sci Technol 1994;28:903–14.
8. Vorhees DJ, Cullen AC, Altshul LM. Exposure to polychlorinated biphenyls in residential indoor air and outdoor air near a superfund site. Environ Sci Technol 1997;31:3612–8.
9. Sandy AL, Guo J, Miskewitz RJ, McGillis WR, Rodenburg LA. Fluxes of polychlorinated biphenyls volatilizing from the Hudson River, New York measured using micrometeorological approaches. Environ Sci Technol 2012;46:885–91.
10. Bremle G, Larsson P. PCB in the air during landfilling of a contaminated lake sediment. Atmos Environ 1998;32:1011–9.
11. Hermanson MH, Scholten CA, Compher K. Variable air temperature response of gas-phase atmospheric polychlorinated biphenyls near a former manufacturing facility. Environ Sci Technol 2003;37:4038–42.
12. Ritter R, Scheringer M, MacLeod M, Moeckel C, Jones KC, et al. Intrinsic human elimination half-lives of polychlorinated biphenyls derived from the temporal evolution of cross-sectional biomonitoring data from the United Kingdom. Environ Health Perspect 2011;119:225–31.
13. James MO. Polychlorinated biphenyls: metabolism and metabolites. In: Robertson LW, Hansen LG, editors. PCBs: recent advances in environmental toxicology and health effects. Lexington, KY: The University Press of Kentucky, 2001:35–46.
14. Hu X, Adamcakova-Dodd A, Lehmler H-J, Hu D, Kania-Korwell I, et al. Time course of congener uptake and elimination in rats after short-term inhalation exposure to an airborne polychlorinated biphenyl (PCB) mixture. Environ Sci Technol 2010;44:6893–900.
15. Hu X, Adamcakova-Dodd A, Thorne PS. The fate of inhaled ^{14}C-labeled PCB11 and its metabolites in vivo. Environ Int 2004;63:92–100.
16. Letcher RJ, Klasson-Wehler E, Bergman Å. Methyl sulfone and hydroxylated metabolites of polychlorinated biphenyls. In: Paasivirta J, editor. The handbook of environmental chemistry Vol. 3 PartK. Berlin Heidelberg: Springer Verlag, 2000.
17. Matthews HB, Tuey DB. The effect of chlorine position on the distribution and excretion of four hexachlorobiphenyl isomers. Toxicol Appl Pharmacol 1980;53:377–88.
18. Johnson CD, Balagurunatham Y, Tadesse MG, Falahatpisheh MH, Brun M, et al. Unraveling gene-gene interactions regulated by ligands of the aryl hydrocarbon receptor. Environ Health Perspect 2004;112:403–12.
19. Vezina CM, Walker NJ, Olson JR. Subchronic exposure to TCDD, PeCDF, PCB126, and PCB153: effect on hepatic gene expression. Environ Health Perspect 2004;112:1636–44.
20. Maier MSV, Legare ME, Hanneman WH. The aryl hydrocarbon receptor agonist 3,3',4,4',5-pentachlorobiphenyl induces distinct patterns of gene expression between hepatoma and glioma cells: chromatin remodeling as a mechanism for selective effects. NeuroToxicology 2007;28:594–612.
21. DeCaprio AP, Johnson GW, Tarbell AM, Carpenter DO, Chiarenzelli JR, et al. Polychlorinated biphenyls (PCB) ecposure assessment by multivariate statistical analysis of serum congener profiles in an adult Native American population. Environ Res 2005;98:284–302.
22. Herrick RF, Meeker JD, Altshul L. Serum PCB and congener profiles among teachers in PCB-containing schools: a pilot study. BMC Environ Health 2011;10: 56. Available at: http://www.ehjournal.net/content/10/1/56.
23. Meyer HW, Frederiksen M, Göen T, Ebbehøj NE, Gunnarsen L, et al. Plasma polychlorinated biphenyls in residents of 91 PCB-contaminated and 108 non-contaminated dwellings – an exposure study. Int J Hyg Environ Health 2013;216:755–62.
24. Lauby-Sectretan B, Loomis D, Grosse Y, Grosse Y, El Ghissassi F, et al. Carcinogenicity of polychlorinated biphenyls and polybrominated biphenyls. Lancet Oncol 2013;14:287. doi: 10.1016/S1470-2045(13)70104-9.

25. Carpenter DO. Polychlorinated biphenyls (PCBs): routes of exposure and effects on human health. Rev Environ Health 2006;21:1–24.
26. van der Plas SA, Sundberg H, van den Berg H, Scheu G, Wester P, et al. Contribution of planar (0-1 ortho) and nonplanar (2-4 ortho) fractions of aroclor 1260 to the induction of altered hepatic foci in female Sprague-Dawley rats. Toxicol Appl Pharmacol 2000;169:255–68.
27. Sandal S, Yilmaz B, Carpenter DO. Genotoxic effects of PCB 52 and PCB 77 on cultured human peripheral lymphocytes. Mutation Res 2008;654:88–92.
28. Yilmaz B, Sandal S, Carpenter DO. PCB 9 exposure induces endothelial cell death while increasing intracellular calcium and ROS levels. Environ Toxicol 2010;27:185–91.
29. Zhu Y, Mapuskar KA, Marek RF, Xu W, Lehmler HJ, et al. A new player in environmentally induces oxidative stress: polychlorinated biphenyl congener, 3,3'-dichlorobiphenyl (PCB11). Toxicol Sci 2013;136:39–50.
30. Ludewig G, Lehmann L, Esch H, Robertson LW. Metabolic activation of PCBs to carcinogens in vivo – a review. Environ Toxicol Pharmacol 2008;25:241–6.
31. Tan Y, Chen C-H, Lawrence D, Carpenter DO. Ortho-substituted PCBs kill cells by altering membrane structure. Toxicol Sci 2004;80:54–9.
32. Mayes BA, McConnell EE, Neal BH, Brunner MJ, Hamilton SB, et al. Comparative carcinogenicity in Sprague-Dawley rats of the polychlorinated biphenyl mixtures Aroclors 1016, 1242, 1254, and 1260. Toxicol Sci 1998;41:62–76.
33. Vansell NR, Muppidi JR, Habeebu SM, Klaassen CD. Promotion of thyroid tumors in rats by pregnenolone-16α-carbonitrile (PCN) and polychlorinated biphenyl (PCB). Toxicol Sci 2004;81:50–9.
34. Greenland S, Salvan A, Wegman DH, Hallock MF, Smith TJ. A case-control study of cancer mortality at a transformer-assembly facility. Int Arch Occup Environ Health 1994;66:49–54.
35. Nakanishi Y, Bai F, Takayama K, Pei XH, Inoue K, et al. Effect of PCBs on mouse lung tumorigenesis induced by 1-nitorpyrene: a preliminary report. Fukuoka igaku zasshi=Kukuoka acta medica 1999;90:231–7.
36. Robertson LW, Ludewig G. Polychlorinated biphenyl (PCB) carcinogenicity with special emphasis on airborne PCBs. Gefahrst Reinhalt Luft 2011;71:25–32.
37. Maddox C, Wang B, Kirby PA, Wang K, Ludewig G. Mutagenicity of 3-methylcholantrene, PCB3, and 4-OH-PCB3 in the lung of transgenic BigBlue® rats. Environ Toxicol Pharmacol 2008;25:260–6.
38. Xie W, Wang K, Robertson LW, Ludewig G. Investigation of mechanism(s) of DNA damage induced by 4-monochlorobiphenyl (PCB3) metabolites. Environ Int 2010;36:950–61.
39. Sergeev AV, Carpenter DO. Hospitalization rates for coronary heart disease in relation to residence near areas contaminated with persistent organic pollutants and other pollutants. Environ Health Perspect 2005;113:756–61.
40. Shcherbatykh I, Huang X, Lessner L, Carpenter DO. Hazardous waste sites and stroke in New York State. BMC Environ Health 2005;4:18. Available at: http://www.jstor.org/stable/4133069.
41. Goncharov A, Haase RF, Santiago-Rivera A, Morse G; Akwesasne Task Force on the Environment, McCaffrey RJ, et al. High serum PCBs are associated with elevation of serum lipids and cardiovascular disease in a Native American population. Environ Res 2008;106:226–39.
42. Aminov Z, Haase RF, Pavuk M, Carpenter DO, Anniston Environmental Health Research Consortium. Analysis of the effects of exposure to polychlorinated biphenyls and chlorinated pesticides on serum lipid levels in residents of Anniston, Alabama. BMC Environ Health 2013;12:108. Available at: http://www.ehjournal.net/content/12/1/108.
43. Hennig B, Meerarani P, Slim R, Toborek M, Daugherty A, et al. Proinflammatory properties of coplanar PCBs: in vitro and in vivo evidence. Toxicol Appl Pharmacol 2002;181:174–83.
44. Ha M-H, Lee D-H, Jacobs DR Jr. Association between serum concentrations of persistent organic pollutants and self-reported cardiovascular disease prevalence: results from the national health and nutrition examination survey, 1999–2002. Environ Health Perspect 2007;115:1204–9.
45. Huang X, Lessner L, Carpenter DO. Exposure to persistent organic pollutants and hypertensive disease. Environ Res 2006;102:101–6.
46. Goncharov A, Bloom M, Pavuk M, Birman I, Carpenter DO. Blood pressure and hypertension in relation to levels of serum polychlorinated biphenyls in residents of Anniston, Alabama. J Hypertens 2010;28:2053–60.
47. Goncharov A, Pavuk M, Foushee HR, Carpenter DO. Blood pressure in relation to concentrations of PCB congeners and chlorinated pesticides. Environ Health Perspect 2011;119:319–25.
48. Everett CJ, Mainous AG III, Frithsen IL, Player MS, Matheson EM. Association of polychlorinated biphenyls with hypertension in the 1999–2002 national health and nutrition examination survey. Environ Res 2008;108:94–7.
49. Ha M-H, Lee D-H, Son H-K, Park S-K, Jacobs DR Jr. Association between serum concentrations of persistent organic pollutants and prevalence of newly diagnosed hypertention: results from the national health and nutrition examination survey 1999–2002. J Hum Hypertens 2009;23:274–86.
50. Kouznetsova M, Huang X, Jing M, Lessner L, Carpenter DO. Increased rate of hospitalization for diabetes and residential proximity of hazardous waste sites. Environ Health Perspect 2007;115:75–9.
51. Codru N, Schymura MJ, Negoita S; The Akwesasne Task Force on the Environment, Rej R, Carpenter DO. Diabetes in relation to serum levels of polychlorinated biphenyls and chlorinated pesticides in adult Native Americans. Environ Health Perspect 2007;115:1442–7.
52. Aminov Z, Haase R, Rej R, Schymura MJ, Santiago-Rivera A, et al. Low chlorinated, non-dioxin-like polychlorinated biphenyls are strongly associated with elevated prevalence of diabetes in a Native American population. Submitted.
53. Newman J, Aucompaugh AG, Schell LM, Denham M, DeCaprio AP, et al. PCBs and cognitive functioning of Mohawk adolescents. Neurotoxicol Teratol 2006;28:439–45.
54. Haase RF, McCaffrey RJ, Santiago-Rivera AL, Morse GS, Tarbell A. Evidence of an age-related threshold effect of polychlorinated biphenyls (PCBs) on neuropsychological functioning in a Native American population. Environ Res 2009;109:73–85.
55. Seegal RF. Neurochemical effects of polychlorinated biphenyls: a selective review of the current state of knowledge. In: Robertson LW, Hansen LG, editors. PCBs: recent advances in environmental toxicology and health effects. Lexington, KY: The University Press of Kentucky, 2001:241–55.

56. Fitzgerald EF, Belanger EE, Gomez MI, Cayo M, McCaffrey RJ, et al. Polychlorinated biphenyl exposure and neuropsychological status among older residents of upper Hudson River communities. Environ Health Perspect 2008;116:209–15.
57. Fitzgerald EF, Belanger EE, Gomez MI, Wilson LR, Belanger EE, et al. Environmental exposures to polychlorinated biphenyls (PCBs) among older residents of upper Hudson River communities. Environ Res 2007;104:352–60.
58. Schell LM, Gallo MV, Denham M, Ravenscroft J, DeCaprio AP. Relationship of thyroid hormone levels to levels of polychlorinated biphenyls, lead, p,p'-DDE, and other toxicants in Akwesasne Mohawk youth. Environ Health Perspect 2008;116:806–13.
59. DeCastro BR, Korrick SA, Spengler JD, Soto AM. Estrogenic activity of polychlorinated biphenyls present in human tissue and the environment. Environ Sci Technol 2006;40:2819–25.
60. Schell LM, Gallo MV. Relationships of putative endocrine disruptors to human sexual maturation and thyroid activity in youth. Physiol Behav 2010;99:246.
61. Goncharov A, Rej R, Negoita S, Schymura M, Santiago-Rivera A, et al. Lower serum testosterone associated with elevated polychlorinated biphenyl concentrations in Native American men. Environ Health Perspect 2009;117:1454–60.
62. Schell LM, Gallo MV, Deane GD, Nelder KR, DeCaprio AP, et al. Relationships of polychlorinated biphenyls and dichlorodiphenyldichloroethylene (p,p'-DDE) with testosterone levels in adolescent males. Environ Health Perspect 2014;122: 304–9.
63. Dallaire F, Dewailly É, Vézina C, Muckle G, Weber JP, et al. Effect of prenatal exposure to polychlorinated biphenyls on incidence of acute respiratory infections in preschool Inuit children. Environ Health Perspect 2006;114:1301–5.
64. Ma J, Kouznetsova M, Lessner L, Carpenter DO. Asthma and infectious respiratory disease in children – correlation to residence near hazardous waste sites. Paediatr Respirat Rev 2007;8:292–8.
65. Hansen S, Strøm M, Olsen SF, Maslova E, Rantakokko P, et al. Maternal concentrations of persistent organochlorine pollutants and the risk of asthma in offspring: results from a prospective cohort with 20 years of follow-up. Environ Health Perspect 2014;122:93–9.
66. Baibergenova A, Kudyakov R, Zdeb M, Carpenter DO. Low birth weight and residential proximity to PCB-contaminated waste sites. Environ Health Perspect 2003;111:1352–7.
67. Govarts E, Nieuwenhuijsen M, Schoeters G, Ballester F, Bloemen K, et al. Birth weight and prenatal exposure to polychlorinated biphenyls (PCBs) and dichlorodiphenyldichloroethylene (DDE): a meta-analysis within 12 European birth cohorts. Environ Health Perspect 2012;120:162–70.
68. Carpenter DO, Hussain RJ, Berger DF, Lombardo JP, Park H-Y. Electrophysiologic and behavioral effects of perinatal and acute exposure of rats to lead and polychlorinated biphenyls. Environ Health Perspect 2002;110:377–86.
69. Gabrio T, Piechotowski I, Wallenhorst T, Klett M, Cott L, et al. PCB-blood levels in teachers, working in PCB-contaminated schools. Chemosphere 2000;40:1055–62.
70. Schwenk M, Gabrio T, Päpke O, Wallenhorst T. Human biomonitoring of polychlorinated biphenyls and polychlorinated dibenzodioxins and dibenzofurans in teachers working in a PCB-contaminated school. Chemosphere 2002;47:229–33.
71. Johansson N, Hanberg A, Wingfors H, Tysklind M. PCB in building sealant is influencing PCB levels in blood of residents. Organohalogen Compounds 2003;63:381–4.
72. Herrick RF, McClean MD, Meeker JD, Baxter LK, Weymouth GA. An unrecognized source of PCB contamination in schools and other buildings. Environ Health Perspect 2004;112:1051–3.
73. Kohler M, Tremp J, Zennegg M, Seiler C, Minder-Kohler S, et al. Joint sealants: an overlooked diffuse source of polychlorinated biphenyls in buildings. Environ Sci Technol 2005;39:1967–73.
74. Wingfors H, Seldén AI, Nilsson C, Haglund P. Identification of markers for PCB exposure in plasma from Swedish construction workers removing old elastic sealants. Am Occup Hyg 2006;50:65–73.
75. Broding HC, Schettgen T, Göen T, Angerer J, Drexler H. Development and verification of a toxicokinetic model of polychlorinated biphenyl elimination in persons working in a contaminated building. Chemosphere 2007;68:1427–34.
76. Ruokojarvi P, Marjaleena M, Ruuskanen J. Toxic chlorinated and polyaromatic hydrocarbons in simulated house fires. Chemosphere 2000;41:825–8.
77. Hsu Y-K, Holsen TM, Hopke PK. Locating and quantifying PCB sources in Chicago: receptor modeling and field sampling. Environ Sci Technol 2003;37:681–90.
78. Hu D, Hornbuckle KC. Inadvertent polychlorinated biphenyls in commercial paint pigments. Environ Sci Technol 2010;44:2822–7.
79. Persoon C, Peters TM, Kumar N, Hornbuckle KC. Spatial distribution of airborne polychlorinated biphenyls in Cleveland, OH and Chicago, IL. Environ Sci Technol 2010;44:2797–802.
80. Lehmann GM, Christensen K, Maddaloni M, Phillips LJ. Evaluating health risks from inhaled polychlorinated biphenyls: research needs for addressing uncertainty. Environ Health Perspect 2015;123:109–13.

CURRICULUM VITAE

Name:	David O. Carpenter
Home Address:	2749 Old State Road Schenectady, New York 12303
	Positions Held: Director, Institute for Health and the Environment University at Albany Professor, Environmental Health Sciences School of Public Health, University at Albany 5 University Place, A217, Rensselaer, NY 12144
	Honorary Professor Queensland Children's Medical Research Institute University of Queensland Brisbane, Australia

Education:	1959	B.A., Harvard College, Cambridge, MA
	1964	M.D., Harvard Medical School, Boston, MA

Positions Held:

9/61-6/62	Research Fellow, Department of Physiology, University of Göteborg, Sweden with Professor Anders Lundberg
7/64-6/65	Research Associate, Department of Physiology, Harvard Medical School, Boston, MA under the direction of Dr. Elwood Henneman
7/65-2/73	Neurophysiologist, Laboratory of Neurophysiology, National Institutes of Mental Health, Dr. Edward V. Evarts, Chief, Assistant Surgeon, USPHS, currently a Reserve Officer in the USPHS.
2/73-3/80	Chairman, Neurobiology Department Armed Forces Radiobiology Research Institute, Defense Nuclear Agency, Bethesda, MD
3/80-9/85	Director, Wadsworth Center for Laboratories and Research, New York State Department of Health, Albany, NY
9/85-1/98	Dean, School of Public Health, University at Albany
9/85-Pres.	Professor, Departments of Environmental Health Sciences and Biomedical Sciences, School of Public Health, University at Albany.
9/85-7/98	Research Physician, Wadsworth Center for Laboratories and Research, New York State Department of Health, Albany, NY
1/98-1/05	Adjunct Professor in the Center for Neuropharmacology & Neuroscience, Albany Medical College, Albany, NY
2001-Pres.	Director, Institute for Health and the Environment, University at Albany, SUNY, Rensselaer, NY. The Institute was named a Collaborating Center of the World Health Organization in 2011.
2005-2010	Senior Fellow, Alden March Bioethics Institute, Albany Medical College/Center, Albany, New York
2011-Pres.	Honorary Professor, Queensland Children's Medical Research Institute, University of Queensland, Brisbane, Australia

Editor-in-Chief:	Cellular and Molecular Neurobiology, 1981 – 1987
Editor-in Chief:	Reviews on Environmental Health 2012-present
Editor-in-Chief:	Environmental Pollution 2015-2019
Editorial Advisor:	Cellular and Molecular Neurobiology, 1987 – Present
Academic Editor:	Journal of Environmental and Public Health, 2009-2013
Academic Editor:	PLoS ONE 2014-2016
Editorial Boards:	Journal of Public Health Management and Practice, 1995 - 2002
	International Journal of Occupational Medicine & Environmental Health 1996 – 2016
	Journal of Alzheimer's Disease – Associate Editor,2007-2009
	Reviews on Environmental Health; 2008-2012
	International Archives of Occupational and Environmental Health; 2009-present.
	Environmental Health Perspectives, 2010-2017
	Global Health Perspective, 2012-present
	Environment International 2013-present
	International Journal of Environmental Research and Public Health: 2019-present.

National and International Committees:

1978, 1981	Physiology Study Section (Ad hoc member)
1979-1985	NIH International Fellowship Study Section
1974-1981	Member, Steering Committee of the Section on the Nervous System, American Physiological Society (Chairman of the Committee, 9/76-4/80)
1981-1989	Member, USA National Committee for the International Brain Research Organization
1985-1986	Committee on Electric Energy Systems of the Energy Engineering Board, National Research Council
1986-1987	Member, Neurophysiology Peer Panel for the National Aeronautics and Space Administration
1987-1989	Member, Science Advisory Council of the American Paralysis Association
1987-1990	Advisory Panel for the Electric Energy System Division, U.S. Department of Energy
1985-1993	Committee #79, National Council on Radiation Protection and Measurements
1986-1997	Member, Legislative and Education Committees, Association of Schools of Public Health
1989-1994	Member, Neuroscience Discipline Working Group, Life Sciences Division of the NASA
1994, 1995	Federation of American Societies for Experimental Biology Consensus Conference on FY 1995 Federal Research Funding
1994-1997	Member, Legislative Committee of the Association of Schools of Public Health
1997	Member, Executive Committee of the Association of Schools of Public Health
1997-2000	National Advisory Environmental Health Sciences Council of the National Institutes of Health
1998-2015.	Member, U.S. Section of the Great Lakes Science Advisory Board of the International Joint Commission
2000-Pres.	Member, Board of Directors, Pacific Basin Consortium for Hazardous Waste Health and Environment; Treasurer, 2001-2004, 2008-pres; Chair, 2004-2008
2001-2008	United States Co-Chair, Workgroup on Ecosystem Health of the Science Advisory Board of the International Joint Commission
2002-2003	Member, Committee on the Implications of Dioxin in the Food Supply, The National Academies, Institute of Medicine
2001-Pres.	Member, Board of Directors, Alliance for Public Health and Associates, Inc.
2003-2008	Member, United States Environmental Protection Agency, Children's Health Protection Advisory Committee
2003-2012	Chair, Advisory Committee to the World Health Organization and National Institute of Environmental Health Sciences on collaborative activities.
2004-2012	Member, Blue Ocean Institute Curriculum Advisory Board.

2007-2011	Chair, Workgroup on Risks vs. Benefits of Fish Consumption, Science Advisory Board, International Joint Commission.
2013	Invited Expert, International Agency for Research on Cancer, Panel for Monograph 107, Carcinogenicity of Polychlorinated Biphenyls.
2013-Pres.	Member, Global Burden of Disease Panel

State and Local Committees:

1980-1987	Executive Secretary, New York State Power Lines Project
1985-1989	Board of Scientific Advisors, Institute of Basic Research, OMRDD, N.Y.
1986-1989	Member, Steering Committee, Health Policy and Administrative Consortium of the Capital District
1991-1992	Member, Connecticut Academy of Sciences and Engineering Committee on Electromagnetic Field Health Effects
1991-1992	Member, Board of Directors of the Capital District Chapter of the Alzheimer's Disease and Related Disorders Association, Inc.
1991-1992	Member, State Task Force for the Reform of Middle Level Education in NY State
1992-1993	Member, State Needs Task Force on Health Care and Education
1987-1998	Delegate-at-Large, New York State Public Health Association
1991-1995	Member, Board of Directors of the Capital District Amyotrophic Lateral Sclerosis Association
1994	Chair, Council of Deans, University at Albany, SUNY
1997-2008.	Member, Board of Directors, (Chair 1998-2004) Albany-Tula Inc.: A Capital Region Alliance
2000-Pres.	Member, Board of Directors, Healthy Schools Network, Inc.
2000-2003	Member, Medical Advisory Board, Hepatitis C Coalition, New York
2000-2004	Member, Environmental Protection Agency /National Association of State Universities and Land Grant Colleges Task Force
2001-2008	Member, Board of Directors, Environmental Advocates of New York
2004-2007	Member, Ad Hoc Advisory Group on Brownfield Cleanup Standards
2005-Pres.	Member, Schooling Chefs Curriculum Advisory Board
2005-Pres.	Member, Advisory Board, Healthy Child Healthy World
2005-2008	Member, Board of Directors, Citizens Environmental Coalition
2006-2009	Member, Board of Directors, Marine Environmental Research Institute
2007-2009	Member, New York State Renewable Energy Task Force
2013-2015	Member, Medical Society of the State of New York (MSSNY)
2013-2015	Member, Preventive Medicine and Family Health Committee, MSSNY
2014-Pres.	Member, Board of Directors, Regenerative Research Foundation
2014-Pres.	Member, Board of Directors, International Institute for Health and Education

Honors, Awards and Fellowships:

1959 B.A. awarded magna cum laude. Thesis entitled "Metamorphosis of visual pigments: A study of visual system of the salamander, *Ambystoma tigrinum*" (Thesis advisor, Professor George Wald)

Elected to Phi Beta Kappa and to Sigma Xi

1964 M.D. awarded *cum laude* for a thesis in a special field. Thesis entitled "Electrophysiological observations on the importance on neuron size in determining responses to excitation and inhibition in motor and sensory systems" (Thesis advisor, Dr. Elwood Henneman)

1964 Awarded the Leon Resnick Prize given to a Harvard Medical School graduate showing promise in research

1970 Awarded the Moseley Traveling Fellowship for study in England (Fellowship declined)

1971 Invited as Visiting Professor of Physiology, Centro de Investigacion y de Estudios

Avanzados, del Institute Politecnico Nacional, Mexico 14, D.F., Mexico, for 3 months

1982, 1986 Visiting Professor of Physiology, Department of Physiology, Kyushu

1987 University, Fukuoka, Japan, for a period of three months each

1989 Awarded Jacob Javits Neuroscience Investigator Award from the National Institute of Neurological and Communicative Diseases and Stroke

1999 Awarded Homer N. Calver Award from the American Public Health Association for studies in environmental health.

2001 Awarded 2001 Academic Laureate from the University at Albany Foundation.

2010 Awarded the Albion O. Bernstein, M.D. Award in recognition of an outstanding contribution to public health and the prevention of disease though lifelong research of environmental health hazards and for limitless devotion to medical education by the Medical Society of the State of New York.

2011 Awarded the Rodney Wylie Eminent Visiting Fellowship 2011 at the University of Queensland, Brisbane, Australia for a period of four weeks.

2013 Awarded the Annual Kenneth V. Dodgson, M.D., Lectureship at the University of Rochester Department of Occupational and Environmental Medicine Grand Rounds.

2019 Received the Third Age Achievement Award for Education, given by Senior Services of Albany

2020 Awarded the Theo Colborn Career Achievement Award for Research and Advocacy in Environmental Heatlh by the Environmental Health Symposia.

Federal Grants Held: (Principal Investigator Only)

1980-1983 United States Air Force, "Mechanisms of Radiation-Induced Emesis in Dogs", $76,847 total direct costs.

1982-1988 National Institute of Health, "Mechanisms of Desensitization at Central Synapses", $464,786 total direct costs.

1984-1986 Defense Nuclear Agency, "Mechanisms of Radiation-Induced Emesis in Dogs@, $330,504 total direct costs.

1986-1996 National Institute of Health, "Mechanisms of Excitatory Amino Acids Actions and Toxicity", 1986-1989 $231,848 total direct costs; 1990-1996 $562,926 total direct costs.

1989-1993 National Institute of Health, "Mechanisms of Lead Neurotoxicity" $373,576 total direct costs

1990-1995 National Institute of Environmental Health Sciences, Superfund Basic Research Program, "Multidisciplinary Study of PCBs and PCDFs at a Waste Site", D.O. Carpenter, P.I. $5,783,419 total direct costs.

1995-2001 Fogarty International Center, National Institutes of Health, International Training Program in Environmental and Occupational Health. ACentral/Eastern European Environ/Occup Training Program@, D.O. Carpenter, P.I. $657,520 total costs.

1995-2001 National Institute of Environmental Health Sciences, Superfund Basic Research Program, "Multidisciplinary Study of PCBs," D.O. Carpenter, P.I. $12,653,709 total direct costs.

1998-1999 Environmental Protection Agency, AIndoor Air Risk at Akwesasne - Pilot Project@, D.O. Carpenter, P.I. $9,996 total costs.

2000-2002 Association Liaison Office for University Cooperation in Development, ACooperative Program in Environmental Health between the Institute of Public Health at Makerere University, Kampala, Uganda and the School of Public Health, University at Albany, USA@, D.O. Carpenter, P.I. $96,432 total costs.

2001-2007 Fogarty International Center, National Institutes of Health, International Training Program in Environmental and Occupational Health. AMultidisciplinary Environmental Health Training@, D.O. Carpenter, P.I. $850,000 total costs.

2006-2011 Pakistan-US Science and Technology Cooperative Program (US National Academy of Sciences). "Association of particulate matter with daily morbidity in an urban population," D.O. Carpenter, P.I., $391,104 total costs.

2009-2013 Exploratory Center on Minority Health and Health Disparities in Smaller Cities. Project 2: Environmental contaminants and reproductive health of Akwesasne Mohawk women. $387,825 for year 1. D.O. Carpenter, Co-PI.

2010-2013 Department of the Army, "Gulf War Illness: Evaluation of an Innovative Detoxification Program: D.O. Carpenter, P.I., $636,958 total costs.

2010-2013 Higher Education for Development of the United States Agency for International Development, "Drinking Water Supply, Sanitation, and Hygiene Promotion : Health Interventions in Two Urban Communities of Kampala City and Mukono Municipality, Uganda". D. O. Carpenter, P.I., $299,736 total costs.

2011-2016 National Institute of Environmental Health Sciences (1RO1ES019620), "Protecting the health of future generations: Assessing and preventing exposures." PK Miller, FA von Hippel, CL Buck and DO Carpenter, Co-P.I.s, $471,521 for the period 8/08/11-4/30/12, $2,354,871 for the period 2011-2016.

2017-2022 National Institute of Environmental Health Sciences (2RO1ES19620-06A1), "Protecting the Health of Future Generations: Assessing and Preventing Exposures to Endocrine0Disrupting Flame Retardant Chemicals & PCBs in Two Alaska Native Arctic communities on St. Lawrence Island." PK Miller, FA von Hippel, CL Buck and DO Carpenter, Co-PIs. $554,464 for the period 2018.

2020-2025 National Institute of Environmental Health Sciences (RO1 ES032392) "Restoring Northeast Cape for the Health and Well-Being of the Yupik Communities of St. Lawrence Island, Alaska." F von Hippel, C Buck, DO Carpenter, PK Miller, Co-PIs. 11/01/2021-10.31.2025. Total Award Amount (including indirect costs): $2, 985,224.

Research Interests:

- Exposure to persistent organic pollutants and risk of diabetes, cardiovascular disease, and hypertension.
- Cognitive and behavioral effects of environmental contaminants on children (IQ, ADHD) and older adults (dementias, Parkinson's Disease and ALS).
- Ionizing and non-ionizing radiation biology.
- Effects of air pollution on respiratory and cardiovascular function.

Other Professional Activities:

Host, The Public Radio Health Show (a 30 min public health information show carried on 170+ stations nationwide), plus the Armed Forces Radio Network and Voice of America, 1985-2001.

Authored a biweekly health column in The Troy Record, a local newspaper, 1997-1999.

Member of the Ethics Board, Town of Guilderland, 2013 – 2018

Albany Mayor's Advisory Committee on Air Pollution in the South End, 2016-present.

Board member and treasurer: Health Schools Network, 200-present.

Board member: Regenerative Research Foundation; 2010-present

Board member: National Toxic Encephalopathy Foundation, 2019 – present.

Board member: RADIX Ecological Sustainability Center, 2018-present.

Major Peer-Reviewed Publications:

1. Carpenter, D.O., Lundberg, A. and Norrsell, U. Effects from the pyramidal tract on primary afferents and on spinal reflex actions to primary afferents. Experientia, 18:337, 1962.
2. Carpenter, D.O., Engberg, I. and Lundberg, A. Presynaptic inhibition in the lumbar cord evoked from the brain stem. Experientia, 18:450, 1962.
3. Carpenter, D.O., Lundberg, A. and Norrsell, U. Primary afferent depolarization evoked from the sensorimotor cortex. Acta Physiol. Scand., 59:126-142.
4. Carpenter, D.O., Engberg, I., Funkenstein, H. and Lundberg, A. Decerebrate control of reflexes to primary afferents. Acta Physiol. Scand., 59:424-437, 1963.
5. Carpenter, D.O., Engberg, I. and Lundberg, A. Differential supraspinal control of inhibitory and excitatory actions from the FRA to ascending spinal pathways. Acta Physiol. Scand., 63:103-110, 1965.
6. Henneman, E., Somjen, G.G. and Carpenter, D.O. Excitability and inhibitibility of motoneurons of different sizes. J. Neurophysiol., 28:599-620, 1965.
7. Henneman, E., Somjen, G.G. and Carpenter, D.O. Functional significance of cell size in spinal motoneurons. J. Neurophysiol., 28:560-580, 1965.
8. Somjen, G.G., Carpenter, D.O. and Henneman, E. Selective depression of alpha motoneurons of small size by ether. J. Pharmacol., 148:380-385, 1965.
9. Somjen, G., Carpenter, D.O. and Henneman, E. Response of motoneurons of different sizes to graded stimulation of supraspinal centers of the brain. J. Neurophysiol., 28:958-965, 1965.
10. Carpenter, D.O., Engberg, I. and Lundberg, A. Primary afferent depolarization evoked from the brain stem and the cerebellum. Arch. Ital. Biol., 104:73-85, 1966.
11. Carpenter, D.O. and Henneman, E. A relation between the threshold of stretch receptors in skeletal muscle and the diameter of axons. J. Neurophysiol., 29:353-368, 1966.
12. Carpenter, D.O. Temperature effects on pacemaker generation, membrane potential, and critical firing threshold in Aplysia neurons. J. Gen. Physiol., 50:1469-1484, 1967.
13. Chase, T.N., Breese, G., Carpenter, D., Schanberg, S. and Kopin, I. Stimulation-induced release of serotonin from nerve tissue. Adv. Pharmacol., 6A:351-364, 1968.
14. Carpenter, D.O. and Alving, B.O. A contribution of an electrogenic Na^+ pump to membrane potential in Aplysia neurons. J. Gen. Physiol., 52:1-21, 1968.
15. Olson, C.B., Carpenter, D.O. and Henneman, E. Orderly recruitment of muscle action potentials. Arch. Neurol., 19:591-597, 1968.
16. Carpenter, D.O. Membrane potential produced directly by the Na^+ pump in Aplysia neurons. Comp. Biochem. Physiol., 35:371-385, 1970.
17. Carpenter, D.O. and Gunn, R. The dependence of pacemaker discharge of Aplysia neurons upon Na^+ and Ca^{++}. J. Cell. Physiol., 75:121-127, 1970.

18. Kraus, K.R., Carpenter, D.O. and Kopin, I. R. Acetylcholine-induced release of norepin-ephrine in the presence of tetrodotoxin. J. Pharmacol. Exp. Therap., 73:416-421, 1970.

19. Barker, J.L. and Carpenter, D.O. Thermosensitivity of neurons in the sensorimotor cortex of the cat. Science, 169:597-598, 1970.

20. Carpenter, D.O., Hovey, M.M. and Bak, A. Intracellular conductance of Aplysia neurons and squid axon as determined by a new technique. Intl. J. Neurosci., 2:35-48, 1971.

21. Carpenter, D.O., Breese, G., Schanberg, S. and Kopin, I. Serotonin and dopamine: Distribution and accumulation in Aplysia nervous and non-nervous tissues. Int. J. Neurosci., 2:49-56, 1971.

22. Hovey, M.M., Bak, A.F. and Carpenter, D.O. Low internal conductivity of Aplysia neuron somata. Science, 176:1329-1331, 1972.

23. Carpenter, D.O. Electrogenic sodium pump and high specific resistance in nerve cell bodies of the squid. Science, 179:1336-1338, 1973.

24. Carpenter, D.O. and Rudomin, P. The organization of primary afferent depolarization in the isolated spinal cord of the frog. J. Physiol. (Lond.), 229:471-493, 1973.

25. Shain, W., Green, L.A., Carpenter, D.O., Sytkowski, A.J. and Vogel, Z. Aplysia acetylcholine receptors: Blockage by and binding of α-bungarotoxin. Brain Res., 72:225-240, 1974.

26. Pierau, Fr.-K., Torrey, P. and Carpenter, D.O. Mammalian cold receptor afferents: Role of an electrogenic sodium pump in sensory transduction. Brain Res., 73:156-160, 1974.

27. Saavedra, J.M., Brownstein, M.J., Carpenter, D.O. and Axelrod, J. Octopamine: Presence in single neurons in Aplysia suggests neurotransmitter function. Science, 185:364-365, 1974.

28. Willis, J.A., Gaubatz, G.L. and Carpenter, D.O. The role of the electrogenic sodium pump in modulation of pacemaker discharge of Aplysia neurons. J. Cell. Physiol., 84:463-472, 1974.

29. Brownstein, M.J., Saavedra, J.M., Axelrod, J., Zeman, G.H. and Carpenter, D.O. Coexistence of several putative neurotransmitters in single identified neurons of Aplysia. Proc. Natl. Acad. Sci. (USA), 71:4662-4665, 1975.

30. Carpenter, D.O. and Gaubatz, G.L. Octopamine receptors on Aplysia neurons mediate hyperpolarization by increasing membrane conductance. Nature, 252:483-485, 1974.

31. Pierau, Fr.-K., Torrey, P. and Carpenter, D.O. Afferent nerve fiber activity responding to temperature changes of the scrotal skin of the rat. J. Neurobiol., 38:601-612, 1975.

32. Carpenter, D.O. and Gaubatz, G.L. H_1 and H_2 histamine receptors on Aplysia neurons. Nature, 254:343-344, 1975.

33. Carpenter, D.O., Hovey, M.M. and Bak, A.F. Resistivity of axoplasm. II. Internal restivity of giant axons of squid and Myxicola. J. Gen. Physiol., 66:139-148, 1975.

34. Zeman, G.H. and Carpenter, D.O. Asymmetric distribution of aspartate in ganglia and single neurons of Aplysia. Comp. Biochem. Physiol., 52C:23-26, 1975.

35. Pierau, Fr.-K., Torrey, P. and Carpenter, D.O. Effect of ouabain and potassium-free solution on mammalian thermosensitive afferents in vitro. Pflugers Arch., 359:349-356, 1975.

36. Swann, J.W. and Carpenter, D.O. The organization of receptors for neurotransmitters on Aplysia neurons. Nature, 258:751-754, 1975.

37. Yarowsky, P.J. and Carpenter, D.O. Aspartate: distinct receptors on Aplysia neurons. Science, 192:806-809, 1976.

38. Foster, K.R., Bidinger, J.M. and Carpenter, D.O. The electrical resistivity of aqueous cytoplasm. Biophys. J., 16:991-1001, 1976.

39. Carpenter, D.O., Greene, L.A., Shain, W. and Vogel, Z. Effects of eserine and neostigmine on the interaction of α-bungarotoxin with Aplysia acetylcholine receptors. Mol. Pharmacol., 12:999-1006, 1976.

40. Saavedra, J.M., Ribas, J., Swann, J. and Carpenter, D.O. Phenylethanolamine: A new putative neurotransmitter in Aplysia. Science, 195:1004-1006, 1977.

41. Carpenter, D.O., Swann, J.W. and Yarowsky, P.J. Effect of curare on responses to different putative neurotransmitters in Aplysia neurons. J. Neurobiol., 8:119-132, 1977.

42. Yarowsky, P.J. and Carpenter, D.O. GABA mediated excitatory responses on Aplysia neurons. Life Sci., 20:1441-1448, 1977.

43. Willis, J.A., Myers, P.R. and Carpenter, D.O. An ionophoretic module which controls electroosmosis. J. Electrophysiol. Tech., 6:34-41, 1977.

44. Yarowsky, P.J. and Carpenter, D.O. Receptors for gamma-aminobutyric acid (GABA) on Aplysia neurons. Brain Res., 144:75-94, 1978.

45. Carpenter, D.O., Gaubatz, G., Willis, J.A. and Severance, R. Effects of irradiation of Aplysia pacemaker neurons with 20 MeV electrons. Rad. Res., 76:32-47, 1978.

46. Yarowsky, P.J. and Carpenter, D.O. A comparison of similar ionic responses to gamma-aminobutyric acid and acetylcholine. J. Neurophysiol., 41:531-541, 1978.

47. Blum, B., Auker, C.R. and Carpenter, D.O. A head holder and stereotaxic device for the rattlesnake. Brain Res. Bull., 3:271-274, 1978.

48. Swann, J.W., Sinback, C.N. and Carpenter, D.O. Dopamine-induced muscle contractions and modulation of neuromuscular transmission in Aplysia. Brain Res., 157:167-172, 1978.

49. Swann, J.W., Sinback, C.N. and Carpenter, D.O. Evidence for identified dopamine motor neurons to the gill of Aplysia. Neurosci. Lett., 10:275-280, 1978.

50. Kebabian, P.R., Kebabian, J.W. and Carpenter, D.O. Regulation of cyclic AMP in heart and gill of Aplysia by the putative neurotransmitters, dopamine and serotonin. Life Sci., 24:1757-1764, 1979.

51. Carpenter, D.O. Interchangeable association of neurotransmitter receptors with several ionophores. Brain Res. Bull., 4:149-152, 1979.

52. Pellmar, T.C. and Carpenter, D.O. Voltage-dependent calcium current induced by serotonin. Nature, 277:483-484, 1979.

53. Ruben, P.C., Swann, J.W. and Carpenter, D.O. Neurotransmitter receptors on gill muscle fibers and the gill peripheral nerve plexus in Aplysia. Canad. J. Physiol. Pharmacol., 57:1088-1097, 1979.

54. Pellmar, T.C. and Carpenter, D.O. Serotonin induces a voltage-sensitive calcium current in neurons of Aplysia californica. J. Neurophysiol., 44:423-439, 1980.

55. Parver, L.M., Auker, C. and Carpenter, D.O. Choroidal blood flow as a heat dissipating mechanism in the macula. Am. J. Ophthamol., 89:641-646, 1980.

56. Mell, L.D., Jr. and Carpenter, D.O. Fluorometric determination of octopamine in tissue homegenates by high-performance liquid chromatography. Neurochem. Res., 5:1089-1096, 1980.

57. Braitman, D.J., Auker, C.R. and Carpenter, D.O. Thyrotropin-releasing hormone has multiple actions in cortex. Brain Res., 194:244-248, 1980.

58. Meszler, R.M., Auker, C.R. and Carpenter, D.O. Fine structure and organization of the infrared receptor relay, the lateral descending nucleus of the trigeminal nerve in pit vipers. J. Comp. Neurol., 196:571-584, 1981.

59. Auker, C.R., Parver, L.M., Doyle, T. and Carpenter, D.O. Choroidal blood flow: I. Ocular tissue temperature as a measure of flow. Arch. Opthal., 100:1323-1326, 1982.

60. Parver, L.M., Auker, C., Carpenter, D.O. and Doyle, T. Choroidal blood flow: II. Reflexive control in the monkey. Arch. Opthal., 100:1327-1330. 1982.

61. Hori, N., Auker, C.R., Braitman, D.J. and Carpenter, D.O. Lateral olfactory tract transmitter: Glutamate, aspartate or neither? Cell. Mol. Neurobiol., 1:115-120, 1981.

62. Scappaticci, K.A., Dretchen, K.L., Carpenter, D.O. and Pellmar, T.C. Effects of furosemide on neural mechanisms in Aplysia. J. Neurobiol., 12:329-341, 1981.

63. Pellmar, T.C. and Carpenter, D.O. Cyclic AMP induces a voltage-dependent current in neurons of Aplysia californica. Neurosci. Lett., 22:151-157, 1981.

64. Parver, L., Auker, C. and Carpenter, D.O. Stabilization of macular temperature: The stabilizing effect of the choroidal circulation on the temperature environment of the macula. Retina, 2:117-120, 1982.

65. Green, R.W. and Carpenter, D.O. Biphasic responses to acetylcholine in mammalian reticulospinal neurons. Cell. Molec. Neurobiol., 1:401-405, 1981.

66. Hori, N., Auker, C.R., Braitman, D.J. and Carpenter, D.O. Pharmacologic sensitivity of amino acid responses and synaptic activation of in vitro prepyriform neurons. J. Neurophysiol., 48:1289-1301, 1982.

67. Slater, N.T. and Carpenter, D.O. Blockade of acetylcholine-induced inward currents in Aplysia neurons by strychnine and desipramine: effect of membrane potential. Cell. Molec. Neurobiol., 2:53-58, 1982.

68. Swann, J.W., Sinback, C.N., Pierson, M.G. and Carpenter, D.O. Dopamine produces muscle contractions and modulates motoneuron-induced contractions in Aplysia gill. Cell. Molec. Neurobiol., 2:291-308, 1982.

69. Swann, J.W., Sinback, C.N., Kebabian, P.R. and Carpenter, D.O. Motoneurons which may utilize dopamine as their neurotransmitter. Cell. Molec. Neurobiol., 2:309-324, 1982.

70. Auker, C.R., Meszler, R.M. and Carpenter, D.O. Apparent discrepancy between single unit activity and ^{14}C-deoxyglucose labelling in the optic tectum of the rattlesnake. J. Neurophysiol., 49:1504-1516, 1983.

71. Slater, N.T., Carpenter, D.O., Freedman, J.E. and Snyder, S.H. Vipoxin both activates and antagonizes three types of acetylcholine response in *Aplysia* neurons. Brain Res., 278:266-270, 1983.

72. ffrench-Mullen, J.M.H., Hori, N., Nakanishi, H., Slater, N.T. and Carpenter, D.O. Assymetric distribution of acetylcholine receptors and M channels on prepyriform neurons. Cell. Molec. Neurobiol., 3:163-182, 1983.

73. Carpenter, D.O., Briggs, D.B. and Strominger, N. Responses of neurons of canine area postrema to neurotransmitters and peptides. Cell. Molec. Neurobiol., 3:113-126, 1983.

74. Slater, N.T. and Carpenter, D.O. Blocking kinetics at excitatory acetylcholine responses on *Aplysia* neurons. Biophys. J., 45:24-25, 1984.

75. Chesnut, T.J. and Carpenter, D.O. Two-component desensitization of three types of responses to acetylcholine in Aplysia. Neurosci. Lett., 39:285-290, 1983.

76. Haas, H.L., Jeffreys, J.G.R., Slater, N.T. and Carpenter, D.O. Modulation of low calcium induced field bursts in the hippocampus by monoamines and cholinomimetics. Pflugers Arch., 400:28-33, 1984.

77. Parvar, L.M., Auker, C.R. and Carpenter, D.O. Choroidal blood flow. III. Reflexive control in human eyes. Arch. Ophthamol., 101:1604-1606, 1983.

78. Slater, N.T., Haas, H.L. and Carpenter, D.O. Kinetics of acetylcholine-activated cation channel blockade by the calcium antagonist D-600 in Aplysia neurons. Cell. Molec. Neurobiol., 3:329:344, 1983.

79. McCreery, M.J. and Carpenter, D.O. Modulation of neuronal responses to L-glutamate in Aplysia. Cell. Molec. Neurobiol., 4:91-95, 1984.

80. Carpenter, D.O., Briggs, D.B. and Strominger, N. Peptide-induced emesis in dogs. Behav. Brain Res., 11:277-281, 1984.

81. ffrench-Mullen, J.M.H., Hori, N. and Carpenter, D.O. N-methyl-D-aspartate and L-aspartate activate distinct receptors in prepyriform cortex. Cell. Molec. Neurobiol., 4:185-189, 1984.

82. Slater, N.T. and Carpenter, D.O. A study of the cholinolytic actions of strychnine using the technique of concentration jump relaxation analysis. Cell Molec Neurobiol 4:263-271,1984.

83. Slater, N.T., Hall, A.F. and Carpenter, D.O. Kinetic properties of cholinergic desensitization in *Aplysia* neurons. Proc. Roy. Soc. Lond. B, 223:63-78, 1984.

84. Akaike, N., Hattori, K., Oomura, Y. and Carpenter, D.O. Bicuculline and picrotoxin block gamma-aminobutyric acid-gated Cl^- conductance by different mechanisms. Experientia, 41:70-71, 1985.

85. Slater, N.T., Carpenter, D.O., Freedman, J.E. and Synder, S.H. Dual effects of the snake venom polypeptide vipoxin on receptors for acetylcholine and biogenic amines in *Aplysia* neurons. Neurosci., 14:723-733, 1985.

86. Mizuno, Y., Oomura, Y., Hori, N. and Carpenter, D.O. Action of vasopressin on CA1 pyramidal neurons in rat hippocampal slices. Brain Res., 309:241-246, 1984.

87. Slater, N.T., Hall, A.F. and Carpenter, D.O. Trifluoperazine and calcium antagonists accelerate cholinergic desensitization in *Aplysia* neurons. Brain Res., 329:275-279, 1985.

88. ffrench-Mullen, J.M.H., Koller, K., Zaczek, R., Coyle, J.T., Hori, N. and Carpenter, D.O. N-acetylaspartylglutamate: Possible role as the neurotransmitter of the lateral olfactory tract. Proc. Nat. Acad. Sci., 82:3897-3900, 1985.

89. Greene, R.W. and Carpenter, D.O. Actions of neurotransmitters on pontine medial reticular formation neurons of the cat. J. Neurophysiol., 54:520-531, 1985.

90. Hori, N., ffrench-Mullen, J.M.H. and Carpenter, D.O. Kainic acid responses and toxicity show pronounced Ca^{2+} dependence. Brain Res., 358:380-384, 1985.

91. Gaillard, W.D. and Carpenter, D.O. Spectra of neurotransmitter receptors and ionic responses on cerebral A and B neurons in Aplysia californica. Brain Res., 373:303-310, 1986.

92. Gaillard, W.D. and Carpenter, D.O. On the transmitter at the A-to-B cell in *Aplysia californica*. Brain Res., 373:311-315, 1986.

93. ffrench-Mullen, J.M.H., Hori, N. and Carpenter, D.O. A comparison on the effects of quinolinate and N-methyl-aspartate on neurons in rat piriform cortex. Neurosci. Lett., 63:66-70, 1986.

94. ffrench-Mullen, J.M.H., Hori, N. and Carpenter, D.O. Receptors for the excitatory amino acids on neurons in rat pyriform cortex. J. Neurophysiol., 55:1283-1294, 1986.

95. Slater, N.T., David, J.A. and Carpenter, D.O. Relaxation studies on the interaction of hexamethonium with acetylcholine-receptor channels in *Aplysia* neurons. Cell. Molec. Neurobiol., 6:191-211, 1986.

96. Leung, M.K., S.-Rozsa, K., Hall, A., Kuruvilla, S., Stefano, G.B. and Carpenter, D.O. Enkephalin-like substance in *Aplysia* nervous tissue and actions of leu-enkephalin on single neurons. Life Sci., 38:1529-34, 1986.

97. Slater, N.T., Filbert, M. and Carpenter, D.O. Multiple interactions of anticholinesterases with *Aplysia* acetylcholine responses. Brain Res., 375:407-412, 1986.

98. Carpenter, D.O. and Briggs, D.B. Insulin excites neurons of the area postrema and causes emesis. Neurosci. Lett., 68:85-89, 1986.

99. Carpenter, D.O., Briggs, D.B., Knox, A.P. and Strominger, N.L. Radiation-induced emesis in the dog: Effects of lesions and drugs. Rad. Res., 108:307-316, 1986.

100. Briggs, D.B. and Carpenter, D.O. Excitation of neurons in the canine area postrema by prostaglandins. Cell. Molec. Neurobiol., 6:421-426, 1986.

101. Chesnut, T.J., Carpenter, D.O. and Strichartz, G.R. Three effects of venom from conus striatus on the delayed rectifier potassium current of molluscan neurons. Toxicon, 25:267-278, 1987.

102. Yakushiji, T., Tokutomi, N., Akaike, N. and Carpenter, D.O. Agonists of GABA responses, studied using internally perfused frog dorsal root ganglion neurons. Neuroscience 22:1123-1133, 1987.

103. Akaike, N., Yakushiji, T., Tokutomi, N. and Carpenter, D.C. Multiple mechanisms of antagonism of GABA responses. Cell. Molec. Neurobiol., 7:97-103, 1987.

104. Hori, N., Galeno, T. and Carpenter, D.O. Responses of pyriform cortex neurons to excitatory amino acids: Voltage dependence, conductance changes and effects of divalent cations. Cell. Molec. Neurobiol., 7:73-90, 1987.

105. Oyama, Y., King, W.M. and Carpenter, D.O. Edrophonium-induced membrane current in single neurons physically isolated from Aplysia californica. Brain Res., 438:95-100, 1988.

106. Jahan-Parwar, B., S.-Rozsa, K., Salanki, J., Evans, M.L. and Carpenter, D.O. In vivo labeling of serotonin containing neurons by 5,7-dihydroxytryptamine in Aplysia. Brain Res., 426:173-178, 1987.

107. King, W.M. and Carpenter, D.O. Distinct GABA and glutamate receptors may share a common channel in Aplysia neurons. Neurosci. Lett., 82:343-348, 1987.

108. Carpenter, D.O., Briggs, D.B., Knox, A.P. and Strominger, N. Excitation of area postrema neurons by transmitters, peptides and cyclic nucleotides. J. Neurophysiol., 59:358-369, 1988.

109. Carpenter, D.O., Hall, A.F. and Rahmann, H. Exogenous gangliosides induce direct voltage and conductance changes on isolated neurons. Cell. Molec. Neurobiol., 8:245-250, 1988.

110. Hori, N., Carpenter, D.O. and Katsuda, N. Effect of acetylcholine on the pyramidal cell in the rat piriform cortex in vitro. Neurosciences, 13:172-174, 1987 (in Japanese).

111. Hori, N. and Carpenter, D.O. Excitatory amino acid receptors in piriform cortex do not show receptor desensitization. Brain Res., 457:350-354, 1988.

112. Allen, C.N., Brady, R., Swann, J., Hori, N. and Carpenter, D.O. N-methyl-D-aspartate (NMDA) receptors are inactivated by trypsin. Brain Res., 458:147-150, 1988.

113. Oyama, Y., Akaike, N. and Carpenter, D.O. Strychnine decreases the voltage-dependent Ca^{2+} current of both *Aplysia* and frog ganglion neurons. Cell. Molec. Neurobiol., 8:307-314, 1988.

114. Oyama, Y., King, W.M., Allen, C.N., Hori, N. and Carpenter, D.O. Characterization of an inward current elicited by edrophonium in physically isolated and internally perfused *Aplysia* neurons. Brain Res., 463:124-132, 1988.

115. Hori, N., Akaike, N. and Carpenter, D.O. Piriform cortex brain slices: Techniques for isolation of synaptic inputs. J. Neurosci. Methods, 25:197-208, 1988.

116. Oyama, Y., Evans, M.L., Akaike, N. and Carpenter, D.O. Electrophysiological detection of acetylcholinesterase activity using concentration clamp on physically isolated *Aplysia* neurons. Neuroscience Res., 6:174-180, 1988.

117. Tsuda, Y., Oyama, Y., Carpenter, D.O. and Akaike, N. Effects of Ca^{2+} on the transient outward current of single isolated *Helix* central neurones. Brit J. Pharmacol., 95:526-530, 1988.

118. Oyama, Y., Hori, N., Evans, M.L., Allen, C.N. and Carpenter, D.O. Electrophysiological estimation of the actions of acetylcholinesterase inhibitors on acetylcholine receptor and cholinesterase in physically isolated *Aplysia* neurones. Brit. J. Pharmacol., 96:573-582,1989.

119. King, W.M. and Carpenter, D.O. Voltage-clamp characterization of Cl- conductance gated by GABA and L-glutamate in single neurons of *Aplysia*. J. Neurophysiol., 61:892-899, 1989.

120. Evans, M.L. and Carpenter, D.O. Desensitization kinetics of a chloride acetylcholine response in *Aplysia*. Brain Res., 495:309-318, 1989.

121. Salanki, J., Evans, M.L. and Carpenter, D.O. Desensitization kinetics of a K+ acetylcholine response in *Aplysia*. Brain Res., 495:298-308, 1989.

122. Büsselberg, D., Evans, M.L., Rahmann, H. and Carpenter, D.O. Effects of exogenous ganglioside and cholesterol application on excitability of *Aplysia* neurons. Membrane Biochemistry, 8:19-26, 1989.

123. Carpenter, D. Neural mechanisms of emesis. Canad. J. Physiol. Pharmacol., 68:230-236, 1990.

124. Oyama, Y., Hori, N., Allen, C.N., and Carpenter, D.O. Influences of trypsin and collagenase on acetylcholine responses of physically-isolated single neurons of *Aplysia californica*. Cell. Molec. Neurobiol., 10:193-205, 1990.

125. Büsselberg, D., Evans, M.L., Rahmann, H., and Carpenter, D.O. Lead inhibits the voltage-activated calcium current of *Aplysia* neurons. Toxicol. Lett., 51:51-57, 1990.

126. Doi, N., Carpenter, D.O. and Hori, N. Differential effects of baclofen and GABA on rat piriform cortex pyramidal neurons *in vitro*. Cell. Molec. Neurobiol., 10: 559-564, 1991.

127. Büsselberg, D., Evans, M.L., Rahmann, H. and Carpenter, D.O. Zn^{2+} blocks the voltage activated calcium current of *Aplysia* neurons. Neurosci. Letts., 117:117-122, 1990.

128. Büsselberg, D., Carpenter, D.O., Sugita, M., Araki, S., Satake, M. and Rahmann, H. Effects of exogenous lipid application on excitability of *Aplysia* neurons. Biomed. Res., 11:77-86, 1990.

129. Evans, M.L., Kadan, M.J., Hartig, P.R. and Carpenter, D.O. Correlation of ^{125}I-LSD autoradiographic labelling with serotonin voltage clamp responses in *Aplysia* neurones. Synapse, 8:22-29, 1991.

130. S.-Rozsa, K., Stefano, G., Salanki, J. and Carpenter, D.O. Characterization of responses to enkephalins and FMRFamide on B neurons of the cerebral ganglion of *Aplysia*. Comp. Biochem. Physiol., 99C:403-412, 1991.

131. Büsselberg, D., Evans, M.L., Rahmann, H. and Carpenter, D.O. Lead and zinc block a voltage activated calcium channel of *Aplysia* neurons. J. Neurophysiol., 65:786-795, 1991.

132. Hori, N., Doi, N., Miyahara, S., Shinoda, Y. and Carpenter, D.O. Appearance of NMDA receptors triggered by anoxia independent of voltage *in vivo* and *in vitro*. Exp. Neurol., 112:304-311, 1991.

133. Büsselberg, D., Evans, M.L., Rahmann, H. and Carpenter, D.O. Effects of inorganic and triethyl lead and inorganic mercury on the voltage activated calcium channel of *Aplysia* neurons. NeuroToxicology, 12:733-744, 1991.

134. Evans, M.L., Büsselberg, D. and Carpenter, D.O. Pb^{2+} blocks calcium currents of cultured dorsal root ganglion cells. Neurosci. Letts., 129:103-106, 1991.

135. Kemenes, G., S.-Rozsa, K., Stefano, G. and Carpenter, D.O. Distinct receptors for leu- and met-enkephalin on the metacerebral giant cell of *Aplysia*. Cell. Molec. Neurobiol., 12:107-119, 1992.

136. Ayrapetyan, S.N. and Carpenter, D.O. Very low concentrations of acetylcholine and GABA modulate transmitter responses. NeuroReport 2:563-565, 1991.

137. Carpenter, D.O. and Hori, N. Neurotransmitter and peptide receptors on medial vestibular nucleus neurons. Ann. NY Acad. Sci., 656:668-686, 1992.

138. Hernadi, L., S.-Rozsa, K., Jahan-Parwar, B. and Carpenter, D.O. A topography and ultrastructural characterization of *in vivo* 5,7-dihydroxytryptamine-labelled serotonin-containing neurons in the central nervous system of *Aplysia californica*. Cell. Molec. Neurobiol., 12:317-326, 1992.

139. Carpenter, D.O., Fejtl, M., Ayrapetyan, S., Szarowski, D. and Turner, J.N. Dynamic changes in neuronal volume resulting from osmotic and sodium transport manipulations. Acta Biologica Hungarica, 43:39-48, 1992.

140. Ayrapetyan, S.N. and Carpenter, D.O. On the modulating effect of ultralow transmitter concentrations on the functional activity of the neuron membrane. J. Evol. Biochem. Physiol., 27:110-116, 1991.

141. Büsselberg, D., Michael, D., Evans, M.L., Carpenter, D.O. and Haas, H.L. Zinc (Zn^{2+}) blocks voltage gated calcium channels in cultured rat dorsal root ganglion cells. Brain Res., 593:77-81, 1992.

142. Matthews, M.R., Parsons, P.J. and Carpenter, D.O. Solubility of lead as lead (II) chloride in HEPES-Ringer and artificial seawater (Ca-ASW) solutions. NeuroToxicology, 14:283-290, 1993.

143. Hori, N., Büsselberg, D., Matthews, R., Parsons, P.J. and Carpenter, D.O. Lead blocks LTP by an action not at NMDA receptors. Exp. Neurol., 119: 192-197, 1993.

144. Büsselberg, D., Evans, M.L., Haas, H.L. and Carpenter, D.O. Blockade of mammalian and invertebrate calcium channels by lead. NeuroToxicology, 14:249-258, 1993.

145. Riepe, M., Hori, N., Ludolph, A.C., Carpenter, D.O., Spencer, P.S. and Allen, C.N. Inhibition of energy metabolism by 3-nitropropionic acid activates ATP-sensitive potassium channels. Brain Res., 586:61-66, 1992.

146. Hori, N., Hirotsu, I., Davis, P.J. and Carpenter, D.O. Long-term potentiation is lost in aged rats but preserved by calorie restriction. NeuroReport, 3:1085-1088, 1992.

147. Knox, A.P., Strominger, N.L., Battles, A.H. and Carpenter, D.O. Behavioral studies of emetic sensitivity in the ferret. Brain Res. Bull., 31:477-484, 1993.

148. Allen, C.N., Spencer, P.S. and Carpenter, D.O. ß-N-methylamino-L-alanine in the presence of bicarbonate is an agonist at non-N-methyl-D-aspartate-type receptors. Neuroscience 54:567-574, 1993.

149. Elekes, K., Stefano, G.B. and Carpenter, D.O. Enkephalin-like immunoreactive neurons in the central nervous system of gastropods (*Helix pomatia, Lymnaea stagnalis, Aplysia californica*): A comparative immunocytochemical study. Cell Tiss. Res. 272:329-41, 1993.

150. Büsselberg, D., Platt, B., Haas, H.L. and Carpenter, D.O. Voltage gated calcium channel currents of rat dorsal root ganglion (DRG) cells are blocked by Al^{3+}. Brain Res. 622:163-168, 1993.

151. Strominger, N.L., Knox, A.P. and Carpenter, D.O. The connectivity of the area postrema in the ferret. Brain Res. Bull., 33:33-47, 1994.

152. Knox, A.P., Strominger, N.L., Battles, A.H. and Carpenter, D.O. The central connections of the vagus nerve in the ferret. Brain Res. Bull., 33:49-63, 1994.

153. Lin, Y. and Carpenter, D.O. Medial vestibular neurons are endogenous pacemakers whose discharge is modulated by neurotransmitters. Cell. Molec. Neurobiol., 13:601-613, 1993.

154. Kemenes, G., S.-Rózsa, K. and Carpenter, D.O. Cyclic-AMP-mediated excitatory responses to leucine enkephalin in *Aplysia* neurones. J. Exp. Biol. 181: 321-328, 1993.

155. Büsselberg, D., Platt, B., Michael, D., Carpenter, D.O. and Haas, H.L. Mammalian voltage-activated calcium channel currents are blocked by Pb^{2+}, Zn^{2+} and Al^{3+}. J. Neurophysiol., 71:1491-1497, 1994.

156. Hori, N. and Carpenter, D.O. Transient ischemia causes a reduction of Mg^{2+} blockade of NMDA receptors. Neurosci. Letts., 173:75-78, 1994.

157. Riepe, M.W., Hori, N., Ludolph, A.C. and Carpenter, D.O. Failure of neuronal ion exchange, not potentiated excitation, causes excitotoxicity after inhibition of oxidative phosphorylation. Neuroscience, 64:91-97, 1995.

158. Hori, N. and Carpenter, D.O. Functional and morphological changes induced by transient *in vivo* ischemia. Exp. Neurol., 129:279-289, 1994.

159. Lin, Y. and Carpenter, D.O. Direct excitatory opiate effects mediated by non-synaptic actions on rat medial vestibular neurons. Eur. J. Pharmacol., 262:99-106, 1994.

160. Carpenter, D.O. Epidemiological evidence for an association between exposure to 50 and 60 Hz magnetic fields and cancer. James Bay Publication Series, Hydro-Electric Development: Environmental Impacts - Paper No. 6, pp. 2-31, 1994.

161. Carpenter, D.O. Communicating with the public on issues of science and public health. Environ. Health Perspect. 103:127-130, 1995.

162. Fejtl, M., Gyori, J. and Carpenter, D.O. Hg^{2+} increases the open probability of carbachol-activated Cl^- channels in *Aplysia* neurons. NeuroReport, 5:2317-2320, 1994.

163. Carpenter, D.O. The public health significance of metal neurotoxicity. Cell. Molec. Neurobiol., 14:591-597, 1994.

164. Gyori, J., Fejtl, M. and Carpenter, D.O. Effect of $HgCl_2$ on acetylcholine, carbachol and glutamate currents of *Aplysia* neurons. Cell. Molec. Neurobiol., 14:653-664, 1994.

165. Fejtl, M., Gyori, J. and Carpenter, D.O. Mercuric (II) chloride modulates single channel properties of carbachol activated Cl^- channels in cultured neurons of *Aplysia californica*. Cell. Molec. Neurobiol., 14:665-674, 1994.

166. Carpenter, D.O., Matthews, M.R., Parsons, P.J. and Hori, N. Long-term potentiation in piriform cortex is blocked by lead. Cell. Molec. Neurobiol., 14:723-733, 1994.

167. Salanki, J., Gyori, J. and Carpenter, D.O. Action of lead on glutamate-activated chloride currents in *Helix Pomatia L.* neurons. Cell. Molec. Neurobiol., 14:755-768, 1994.

168. Carpenter, D.O. How hazardous wastes affect hu man health. Cent. Eur. J. Publ. Hlth. 2:6-9, 1994.

169. Oyama, Y., Carpenter, D.O., Ueno, S., Hayashi, H. and Tomiyoshi, F. Methylmercury induces Ca^{2+}-dependent hyperpolarization of mouse thymocytes: A flow-cytometric study using fluorescent dyes. Eur. J. Pharmacol., 293:101-107, 1995.

170. Fejtl, M., Szarowski, D.H., Decker, D., Buttle, K., Carpenter, D.O. and Turner, J.N. Three-dimensional imaging and electrophysiology of live *Aplysia* neurons during volume perturbation: confocal light and high-voltage electron microscopy. JMSA 1(2):75-85, 1995.

171. Carpenter, D.O., Kemenes, G., Elekes, K., Leung, M., Stefano, G., S.-Rozsa, K. and Salanki, J. Opioid peptides in the nervous system of *Aplysia*: A combined biochemical immunocytochemical, and electrophysiological study. Cell. Molec. Neurobiol. 15:239-256, 1995.

172. Riepe, M. and Carpenter, D.O. Delayed increase of cell volume of single pyramidal cells in live hippocampal slices upon kainate application. Neurosci. Letts. 191:35-38, 1995.

173. Son, H. And Carpenter, D.O. Protein kinase C activation is necessary but not sufficient for induction of LTP at the synapse of mossy fiber-CA3 in the rat hippocampus. Neuroscience 72:1-13, 1996.

174. Iwase, T., Hori, N., Morioka, T. and Carpenter, D.O. Low power laser irradiation reduces ischemic damage in hippocampal slices in vitro. Lasers Surg. Med., 19:465-450, 1996.

175. Carpenter, D.O., King, W.M. and McCreery, M.J. The role of glutamate reuptake in regulation of glutamate responses in *Aplysia* neurons. Acta Biologica Hungaria 46:363-373, 1995.

176. Saghian, A.A., Ayrapetyan, S.N. and Carpenter, D.O. Low concentrations of ouabain stimulate Na/Ca exchange in neurons. Cell. Molec. Neurobiol., 16:489-498, 1996.

177. Platt, B., Carpenter, D.O., Büsselberg, D., Reymann, K.G. and Riedel, G. Aluminum impairs hippocampal long-term potentiation in rats in vitro and in vivo. Exp. Neurol., 134:73-86, 1995.

178. Rubakhin, S.S., Gyori, J., Carpenter, D.O. and Salanki, J. $HgCl_2$ potentiates GABA activated currents in *Lymnaea stagnalis L.* neurons. Acta Biologica Hungaria, 46:431-444, 1995.

179. Fejtl, M. and Carpenter, D.O. Neurite outgrowth is enhanced by conditioning factor(s) released from central ganglia of Aplysia californica. Neurosci. Letts., 199:33-36, 1995.

180. Riepe, M.W., Niemi, W.N., Megow, D., Ludolph, A.C. and Carpenter, D.O. Mitochondrial oxidation in rat hippocampus can be preconditioned by selective chemical inhibition of SDH. Exp. Neurol., 138:15-21, 1996.

181. Son, H. and Carpenter, D.O. Interactions among paired-pulse facilitation and post-tetanic and long-term potentiation in the mossy fiber-CA3 pathway in rat hippocampus. Synapse, 23:302-311, 1996.

182. Carpenter, D.O., Suk, W.A., Blaha, K. and Cikrt, M. Hazardous wastes in Eastern and Central Europe. Environ. Health Perspect., 104:244-248, 1996.

183. Son, H., Davis, P.J. and Carpenter, D.O. Time course and involvement of protein kinase C-mediated phosphorylation of F1/GAP-43 in area CA3 after the mossy fiber stimulation. Cell. Molec. Neurobiol., 17:171-194, 1997.

184. Dyatlov, V.A., Platoshin, A.V., Lawrence, D.A. and Carpenter, D.O. Mercury ($Hg2^+$) enhances the depressant effect of kainate on Ca-inactivated potassium current in telencephalic cells derived from chick embryos. Toxicol. Appl. Pharmacol., 138:285-297, 1996.

185. Carpenter, D.O. and Conway, J.B. Optimizing professional education in public health. J. Public Health Management Practice, 2:66-72, 1996.

186. Carpenter, D.O. Great Lakes contaminants: A shift in human health outcomes. Health and Environment Digest, 10:17-19, 1996.

187. Boldyrev, A.A., Stvolinsky, S.L., Tyulina, O.V., Koshelev, V.B., Hori, N. and Carpenter, D.O. Biochemical and physiological evidence that carnosine is an endogenous neuroprotector against free radicals. Cell. Molec. Neurobiol., 17:259-271, 1997.

188. Szücs, A., Angiello, C., Salánki, J. and Carpenter, D.O. Effects of inorganic mercury and methylmercury on the ionic currewwnts of cultured rat hippocampal neurons. Cell. Molec. Neurobiol., 17:273-288, 1997.

189. Niemi, W.D., Slivinski, K., Audi, J., Rej, R. and Carpenter, D.O. Propylthiouracil treatment reduces long-term potentiation in area CA1 of neonatal rat hippocampus. Neurosci. Letts., 210:127-129, 1996.

190. Son, H., Madelian, V. and Carpenter, D.O. The translocation and involvement of protein kinase C in mossy fiber-CA3 long-term potentiation in hippocampus of the rat brain. Brain Res., 739:282-292, 1997.

191. Oyama, Y., Carpenter, D.O., Chikahisa, L. and Okazaki, E. Flow-cytometric estimation on glutamate- and kainate-induced increases in intracellular Ca^{2+} of brain neurons. Brain Research, 728:121-124, 1996.

192. Carpenter, D.O., Stoner, C.R.T. and Lawrence, D.A. Flow cytometric measurements of neuronal death triggered by PCBs. NeuroToxicology, 18:507-514, 1997.

193. Azatian, K.V., Ayrapetyan, S.N. and Carpenter, D.O. Metabotropic GABA receptors regulate acetylcholine responses on snail neurons. Gen. Pharmacol., 29:67-72, 1997.

194. Carpenter, D.O., Stoner, C.T., Lawrence, D.A., Niemi, W.D., Shain, W. and Seegal, R. Multiple mechanisms of PCB neurotoxicity. Proceedings of the 1996 Pacific Basin Conference on Hazardous Waste, Kuala Lumpur, Malaysia, CONF-9611157, pp. 404-918.

195. Carpenter, D.O. New Dimensions in our understanding of the human health effects of environmental pollutants. Proceedings of the 1996 Pacific Basin Conference on Hazardous Waste, Kuala Lumpur, Malaysia, CONF-9611157, pp. 37-53.

196. Carpenter, D.O. Possible effects of electromagnetic fields on the nervous system and development. Men. Retard. Dev. Dis. Res. Rev. 3:270-274, 1997.

197. Chiarenzelli, J., Scrudato, R., Bush, B., Carpenter, D. and Bushart, S. Do large-scale remedial and dredging events have the potential to release significant amounts of semi-volatile compounds to the atmosphere? Environ. Hlth. Perspect., 106:47-49, 1998.

198. Dyatlov, V.A., Dytlova O.M., Parsons, P.H., Lawrence, D.A. and Carpenter, D.O. Lipopolysaccharide and interleukin-6 enhance lead entry into cerebellar neurons: Application of a new and sensitive flow cytometric technique to measure intracellular lead and calcium concentrations. NeuroToxicology, 19:293-302, 1998.

199. Dyatlov, V.A., Platoshin, A.V.,Lawrence, D.A. and Carpenter, D.O. Lead potentiates cytokine- and glutamate-mediated increases in permeability of the blood-brain barrier. NeuroToxicology, 19:283-292, 1998.

200. Niemi, W.D., Audi, J., Bush, B. and Carpenter, D.O. PCBs reduce long-term potentiation in the CA1 region of rat hippocampus. Exper. Neurol., 151:26-34, 1998.

201. Carpenter, D.O. Health effects of metals. Cent. Eur. J. Publ. Hlth., 6:160-163, 1998.

202. Carpenter, D.O., Bláha, K., Buekens, A., Cikrt, M., Damstra, T., Dellinger, B., Sarofim, A., Suk, W.A., Wyes, H. and Zejda, J. Remediation of hazardous wastes in Central and Eastern Europe: Technology and health effects. Cent. Eur. J. Publ. Hlth., 6:77-78, 1998.

203. Carpenter, D.O. Human health effects of environmental pollutants: New Insights. Environ. Monitor. Assess. J., 53:245-258, 1998.

204. Dyatlov, V.A., Makovetskaia, V.V., Leonhardt, R., Lawrence, D.A. and Carpenter, D.O. Vitamin E enhances Ca^{2+}-mediated vulnerability of immature cerebellar granule cells to ischemia. Free Rad. Biol. Med., 25: 793-802, 1998.

205. Fitzgerald, E.F., Schell, L.M., Marshall, E.G., Carpenter, D.O., Suk, W.A. and Zejda, J.E. Environmental pollution and child health in Central and Eastern Europe. Environ. Health Persp., 106:307-311, 1998.

206. Carpenter, D.O., Arcaro, K.F., Bush, B., Niemi, W.D., Pang, S. and Vakharia, D.D. Human health and chemical mixtures: An overview. Environ. Health Perspect., 106: 1263-1270, 1998.

207. Carpenter, D.O., Cikrt, M. and Suk, W.A. Hazardous wastes in Eastern and Central Europe: Technology and health effects. Environ. Health Perspect., 107: 3-4, 1999.

208. Carpenter, D.O. Polychlorinated biphenyls and human health. Int. J. Occup. Med. Environ. Hlth. 11: 291-303, 1998.

209. Boldyrev, A.A., Johnson, P., Yanzhang, W., Tan, Y. and Carpenter, D.O. Carnosine and taurine protect rat cerebellar granular cells from free radical damage. Neurosci. Letts., 263: 169-172, 1999.

210. Boldyrev, A.A., Carpenter, D.O., Huentelman, M.J., Peters, C.M. and Johnson, P. Sources of reactive oxygen species production in excitotoxin-stimulated neurons. Biophys. Biochem. Res. Commun., 256: 320-324, 1999.

211. Ayrapetyan, S.N., Ayrapetyan, G. and Carpenter, D.O. The electrogenic sodium pump activity in *Aplysia* neurons is not potential dependent. Acta Biologica Hungarica, 50: 27-34, 1999.

212. Boldyrev, A., Song, R., Lawrence, D. and Carpenter, D.O. Carnosine protects against excitotoxic cell death independently of effects on reactive oxygen species. Neuroscience, 94: 571-577, 1999.

213. Boldyrev, A., Song, R., Dyatlov, V.A., Lawrence, D.A. and Carpenter, D.O. Neuronal cell death and reactive oxygen species. Cell. Molec. Neurobiol., 20:433-450, 2000.

214. Gyori, J., Platoshyn, O., Carpenter, D.O. and Salanki, J. Effect of inorganic- and organic tin compounds on ACh- and voltage-activated Na currents. Cell. Molec. Neurobiol. 20:591-604, 2000.

215. Hussain, R.J., Gyori, J., DeCaprio, A.P. and Carpenter, D.O. *In vivo* and *in vitro* exposure to PCB 153 reduces long-term potentiation. Environ. Hlth. Perspect., 108 :827-831, 2000.

216. Negoita, S., Swamp, L., Kelley, B. and Carpenter, D.O. Chronic diseases surveillance of St. Regis Mohawk health service patients. J. Public Health Management Practice, 7:84-91, 2001.

217. Hussain, R.J., Parsons, P.J., Carpenter, D.O. Effects of lead on long-term potentiation in hippocampal CA3 vary with age. Dev. Brain Res., 121: 243-252, 2000.

218. Tanji, M., Katz, B.H., Spink, B.C. and Carpenter, D.O. Growth inhibition of MCF-7 cells by estrogen is dependent upon a serum factor. Anticancer Res., 20: 2779-2784, 2000.

219. Tanji, M. and Carpenter, D.O. A steroid-binding protein mediates estrogen-dependent inhibition of growth of MCF-7 breast cancer cells. Anticancer Res., 20:2785-2790, 2000.

220. Gyori, J., Hussain, R., Carpenter, D.O. Long-term potentiation in CA1 region of rat brain slices is blocked by PCB 153. Cent. Europ. J. Publ. Hlth., 8: 21-22, 2000.

221. Carpenter, D.O. Human health effects of polychlorinated biphenyls. Cent. Eur. J. Public Health, 8: 23-24, 2000.

221a. Sukdolova, V., Negoita, S., Hubicki, L., DeCaprio, A., and Carpenter, D.O. The assessment of risk to acquired hypothyroidism from exposure to PCBs: a study among Akwesasne Mohawk women. Cent. Eur. J. Public Health, 8: 167-168, 2000.

222. Carpenter, D.O., Chew, F.T., Damstra, T., Lam, L.H., Landrigan, P.J., Makalinao, I., Peralta, G.L. and Suk, W.A. Environmental threats to the health of children: The Asian perspective. Environ. Hlth. Perspect., 108: 989-992, 2000.

223. Boldyrev, A.A., Carpenter, D.O. and Johnson, P. Natural mechanisms of protection of neurons against oxidative stress. Recent Res. Devel. Comparative Biochem. & Physiol. 1: 91-103, 2000.

224. Strominger, N.L., Hori, N., Carpenter, D.O., Tan, Y. and Folger W.H. Effects of acetylcholine and GABA on neurons in the area postrema of *Suncus murinus* brainstem slices. Neurosci. Letts. 309: 77-80, 2001.

225. Strominger, N.L., Brady, R., Gullikson, G. and Carpenter, D.O. Imiquimod-elicited emesis is mediated by the area postrema, but not by direct neuronal activation. Brain Res. Bull. 55: 445-451, 2001.

226. Hori, N., Tan, Y., Strominger, N.L. and Carpenter, D.O. Intracellular activity of rat spinal cord motoneurons in slices. J. Neurosci. Meth. 112: 185-191, 2001.

227. Sukocheva, O.A., Abramov, A.Y., Levitskaya, J.O., Gagelgans, A.I. and Carpenter, D.O. Modulation of intracellular Ca concentration by vitamin B12 in rat thymocytes. Blood Cells. Mol. Dis. 27: 812-824, 2001.

228. Gilbertson, M., Carpenter, D. and Upshur, R. Methodology for assessing community health in Areas of Concern: Measuring the adverse effects on human health. Environ. Health Perspect. 109 (Suppl 6): 811-812, 2001.

229. Carpenter, D.O., Shen, Y., Nguyen, T., Le, L. and Lininger, L.L. Incidence of endocrine disease among residents of New York Areas of Concern. Environ. Health Perspect. 109: (Suppl 6) 845-851, 2001.

230. Suk, W.A., Carpenter, D.O., Cirkt, M. and Smerhovsky, Z. Metals in Eastern and Central Europe: Health effects, sources of contamination and methods of remediation. Internat. J. Occup. Med. Environ. Health 14, 151-156, 2001.

231. Carpenter, D.O. Effects of metals on the nervous system of humans and animals. Internat. J Occup. Med. Environ. Health 14: 209-218, 2001.

232. Carpenter, D.O., Arcaro, K. and Spink, D.C. Understanding the human health effects of chemical mixtures. Environ. Health Perspect. 110 (Suppl 1), 25-42, 2002.

233. Carpenter, D.O., Nguyen, T., Le, L., Kudyakov, R. and Lininger, L. Human disease in relation to residence near hazardous waste sites. Proceedings of The 10th Pacific Basin Conference on Hazardous Waste, Okayama, Japan, December 5-7, 2001.

234. Carpenter, D.O., Tarbell, A., Fitzgerald, E., Kadlec, M.J., O'Hehir, D.O. and Bush, B. University-community partnership for the study of environmental contamination at Akwesasne. In: Biomarkers of Environmentally Associated Disease, S.H. Wilson and W.A. Suk, editors, CRC Press/Lewis Publishers, 507-523, 2002.

235. Carpenter, D.O., Hussain, R.J., Berger, D.F., Lombardo, J.P., Park, H-Y. Electrophysiological and behavioral effects of perinatal and acute exposure of rats to lead and polychlorinated biphenyls. Environ. Health Perspect., 110: 377-386, 2002.

236. Hori, N., Tan, Y. King, M., Strominger, N.L. and Carpenter, D.O. Differential actions and excitotoxicity of glutamate agonists on motoneurons in adult mouse cervical spinal cord slices. Brain Res., 958: 434-438, 2002.

237. Laemle, L.K., Hori, N., Strominger, N.L., Tan, Y. and Carpenter, D.O. Physiological and anatomical properties of the suprachiasmatic nucleus of an anophthalmic mouse. Brain Res., 953: 73-81, 2002.

238. Hori, N., Tan, Y., Strominger, N.L. and Carpenter, D.O. Rat motoneuron cell death in development correlates with loss of N-methyl-D-aspartate receptors. Neurosci. Letts., 330:131-134, 2002.

239. Carpenter, D.O., Morris, D.L. and Legator, M. Initial attempts to profile health effects with types of exposure in Anniston, Alabama. FEB, 12: 191-195, 2003.

240. Carpenter, D.O., Nguyen, T., Le, L., Baibergenova, A. and Kudyakov, R. Profile of health effects related to proximity to PCB-contaminated hazardous waste sites in New York. FEB, 12: 173-180, 2003.

241. Hori, N., Carp, J.S., Carpenter, D.O. and Akaike, N. Corticospinal transmission to motoneurons in cervical spinal slices from adult rats. Life Sci., 72: 389-396, 2002.

242. Carpenter, D.O. and Hussain, R.J. Cell-to-cell communication of neurons is impaired by metals. Mat.-wiss. U. Werkstofftech. 34: 1-8, 2003.

243. Tan, Y., Hori, N. and Carpenter, D.O. The mechanism of presynaptic long-lasting-depression mediated by group 1 metabotropic glutamate receptors. Cell. Molec. Neurobiol., 23: 187-203, 2003.

244. Baibergenova, A., Kudyakov, R., Zdeb, M., and Carpenter, D.O. Low birth weight and residential proximity to PCB-contaminated waste sites. Environ. Health Perspect., 111: 1352-1357, 2003.

245. Nishizaki, Y., Oyama, Y., Sakai, Y., Hirama, S., Tomita, K., Nakao, H., Umebayashi, C., Ishida, S., Okano, Y. and Carpenter, D.O. $PbCl_2$-induced hyperpolarization of rat thymocytes: Involvement of charybdotoxin-sensitive K+ channels. Environ. Toxicol., 18(5): 321-326, 2003.

246. Hussain, R.J. and Carpenter, D.O. The effects of protein kinase C activity on synaptic transmission in two areas of rat hippocampus. Brain Res., 990: 28-37, 2003.

247. Suk, W.A., Ruchirawat, K., Balakrishnan, K., Berger, M., Carpenter, D., Damstra, T,. Pronczuk de Garbino, J., Koh, D., Landrigan, P.J., Makalinao, I., Sly, P.D., Xu, Y. and Zheng, B.S.

Environmental threats to children's health in Southeast Asia and the Western Pacific. Environ. Health Perspect. 111: 1340, 2003.

248. Carpenter, D.O. The need for global environmental health policy. New Solutions, 13(1): 53-59, 2003.

249. Tan, Y., Li, D., Song, R., Lawrence, D. and Carpenter, D.O. Ortho-substituted PCBs kill thymocytes. Toxicol. Sci., 76: 328-337, 2003.

250. Boldyrev, A., Bulygina, E., Carpenter, D.O. and Schoner, W. Glutamate receptors communicate with Na+/K+-ATPase in rat cerebellum granule cells: Demonstration of differences in the action of several metabotropic and ionotropic glutamate agonists on intracellular reactive oxygen species and the sodium pump. J. Molec. Neurosci., 21:213-222, 2003.

251. Hites, R.A., Foran, J.A., Carpenter, D.O., Hamilton, M.C., Knuth, B.A. and Schwager, S.J. Global assessment of organic contaminants in farmed salmon. Science 303: 226-229, 2004.

252. Sandal, S., Yilmaz, B., Chen, C-H and Carpenter, D.O. Comparative effects of technical toxaphene, 2,5-dichloro-3-biphenylol and octabromodiphenylether on cell viability, $[Ca^{2+}]_i$ levels and membrane fluidity in mouse thymocytes. Toxicol. Letts., 151: 417-428, 2004.

253. Tan, Y., Chen, C-H., Lawrence, D. and Carpenter, D.O. Ortho-substituted PCBs kill cells by altering membrane structure. Toxicol. Sci., 80: 54-59, 2004.

254. Tan, Y., Song, R., Lawrence, D. and Carpenter, D.O. Ortho-substituted but not coplanar PCBs rapidly kill cerebellular granule cells. Toxicol. Sci., 79: 147-156, 2004.

255. Ozcan, M., Yilmaz, B., King, W.M. and Carpenter, D.O. Hippocampal long-term potentiation (LTP) is reduced by a coplanar PCB congener. NeuroToxicology, 25: 981-988, 2004.

256. Ssempebwa, J.C., Carpenter, D.O., Yilmaz, B., DeCaprio, A.P., O=Hehir, D.J. and Arcaro, K.F. Waste crankcase oil: an environmental contaminant with potential to modulate estrogenic responses. J. Toxicol. Environ. Hlth, Part A, 67: 1081-1094, 2004.

257. Foran, J.A., Hites, R.A., Carpenter, D.O., Hamilton, M.C., Mathews-Amos, A. and Schwager, S.J. A survey of metals in tissues of farmed Atlantic and wild Pacific salmon. Environ. Toxicol. Chem., 23: 2108-2110, 2004.

258. Oenga, G.N., Spink, D.C. and Carpenter, D.O. TCDD and PCBs inhibit breast cancer cell proliferation in vitro. Toxicol. In Vitro, 18: 811-819, 2004.

259. Hussain, R.J. and Carpenter, D.O. A comparison of the roles of protein kinase C in long-term potentiation in rat hippocampal areas CA1 and CA3. Cell. Molec. Neurobiol., 25: 649-661, 2005.

260. Hites, R.A., Foran, J.A., Schwager, S.J., Knuth, B.A., Hamilton, M.C. and Carpenter, D.O. Global assessment of polybrominated diphenyl ethers in farmed and wild salmon. Organohalogen Compounds, 66: 3826-3829, 2004.

261. Kudyakov, R., Baibergenova, A., Zdeb, M. and Carpenter, D.O. Respiratory disease in relation to patient residence near to hazardous waste sites. Environ. Toxicol. Pharmacol., 18: 249-257, 2004.

262. Gilbertson, M. and Carpenter, D.O. An ecosystem approach to the health effects of mercury in the Great Lakes basin ecosystem. Environ. Res. 95: 240-246, 2004.

263. Hites, R.A., Foran, J.A., Schwager, S.J., Knuth, B.A., Hamilton, M.C. and Carpenter, D.O. Global assessment of polybrominated diphenyl ethers in farmed and wild salmon. Environ. Sci. Technol., 38: 4945-4949, 2004.

264. DeCaprio, A.P., Johnson, G.W., Tarbell, A.M., Carpenter, D.O. Chiarenzelli, J.R., Morse, G.S., Santiago-Rivera, A.L., Schymura, M.J., and the Akwesasne Task Force on the Environment. PCB exposure assessment by multivariate statistical analysis of serum congener profiles in an adult Native American population. Environ. Res., 98: 284-302, 2005.

265. Boldyrev, A.A., Kazey, V.I., Leinsoo, T.A., Mashkina, A.P., Tyulina O.V., Tuneva, J.O., Chittur, S. and Carpenter, D.O. Rodent lymphocytes express functionally active glutamate receptors. Biochem. Biophys. Res. Comm., 324: 133-139, 2004.

266. Boldyrev, A.A., Koudinov, A., Berezov, T. and Carpenter, D.O. Amyloid-β induced cell death is independent of free radicals. J. Alzheimer=s Dis., 6: 633-638, 2004.

267. Neagu, B., Strominger, N.L. and Carpenter, D.O. Use of bipolar parallel electrodes for well-controlled microstimulation in a mouse hippocampal brain slice. J. Neurosci. Meth., 144: 153-163, 2005.

268. Suk, W.A., Avakian, M.D., Carpenter, D., Groopman, J.D., Scammell, M. and Wild, C.P. Human exposure monitoring and evaluation in the Arctic: The importance of understanding exposures to the development of public health policy. Environ. Health Perspect. 112: 113-120, 2004.

269. Neagu, B., Neagu, E.R., Strominger, N.L. and Carpenter, D.O. A new fast electro-physiological response measured extracellularly in a mouse hippocampal brain slice. Neurosci. Letts., 381: 179-184, 2005.

270. Sergeev, A.V. and Carpenter, D.O. Hospitalization rates for coronary heart disease in relation to residence near areas contaminated with POPs and other pollutants. Environ. Health Perspect., 113: 756-761, 2005.

271. Foran, J.A., Carpenter, D.O., Hamilton, M.C., Knuth, B.A. and Schwager, S.J. Risk-based consumption advice for farmed Atlantic and wild Pacific salmon contaminated with dioxins and dioxin-like compounds. Environ. Health Perspect. 113: 552-556, 2005.

272. Shaw, S.D., Bourakovsky, A., Brenner, D., Carpenter, D.O., Tao, L., Kannan, K. and Hong, C-S. Polybrominated diphenyl ethers (PBDEs) in farmed salmon from Maine and Eastern Canada. In: Proceedings of 25th International Symposium on Halogenated Environmental Organic Pollutants and POPs (DIOXIN 2005), August 21-26, 2005, Toronto, Canada.

273. Carpenter, D.O., DeCaprio, A.P., O=Hehir, D., Akhtar, F., Johnson, G., Scrudato, R.J., Apatiki, L., Kava, J., Gologergen, J., Miller, P.K. and Eckstein, L. Polychlorinated biphenyls in serum of the Siberian Yupik people from St. Lawrence Island, Alaska. Int. J. Circumpolar Health, 64(4): 322-335, 2005.

274. Foran, J.A., Good, D.H., Carpenter, D.O., Hamilton, M.C., Knuth, B.A. and Schwager, S.J. Quantitative analysis of the benefits and risks of consuming farmed and wild salmon. J. Nutr 135: 2639-2643, 2005.

275. Huang, X., Hites, R.A., Foran, J.A., Hamilton, C., Knuth, B.A., Schwager, S.J. and Carpenter, D.O. Consumption advisories for salmon based on risk of cancer and non-cancer health effects. Environ. Res., 101: 263-274, 2006.

276. Shcherbatykh, I., Huang, X., Lessner, L. and Carpenter, D.O. Hazardous waste sites and stroke in New York State. Environ. Health, 4:18, 2005.

277. Hamilton, M.C., Hites, R.A., Schwager, S.J., Foran, J.A., Knuth, B.A. and Carpenter, D.O. Lipid composition and contaminants in farmed and wild salmon. Environ. Sci. Tech., 39: 8622-8629, 2005.

278. Yilmaz, B., Sandal, S., Chen, C-H. and Carpenter, D.O. Effects of PCB 52 and PCB 77 on cell viability, $[Ca^{2+}]_i$ levels and membrane fluidity in mouse thymocytes. Toxicology, 217: 184-193, 2006.

279. Tan, Y., Hori, N., and Carpenter, D.O. Electrophysiological effects of three groups of glutamate metabotropic receptors in rat piriform cortex. Cell. Molec. Neurobiol., 26: 915-924, 2006.

280. Boldyrev, A.A., Carpenter, D.O. and Johnson, P.A., Emerging evidence for a similar role of glutamate receptors in the nervous and immune systems. J. Neurochem., 95: 913-918, 2005.

281. Sandal, S., Yilmaz, B., Godekmerdan, A., Kelestimur, H. and Carpenter, D.O. Effects of PCBs 52 and 77 on Th1/Th2 balance in mouse thymocyte cell cultures. Immunopharmacol. Immununotoxicol. 27: 601-613, 2005.

282. Carpenter, D.O. Environmental contaminants and learning and memory. International Congress Series, 1287: 185-189, 2006.

283. Carpenter, D.O. Polychlorinated biphenyls (PCBs): Routes of exposure and effects on human health. Rev. Environ. Health, 21: 1-23, 2006.

284. Huang, X., Lessner, L. and Carpenter, D.O. Exposure to persistent organic pollutants and hypertensive disease. Environ. Res., 102: 101-106, 2006.

285. Carpenter, D.O., El-Qaderi, S., Fayzieva, D., Gilani, A., Hambartsumyan, A., Herz, K., Isobaev, M., Kasymov, O., Kudyakov, R., Majitova, Z., Mamadov, E., Nemer, L., Revich, B., Stege, P., Suk, W., Upshur, R., Yilmaz, B. and Zaineh K. Children's environmental health in Central Asia and the Middle East. Int. J. Occup. Environ. Health, 12: 362-368, 2006.

286. King, W.M., Sarup, V., Sauve, Y., Moreland, C.M., Carpenter, D.O. and Sharma. S.C. Expansion of visual receptive fields in experimental glaucoma. Visual Neurosci. 23: 137-142, 2006.

286b. Laemle LK, Strominger NL, and Carpenter DO. Cross-modal innervation of primary visual cortex by auditory fibers in congenitally anophthalmic mice. Neurosci Lett 396: 108-112: 2006.

287. Tuneva, J., Chittur, S., Boldyrev, A.A., Birman, I. and Carpenter, D.O. Cerebellar granule cell death induced by aluminum. Neurotox. Res., 9: 297-304, 2006.

288. Trasande, L., Boscarino, J., Graber, N., Falk, R., Schechter, C., Dunkel, G., Geslani, J., Moline, J., Kaplan-Liss, E., Miller, R.K., Korfmacher, K., Carpenter, D., Balk, S.J., Laraque, D., Frumkin, H. and Landrigan, P.J. The environment in pediatric practice: A study of New York pediatricians' attitudes, beliefs, and practices towards children's environmental health. J. Urban Health, 2006, DOI: 10.1007/s11524-006-9071-4.

289. Surdu, S., Montoya, L.D., Tarbell, A. and Carpenter, D.O. Childhood asthma and indoor allergens in Native Americans in New York. Environ. Health: A Global Access Science Source, 5:22, 2006. DOI: 10.1186/1476-069X-5-22.

290. Ozcan M., Yilmaz, B. and Carpenter, D.O. Effects of melatonin on synaptic transmission and long term potentiation in two areas of mouse hippocampus. Brain Res., 1111: 90-94, 2006.

291. Shaw, S.D., Brenner, D., Berger, M.L., Pulser, E.L., Carpenter, D.O., Hong, C-W and Kannan K. PCBs, dioxin-like PCBs, dioxins, and organochlorine pesticides in farmed salmon (Salmo salar) from Maine and Eastern Canada. Environ. Sci. Technol. 40: 5347-5354, 2006.

292. Yilmaz, B., Ssempebwa J., Mackerer, C.R., Arcaro, K.F. and Carpenter, D.O. Effects of polycyclic aromatic hydrocarbon-containing oil mixtures on generation of reactive oxygen species and cell viability in MCF-7 breast cancer cells. J. Toxicol. Environ. Health, Part A: 70: 1-8, 2007.

293. Kouznetsova, M., Huang, X., Ma, J., Lessner, L. and Carpenter, D.O. Increased rate of hospitalization for diabetes and residential proximity of hazardous waste sites. Environ. Health Perspect., 115:75-79, 2007.

294. Yilmaz, Y., Seyran, A.D., Sandal, S., Aydin, M., Colakoglu, N., Kocer, M. and Carpenter, D.O. Modulatory effects of Aroclors 1221 and 1254 on bone turnover and vertebral histology in intact and ovariectomized rats. Toxicology Letts., 166: 276-294, 2006.

295. Shcherbatykh, I. and Carpenter, D.O. The role of metals in the etiology of Alzheimer's disease. J. Alzheimer's Dis., 11: 191-205, 2007.

296. Surdu S, Neamtiu I, Gurzau E, Kasler I and Carpenter D. Blood lead levels and hand lead contamination in children ages 4-6 in Copsa Mica, Romania. In: *Environmental Health in Central and Eastern Europe*. KC Donnelly and LH Cizmas, Eds. Springer Netherlands. pp. 123-134, 2007.

297. Carpenter D.O. The importance of the Great Lakes Water Quality Agreement. J Public Health Policy 28: 216-220, 2007.

298. Codru N, Schymura MJ, Negoita S, the Akwesasne Task Force on the Environment, Rej R and Carpenter DO. Diabetes in relation to serum levels of polychlorinated biphenyls (PCBs) and chlorinated pesticides in adult Native Americans. Environ Health Perspect. 115: 1442-1447, 2007.

299. Carpenter DO. Biomarcadores de efectos neuroconductuales. Acta Toxicol Argent 14 (Suplemento): 11-12, 2006.

300. Hennig B, Ormsbee L, Bachas L, Silverstone A, Milner J, Carpenter D, Thompson C and Suk WA. Introductory comments: nutrition, environmental toxins and implications in prevention and intervention of human diseases. J Nutrit Biochem 189: 161-163, 2007.

301. Arnold R, Armour MA, Barich J, Cebrian M, Cifuentes L, Kirk D, Koh D, Lewis ND, Ling B, Makalinao I, Maiden T, Paz-y-Mino C, Peralta G, Singh K, Sly P, Suk W, Woodward A, Zheng B and Carpenter DO. Threats to human health and environmental sustainability in the Pacific Basin: The 11th International Conference of the Pacific Basin Consortium. Environ Health Perspect. 115: 1770-1775, 2007.

302. Parrish RR, Horstwood M, Arnason JG, Chenery S, Brewer T, Lloyd NS and Carpenter DO (2008) Depleted uranium contamination by inhalation exposure and its detection after approximately 25 years: Implications for health assessment. Sci Total Environ 390: 58-68.

303. Goncharov A, Haase RF, Santiago-Rivera A, Morse G, Akwesasne Task Force on the Environment, McCaffrey RJ, Rej R and Carpenter DO. (2008) High serum PCBs are associated with elevation of serum lipids and cardiovascular disease in a Native American population. Environ Res. 106: 226-239.

304. Ma J, Kouznetsova M, Lessner L and Carpenter DO. Asthma and infectious respiratory disease in children – correlation to residence near hazardous waste sites. Paediatr Respir Rev 8: 292-298, 2007.

305 Schell LM, Gallo MV, Denham M, Ravenscroft J, DeCaprio AP and Carpenter DO (2008) Relationship of thyroid hormone levels of polychlorinated biphenyls, lead, p,p'-DDE and other toxicants in Akwesasne Mohawk youth. Environ Health Perspect. 116: 806-813.

306. Ssempebwa J and Carpenter DO (2009) The generation, use and disposal of waste crankcase oil in developing countries: A case for Kampala District, Uganda. J Hazard Materials 161: 835-841.

307. Carpenter DO (2008) Environmental contaminants as risk factors for developing diabetes. Rev Environ Health 23: 59-74.

308. Shaw SD, Berger ML, Brenner D, Carpenter DO, Lao L, Hong CS and Kannan K (2008) Polybrominated diphenyl ethers (PBDEs) in farmed and wild salmon marketed in the Northeastern United States. Chemosphere 71: 1422-1431.

309. Sandel S, Yilmaz B and Carpenter DO (2008) Genotoxic effects of PCB 52 and PCB 77 on cultured human peripheral lymphocytes. Mutation Res. 654: 88-92.

310. Carpenter DO and Sage C (2008) Setting prudent public health policy for electromagnetic field exposures. Rev Environ Health 23: 91-117.

311. Neagu B, Strominger NL and Carpenter DO (2008) Contribution of NMDA receptor-mediated component to the EPSP in mouse Schaffer collateral synapses under single pulse stimulation protocol. Brain Res. 1240: 54-61.

312. Holdren J, Tao S and Carpenter DO (2008) Environment and health in the 21st Century: Challenges and solutions. Ann NY Acad Sci. 1140:1-21.

313. Carpenter DO, Ma J and Lessner L (2008) Asthma and infectious respiratory disease in relation to residence near hazardous waste sites. Ann NY Acad Sci. 1140: 201-208.

314. Sandal S, Tuneva J, Yilmaz B and Carpenter DO (2009) Effects of cholesterol and docosahexaenoic acid on cell viability and $(Ca^{2+})_i$ levels in acutely isolated mouse thymocytes. Cell Biochem Funct 27: 155-161.

315. Steele RE, de Leeuw, E and Carpenter DO (2009) A novel and effective treatment modality for medically unexplained symptoms. J Pain Management 1: 402-412

316. Sage C and Carpenter DO (2009) Public health implications of wireless technologies. Pathophysiology 16: 233-246.

317. Sly PD, Eskenazi B, Pronczuk J, Sram R, Diaz-Barriga F, Machin DG, Carpenter DO, Surdu S and Meslin EM (2009) Ethical issues in measuring biomarkers in children's environmental health. Environ Health Perspect. 117: 1185-1190.

318. Goncharov A, Rej R, Negoita S, Schymura M, Santiago-Rivera A, Morse G, Akwesasne Task Force on the Environment and Carpenter DO (2009) Lower serum testosterone associated with elevated polychlorinated biphenyl concentrations in Native American men. Environ Health Perspect. 117:1454-1460.

319. Tuneva JO, Karpova LV, Shittur SV, Carpenter DO, Johnson P and Boldyrev AA (2009) Amyloid-β and aluminum ions enhance neuronal damage mediated by NMDA-activated glutamate receptors. Biochemistry (Moscow) Supplement Series A: Membrane and Cell Biology 4: 466-471.

320 Carpenter DO and Nevin R (2009) Environmental causes of violence. Physiol Behavior 99: 260-268.

321. Goncharov A, Bloom MS, Pavuk M, Carpenter DO for the Anniston Environmental Health Research Consortium. (2009) Exposure to PCBs and hypertension in the Anniston Community Health Survey. Organohal Comp 71: 0-136.

322. Sergeev AV and Carpenter DO (2010) Residential proximity to environmental sources of persistent organic pollutants and first-time hospitalizations for myocardial infarction with comorbid diabetes mellitus: A 12-year population-based study. Int J Occup Med Environ Health 23: 5-13.

323. Carpenter DO (2010) Electromagnetic fields and cancer: The cost of doing nothing. Rev Environ Health 25: 75-80.

324. Sergeev AV and Carpenter DO (2010) Exposure to persistent organic pollutants increases hospitalization rates for myocardial infarction with comorbid hypertension. Primary Prevention Insights. 2: 1-9.

325. Hori N, Kadota MT, Watanabe M, Ito Y, Akaike N and Carpenter DO (2010) Neurotoxic effects of methamphetamine on rat hippocampus pyramidal neurons. Cell Mol Neurobiol.30: 849-856.

326. Hardell, S, Tilander H, Welfinger-Smith G and Carpenter DO (2010) Levels of polycholorinated biphenyls (PCBs) and three organochlorine pesticides in fishes from the Aleutian Islands of Alaska. PLoS ONE, 5:e12396.

327. Carpenter, DO. (2010) Human health effects of EMFs: The cost of doing nothing. IOP Conf. Series: Earth and Environmental Science 10: 012004. doi:10:1088/1755-1315/10/1/10/012004.

328. Goncharov A, Bloom M, Pavuk M, Birman I and Carpenter DO for the Anniston Environmental Health Research Consortium. Blood pressure and hypertension in relation to levels of serum polychlorinated biphenyls in residents of Anniston, Alabama. J Hypertension. 28: 2053-2060..

329. Prasad A, Ahs M, Goncharov A and Carpenter DO (2010) Omega-3 and omega-6 fatty acids kill thymocytes and increase membrane fluidity. The Open Cell Development & Biology Journal 3: 1-8

330. Sergeev AV and Carpenter DO (2010) Increased hospitalizations for ischemic stroke with comorbid diabetes and residential proximity to source of organic pollutants: A 12-year population-based study. Neuroepidemiology 35:19.

331. Prasad A, Bloom M and Carpenter DO (2010) Role of calcium and ROS in cell death induced by polyunsaturated fatty acids in murine thymocytes. J Cell Physiol. 225: 829-836.

332. Sergeev AV and Carpenter DO (2010) Geospatial patterns of hospitalization rates for stroke with comorbid hypertension in relation to environmental sources of persistent organic pollutants: Results from a 12-year population-based study. Environ Sci Pollut Res Int 18: 576-585.

333. Brown D, Goncharov A, Paul E, Simonin H and Carpenter DO. (2010) The relationships between Adirondack lake pH and levels of mercury in yellow perch. J Aquat Animal Health. 22:280-290.

334. Gavidia T, Brune M-N, McCarty KM, Pronczuk J, Etzel R, Neira M, Carpenter DO, Suk WA, Arnold RG, Ha EH, and Sly PD (2010) Children's environmental health – from knowledge to action. Lancet 377:1134-1136.

335. Bushkin-Bedient S and Carpenter DO (2010) Benefits versus risks associated with consumption of fish and other seafood. Rev Environ Health 25: 161-191.

336. Goncharov A, Pavuk M, Foushee HR and Carpenter DO for the Anniston Environmental Health Consortium (2010) Blood pressure in relation to concentrations of PCB congeners and chlorinated pesticides. Environ Health Perspect. 119:319-325.

337. Yilmaz B, Sandal S and Carpenter DO (2012) PCB 9 exposure induces endothelial cell death while increasing intracellular calcium and ROS levels. Environ Toxicol.27: 185-191.

338. Sly PD, Arnold RG and Carpenter DO (2011) Environmental exposures in the era of climate change. Rev Environ Health 26: 1-4.

339. Carpenter DO (2011) Health effects of persistent organic pollutants: The challenge for the Pacific Basin and for the World. Rev Environ Health 26: 61-69.

340. Sergeev AV and Carpenter DO (2011) Increase in metabolic syndrome-related hospitalizations in relation to environmental sources of persistent organic pollutants. Int J Environ Res Public Health 8:762-776.

341. Carpenter DO, Miller PK, Waghiyi, Welfinger-Smith G (2011) Environmental contamination of the Yupik people of St. Lawrence Island, Alaska. J Indigenous Res In Press.

342. Carpenter DO (2010) Human health effects of EMFs: The cost of doing nothing. IOP C Ser Earth Env 10:1-6.

343. Kamalov J, Carpenter DO, Birman I (2011) Cytotoxicity of environmentally relevant concentrations of aluminum in murine thymocytes and lymphocytes. J Toxicol. Doi:10.1155/2011/796719.

344. Silbernagel S, Carpenter DO, Gilbert SG, Gochfeld M, Groth E, Hightower JM, Schiavone FM. (2011) Recognizing and preventing over exposure to methylmercury from fish and seafood consumption: Information for physicians. J Toxicol, 2011; doi:10.1155/2011/983072

345. Welfinger-Smith G, Minholz JL, Byrne S, Waghiyi V, Gologergen J, Kava J, Apatiki M, Ungott E, Miller PK, Arnason J and Carpenter DO. (2011) Organochlorine and metal contaminants in traditional foods from St. Lawrence Island, Alaska. J Toxicol Environ Health A. 74: 1-20.

346. Åhs M, Prasad A, Aminov Z and Carpenter DO (2011) Mechanisms of cell death of thymocytes induced by polyunsaturated, monounsaturated and trans-fatty acids. J Cell. Biochem. 112: 3863-3871.

347. Boberg E, Lessner L and Carpenter DO. (2011) The role of residence near hazardous waste sites containing benzene in the development of hematologic cancers in upstate New York. Int J Occup Med Environ Health. 24: 1-12..

348. Turyk ME, Bhazsar SP, Bowerman W, Boysen E, Clark M, Diamond M, Mergler D, Pantazopoulos P, Schantz S and Carpenter DO (2012) Risks and benefits of consumption of Great Lakes fish. Environ Health Perspect. 120: 11-18.

349. Ma J, Lessner L, Schreiber J and Carpenter DO (2009) Association between residential proximity to PERC dry cleaning establishments and kidney cancer in New York city. J Environ Public Health doi:10.1155/2009/183920.

350. Morse GS, Duncan G, Noonan C, Carroutte E, Santiago-Rivera A, Carpenter DO and Tarbell A (2011) Environmental toxins and depression in an American Indian Community. J Indigen Res 1: (1) Article 6. http://digitalcommons.usu.edu/kicjir/vol1/iss1/6.

351. Liu X, Lessner L and Carpenter DO (2012) Association between residential proximity to fuel-fired power plants and hospitalization rate for respiratory diseases. Environ Health Perspect 120: 807-810.

352. Ruzzin J, Lee D-H, Carpenter DO and Jacobs DR Jr. (2012) Reconsidering metabolic disease: The impact of persistent organic pollutants. Atherosclerosis 224: 1-3.

353. Florea A-M, Busselberg D and Carpenter D (2012) Metals and disease. J Toxicol 2012. Doi:10.1155/2012/825354.

354. Smolyaninova LV, Carpenter DO, Dergalev AA, Kulebyakin KY and Boldyrev AA (2013) Carnosine prevents necrotic and apoptotic death of rat thymocytes via ouabain sensitive Na/K-ATPase. Cell Biochem Funct. 20: 30-35.

355. Khwaja HA, Fatmi Z, Malashock D, Aminov Z, Siddique A and Carpenter DO (2012) Effect of air pollution on daily morbidity in Karachi, Pakistan. J Local Global Health Science, 2012:3 http://dx.doi.org/10.5339/jlghs.2012.3

356. Scrudato RJ, Chiarenzelli FR, Miller PK, Alexander CR, Arnason J, Zamzow K, Zweifel K, Gologergen J, Kava J, Waghiyi V and Carpenter DO. (2012) Contaminants at Arctic formerly used defense sites. J Local Global Health Science. 2012:2 http://dx.doi.org/10.5339/jlghs.2012.2

357. Hoover E, Cook K, Plain R, Sanchez K, Waghiyi V, Miller P, Dufault R, Sislin C and Carpenter DO (2012) Indigenous peoples of North America: Environmental exposures and reproductive justice. Environ Health Perspect. 120: 1645-1649.

358. Pantazopoulos P, Sawyer JM, Turyk ME, Diamond M, Bhavsar SP, Mergler D, Schantz S, Ratnayake N and Carpenter DO (2012) Fatty acids in Great Lakes lake trout and whitefish. J Great Lakes Res. 39: 120-127.

359. Sly JL and Carpenter DO (2012) Special vulnerability of children to environmental exposures. Rev Environ Health 27: 151-157.

360. Bushkin-Bedient S and Carpenter DO (2013) Exposure to chemicals and radiation during childhood and risk for cancer later in life. J Adolesc Health, 52: S21-S29.

361. Surdu S, Fitzgerald EF, Bloom MS, Boscoe FP, Carpenter DO et al. (2013) Occupational exposure to ultraviolet radiation and risk of non-melanoma skin cancer in a multinational European study. PLoS One. In press.

362. Surdu A, Fitzgerald EF, Bloom MS, Boscoe FP, Carpenter DO et al. (2013) Occupational exposure to arsenic and risk of non-melanoma skin cancer in a multinational Furopean study. Int J Cancer. 133:2182-2191.

363. Norman RE, Carpenter DO, Scott J, Brune MN and Sly PD (2013) Environmental exposure: an under-recognized contribution to noncommunicable diseases. Rev Environ Health 28: 59-65.

364. Sly PD, Chen L, Gangell CL, Scott J, Zubrick S, Whitehouse A and Carpenter DO (2012) Polychlorinated biphenyls but not chlorinated pesticides are associated with externalizing behavior in adolescents. Organohal Comps.

365. Grant KL, Carpenter DO, Sly LJ and Sly PD)2013) Environmental contributions to obesity and type 2 diabetes. J Environ Immunol Toxicol 1: 80-91.

366. Miller PK, Waghiyi V, Welfinger-Smith G, Byrne SC, Kava J, Gologergen J, Eckstein L, Scrudato R, Chiarenzelli J, Carpenter DO and Seguinot-Medina S. (2013) Community-based participatory research projects and policy engagement to protect environmental health on St. Lawrence Island, Alaska. Int J Circumpolar Health 72: 1-11. http://dx.doi.org/10.3402/ijch.v7210.21656.

367. Gore AC, Balthazart J, Bikle D, Carpenter DO, Crews D et al. (2013). Policy decisions on endocrine disruptors should be based on science across disciplines: a response to Dietrich et al. Eur J Endocrinol 169: E1-E4.

368. Nayebare SR, Wilson LR, Carpenter DO, Dziewulski DM, and Kannan K (2014) A review of potable water accessibility and sustainability issues in developing countries – case study of Uganda. Rev Environ Health. In press.

369. Carpenter DO (2013) Human disease resulting from exposure to electromagnetic fields. Rev Environ Health 28: 159-172.

370. Aminov Z, Haase RF, Pavuk M and Carpenter DO (2013) Analysis of the effects of exposure to polychlorinated biphenyls and chlorinated pesticides on serum lipid levels in residents of Anniston, Alabama. Environ Health 12: 108

371. Musoke D, Carpenter D, Kasasa S, Bazeyo W and Ssempebwa JC (2013) Water, sanitation and hygiene status of two urban slums in Uganda: a baseline survey. Environ Health Internat 14: 24-36.

372. Carpenter DO (2014) Environmental exposure in indigenous communities: an international perspective. Rev Environ Health 29: 3-4.

373. Falfushynska HI, Gnatyshyna LL, Osadchuk OY, Farkas A, Vehovszky A, Carpenter DO, Gyori J and Stoliar OB. (2014) Diversity of the molecular responses to separate wastewater effluents in freshwater mussels. Comp Biochem Physiol, 164: 51-58.

374. Neff MR, Bhavsar SP, Ni F, Carpenter DO, Drouillard K, Fisk AT, and Arts MT (2014) Risk-benefit of consuming Lake Erie fish. Environ Res. 134: 57-65.

375. Wang H, Liddell CA, Coates MM, Mooney MD et al. (2014) Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet http://dx.doi.org/10.1016/50140-6736(14)60497-9.

376. Lu X, Lessner L and Carpenter DO (2014) Association between hospital discharge rate for female breast cancer and residence in a zip code containing hazardous waste sites. Environ Res. 134: 375-381.

377. Aminov Z, Haase R, Olson JR, Pavuk M and Carpenter DO (2014) Racial differences in levels of serum lipids and effects of exposure to persistent organic pollutants on lipid levels in residents of Anniston, Alabama. Environ Internat 73: 216-223..

378. Carpenter DO (2014) Excessive exposure to radiofrequency electromagnetic fields may cause the development of a syndrome of electro-hypersensitivity. Alt Therap 20: 80-82379.

379. Macey GP, Breech R, Chernaik M, Cox C, Larson D, Thomas D and Carpenter DO (2014) Air concentrations of volatile compounds near oil and gas production: a community-based exploratory study. Environ Health 13: 82.

380. Surdu S, Fitzgerald EF, Bloom MS, Boscoe FP, Carpenter DO, Haase RF, Gurzau E, Rudnai P, Koppova K, Vahter M, Leonardi G, Goessler W, Kumar R and Fletcher T (2014) Polymorphisms in DNA repair genes XRCC1 and XRCC3, occupational exposure to arsenic and sunlight, and the risk of non-melanoma skin cancer in a European case-control study. Environ Res 134: 382-389.

381. Chacko A, Carpenter DO, Callaway L and Sly PD (2015) Early life risk factors for chronic non-respiratory diseases. Eur Resp 45: 244-259

382. GBD 2013 Mortality and Causes of Death Collaborators (2014) Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease. Lancet http://dx.doi.org/10.1016/S0140-6736(14)61682-2.

383. Brune M-N, Goldizen FC, Neira M, van den Berg M, Lewis N, King M., Suk WA, Carpenter DO, Arnold RG and SlyPD (2013) Health effects of exposure to e-waste. Lancet Global Health 1(2): e70.

384. Goodson, W III, Lowe L, Carpenter D, Gilbertson M, Ali A et al. (2015). Assessing the carcinogenic potential of low dose exposures to chemical mixtures in the environment: The challenge ahead. Carcinogenesis. 36, Suppl 1, S254-S296.

385. Carpenter DO (2015) Exposure to and health effects of volatile PCBs. Rev Environ Health 30:81-92..

386. Byrne S, Miller P, Vaghiyi V, Buck CL, von Hippel F and Carpenter DO (2015) Persistent organochlorine pesticide exposure related to a formerly used defense site on St. Lawrence Island, Alaska: Data from sentinel fish and human sera. J Toxicol Environ Health A 78: 976-992.

387. GBD 2013 Disease and Injury Incidence and Prevalence Collaborators (2015) Global, regional, and national incidence, prevalence and YLDs for 301 acute and chronic diseases and injuries for 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet

388. Pavuk M, Olson JR, Wattigney WA, Dutton ND, Sjodin A et al. (2014) Predictors of serum polychlorinated biphenyl concentrations in Anniston residents. Sci Total Environ 496: 624-634.

389. Sly PD, Neira M, Collman G, Carpenter DO, Landrigan PJ, van den Berg M, Barriga FD, Ruchirawat M, Laborde A, Pascale A, Heacock M, Calmau MT and Suk WA (2014) Networking to advance progress in children's environmental health. Lancet Global Health e129-130.

390. Wang, G, Liddell CA, Coates MM, Mooney MD, Levitz CE et al. (2014) Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 384: 957-979.

391. Global Burden of Disease Cancer Collaboration (2015) The Global Burden of Cancer. JAMA Oncol 1(4): 505-527. Doi:100.1001/jamaoncol.2015.0735.

392. DeNicola E, Aburizaiza OS, Siddique A, Khwaja H and Carpenter DO (2015) Obesity and public health in the Kingdom of Saudi Arabia. Rev Environ Health 30: 191-205.

393. Bwesigye DA, Loneck BM, Sherman BR and Carpenter DO (2015) Theoretical application assessing adaptation of District Health Information System (DHIS 2) for HIZ/AIDS surveillance in Uganda. Health Sys Policy Res 2: 1-7.

394. Lombardo JP, Berger DF, Hunt A and Carpenter DO (2015) Inhalation of polychlorinated biphenyls (PCB) produces hyperactivity in rats. J Toxicol Environ Health A 00: 1-12. DOI 10.1080/15287394.2015.1060913.\395.

395. GBD (2015) Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death. 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancer 385: 117-171.

396. GBD (2015) Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic disease and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 388: 743-800.

397. Carpenter DO (2015) The microwave syndrome or electro-hypersensitivity: Historical background. Rev Environ Health, 30: 217-222.

398. Saxton DI, Brown P, Segininot-Medina S, Eckstein L, Carpenter DO, Miller P and Waghiyi V (2015) Environmental health and justice and the right to research: institutional review board denials of community-based chemical biomonitoring of breast milk. Environ Health DOI: 10.1186/s12940-015-0076-x\

399. DeNicola E, Aburizaiza OS, Siddique A, Khwaja H and Carpenter DO (2015) Climate change and water scarcity: The case of Saudi Arabia. Ann Global Health 81: 342-353.

400. GBD (2015) Global, regional, and national levels of neonatal, infant and under-5 mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 384: 957-979.

401. GBD (2015) Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990-2013: a systematic analysis for the Global of Disease Study 2013. Lancet 386: 2287-2323.

402. GBD (2015) Global, regional and national incidence, prevalence and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 386: 743-800.

403. GBD (2015) Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990-2013: quantifying the epidemiological transition. Lancet 386: 2145-2101.

404. Portier CJ, Armstrong B, Baguley BC, Baur X, Belyaev I et al. (2016) Differences in the carcinogenic evaluation of glyphosate between the International Agency for Research on Cancer (IARC) and the European Food Safety authority (EFSA). J Epidemiol Comm Health. 10.1136/jech-2015-207005.

405. Carpenter DO (2016) Hydraulic fracturing for natural gas: Impact on health and environment. Rev Environ Health, 31: 47-52.

406. Heacock M, Kelly CB, Asante KA, Birnbaum LS, Bergman AL et al. (2016) E-Waste and harm to vulnerable populations: A growing Global problem. Environ Health Perspect. 124: 550-555.

407. Aminov Z, Haase R and Carpenter DO (2016) Diabetes in Native Americans: Elevated risk as a result of exposure to polychlorinated biphenyls (PCBs). Rev Environ Health, 31: 115-120

408. Mukama T, Ndejjo R, Musoke D, Musinguzi G, Halaga AA, Carpenter DO and Ssempebwa J (2016) Practices, concerns and willingness to participate in solid waste management in two urban slums in central Uganda. J Environ Public Health. http://dx.doi.org/10.1155/2016/6830163.

409. Aminov Z, Haase R, Rej R, Schymura MJ, Santiago-Rivera A, Morse G, DeCaprio A et al.(2016) Diabetes prevalence in relation to serum concentrations of polychlorinated biphenyl (PCB) congener groups and three chlorinated pesticides in a Native American population. Environ Health Perspect. 124: 13761383.

410. Suk WA, Ahanchian H, Asante KA, Carpenter DO, Diaz-Barriga F et al. (2016) Environmental pollution: an under-recognized threat to children's health, especially in low- and middle-income countries. Environ Health Perspect 124: A41-A45.

411. GBD Mortality and Causes of Death Collaborators (2016) Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015. Lancet 388: 1459-1544.

412. Nayebare SR, Aburizaiza OS, Khwaja HA, Siddique A, Hussain MM, Zeb J, Khatib F, Carpenter DO and Blake DR (2016) Chemical characterization and source apportionment of $PM_{2.5}$ in Rabigh, Saudi Arabia. Aerosol Air Qual Res 16: 3114-3129

413. Sly PD, Carpenter DO, Van den Berg M, Stein RT, Landrigan PJ, Brune-Drisse M-N and Suk W (2016) Health consequences of environmental exposure: Causal thinking in global environmental epidemiology. Ann Global Health 82: 3-9.

414. Suk W, Ruchirawat M, Stein RT, Diaz-Barriga F, Carpenter DO, Neira M and Sly PD (2016) Health consequences of environmental exposures in early life: Coping with a changing world in the post-MDG era, Ann Global Health 82: 20-27

415. Gallo MV, Ravenscroft J, Carpenter DO, Frye CA, Akwesasne Task Force on the Environment, Cook B and Schell LM (2016) Endocrine disrupting chemicals and ovulation: Is there a relationship? Environ Res. 151: 410-418.

416. DeNicola E, Aburizaize OS, Siddique A, Khwaja H and Carpenter DO (2016) Road traffic injury as a major public health issue in the Kingdom of Saudi Arabia: A review. Front Public Health 4:215.

417. GBD 2015 Child Mortality Collaborators (2016) Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and unde-5 mortality, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388: 1725-1774.

418. GBD 2015 Mortality and Causes of Death Collaborators (2016) Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global burden of Disease Study 2015. Lance 388: 1459-1544.

419. GBD Disease and Injury Incidence and Prevalence Collaborators (2016) Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388: 1545-1598.

420. GBD 2015 Risk Factors Collaborators (2016) Global, regional and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388: 1659-1724.

421. Fazzo L, Bianchi F, Carpenter D, Martuzzi M and Comba P (2017) Hazardous waste: A challenge for public health. Public Health Panorama 3: 247-252.

422. Nayebare SR, Aburizaiza OS, Siddique A, Carpenter DO, Zeb J, Aburizaiza AJ, Pantea C, Hussain MM and Khwaja HA (2017) Association of fine particulate air pollution with cardiopulmonary morbidity in Western Saudi Arabia. Saudi Med J 38: 179-189.

423. Lee D-H, Jacobs DR Jr., Park HY and Carpenter DO (2017) A role of low dose chemical mixtures in adipose tissue in carcinogenesis. Environ Int 108: 170-175.

424, Byrne S, Seguinot-Medina S, Miller P, Waghiyi V, von Hippel FA, Buck CL and Carpenter DO (2017) Exposure to polybrominated diphenyl ethers and perfluoroalkyl substances in a remote population of Alaska Natives. Environ Poll 231: 387-395.

425. Zhang X-Y, Carpenter DO, Song Y-J, Chen P, Qin Y, Wei N- Y and :om S-C(2017) Application of the IEUBK model for linking childrens' blood lead with environmental exposure in a mining site, south China. Environ Poll 231: 971-978.

426. Fatmi SS, Zehra R and Carpenter DO (2017) Powassan Virus: A new re-emerging tick-borne disease. Frontiers in Public Health 5:342.

427. Asad N and Carpenter DO (2017) Effects of climate change on spread of zika virus. Rev Environ Health. 28: 31-42.

428. von Hippel F, Miller P, Carpenter D, Dillon D, Smayda L, Katsiadaki I, Titus T, Batzel P, Postlethwait J, and Buck C (2017) Endocrine disruption and differential gene expression in sentinel fish on St. Lawrence Island, Alaska: Health implications for indigenous residents. Environ Pollution 234: 279-287.

429. Byrne SC, Miller P, Seguinot-Medina S, Waghiyi V, Buck CL, von Hippel FA and Carpenter DO (2018) Associations between serum polybrominated diphenyl ethers and thyroid hormones in a cross-sectional study of a remote Alaska Native population. Sci Reports 8: 2198.

430. GBD Study Group 2016 (2017) Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2016: a systematic analysis for the Global Burden of Disease Study, 2016. Lancet 390: 1260-1344.

431. GBD Study Group 2016 (2017) Global, regional, and national under-5 mortality, adult mortality, age-specific mortality and life expectancy, 1970-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 390: 1084-1160.

432. GBD Study Group 2016 (2017) Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 390; 1211-1259.

433. Moradi-Lakeh, ElBcheraoui C, Khalil I, Charara R et al. (2017) Diabetes mellitus and chronic kidney disease in the Eastern Mediterranean Region: findings from the Global Burden of Disease 2015 study. Int J Public Health doi:10.1007/s00038-017-1014-1.

434. GBD 2015 Chronic Respiratory Disease Collaborators (2017) Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancel Respir Med 5: 691-706.

435. Musoke D, Ndeejjo R, Halage AA, Kasasa S, Ssempebwa J and Carpenter DO (2017) Drinking water supply, sanitation and hygiene promotion interventions in two slum communities in central Uganda. J Environ Public Health, doi:10.1155/2018/3710120.

436. Gallo MV, Ravenscroft J, Carpenter DO, Schell LM and the Akwesasnė Task Force on the Environment. (2018) Persistent organic pollutants as predictors of increased FSH:LH ratio in naturally cycling, reproductive age women. Environ Res 164: 556-564.

437. Bandara P and Carpenter DO (2018) Planetary electromagnetic pollution: It is time to assess its impact on life on earth. Lancet Planetary Health, 2: e512-e514.

438. Byrne SC, Miller P, Seguinot-Medina S, Waghiyi V, Buck CL, von Hippel FA and Carpenter DO (2018) Exposure to perfluoroalkyl substances and associations with serum thyroid hormones in a remote population of Alaska Natives. Environ Res 166: 537-543.

439. Belpomme D, Hardell L, Belyaev I, Burgio E and Carpenter DO (2018) Thermal and non-thermal health effects of non-ionizing radiation: an international perspective. Environ Poll 242: 643-658.

440. Heacock M, Trottier B, Adhikary S, Asante KA, Basi M et al. (2018) Prevention-intervention strategies to reduce exposure to e-waste. Rev Environ Health 33: 219-228..

441. Nayebare SR, Aburizaiza OS, Siddique A, Carpenter DO, Pope AC, Hussain MM, Zeb J, Aburizaiza AJ and Khwaja HA (2018) Fine particulate (PC2.5) air pollution is a major risk factor for cardiopulmonary morbidity in Jeddah, Saudi Arabia. Science of the Total Environment, In press.

442. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators (2018) Global, regional, and national incidence, prevalence and year lived with disability for 328 disease and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 390: 1211-1259.

443. Nayebare SR, Aburizaiza OS, Siddique A, Carpenter DO, Hussain MM, Zeb J, Aburiziza AJ and Khwaja HA (2018) Ambient air quality in the holy city, Makkah: a source apportionment with elemental enrichment factors (EFs) and factor analysis (PMF). Environ Poll. 243: 1791-1801.

444. Malashock D, Khwaja H, Fatmi Z, Siddique A, Lu Y, Lin S,and Carpenter DO (2018) Short-term association between black carbon exposure and cardiovascular diseases in Pakistan's largest megacity. Atmosphere, In press.

445. Sly PD, Trottier B, Carpenter D, Cha'on U, Cormier S, Galluzzo B et al. (2019) Children's environmental health in south and southeast Asia: Networking for better child health outcomes. Ann global Health 85: 1-11. DOI:https://doi.org/10.5334/aogh.2403.

447. Fatmi SS, Zehra R and Carpenter DO (2018) Dietary magnesium intake and heart health. J Food Nutri Metab http://dx.doi.org/10.31487/j.JFNM.2018.01.001.

448. Lurie K, Nayebare SR, Fatmi Z, Carpenter DO, Siddique A, Malashcock D, Khan K, Zeb J, Hussain MM, Khatib F, Khwaja HA (2019) PM 2.5 in a megacity of Asia (Karachi): Source apportionment and health effects. Atmospheric Environment 202: 223-233.

449. GBD2016 (2019) Global, regional, and national burden of Alzheimer's disease and other dementias, 1990-2026: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol 18: 88-106.

450. Zehra R, Fatmi S and Carpenter DO (2018) Pathophysiological mechanisms of mercury's effect on thyroid gland. Int J Thyroid Disorders Therapy 1(1): 1-6.

451. Russo PN and Carpenter DO (2019) Occupational exposures to carcinogens in an industry: Identifying and communicating chemical risk. Int J Poll Res IJPE-105. DOI:10: 10.29011/IJPR-105.000005.

452. Russo PN and Carpenter DO (2019) Air emissions from natural gas facilities in New York State. Internat J Environ Res Pub Health 16: 1591: doi:10.3390/ijerph16091591.

453. Lu Y, Lin S, Fatmi Z, Malashock D, Hussain MM, Siddique A, Carpenter DO, Lin Z and Khwaja HA (2019) Assessing the association between fine particulate matter (PM2.5) constituents and cardiovascular diseases in a mega-city of Pakistan. Environ Poll 252: 1412-1422.

454. Carpenter DO (2019) Extremely low frequency electromagnetic fields and cancer: How source of funding affects results. Environ Res 178: 108688.

455. Kerr K, Morse G, Graves D, Zuo F, Lipowicz A and Carpenter DO (2019) A detoxification intervention for Gulf War Illness: A pilot randomized controlled trial. Int J Environ Res Public Health 16, 4143.

456. Bandara P and Carpenter DO (2019) Causes of Cancer: Perceptions vs. Scientific Evidence. Eur J Cancer https://doi.org/10.1016/j.ejca.2019.08.016.

457. Zheng G, Miller P, von Hippel FA, Buck CL, Carpenter DO and Salamova A (2020) Legacy and emerging semi-volatile organic compounds in sentinel fish from an Arctic formerly used defense site in Alaska. Environ Poll 259: 113872.

458. Aminov Z, Carpenter DO and the Akwesasne Task Force on the Environment (2020) Serum concentrations of persistent organic pollutants and the metabolic syndrome in Akwesasne Mohawks, a Native American community. Environ Poll 260: 114004

459. Graves DF, Morse GS, Kerr K and Carpenter DO (2020) Review of study of novel treatment of Gulf War Illness. J Ment Health Clin Psychol 4: 1-4.

460. Goodson WH III, Lowe L, Gilbertson M and Carpenter DO (2020) Testing the low dose mixtures hypothesis from the Halifax Project. Rev Environ Health. In press.

461. Graves DF, Morse GS, Kerr K, and Carpenter DO (2020) A pilot study to examine psychological and neuropsychological outcomes and a novel detoxification program for Gulf War Illness. Mil Med In press.

462. Mohammad A, Alshamarri T, Adeyeye T, Lazariu V, McNutt LA and Carpenter DO (2020) A comparison of risk factors for osteo- and rheumatoid arthritis using NHANES data. Prev Med Rep, 20: 101242.

463. Weinstein B, da Silva AR, Kouzoukas DE, Bose T, Kim GJ, Correa PA, Pondugula S, Lee YJ, Kim J and Carpenter DO (2021) Precision mapping of COVID-19 vulnerable locales by epidemiological and socioeconomic risk factors, developed using South Korean data. Int J Envirion Res Public Health 18: 604.

464. Emeny RT, Carpenter DO and Lawrence DA (2021) Health disparities: Intracellular consequences of social determinants of health. Toxicol Appl Pharmacol 416: 115444 https://doi.org/10.1016/j.taap.2021.115444.

465. Weinstein B, Muresan B, Solano S, Vaz de Macedo A, Lee Y, Kim GJ, Camargo C, Su YC, Henriquez-Luthje G, Ahn YS and Carpenter DO (2021) Comparative efficacy and safety of experimental versus approved CAR T-cell therapies in large B-cell lymphoma using matching

adjusted indirect comparison: A systematic review and meta-analysis. Principal and Practice of Clinical Research Journal, In press.

466. Bella D, Carpenter DO and the Akwesasne Task Force on the Environment (2021) Interactions among thyroid hormones and serum lipid levels in association with PCB exposure in the Mohawk Akwesasne population. Environ Res 200: 111334

467. Moslehi R, Stagnar C, Srinivasan S, Radziszowski P and Carpenter DO (2020) The possible role of arsenic and gene-arsenic interactions in susceptibility to breast cancer: a systematic review. Rev Environ Health https://doi.org/10/1515/reveh-2020-0080.

468. Belpomme D, Carlo GL, Irigaray P, Carpenter DO, Hardell L, Kundi M Belyaev I et al. (2021) The critical importance of molecular biomarkers and imaging in the study of electrohypersensitivity. A scientific consensus international report. Int J Mol Sci 22: 7321.

469. Saheb T, Sabeb, T and Carpenter DO (2021) Mapping research strands of ethics of artificial intelligence in healthcare: A bibliometric and content analysis. Computers Biol Med 135: 104660..

470. Lebbie T, Omosehin O, Asante, KA, Fobil JN, Brune-Drisse MN, Suk WA, Sly PD, Gorman JF and Carpenter DO (2021) E-Waste in Africa: A serious threat to the health of children. Int J Environ Res Public Health 18: 8488 https://doi.org/10.3390/ijerph181648488.

471. Hori N, Xu Z, Akaike N, Tan Y and Carpenter DO (2021) Physiological and pharmacological studies on cervical motor neurons in slices prepared from neonatal and aged mice. J Brain Nerves. http://dx.doi.org/10.31487/j.JBN.2021.01.02.

472. Hori N, Tan Y, Xu Z, Akaike N and Carpenter DO (2021) Electrophysiological and morphological studies of SOD1 transgenic mice: An animal model of ALS. J Brain Nerves http://dx.doi.org/10.31487/j.JBN.2021.01.03.

473.

474 Begum T and Carpenter DO (2021) Health effects associated with phthalates activity on nuclear receptors. Rev Environ Health, In press.

475. Weinstein B, Muresan B, Solano S, Vaz de Macedo A, Lee Y, Su YC. Ahn Y, Henriquez G, Camargo C, Kim G and Carpenter DO (2021) Efficacy and safety of innovative experimental chimeric antigen receptor (CAR) T-cells versus axicabtagene ciloleucel (Yescarta) for the treatment of relapsed/refractory large B-cell lymphoma (LBCL):Matching adjusted indirect comparisons (MAICs) and Syst. Innovations in Pharmacology, 12 (4): Article 18.

476. Parvez SM, Johan F, Brune MN, Gorman J, Rahman MJ, Carpenter D, Islam Z, Raahman M, Aich N, Knibbe LD and Sly PD (2021) Health consequences of exposure to e-waste: an updated systematic review. The Lancet Planetary Health 4: e905-e920.

477. Weinstein B, da Silva A and Carpenter DO (2022) Exocrine pancreatic cancer and living near to waste sites containing hazardous organic cheicals, New York State, USA. An 180year population-based study. Int J Occup Med Environ Health 35 (4). https://doi.org/10.13075/ijomed.1896.01886.

478. Casey A, Bush B and Carpenter DO (2022) PCBs in indoor air and human blood in Pittsfield, Massachusetts. Chemosphere 293: 13551.

479. Begum T, Morse GS, Buchwald D and Carpenter DO (2021) Assessing the psychometric properties of the WHO-DAS 2.0 in an American Indian Community. J Indig Res 9 (12): Article 12.:

480. Sasaki N and Carpenter D (2022) Associations between metal exposures and cognitive function in American older adults. Int J Environ Res Public Health 19: 2327. https://doi.org/10/3390/ijerph19042327.

481. Jordan-Ward R, von Hippel FA, Zheng G, Salamova A, Dillon D, Gologergen J, Immingan T, Dominguez E, Miller P, Carpenter DO, Postlethwait JH, Byrne S and Buck CL (2022) Elevated

mercury and PCB concentrations in Dolly Varden (*Salvelinus malma)* collected near a formerly used defense site on Sivuqaq, Alaska. Sci Total Environ s.

482. Begum TF, Carpenter DO and the Akwesasne Task Force on the Environment (ATFE) (2022) Review of environmental contamination at Akwesasne and associated health outcomes. J Indig Res 10: Issue 2022, Article1.

483. Nayebare N, Aburizaiza OS, Siddique A, Hussain MM, Zeb J, Khatib F, Carpenter DO, Blake DR and Khwaja HA (2022) Understanding the sources of ambient fine particulate matter (PM2.5) in Jeddah, Saudi Arabia. Atmosphere 1681315.

484. Moyebi OD, Frank BP, Tang S, LaDuke G, Carpenter DO and Khwaja HA (2022) Ambient size-segregated particulate matter characteriza4tion from a Port in Upstate New York. Atmosphere 13: 984. https://doi.org/10.3390/atnis13060984.

485. Mohammad A and Carpenter DO (2022). PCBs and dioxins either cause or maker worse both osteo and rheumatoid arthritis. Med Res Arch 10(7) https://doi.org/10.1813/mra.v107.2900.

486. Madani NA and Carpenter DO (2022) Effects of glyphosate and glyphosate-based herbicide like Roundup™ on the mammalian nervous system. Environ Res In press.

487. Sasaki N, Jones LE , Morse GS, Carpenter DO and on behalf of Akwesasne Task Force on the Environment (2022) Mixture effects of polychlorinated biphenyls (PCBs) and three organochlorine pesticides on cognitive function in Mohawk adults at Akwesasne. Int J Environ Res Public Health 20: 1148: https://doi.org/10.3390/ijerph200211148.

488. Moyebi OD, Fatmi Z, Carpenter DO, Santoso M, Siddique A, Khan K, Zeb J, Hussain MM and Khwaja HA (2023) Fine particulate matter and its chemical constituents' levels: A troubling environmental human health situation in Karachi, Pakistan. Sci Total Environ 868: 161474.

489. Moyebi OD, Sannoh F, Fatmi Z, Siddique A, Khan K, Zeb J, Hussain MM, Carpenter DO and Khwaja HA (2023) State of gaseous air pollutants and resulting health effects in Karachi, Pakistan. Environ Monit Assess 195: 266. https://doi.org/10.1007/s10661-022-10787-1.

490. Madani NA and Carpenter DO (2023) Patterns of emergency room visits for respiratory diseases in New York State in relation to air pollution, poverty and smoking. Int J Enviro Res Public Health 20: 3267.

Books:

1. Cellular Pacemakers I: Mechanisms of Pacemaker Generation, David O. Carpenter, editor; John Wiley & Sons, New York, 1982.
2. Cellular Pacemakers II: Function in Normal and Disease States, David O. Carpenter, editor; John Wiley & Sons, New York 1982.
3. Biologic Effects of Electric and Magnetic Fields, Volume I: Sources and Mechanisms of Biologic Effects, David O. Carpenter and Sinerik Ayrapetyan, editors; Academic Press, California, 1994.
4. Biologic Effects of Electric and Magnetic Fields, Volume II: Beneficial and Harmful Effects, David O. Carpenter and Sinerik Ayrapetyan, editors; Academic Press, California, 1994.
5. Environmental Challenges in the Pacific Basin, David O. Carpenter, ed. New York Academy of Sciences, Vol 1140, 457 pp, 2008.
6. Effects of Persistent and Bioactive Organic Pollutants on Human Health. David O. Carpenter, ed. Wiley-Blackwell, In press, 2013.

Reviews and Book Chapters:

1. Carpenter, D.O. Ionic mechanisms and models of endogenous discharge of Aplysia neurons. Proceedings of the Symposium on Neurobiology of Invertebrates: Mechanisms of Rhythm Regulation. Tihany, Hungary, August 2-5, 1971, Hungarian Academy of Sciences, pp. 35-58, 1973.

2. Carpenter, D.O., Hovey, M.M. and Bak, A.F. Measurements of intracellular conductivity in Aplysia neurons: Evidence for organization of water and ions. Ann. NY Acad. Sci., 204:502-533, 1973.

3. Carpenter, D.O., Hubbard, J.H., Humphrey, D.R., Thompson, H.K. and Marshall, W.H. CO_2 effects on nerve cell function. In: Topics in Environmental Physiology and Medicine: Carbon Dioxide and Metabolic Regulation. (Eds.: G. Nahas and K.A. Schaefer), Springer-Verlag, New York, pp. 49-62, 1974.

4. Parmentier, J. and Carpenter, D.O. Blocking action of snake venom neurotoxins at receptor sites to putative central nervous system transmitters. In: Animal, Plant and Microbial Toxins (Eds.: A. Ohaska, K. Hayashi, and Y. Sawai), Plenum Press, London, Vol. 2, pp. 179-191, 1976.

5. Pierau, Fr.-K. and Carpenter, D.O. Metabolic control of peripheral temperature receptors in the scrotal skin of the rat. Israel J. Med. Sci., 12:1044-1046, 1976.

6. Carpenter, D.O. Membrane Excitability: In: Mammalian Cell Membranes Vol. 4, Membranes and Cellular Functions, (Eds.: G.A. Jamieson and D.M. Robinson), Butterworth & Co., London, pp. 184-206, 1977.

7. Carpenter. D.O., Myers, P.R., Shain, W., Sinback, C.N. and Swann, J.W. Interchangeable association of neurotransmitter receptors and ionophores in vertebrate and invertebrate cells. Proc. Symposium: "Iontophoresis and Transmitter Mechanisms in the Mammalian Central Nervous System", Cambridge, England, Raven Press, pp. 203-205, 1978.

8. Carpenter, D.O., McCreery, M.J., Woodbury, C.M. and Yarowsky, P.J. Modulation of endogenous discharge in neuron R-15 through specific receptors for several neurotransmitters. In: Abnormal Neuronal Discharges, (Eds: N. Chalazonitis and M. Boisson), Raven Press, New York, pp. 189-203, 1978.

9. Tsien, R.W. and Carpenter, D.O. Ionic mechanisms of pacemaker activity in cardiac purkinje fibers. Fed. Proc., 37:2127-2131, 1978.

10. Kebabian, P.R., Kebabian, J.W. and Carpenter, D.O. Serotonin causes accumulation of cyclic AMP in Aplysia hear. The Proceedings of the Fourth International Catecholamine Symposium, (Eds: E. Usdin and I. Kopin), Pergamon Press, New York, pp. 1167-1169.

11. Braitman, D.J., Auker, C.R. and Carpenter, D.O. Direct and modulatory actions of thyrotropin-releasing hormone (TRH) in sensorimotor cortex. Proc. EMBO Workshop on Drug Receptors in the Central Nervous System, Weizman Institute of Science, Rehovot, Israel, February 10-14, 1980.

12. Carpenter, D.O. Ionic and metabolic bases of neuronal thermosensitivity. Fed. Proc., 40:2808-2813, 1981.

13. Carpenter, D.O. and Reese, T.S. Chemistry and Physiology of Synaptic Transmissions. In: Basic Neurochemistry, 3rd Edition, (Eds.: Siegel, Albers, Agranoff and Katzman), Little, Brown and Company, pp. 161-168, 1981.

14. Shain, W. and Carpenter, D.O. Mechanisms of synaptic modulation. Intl. Rev. Neurobiol., 22:205-247, 1981.

15. Wiederhold, M.L. and Carpenter, D.O. Possible Role of Pacemaker Mechanisms in Sensory Systems. In: Cellular Pacemakers II: Function in Normal and Disease States, (Ed.: D.O. Carpenter), John Wiley & Sons, New York, pp. 27-58, 1982.

16. Carpenter, D.O. The generator potential mechanism in cold afferents may be an electrogenic sodium pump. Workshop on Mechanisms of Thermal Regulations. J. Therm. Biol., 387-390, 1983.

17. Carpenter, D.O. and Gregg, R.A. Functional significance of electrogenic pumps in neurons. In: Electrogenic transport: Fundamental Principles and Physiological Implications, (Eds.: M. Blaustein and M. Liebermann), Raven Press, pp. 253-270, 1984.

18. Carpenter, D.O., Briggs, D.B. and Strominger, N. Behavioral and electrophysiological studies of peptide-induced emesis in dogs. Fed. Proc., 43:16-18, 1984.

19. Coyle, J.T., Blakeley, R.D., Zaczeck, R., Ory-Lavollee, L., Koller, K., ffrench-Mullen, J.M.H. and Carpenter, D.O. Acidic peptides in brain: Do they act at putative glutamatergic synapses. In: Excitatory Amino Acids and Epilepsy, (Eds.: Y. Ben-Ari and R. Schwarcz), Plenum Press, New York, pp. 375-384.

20. Carpenter, D.O., ffrench-Mullen, J.M.H., Hori, N., Sinback, C.N. and Shain, W. Segregation of synaptic function on excitable cells. In: Neural Mechanisms of Conditioning, (Eds.: D. Alkon and C.D. Woody), Plenum Press, NY, pp. 355-369, 1985.

21. Carpenter, D.O. and Hall, A.F. Responses of Aplysia cerebral ganglion neurons to leucine enkephalin. In: Comparative Aspects of Opioid and Related Neuropeptide Mechanisms, (Eds.: M. Leung and G. Stefano), CRC Press, pp. 49-57.

22. Zaczeck, R., Koller, K., Carpenter, D.O., Fisher, R., ffrench-Mullen, J.M.H. and Coyle, J.T. Interactions of acidic peptides: Excitatory amino acid receptors. In: Excitatory Amino Acids, (Ed.: P.J. Roberts), Macmillan, London, 1987.

23. Carpenter, D.O. Central nervous system mechanisms in deglutition and emesis. In: Handbook of Physiology, Section 6: The Gastrointestinal System. Vol. I, Motility and Circulation, (Ed.: J.D. Wood), American Physiological Society, Chapter 18, pp. 685-714, 1989.

24. Carpenter, D.O., Briggs, D.B. and Strominger, N. Mechanisms of radiation-induced emesis in the dog. Pharmacol. Ther., 39:367-371, 1988.

25. Carpenter, D.O. Comparative biology of neurotransmitter functions. Biology International, 15:2-9, 1987.

26. Carpenter, D.O. Electromagnetic Fields: Do We Know Enough to Act? In: Health and Environmental Digest, Vol. 2, pp. 3-4, 1988.

27. Carpenter, D.O. The New York State Power Lines Project: Summary and Conclusions. In: 20th Annual National Conference on Radiation Control, CRCPD Publication 88-6, Nashville, Tennessee, May 15-19, 1988, pp. 399-409.

28. S.-Rozsa, K., Carpenter, D.O., Stefano, G.B. and Salanki, J. Distinct responses to opiate peptides and FMRFamide on B-neurons of the Aplysia cerebral ganglia. In: Comparative Aspects of Neuropeptide Function, (Eds. E. Florey and G.B. Stefano), Manchester University Press, Chapter 6, pp. 73-86, 1991.

29. Carpenter, D.O. A common mechanism of excitation of area postrema neurons by several neuropeptides, hormones and monoamines. In: Comparative Aspects of Neuropeptide Function, (Eds. E. Florey and G.B. Stefano) Manchester University Press, Chapter 21, pp. 260-270, 1991.

30. Carpenter, D. O., Hirotsu, I., Katsuda, N. and Hori, N. The effects of acetylcholine and aging on electrical excitability of the central nervous system. In: Neuroregulatory Mechanisms in Aging, Pergamon Press LTD, pp. 5-23, 1993.

31. Turner, J.N., Swann, J.W., Szarowski, D.H., Smith, K.L., Shain, W., Carpenter, D.O. and Fejtl, M. Three-dimensional confocal light and electron microscopy of neurons: fluorescent and reflection stains. Methods in Cell Biology, 38:345-366, 1993.

32. Deno, D. and Carpenter, D.O. Sources and characteristics of electric and magnetic fields in the environment. In: Biologic Effects of Electric and Magnetic Fields, Volume I: Sources and Mechanisms of Biologic Effects, David O. Carpenter and Sinerik Ayrapetyan, editors, Academic Press, California, pp. 3-59, 1994.

33. Carpenter, D.O. The public health implications of magnetic field effects on biological systems. In: Biologic Effects of Electric and Magnetic Fields, Volume II: Beneficial and Harmful Effects, David O. Carpenter and Sinerik Ayrapetyan, editors, Academic Press, California, pp. 321-329, 1994.

34. Carpenter, D.O. Multidisciplinary study of hazardous wastes at a Great Lakes Superfund Site. Great Lakes Research Review, 1: 37-39, 1994.

35. Fejtl, M. and Carpenter, D.O. Single-channel studies in molluscan neurons. In: Ion Channels, Vol. 4, Toshio Narahashi, ed., Plenum Press, New York, pp. 333-376, 1996.

36. Turner, J.N., Swann, J.W., Szarowski, D.H., Smith, K.L., Shain, W., Carpenter, D.O. and Fejtl, M. Three-dimensional confocal light and electron microscopy of central nervous system tissue, and neurons and glia in culture. In: International Review of Experimental Pathology, V.J. Savin and T.B. Wiegmann, editors, Volume 36, Academic Press, pp. 53-72, 1996.

37. Boldyrev, A., Lawrence, D. and Carpenter, D. Effect of carnosine and its natural derivatives on apoptosis of neurons induced by excitotoxic compounds. In: Peptide Science-Present and Future, Y. Shimonishi, editor, Kluwer Academic Publishers, Great Britain, pp. 424-426, 1998.

38. Carpenter, D.O., Hussain, R., Tan, Y., Niemi, W. and Hori, N. Long-term potentiation and long-term depression: Relevance to learning and memory. In: Modern Problems of Cellular and Molecular Biophysics. S.N. Ayrapetyan and A.C.T. North, editors, Nayan Tapan, pp. 83-94, 2001.

39. Carpenter, D.O. NMDA receptors and molecular mechanisms of excitotoxicity. In: Oxidative Stress at Molecular, Cellular and Organ Levels, A. Boldyrev and P. Johnson, editors, Research Signpost, pp. 77-88, 2002.

40. Carpenter, D.O. Clearing the air: Asthma an indoor exposure. JNMA 96: 1-2, 2004.

41. Carpenter DO. Environmental contaminants and human health: The health effects of persistent toxic substances. Firat Tip Dergisi 10: ____: 2005.

42. Hermanson MH, Johnson GW and Carpenter DO. Routes of human exposure to PCBs in Anniston, Alabama. ACS Division of Environmental Chemistry, 232rd National Meeting, 46: 1117-1122, 2006

43. Carpenter DO and Welfinger-Smith G. The Hudson River: A case study of PCB contamination. In: Water and Sanitation-Related diseases and the Environment: Challenges, Interventions, and Preventative Measures. Janine M.H. Selendy, Ed., Wiley & Sons, Inc. 2011, pp 303-327.

44. Welfinger-Smith G and Carpenter DO. Addressing sources of PCBs and other chemical pollutants in water. In: Water and Sanitation-Related diseases and the Environment: Challenges, Interventions, and Preventative Measures. Janine M.H. Selendy, Ed., Wiley & Sons, Inc. 2011, pp 359-384.

45. Carpenter DO. Human health effects of nonionizing electromagnetic fields. In: Patty's Toxicology. Sixth Edition. 2012 Volume 6. E Bingham and B Cohrssen, editors. Chapter 100, pp 109-132

46. Carpenter DO Introduction: Why should we care about organic chemicals and human health? In: Effects of Persistent and Bioactive Organic Pollutants on Human Health. 2013 DO Carpenter, editor. Chapter 13, pp 1-7..

47. Carpenter DO Organic chemicals and the Immune System. In: Effects of Persistent and Bioactive Organic Pollutants on Human Health. 2013 DO Carpenter, editor. Chapter 13, pp 362-382.

48. Carpenter DO Intellectual developmental disability syndromes and organic chemicals. In: Effects of Persistent and Bioactive Organic Pollutants on Human Health. 2013 DO Carpenter, editor. Chapter 16, pp 421-447.

49. Carpenter DO. Mechanisms of the neurotoxic actions of organic chemicals. In: Effects of Persistent and Bioactive Organic Pollutants on Human Health. 2013 DO Carpenter, editor. Chapter 17 pp 448-470.

50. Carpenter DO. How much human disease is caused by exposure to organic chemicals? In: Effects of Persistent and Bioactive Organic Pollutants on Human Health. 2013 DO Carpenter, editor. Chapter 13, pp 557-569..

Other Publications:

1. Barker, J.L. and Carpenter, D.O. Neuronal thermosensitivity. Science, 172:1361-1362, 1971.
2. Carpenter, D.O. Cellular Pacemakers. Fed. Proc., 37:2125-2126, 1978.
3. Carpenter, D.O. Membrane biophysics and general neurobiology in Japan. ONR Tokyo Scientific Bulletin, 3:23-27, 1978.
4. Carpenter, D.O. Research on the primate nervous system in Japan. ONR Tokyo Scientific Bulletin, 3:28-32, 1978.
5. Carpenter, D.O. Report on the Sixth International Biophysics Congress, Kyoto, Japan. ONR Tokyo Scientific Bulletin, 3:38-40, 1978.
6. Carpenter, D.O. Interchangeable association of neurotransmitter receptors with several ionophores. Brain Research Bulletin, 4:149-152, 1978.
7. Carpenter, D.O. and Ahlbom, A. Power lines and cancer: Public health and policy implications. Forum, 3:96-101, 1988.
8. Carpenter, D.O. Setting Health Policy When the Science and the Risk are Uncertain. In: The Scientific Basis of Health Policy in the 1990s, Proceedings of the School of Public Health's Fifth Anniversary Symposium, 54-63, 1990.
9. Carpenter, D.O. Integrating public health in professional education. Optometry and Vision Science, 70: 699-702, 1993.
10. Bowerman, W.W., Carey, J., Carpenter, D.O., Colborn, T., DeRosa, C., Fournier, M., Fox, G.A., Gibson, B.L., Gilbertson, M., Henshel, D., McMaster, S. and Upshur, R. Is it time for a Great Lakes Ecosystem Agreement separate from the Great Lakes Water Quality Agreement? J. Great Lakes Res. 25:237-238, 1999.
11. Carpenter, D.O. Editorial Comment of APrimary hypoxic tolerance and chemical preconditioning during estrus cycle@. Stroke, 30:1262, 1999.
12. Carpenter, D.O. Bring environmental health back into public Health. J. Pub. Health Mgmt. Pract., 5:vii-viii, 1999.
13. Carpenter, D.O. Should children and women of childbearing age eat Great Lakes fish? Great Lakes Commission Advisor, 13: 8, 2000.
14. Hites, R.A., Foran, J.A., Schwager, S.J., Knuth, B.A., Hamilton, M.C. and Carpenter, D.O. Response to comment on AGlobal Assessment of Polybrominated Diphenyl Ethers in Farmed and Wild Salmon@. Environ. Sci. Technol. 39: 379-380.
15. Carpenter, D.O. Blood lead and IQ in older children. Letter to the editor. Environ. Health Perspect., 113: A581-A582, 2005.
16. Foran, J.A., Carpenter, D.O., Good, D.H., Hamilton, M.C., Hites, R.A., Knuth, B.A. and Schwager, S.J. Risks and benefits of seafood consumption. Letter to the editor. Am. J. Prev. Med. 30: 438-439, 2006.
17. Kouznetsova,M, Huang X, Lessner L and Carpenter DO. Zip code and GIS Studies: Kouznetsova et al. Respond. Environ Health Perspect 116: A18-A19, 2008.

18. Bolte G, Kohlhuber M, Carpenter DO and Tamburlini G Environmental inequalities among children and adolescents in Europe. Report prepared and submitted to the World Health Organization, 2009.

19. Gavidia T, Brune M-N, McCarty KM, Pronczuk J et al. (2010) Children's environmental health – from knowledge to action. The Lancet DOI:10.1016/S0140-6736(10)60929-4.

20. Toxins and the Brain. PSR's Environmental Health Policy Institute, 9 April 2012

21. Carpenter DO Electromagnetic fields: The effect on human health. San Francisco Medicine 85: 30-31: 2012

22. Carpenter DO and Sly P (2012) New leadership for Reviews on Environmental Health. Rev Environ Health 27: 65.

23. Florea A-M, Busselberg D and Carpenter (2012) Metals and disease. J Toxicol doi:1155/2012/825354

24. Brune M-N, Goldizen FC, Neira M, van den Berg M et al. (2013) Health effects of exposure to e-waste. The Lancet 1:e70

25. Sage C, Carpenter DO and Hardell L (2015) Comment on SCENIHR: Opinion on potential health effects of exposure to electromagnetic fields. Bioelectromagnetics 36: 480-484.

26. Carpenter DO and Belpomme D (2015) Idiopathic environmental intolerance. Rev Environ Health 30: 207.

27. Carpenter DO (2016) What constitutes environmental health? Rev Environ Health 31: 193.

28. Carpenter DO and Sly PD (2016) Environmental chemicals as endocrine disruptors. Rev Environ Health 31: 389.

29. Sly PD and Carpenter DO (2016) Traditional and emerging environmental hazards in South-East Asia: double-trouble in the 21st Century. Rev Environ Health 31: 1.

30. Carpenter DO (2017) Beware: New dangers from the chemicals all around us. Bottom Line Health May: 3-5.

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- Cleaning up the Housatonic
- Understanding PCB Risks
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Understanding PCB Risks at the GE-Pittsfield/Housatonic River Site

On this page:

What are PCBs?

PCBs are a group of man-made organic chemicals consisting of carbon, hydrogen, and chlorine atoms. PCBs were manufactured in the US from 1929 until their manufacture was banned in 1979.

For more information on PCBs, please visit EPA's PCB webpage.

Printer-friendly Fact Sheets

- PCB Fact Sheet Regarding PCB Exposure Associated with the GE Pittsfield Facility and the Housatonic River (pdf) (483 KB)
- ATSDR FAQs about PCBs

Fast Facts: Housatonic River PCBs

- The Housatonic River and its floodplain are heavily contaminated with PCBs originating from the GE Facility in Pittsfield, MA.
- Most of the contamination is found between the confluence of the East and West branches in Pittsfield and Woods Pond Dam in Lenox and further into Rising Pond in Great Barrington, MA.
- Currently, more than 50% of the PCBs that enter Woods Pond go over the dam and continue downstream, even into Connecticut. A distance of approximately 140 miles.
- PCBs are present in large quantities in river sediment and floodplain soil; estimates range from between 100,000 to nearly 600,000 pounds of PCBs.
- The PCBs found at this site are persistent in the environment and resistant to biodegradation. As a result, the rate of natural degradation of the type of PCBs in the Housatonic River is very slow --- on the scale of hundreds of years.
- Without cleanup, it would take decades if not hundreds of years, before PCB concentrations in fish would decrease to a level that would permit unlimited consumption.

GE/Housatonic River Site Update (pdf) (700 KB) on how PCBs move through the environment, what EPA knows about the PCBs in the Housatonic River, and their health effects.

How do PCBs get into the environment?

PCBs entered the air, water, and soil during their manufacture, use, and disposal; from spills and leaks during their transport; and from leaks in products containing PCBs.

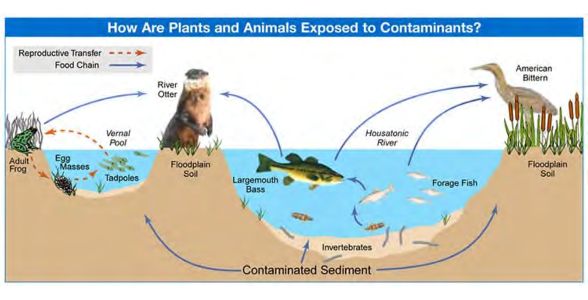
Once in the environment, most PCBs do not readily break down and may remain for very long periods of time. PCBs can travel long distances in the air and via suspended solids in water and be deposited in areas far from where they were originally released.

In water, a small amount of PCBs may be dissolved, but most stick to organic particles and soil/sediment. That is because soil and sediment consist not just of mineral particles, but also include organic carbon.

Each congener (PCB mixture) has a different potential for degradation. In general, "lighter" PCBs have a higher degradation potential. The heavier PCBs, such as the ones in the Housatonic watershed (Aroclors 1254 and 1260), are more persistent in the environment because they are more resistant to volatilization, weathering, biodegradation and other mechanisms of degradation.

Many different types of natural degradation have been documented in PCB-contaminated sediment and soil; however, although some PCB congeners eventually degrade, the rate of degradation of the type of PCBs found in the Housatonic watershed is very slow, on the scale of hundreds of years.

How do PCBs get into plants and animals?



View a larger version of this image.
Graphic derived from GE Housatonic Ecological Risk Assessment Fact Sheet

PCBs in the environment are taken up by many animals and a few plants in a process known as bioaccumulation.

Bioaccumulation can occur in wild populations and animals that are raised for food in both commercial and backyard operations. The rate of bioaccumulation and the concentration of PCBs in an organism depends on many factors, one of the most important being the amount of fat (lipid) in body. In general, organisms with high amounts of body fat will accumulate higher concentrations of PCBs than those with less fat. The vast majority of PCBs in any living organism will be found in the fat cells. Other factors controlling organism-specific bioaccumulation include life history and diet.

Studies show that while PCBs accumulate rapidly in most animals, they are slow to leave the body. Once they have entered the body, PCBs are moved to fat reservoirs where they tend to remain for long periods of time, typically for the life of the animal, reaching concentrations that may be many thousands of times higher than in water, sediment, or soil, a process known as **biomagnification**. PCBs have been measured at very high concentrations in biota in the Housatonic River watershed, leading to consumption advisories for fish, frogs, turtles and waterfowl in MA, and fish in CT.

In contrast, most plants do not bioaccumulate PCBs from contaminated soil due to the presence of a waxy layer, or cuticle, which binds the PCBs and prevents them from being absorbed into the plant. Some plants in the squash family appear to be able to accumulate PCBs from soil via their roots. Studies of tomatoes grown downwind from a PCB-contaminated sediment site demonstrated that lighter, more volatile, congeners released into the atmosphere can be taken up by the leaves and transported into edible portions of the plant.

Generally, however, most of the PCBs remain on the surface of fruits and vegetables, often as part of the soil deposited by wind or rainwater splash clinging to the plant.

Wildlife and Human Health Effects from PCBs

PCBs have been demonstrated to cause a wide variety of adverse health effects, as well as cancer. There are a number of serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, endocrine system and other organs. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs. The different health effects of PCBs may be interrelated, as alterations in one system may have significant implications for the other systems of the body. Some PCB congeners exhibit dioxin-like effects.

Cancer
Studies definitively show that PCBs cause cancer in animals. The data strongly suggest that PCBs are probable human carcinogens, and EPA and the International Agency for Research on Cancer have classified them as such.

Immune Effects
Studies in animals have revealed serious effects on the immune system following exposures to PCBs, including a significant decrease in size of the thymus gland, reductions in the response of the immune system following a challenge with sheep red blood cells (a test of the antibody response and protective immunity), and decreased resistance to Epstein-Barr virus and other infections. Immune effects were also noted in humans who experienced exposure to rice oil contaminated with PCBs, dibenzofurans and dioxins.

Reproductive Effects
Reproductive effects of PCBs have been studied in animal species. Potentially serious effects on the re-productive system were seen following exposures to PCB mixtures. Most significantly, PCB exposures were found to reduce the birth weight, conception rates, and live birth rates of monkeys and other species, and PCB exposure reduced sperm counts in rats. Effects in monkeys were long-lasting and were observed long after the dosing with PCBs occurred. Studies of reproductive effects have also been carried out in human populations exposed to PCBs. Children born to women who worked with PCBs in factories, and studies in fishing populations, showed decreased birth weight and a significant decrease in gestational age with increasing exposures to PCBs.

Neurological Effects
Effects of PCBs on nervous system development have been studied in animal species. Newborn monkeys exposed to PCBs showed persistent and significant deficits in neurological development, including visual recognition, short-term memory and learning. Studies in humans have suggested effects similar to those observed in monkeys exposed to PCBs, including learning deficits and changes in activity associated with exposures to PCBs.

Endocrine Effects
PCBs have been demonstrated to exert effects on thyroid hormone levels in animals and humans.

Other Non-cancer Effects
A variety of other non-cancer effects of PCBs have been reported in animals and humans, including skin and eye effects and liver toxicity. Elevations in blood pressure, serum triglyceride, and serum cholesterol have also been reported with increasing serum levels of PCBs in humans.

Understanding the Housatonic Rest of River Risk Assessments

EPA's Human Health Risk Assessment (2005) for the Housatonic Rest of River and its floodplain, quantifies risks to adults and children exposed to PCBs originating from the GE Facility in Pittsfield, MA. For a risk, there must be an exposure; potential exposures could occur while living or working near the river and its floodplain, or using either for recreation or agriculture.

EPA's Ecological Risk Assessment (2004) quantifies risks from PCBs to the animals living and / or feeding in the Housatonic Rest of River and its floodplain.

Both the Ecological and Human Health Risk Assessments at this site were conducted by teams of experts working with EPA using state-of-the-art techniques. These assessments were based on an extensive site-specific database derived from thousands of samples collected over several years as well as laboratory and field studies. Both went through a public external review process and formal public comment period. The peer review panels were composed of internationally recognized experts in risk assessment.

NOTE: These risk assessments address what EPA considers the "Rest of River" which does not include the upper 2-mile reach which has since broken into the Upper ½ Mile reach and the 1 ½ mile reach and the floodplains adjacent to the 1 ½ Mile reach. To see risk assessment information for the upper section, or beginning portion of the river:

- Human Health Evaluation and Ecological Risk Assessment Regarding PCB Contamination in Two Mile Stretch of Housatonic River

Housatonic Rest of River Human Health Risks from PCBs

This assessment began with an initial screening of all environmental media (air, soil, water, food…) to determine the most serious routes of exposure to PCBs in the river and its floodplain. The routes of exposure were identified as:

- Direct contact with contaminated soil and sediment,
- Consumption of contaminated fish and waterfowl, and
- Consumption of contaminated agricultural products produced in the floodplain.

The assessment evaluated each of these pathways separately and provided insight into how these risks could be combined for individuals exposed to multiple pathways.

*Note: Risks from exposure to PCBs in river water and air were found to be below levels EPA considers to be unacceptable.

EPA identified carcinogenic, and non-carcinogenic risks from exposure to soil along the river, consumption of area fish and waterfowl, as well as risks from the consumption of agricultural products grown on commercial, backyard farms or gardens. For specific information as well as graphs summarizing the range of risks, see this Community Update regarding site risks (pdf) (1 MB).

Housatonic Rest of River Ecological Health Risks from PCBs

EPA's Ecological Risk Assessment (2004) of the Housatonic Rest of River and its floodplain studied risk to eight different groups of animals:

- Benthic Invertebrates
- Amphibians
- Fish
- Insectivorous (insect-eating) Birds
- Piscivorous (fish-eating) Birds
- Piscivorous Mammals
- Omnivorous / Carnivorous (plant and animals/ animal-eating) Mammals
- Threatened & Endangered Species

These groups are all important components of the Housatonic River ecosystem. Concentrations of PCBs in the environment that each group comes into contact with (generally by water, sediment, soil, and food) were compared to data on the toxicity of PCBs for the species in question. In addition, site-specific field surveys and toxicity studies using soil, sediment, water, and animals collected from the site were conducted for many species by scientists from around the country. Read the detailed findings about Ecological Risk Assessment Peer Review, or review the Fast Facts: Ecological Risk Assessment below.

Fast Facts: Ecological Risk Assessment

- For many species, PCBs in the river and / or floodplain are 10 or as much as 100 times greater than a concentration considered to not pose a risk to that species.
- Site-specific field and toxicity studies observed these and other effects:
  - Benthic invertebrate mortality and impaired development;
  - Reduced survival of larval fish, and various deformities including swim bladders that were malformed or formed outside of the body cavity;
  - Frogs with abnormal egg masses, malformations, impacts to metamorphosis (development from tadpoles to frogs), and sex changes;
  - Mortality in 50% of mink young within six weeks of birth from mothers that were fed a diet containing very low concentrations of PCBs in fish harvested from the Housatonic River. Jaw lesions were observed in the developing young that did survive, which results in eventual loss of teeth, leading to anorexia and finally death.
  - While not measured directly, there is expected impairment of reproduction in osprey and bald eagles.
- Many species of aquatic life and wildlife in the Housatonic River ecosystem are at an intermediate to high risk from their exposure to PCBs in both the river and floodplain.
- Similar risks extend to species beyond those specifically evaluated.

Effects to Ecological Receptors in the Rest of River

PCBs in the environment affect ecological receptors to varying degrees and in a variety of ways; these differences in the nature and extent of PCB effects depend in part on the specific PCB congeners present, as well as natural differences in basic physiological processes, diet, and life history among animal species. With the type of PCBs and concentrations measured in the Housatonic River and its floodplain, effects are considered likely. In a number of cases, significant adverse effects were documented in site-specific field and/or laboratory studies for the representative animal species evaluated in the Housatonic River Ecological Risk Assessment.

The known toxic effects of PCBs on aquatic species and wildlife include mortality, compromises in immune system function, and various adverse effects on reproduction, development, and endocrine function, in addition to a number of equally serious effects on other body systems. PCB exposure leads to a loss of liver function and death of liver tissue, and similar effects to the tissues and organs of the digestive system. The nervous systems of animals are also affected, with resultant depression of motor activity and decreased perception. Other effects include behavioral abnormalities, impaired reproduction, and developmental toxicity. PCBs have been demonstrated in laboratory studies to promote cancer in a number of animal species. In sufficient doses, PCB exposure can lead to acute mortality in aquatic and wildlife species, and chronic exposure to lower doses can also result in mortality, leading to changes in community and ecosystem structure and function.

Benthic Invertebrates
PCBs in sufficient concentrations, which are exceeded in sediment in some areas of Housatonic River, are acutely toxic to aquatic organisms, particularly benthic invertebrates at the base of the aquatic food chain. These effects are commonly expressed by the absence of species of known sensitivity to PCBs, and as alterations in the structure of the benthic community when the more-sensitive species are replaced by more pollution-tolerant organisms. Non-lethal effects of PCBs on benthic organisms include reduction in growth and number of offspring. All of these types of effects were clearly demonstrated in the site-specific studies conducted using Housatonic River sediment and well-established sediment toxicity testing organisms. In addition, benthic community impairment also corresponded to PCB sediment concentration.

Fish
Fish from the Housatonic River that were captured and bred in captivity were shown to produce larvae with increased incidence of a wide variety of deformities, many of which are reported in the scientific literature to be related to PCB exposure. However, because of the large number of eggs fish produce and high natural mortality of the young, the effects of PCBs on the local fish populations do not appear to be significant.

Amphibians
Harmful effects can include damage to the reproductive organs of adults as well as decreased viability of offspring and life-threatening deformities in larvae. A number of reproductive effects such as deformed gonads (see pictures on page 5), impaired development, altered sex ratio, and larval deformities were observed in frogs and frog larvae exposed to PCBs from the Housatonic River floodplain vernal pools and backwaters.

Birds
PCB exposure has been demonstrated in species such as chickens and pheasants to cause decreased egg production and fertility with relatively low PCB exposure, and mortality with higher exposures. In contrast to the animal groups discussed above, however, some bird species such as hawks and finches appear to be less sensitive to the harmful effects of PCBs. Site-specific studies conducted on tree swallows, kingfishers, and robins in the Housatonic River study area did not identify severe effects as a result of PCB exposure. However, although no field study was conducted on wood ducks, measured exposures suggest that harm is likely for that species from dioxin-like PCBs. In addition, very high concentrations of PCBs were present in the migratory waterfowl sampled by EPA. Estimated exposure derived from their fish diet indicates the high probability of risk to fish eating birds such as osprey and bald eagles.

Piscivorous Mammals
Piscivorous (fish-eating) mammals such as mink and otter receive elevated exposure to PCBs with their diet of contaminated fish, due to bioaccumulation. In addition, certain piscivorous mammals, particularly mink, have been shown in the scientific literature to have unusually high sensitivity to the effects of PCBs.

In a carefully controlled dietary study conducted at the University of Michigan, the young (kits) of female mink fed a diet containing fish collected from the Housatonic River were shown to suffer from increased significant increased mortality and developed jaw lesions that would lead to death in the wild due to inability to consume a normal diet.

This study was corroborated by the result of field investigations indicating the absence of resident reproducing mink and otter, despite the highly suitable habitat present in the river and floodplain.