DRAFT

Binational Strategy for PCB Risk Management

February 2017

A document to assist in the engagement of key stakeholders and the public in strategy development

This draft prepared by the Environment and Climate Change Canada and the United States Environmental Agency

Disclaimer

The purpose of this document is to provide PCB risk mitigation and management strategies in accordance with Annex 3 of the Great Lakes Water Quality Agreement (GLWQA). The mention of trade names, commercial products, or organizations does not imply endorsement by the United States or Canadian governments.

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Acknowledgments

Executive Summary

The Canada – United States Great Lakes Water Quality Agreement (GLWQA) seeks to reduce the presence of all chemicals of mutual concern (CMCs), including polychlorinated biphenyls (PCBs), and protect human health and the environment. Reductions in anthropogenic releases of CMCs into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes are to be achieved through cooperative and coordinated measures taken by the two nations.

PCBs are manmade organic chemicals that can cause a variety of harmful human health and environmental effects. Due to the overall size of the watershed and the population of people living and working within the watershed, the Great Lakes have been identified as a major PCB sink. The human ingestion of fish containing bioaccumulated PCBs above fish consumption guideline concentrations is a concern within the Great Lakes Basin. In the United States, all production of PCBs ceased in 1977, prior to the subsequent ban of all manufacture, import, export, distribution, and use (except under certain circumstances) of PCBs in 1979. PCBs were never produced in Canada; however, they were widely used prior to a 1977 ban on all Canadian imports, exports, sales, manufacturing, and use (except under certain circumstances). Due to the high stability of the compounds, legacy PCBs can still be found within sediments, waters, biota tissues, wastes, waste oils, air, and certain in-use products within the region.

This document provides a Binational Strategy for PCBs to focus efforts of the Governments of Canada and the United States, in cooperation and consultation with State and Provincial Governments, Tribal Governments, First Nations, Métis, Municipal Governments, watershed management agencies, other local public agencies, and the Public in implementing risk mitigation and management actions aimed at reducing PCBs in the Great Lakes region.

Binational efforts have made significant strides in reducing the incidence of PCB release to the environment and cleaning up of PCB-contaminated sites. Between the years 2004 and 2015, an estimated 4 million cubic yards (3 million cubic meters) of contaminated sediments within 43 Areas of Concern (AOCs) within the Great Lakes Basin have been remediated. PCB concentrations in fish tissue are largely responsible for restrictions on fish and wildlife consumption at nearly every AOC. Recommended risk mitigation and management strategies to diminish the presence of PCBs from the Great Lakes region include the creation of additional regulations and guidance that clarifies existing regulations, increased enforcement of existing regulations, green chemistry and pollution prevention strategies to address inadvertent manufacture of PCBs and releases into the Great Lakes Basin, and increased monitoring facilitated by the development of cost-effective monitors and sensors. Additional database refinement is needed to ensure all data regarding PCB loadings and sources are accessible. Stakeholders committed to protecting and restoring the Great Lakes ecosystem are invited to identify, review, and prioritize the PCB risk mitigation and management options outlined in this document. It is also anticipated that, through identification, review, and prioritization of risk mitigation and management options, stakeholders can begin to implement these options within the Great Lakes Basin and their respective communities.

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Acronyms and Abbreviations

ANPRM	Advance Notice of Proposed Rulemaking
AOC	Areas of Concern
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation Factors
BUI	Beneficial Use Impairments
CAA	Clean Air Act
CCME	Canadian Council of Ministers of the Environment
CDC	Centers for Disease Control and Prevention
CEC	Commission for Environmental Cooperation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEPA	Canadian Environmental Protection Act
CFR	Code of Federal Regulations
CMC	Chemicals of Mutual Concern
CWA	Clean Water Act
DMR	Discharge Monitoring Report Pollutant Loading Tool
ECCC	Environment and Climate Change Canada
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESM	Environmentally Sound Management
EU	European Union
FAO	Food and Agriculture Organization
GLBTS	Great Lakes Binational Toxics Strategy
GLENDA	Great Lakes Environmental Database
GLHHFTS	Great Lakes Human Health Fish Tissue Study
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
GLRPPR	Great Lakes Regional Pollution Prevention Roundtable
GLWQA	Great Lakes Water Quality Agreement
HAP	Hazardous Air Pollutants
HBCD	Hexabromocyclododecane
IADN	Integrated Atmospheric Deposition Network
IARC	International Agency for Research on Cancer
ITT	Identification Task Team
LAMP	Lakewide Action and Management Plan
LC-PFCA	Long-Chain Perfluorinated Carboxylic Acid
LMMB	Lake Michigan Mass Balance
LRTAP	Long-Range Transboundary Air Pollution
LSBP	Lake Superior Binational Program
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAICS	North American Industry Classification System
NARAP	North American Regional Action Plan

NCCA	National Coastal Condition Assessment
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NGO	Non-Government Organization
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPPR	National Pollution Prevention Roundtable
NPRM	Notice of Proposed Rulemaking
OMOECC	Ontario Ministry of Environment and Climate Change
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
PBDE	Polybrominated Diphenyl Ether
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxin
PCDF	Polychlorinated Dibenzofurans
PEL	Permissible Exposure Limit
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
POP	Persistent Organic Pollutants
RCRA	Resource Conservation and Recovery Act
SAICM	Strategic Approach to International Chemicals Management
SCCP	Short-Chain Chlorinated Paraffin
SDWA	Safe Drinking Water Act
SiGL	Science in the Great Lakes
SOLEC	State of the Lakes Ecosystem Conferences
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average
UNECE	United Nations Economic Commission for Europe
US	United States of America
US FDA	Unites States Food and Drug Administration
USGS	United States Geological Survey
WHO	World Health Organization
WQS	Water Quality Standard
ZDDP	Zero Discharge Demonstration Program

1. Introduction

Annex 3 of the Canada – United States Great Lakes Water Quality Agreement (GLWQA) seeks to reduce the anthropogenic release of chemicals of mutual concern (CMCs) into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes. Under Annex 3, Canada and the United States are tasked to (1) identify CMCs that originate from anthropogenic sources and are harmful to human health and the environment, and (2) develop a Binational Strategy for each CMC in cooperation and consultation with State and Provincial Governments, Tribal Governments, First Nations, Métis, Municipal Governments, watershed management agencies, other local public agencies, industry, non-government organizations (NGOs) and the public. Binational strategies for CMCs may include research, monitoring, surveillance, and pollution prevention and control provisions. The United States Environmental Protection Agency (EPA) and the Environment and Climate Change Canada (ECCC) are the responsible agencies for coordinating the GLWQA between the two respective nations. Within the United States, the EPA's Great Lakes National Program Office (GLNPO) coordinates these efforts. Within Canada, ECCC's Ontario Regional Director General's Office coordinates these efforts.

In 2016, the first CMCs were designated by the two governments. These are:

- Hexabromocyclododecane (HBCD)
- Long-chain perfluorinated carboxylic acids (LC-PFCAs)
- Mercury
- Perfluorooctanoic acid (PFOA)
- Perfluorooctane sulfonate (PFOS)
- Polybrominated diphenyl ethers (PBDEs)
- Polychlorinated biphenyls (PCBs)
- Short-chain chlorinated paraffins (SCCPs).

The focus of this document is a Binational Strategy for PCBs. The objective of this Binational Strategy is not only to focus Canada and United States Federal Government efforts, but to also assist individuals, and stakeholder groups in the public, private, non-profit, State/Provincial, or Tribal sectors to develop and implement PCB mitigation and management (e.g., pollution prevention) and/or science (e.g., monitoring and/or research) actions. Environmental and Natural Resource Program Managers, community, non-governmental organization and industry leaders, their collaborators or others able to implement projects or maintain and refine existing programs, efforts, and projects on PCBs, may find this document useful in setting priorities for additional PCB–related activities. An extensive summary of environmental data and other pertinent information considered as part of the process of designating PCBs as a CMC is available in the PCB Binational Summary Report (Appendix A) produced by the Identification Task Team (ITT) (2015).

The long-term goal for PCBs is to reduce their presence in the environment to the point that they no longer have a negative impact on human or environmental health (US EPA 2002). The purpose of Canadian PCB regulations is to protect the health of Canadians and the environment by preventing the release of PCBs to the environment, and by accelerating the phasing out of these substances (ECCC, 2016a). For many years, PCBs have been the focus of efforts to reduce their presence in the environment. For example, Canada and the United States sought to reduce PCBs under the Great Lakes Binational Toxics Strategy from 1997 to 2007. Appendix B contains the final Great Lakes Binational Toxics Strategy Management Assessment for PCBs. Despite these efforts, PCB concentrations remain at levels that pose risks to human health and the environment.

2. Chemical Profile

2.1 Chemical Identity

PCBs are synthetic compounds that were globally manufactured and used for their superior insulating properties, low flammability, high heat capacity, low chemical reactivity, and long-term degradation resistance. PCBs were produced through the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst, such as iron filings or ferric chloride. The degree of chlorination of the final product ranged from 21% to 68%, and was controlled by the chlorine-contact time (ATSDR, 2000).

Figure 2-1 shows the general chemical structure of PCBs (formula $C_{12}H_{10-n}Cl_n$, where n = 1 to 10 = x+y). Biphenyl, the parent compound to all PCBs, consists of two six-membered carbon rings joined by a single carbon-carbon bond. Chlorine atoms can attach to the parent biphenyl molecule to produce 209 possible chlorinated compounds called congeners. PCB congeners are unique PCB compounds with individual properties that, when mixed in various proportions, produce different physical and chemical properties. Commercially available PCBs (e.g., Aroclors) were high-concentration liquids that contained one or more PCB congeners. When PCBs are categorized by degree of chlorination, the term “homolog” is used; the term “isomer” is used to designate homologs with differing substitution patterns (e.g., the dichlorophenyl homolog contains 12 isomers) (ATSDR, 2000).

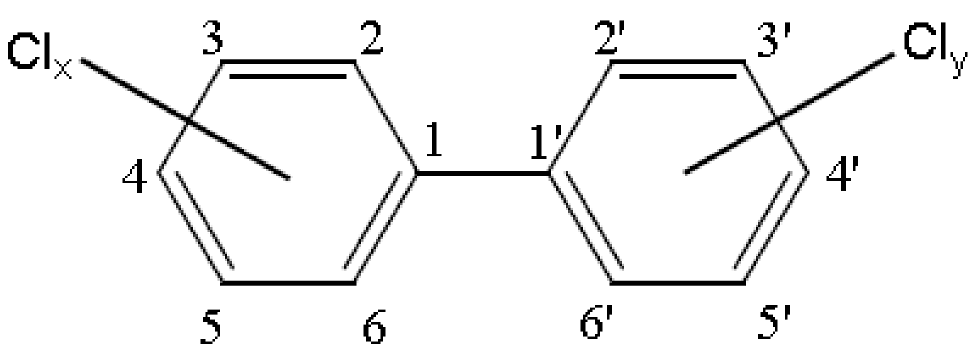


Figure 2-1. General Chemical Structure of PCBs

2.2 Physical and Chemical Properties

Commercially available PCB mixtures were identified by a four-digit number code where the first two digits indicated the type of mixture, and the second two digits indicated the approximate chlorine content by weight percent (ATSDR, 2000).

Many chemical properties of select PCB commercial mixtures (Aroclors) are listed in Table 2-1. Most PCB mixtures are clear, odorless, viscous liquids with the degree of chlorination controlling the overall viscosity (e.g., highly chlorinated PCB Aroclor 1260 is a sticky resin) (Erickson, 1997). PCBs are especially noted for their inertness to both acids and alkalis, thermal stability, low water solubility, and low vapor pressures (ATSDR, 2000; Erickson, 1997). These properties contributed to their usefulness as dielectric fluids within transformers, capacitors, and heat transfer fluids. PCBs are also relatively insoluble in water, and increased chlorination decreases solubility further (ATSDR, 2000). PCBs are soluble in most organic solvents, oils, and fats, which contributes to their bioaccumulative potential.

Table 2-1. Physical and Chemical Properties of Eight Common PCB Commercial Mixtures (Aroclors)

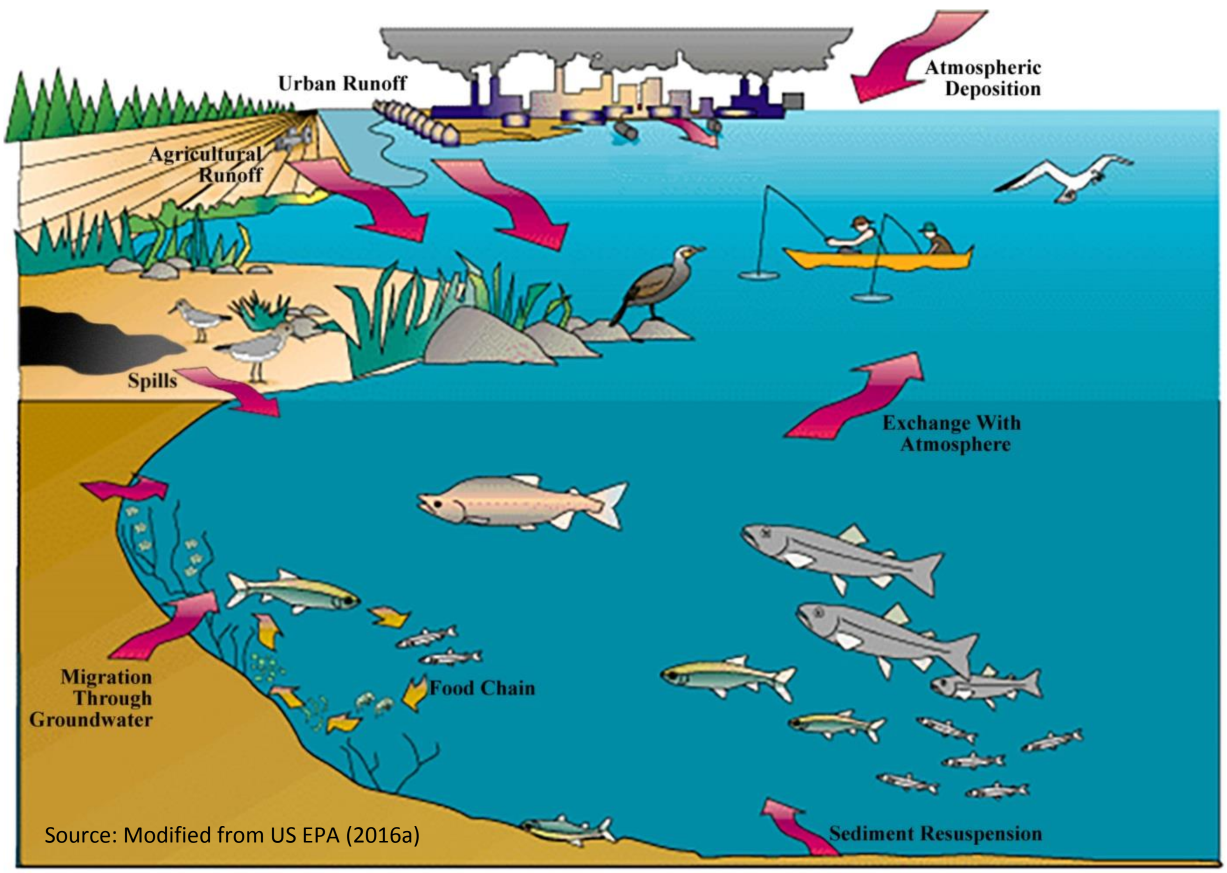
PROPERTY	COMMERCIALLY AVAILABLE PCB MIXTURES							
	1016	**1221**	**1232**	**1242**	**1254**	**1260**	**1262**	**1268**
MOLECULAR WEIGHT	257.9	200.7	232.2	266.5	328	357.7	389	453
COLOR	Clear	Clear	Clear	Clear	Light Yellow	Light Yellow	No Data	Clear
PHYSICAL STATE	Oil	Oil	Oil	Oil	Viscous liquid	Sticky resin	No Data	Viscous liquid
MELTING POINT, °C	No data	1	No data	No data	No data	No data	No data	No data
BOILING POINT, °C	325-356	275-320	290-325	325-366	356-390	385-420	390-425	435-450
DENSITY, G/CM^3 AT 25°C	1.37	1.18	1.26	1.38	1.54	1.62	1.64	1.81
ODOR	No data	No data	No data	Mild hydrocarbon	Mild hydrocarbon	No data	No data	No data
SOLUBILITY (25°C)								
WATER, MG/L	0.42	0.59 (24°C)	0.45	0.24, 0.34	0.012, 0.057 (24°C)	0.0027, 0.08 (24°C)	0.052 (24°C)	0.3 (24°C)
ORGANIC SOLVENT(S)	Very Soluble	Very Soluble	Very Soluble	Very Soluble	Very Soluble	Very Soluble	No Data	Soluble
PARTITION COEFFICIENTS								
LOG K_{OW}	5.6	4.7	5.1	5.6	6.5	6.8	No Data	No Data
LOG K_{OC}	No data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
VAPOR PRESSURE, MM HG AT 25°C	4.00×10^{-4}	6.70×10^{-3}	4.06×10^{-3}	4.06×10^{-4}	7.71×10^{-5}	4.05×10^{-5}	No data	No data
HENRY'S LAW CONSTANT, ATM-M^3/MOL AT 25°C	2.9×10^{-4}	3.5×10^{-3}	No data	5.2×10^{-4}	2.0×10^{-3}	4.6×10^{-3}	No data	No data
FLASHPOINT, °C	170	141-150	152-154	176-180	No data	No data	195	195
FLAMMABILITY LIMITS, °C	None to boiling point	176	328	None to boiling point	None to boiling point	None to boiling point	None to boiling point	None to boiling point
AIR CONVERSION FACTORS, AT 25°C	1 mg/m^3 =0.095 ppm	1 mg/m^3 =0.012 ppm	1 mg/m^3 =0.105 ppm	1 mg/m^3 =0.092 ppm	1 mg/m^3 =0.075 ppm	1 mg/m^3 =0.065 ppm	1 mg/m^3 =0.061 ppm	1 mg/m^3 =0.052 ppm

SOURCE: ATSDR (2000)

2.3 Environmental Fate and Transport

PCBs do not occur naturally in the environment. PCB exposure and sources within the Great Lakes are anthropogenic and may be from domestic (here defined as both Canada and the United States) or international sources via long-range transport. Once released into the environment, PCBs may be subject to different forms of transportation (in water, on suspended sediment, or through the atmosphere), transformation (physical, chemical, or biological), or accumulation (bioaccumulation or deposited sediments). PCBs in the environment transfer and cycle between air, water, animal tissues, and soil media, and can be easily transported on a global scale through the atmosphere (US EPA, 2016f).

Figure 2-2 illustrates many of the sources and pathways by which PCBs may circulate within the Great Lakes system (US EPA, 2016a). PCBs enter the Great Lakes ecosystem through urban and industrial sources, atmospheric deposition, groundwater migration, or sediment resuspension. Within the lakes system, PCBs enter the food chain, adhere to sediment, or exchange with the atmosphere. Human ingestion of fish with concentrations of bioaccumulated PCBs are of concern within the Great Lakes Basin.



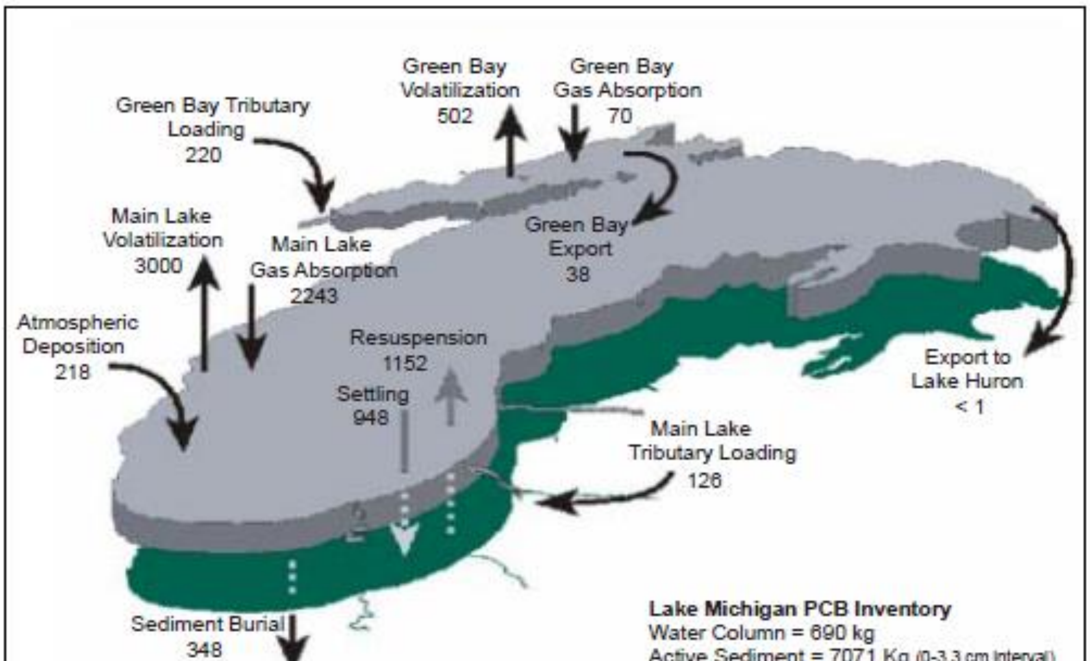
Source: Modified from US EPA (2016a)

Figure 2-2. Sources and Pathways of PCB Pollution in Aquatic Ecosystems

Of the 209 possible PCB congeners, approximately 113 are found in environmental media/biota (ITT, 2015). In general, more chlorinated PCB congeners absorb more strongly to sediment and soil, have higher bioaccumulation factors (BAFs), and can have half-lives on the order of months to years (ATSDR, 2011; Henry and DeVito, 2003; ITT, 2015). Less chlorinated congeners are more volatile, more water soluble, and are more readily metabolized by animals. Therefore, less chlorinated congeners are more commonly found within the atmosphere, surface waters, and fish from temperate waters (Henry and DeVito, 2003). Unfortunately, the most carcinogenic components of PCB mixtures are also the ones that most readily bioaccumulate in the food chain (US EPA, 2012d).

Between March 1994 and October 1995, the Lake Michigan Mass Balance (LMMB) Study conducted an in-depth analysis of PCB concentrations within the atmosphere, tributaries, lake water, sediments, and food web of Lake Michigan. These concentrations were used to estimate pollutant loading rates, establish a baseline for future programs, and develop an understanding of ecosystem dynamics. As shown in Figure 2-3**,** the 1994/95 PCB Inventory for Lake Michigan involves complex transport and transformation interactions that PCBs may undergo once released within the Great Lakes ecosystem (US EPA, 2012d). The values presented in the figure can be considered estimated baseline values, in kilograms (US EPA, 2004b).

While such efforts have not been conducted for each of the Great Lakes, it is assumed that the PCB mass balances for other Great Lakes are similar. Largely due to the overall size of the watershed and the population of people living and working within the watershed, the Great Lakes have been identified as a major PCB sink.



Source: US EPA (2012d)

Figure 2-3. Lake Michigan PCB Mass Balance for 1994/95

2.4 High Level Summary of Effects

While PCBs were initially banned due to probable carcinogenicity, more recent studies have also linked PCBs to human neurological and endocrine threats (Shanahan, et al., 2015). Animal studies indicate a correlation of PCBs to cancers and other serious non-cancer effects on the immune system, reproductive system, nervous system, endocrine system, and other health effects. Human studies have shown potential carcinogenic and non-carcinogenic effects from PCBs. The EPA has designated PCBs as a probable human carcinogen, the Centers for Disease Control and Prevention (CDC) has designated PCBs as reasonably anticipated to be a Human Carcinogen, and the Canadian Environmental Protection Act (CEPA) lists PCBs as toxic (CDC, 2011; ECCC, 2016a; US EPA, 2016f). The International Agency for Research on Cancer (IARC) (2015) has determined that there is sufficient human evidence that PCBs cause malignant melanoma, and that there is a positive association for non-Hodgkin lymphoma and breast cancer.

Ingestion of contaminated fish is one of the main routes for PCB human exposure within the Great Lakes region. A series of fish contamination studies within the lower 48-contiguous United States was conducted between 2000 and 2003. Results indicated the presence of PCBs and mercury in every fish sample from all 500 lakes and reservoirs sampled nationwide (Stahl, et al., 2009). In 17% of the lakes assessed, the total PCB concentration exceeded the 12 ppb human health risk-based consumption limit (Stahl, et al., 2009).

While the Stahl, et al. (2009) study focused on the national status of PCBs within fish tissues, an assessment of Lake Michigan lake trout was conducted as part of the LMMB. Estimated projections forecast that the concentration of PCBs within lake trout (age 5.5) will reach EPA’s wildlife protection level of 0.16 ppm by 2030 and fish consumption protocol levels by 2035 (Figure 2-4). Work conducted for the Lake Superior LAMP also concluded that lake trout total PCB concentrations are decreasing, however in 2013, the total PCB concentration found within 33 of 53 sampled Lake Superior lake trout still surpassed the 1987 GLWQA criteria value of 0.1 ppm (The Lake Superior Partnership, 2016).

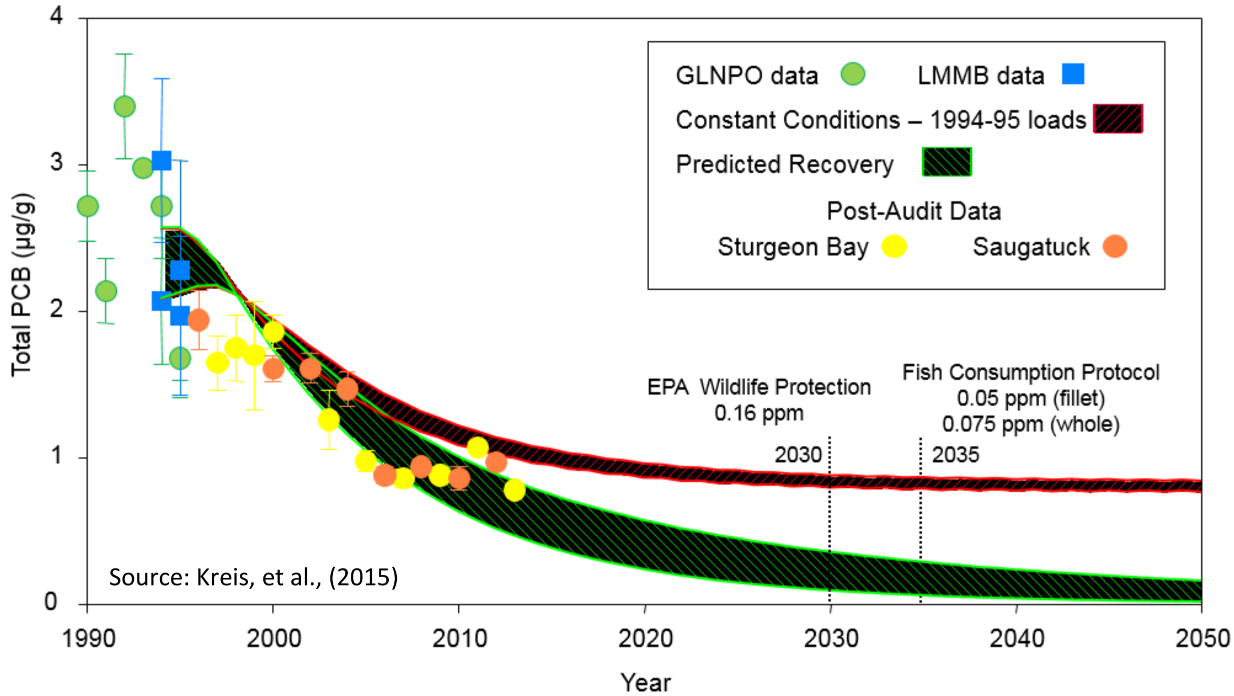


Figure 2-4. PCB Forecasts for Lake Michigan Lake Trout.

While total PCB concentrations have declined over the past 30 years across the Great Lakes, total PCB concentrations in fish tissues remain above the 1987 GLWQA guidelines and remain a significant issue (ECCC and US EPA, 2014). Due to the large concern for PCB ingestion with sport fishing, every Great Lakes State and the Province of Ontario has a fish contaminant monitoring program that annually issues fish consumption advice for their residents.

Representatives from each of the Great Lakes States collaborated to form the Great Lakes Sport Fish Consumption Advisory Task Force to generate guidelines for determining consumption advice. Begun as a resource for anglers who consumed fish at a higher frequency than national averages, the Advisory Task Force published a protocol that can be used by individual States/Provinces to categorize average fish tissue PCB concentrations and recommended fish consumption rates (The Great Lakes Sport Fish Consumption Advisory Task Force, 1993). The overall goal of the Advisory Task Force was to keep the sport fish associated dietary PCB ingestion below 3.5 µg PCB per day (The Great Lakes Sport Fish Consumption Advisory Task Force, 1993).

While many States adhere to the guidelines developed by the Advisory Task Force (Minnesota, Ohio, Wisconsin), each state/province has the authority to establish its own threshold limits for determining consumption rates. For instance, the State of Michigan and the Province of Ontario have each published separate guidelines for determining consumption advice (Table 2-2) (Michigan Department of Environmental Quality, 2014; OMOECC, 2015). Therefore, the advice given by different States/Province may differ for the same Lake and species within that Lake (Great Lakes Commission, 2005). For instance, if the average lake trout PCB concentration is found to be 1.0 ppm, States that follow the Great Lakes Sport Fish Consumption Advisory Task Force would recommend a one meal a month consumption rate, the Michigan Department of Environmental Quality would recommend "limited" consumption (i.e., less than six times a year), and the Ontario Ministry of the Environment and Climate Change would recommend not eating the fish (Table 2-2).

Table 2-2. Fish Advisory Consumption PCB Limits

Meal Category Meals/month	*Great Lakes Sport Fish Advisory, ppm (Illinois, Indiana, Minnesota, New York, Ohio, Pennsylvania, Wisconsin)*	*Michigan Consumption Guidance, ppm*	*Ontario Ministry of the Environment and Climate Change, ppm*
Unlimited	0 to 0.05		
52	0.06 to 0.2		
32			≤0.026
16		≤ 0.01	>0.026
12		>0.01 to 0.02	>0.053
8		>0.02 to 0.03	>0.070
4		>0.03 to 0.05	>0.105
2		>0.05 to 0.11	
1	0.21 to 1.0	>0.11 to 0.21	
6 meals per year	1.1 to 1.9	>0.21 to 0.43	
Limited		>0.43 to 2.7	
Do Not Eat	>1.9	≥2.7	>0.844
Sources:	The Great Lakes Sport Fish Consumption Advisory Task Force (1993)	Michigan Department of Environmental Quality (2014)	OMOECC (2015)

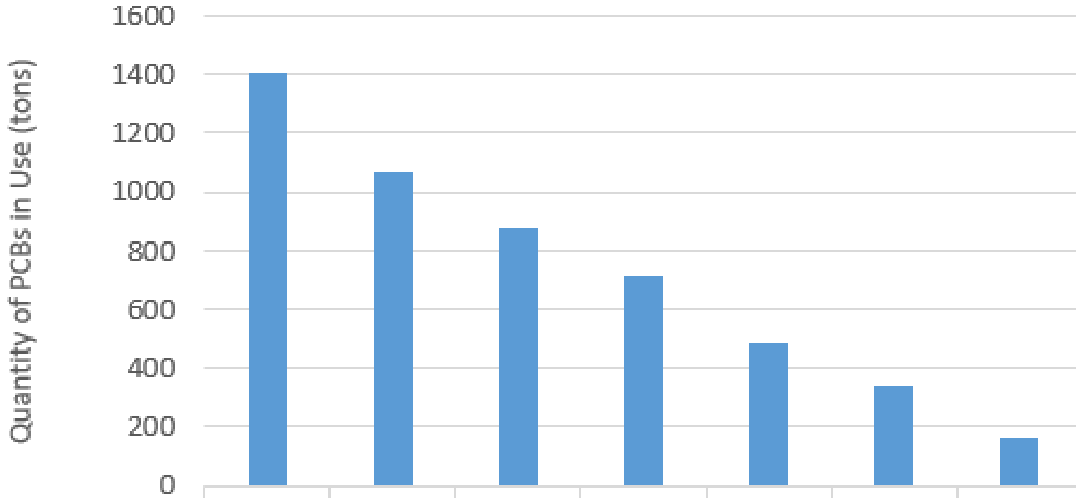
2.5 Sources and Releases of PCBs in the Great Lakes

Worldwide production of PCBs has been estimated to be one million metric tons (Erickson, 2001). Nearly 60% of these were produced within the United States by Monsanto. Peak PCB production and use in the late 1960s coincided with a building boom and infrastructure expansion projects in many United States cities between the 1950s and 1970s (Csiszar, et al., 2014; Hornbuckle, et al., 2006). The PCBs present in the buildings and infrastructure built in this era, along with the original production sites, leave a plethora of potential legacy PCB sources today (Csiszar, et al., 2014). In Canada, the import, manufacture, and sale (for reuse) of PCBs was banned in 1977, and direct release of PCBs into the Canadian environment was made illegal in 1985. In the United States, all manufacture, import, export, distribution and use of PCBs were banned in 1979. However, both nations have authorized the continued use of certain PCB-containing products and equipment (e.g., transformers, capacitors). December 31, 2025 is the end-of-use deadline for eliminating certain continued-uses within Canada (Government of Canada, 2014). The United States currently does not have a mandated end-of-use date.

2.5.1 Legacy PCBs (pre-1979)

Legacy PCBs were manufactured prior to the 1979 ban and may be found in existing PCB-containing equipment (e.g., transformers, capacitors) or within soils, landfills, architectural paints, waste oils, building materials, and other items within the built environment and wastewater treatment plant sludge drying facilities (Shanahan, et al., 2015). Between 1930 and 1970, an estimated 300,000 tons (272,155 metric tons) of PCBs, as pure fluids and PCB-containing fluids or materials, were placed into dumps and landfills, 30,000 tons (27,215 metric tons) were released to the air, and an additional 6,000 tons (5443 metric tons) were released into fresh and coastal waters of the United States (Oregon Department of Environmental Quality, 2003).

In Canada, owners of PCBs and PCB-containing equipment subject to the *PCB Regulations* are required to report annually on the status of their inventory of PCBs in use, in storage, and sent for destruction. The quantity of PCBs reported to be in use in Canada continues to steadily decline (Figure 2-5). This is expected as the materials from known sectors and sources are removed from service and destroyed. In 2014, companies in Ontario reported 85.5% of all PCBs in use in Canada, with companies in Quebec reporting 13.95% of reported in use equipment, and the rest of Canada reporting 0.2% (ECCC, 2016b).



	2008	2009	2010	2011	2012	2013	2014
tons	1405	1069	873	712	484	338	162
metric tonnes	1275	970	792	646	439	307	147

Year

Source: ECCC (2016b)

Figure 2-5. Quantities of PCBs Reported in Use in Canada 2008 – 2014.

The total quantity of legacy PCBs still in use in the United States is not well known. The last inventory assessing the number of PCB-containing electrical equipment was conducted in 2011, focusing on transformers and capacitors that are subject to use authorization under the Toxic Substances Control Act (TSCA) (Table 2-3). In the years since the last inventories, the amount of continued-use equipment in the United States may have declined due to retirement of equipment at the end of its useful life, equipment failure, capital planning or equipment upgrades, decontamination and other remediation projects, and other planned efforts to remove PCB-containing equipment prior to its end of service life. In addition, these inventories are not a complete listing of all PCB sources within the Great Lakes Basin. Current efforts have not surveyed for items not covered under TSCA, such as small capacitors and sealants. To date, only the State of Minnesota has tracked disposal records over time. Minnesota has also fielded a voluntary PCB phase-out confirmation survey for electrical utilities. Roughly one-third of the utilities in Minnesota have determined their systems to be non-PCB (<50 ppm).

Table 2-3. Estimated Quantities of PCB-Containing Electrical Equipment in the United States.

Item[a]	*Number of Units*		
	1981	1988	2010
Utility Transformers			
Askarel[b]	39,640	32,505	7,004
PCB (≥500 ppm PCBs)	219,918	199,038	90,606
PCB-contaminated (≥50 to <500 ppm PCBs)	2,166,159	1,459,611	892,458
Non-Utility Transformers			
Askarel[b]	92,499	75,850	16,344
PCB (≥500 ppm PCBs)	54,979	49,759	22,651
PCB-contaminated (≥50 to <500 ppm PCBs)	541,533	364,898	223,112
Capacitors			
Large Utility PCB >500 ppm	2,800,619	1,454,270	119,207
Large Non-utility PCB > 500 ppm	772,585	401,178	32,885
Small PCB	75,000,000		
PCB Fluorescent Light Ballasts	800,000,000		322,603,642

[a] *Note that only PCB Transformers were tracked. Capacitor quantities are based on modeled values.*
[b] *Askarel is a trade name for dielectric fluids that can contain up to 100% PCBs*

Source: US EPA (2012a); US EPA (2012b)

The EPA uses the Transformer Registration Database to document and track all PCB transformers in the United States that are authorized for use until the end of their product life. Table 2-4 outlines the most updated number of PCB transformers in the Great Lakes EPA Regions and the average weight of PCBs per transformer. Caution must be used when assessing these values, as they are based upon self-reporting, the database is becoming dated (February 2011), and only reflects information at the time of the most recent registration. Current numbers may be different due to issues such as the lack of reporting of ownership or locational transfers, decommissioning without notification, abandonment, and other compliance-related concerns. It must also be noted that the EPA has exempted capacitors containing less than 3 pounds (1.3 kg) of PCBs from Federal regulation; additionally, in some States the disposal of PCB-containing light ballasts in landfills is completely banned, limited to permitted hazardous waste entities (e.g., Minnesota), or limited to a small quantity by State or local waste programs (US EPA, 2012c).

Table 2-4. Summary of PCB Transformers by Great Lakes EPA Regions.

EPA Region	*No. of Transformer Locations*		*Weight, ton[a]*		*Weight, metric ton*	
	Total	With PCBs	Total	Average per Transformer with PCBs	Total	Average per Transformer with PCBs
2	832	801	935	2,332	848	1,059
3	1,364	1,152	3,235	5,612	2,934	2,548
5	3,719	3,555	7,969	4,479	7,229	2,034
Total	**5,915**	**5,508**	**12,139**	**12,423**	**11,012**	**5,641**

[a] Weight of PCBs in units of tons was calculated from the weight in kilograms, as reported in the PCB Transformer Database.

Source: US EPA (2012b)

2.5.2 By Product PCBs

While intentional production and use of PCBs has been banned for many years, inadvertently generated PCBs have been and continue to be generated as by-products in certain industries. Chemical processes that involve carbon, chlorine, and elevated temperatures or catalysts have the potential to produce PCB by-products (Hu, et al., 2011). Pigment production (inks), paint manufacturing, papermaking processes, and titanium dioxide production have each been associated with PCB by-products (Grossman, 2013). A primary example of an inadvertently produced PCB within inks is PCB-11.

PCB-11 is a congener that is present in paints/pigments (Khairy, et al., 2015). PCB-11 is a known by-product of diarylide yellow pigments, and is being used as a marker for non-legacy PCB contamination, as it has not been associated with historic (legacy) PCB products or their breakdown products (Grossman, 2013; Stone, 2016a; Stone, 2016b). In one study, 60% of the consumer goods or packaging tested contained elevated concentrations of PCB-11 (Rodenburg, et al., 2010; Stone, 2016a; Stone, 2016c; Stone, 2016b). Due to the ubiquitous use of PCB-11 in consumer goods, PCB-11 is being used as a tracer for wastewater and combined sewer overflows, even in watersheds where there are no known manufacturers of pigments (Rodenburg, et al., 2010). PCB-11 is expected to have less bioaccumulative potential than heavier PCB congeners; however, as traces of PCB-11 were found in 60% of female blood samples collected in one study, the presence of PCB-11 remains a concern (Marek, et al., 2013). In 2006, the worldwide production of diarylide yellow pigments was estimated to be about 68.9 million tons (62.5 million metric tons) with an estimated PCB-11 load of 1.7 million tons (1.5 metric tons) (Rodenburg, et al., 2010).

Table 2-5 outlines industrial sectors that have reported PCB emissions and/or discharges to one or more EPA databases (Toxics Release Inventory [TRI], National Emissions Inventory [NEI], Discharge Monitoring Report [DMR] Pollutant Loading Tool). These industries in and near the Great Lakes region may contribute new PCBs being released to the environment. Further detail regarding the types of activities that cause PCB emissions is provided in Table 2-6.

Table 2-5. Industrial Sectors with Annual Reported PCB Emissions

Industry	*NAICS Code*	*Media*
Pulp & Paper	322121 & 322130 & 322291	Air & Water
Landfills	562212 & 562998	Air
Renewable Fuel Power Generation	221112 & 221118	Air & Water
Taconite	21221	Air
Wood Manufacturing/ Lumber/Sawmill	321113 & 321219 & 321911	Air
Medical Incinerator	61131	Air
Municipal Waste Combustor	221118	Air
Polystyrene Foam Manufacturing	326140	Air
Plastic Resin Mixing	325991	Air
Travel Trailer and Camper Manufacturing	336214	Air
Ammunition	332993	Air
Pigments	325130	Air & Water
Organic Chemical Manufacturing.	325998 & 325199	Air & Water
Aluminum Smelting	331314	Air
WWTP	221320	Air
Hazardous Waste Treatment & Disposal	562211	Water
Pesticide Mfg.	325320	Water
Petroleum Lubricating Oil & Grease Manufacture	324191	Water
Petrochemical Manufacturing	325110	Water

Source: US EPA (2016c)

Table 2-6. PCB Sources in Waste Materials and Recycling Operations

Material or Operation	*Remarks*
Scrap metal recycling	*Transformer shell salvaging, heat transfer and hydraulic equipment, and fluff (shredder waste from cars and appliances including upholstery, padding, and insulation). PCBs also present in non-ferrous metal salvaging as parts from PCB-containing electrical equipment, and oil & grease insulated electrical cable.*
Auto salvage yards, auto crushing	*Hydraulic fluid, brake fluid, recycled oil, capacitors, and oil-filled electrical equipment, such as some ignition coils.*
Repair activities	*Shipyards (electrical equipment, hydraulic oil, paint, etc.), locomotive repair, heavy equipment repair facilities, auto repair, repair of manufacturing equipment, etc.*

Used oil	*Used oil auto salvage yards, automotive and heavy equipment repair shops, hydraulic equipment repair, industrial machinery repair, etc. Because some PCBs have been mixed with used oil, some recycled oils currently in circulation may contain PCBs at concentrations generally <50 ppm. PCBs may also be present where used oil has been used for dust suppression/road oiling, weed control, and energy recovery.*
Recycled paper	*Paper may contain PCBs where carbonless copy paper has been used in recycling. PCB concentrations have decreased over time as the volume of unrecycled carbonless copy paper is reduced. Recycled paper containing PCBs has historically been used for food packaging, where PCB concentrations are restricted to 10 ppm unless an impermeable barrier is present between the packaging and food product.*
Effluent	*Wastewaters from manufacturing facilities and equipment such as chemical and pesticide facilities, pulp and paper mills, cooling waters from vacuum pumps and electric power generation facilities where leaks have occurred, and condensate from vacuum pumps and natural gas pipelines. Significant cleanup activities have been performed at natural gas pipeline compressor stations from discharges of condensate to ground and storm drainage systems.*
Asphalt roofing materials, tar paper, and roofing felt	*Anticipated at generally very low concentrations where used oil containing PCBs has been used in asphalt mix.*
Building demolition	*Electrical equipment, joint caulking, oil & grease insulated cable, surface coatings as flame retardant and waterproofing.*
Dredge spoils	*From areas where contaminated sediments are present.*
Landfills	*Municipal and industrial solid waste; virtually all potential sources could be present, including waste materials and soils from remediation sites.*
Wastewater treatment plant sludge	*Derived from atmospheric deposition and stormwater, water supply systems, leaks and spills, leaching from coatings and plastics containing PCBs, PCBs in food and human waste*

Source: Oregon Department of Environmental Quality (2003)

2.5.3 Contaminated Sediments

PCB re-emission from contamination within Great Lakes sediments is of concern, and removal of PCB contaminated sediments has been a focus of some Canadian and United States AOC remediation efforts (e.g., Ashtabula, Ohio). In addition to the 43 listed AOCs in the Great Lakes Basin, PCBs have been identified within 500 of the 1,598 National Priority List Superfund sites in the United States (ATSDR, 2000). Each of these known reservoirs of legacy PCB contamination has the potential for continued environmental cycling, which may contribute to PCB contamination in the Great Lakes.

Recent studies have shown that the lakewide surficial sediment averages over the last 25 years (1980 to 2005) have decreased by approximately 30% within the region, with PCB concentrations generally below permissible exposure limit (PEL) guidelines (277 ng/g total PCBs) (Li, et al., 2009). The 2005 sediment PCB loads within the Great Lakes were highest in Lake Erie, followed by Lake Ontario > Lake Michigan > Lake Huron > and Lake Superior (Li, et al., 2009). Additional details regarding the levels and trends of PCBs in Great Lakes sediments can be found within Appendix A.

2.5.4 Atmospheric Deposition

Airborne PCBs are continually detected in ambient air samples around the globe. Nationally, an estimated 3,000 tons (2,721 metric tons) of PCBs were released in the air between 1930 and 1970 (Oregon Department of Environmental Quality, 2003). In 2011, NEI recorded 8,988 pounds (4076 kg) of PCB emissions from the eight Great Lakes States (US EPA, 2016b), supporting the conclusion that airborne deposition of PCBs is one of the largest PCB sources to the Great Lakes (Shanahan, et al., 2015).

Studies have shown that in addition to long-range atmospheric transport and deposition, regional industrial sources (e.g. combustion, wastewater treatment drying activities, dying and pigment production activities, hazardous waste facilities) are potentially an important source of atmospheric PCBs within the Great Lakes region (Csiszar, et al., 2014; Khairy, et al., 2015). A recent study estimated the annual PCB emission rate from Chicago, Illinois to be 447 pounds year^{-1} (203 kg year^{-1}) (Shanahan, et al., 2015). Volatilization of known legacy sources accounted for approximately 70% of the total, while the remaining 30% was attributed to various sources, including municipal sludge drying beds (Shanahan, et al., 2015). While additional work is needed to ascertain the extent to which inadvertent generation of by-product PCBs versus redistribution of legacy PCBs may be impacting the PCBs in air, it is clear that industrial activities continue to be a major source of PCBs in the atmosphere across the Great Lakes (Khairy, et al., 2015).

2.5.5 Summary of PCB Sources

In summary, the primary sources of PCBs to the Great Lakes Basin are (ITT, 2015; US EPA, 2016f):

- Release from remaining in-service equipment which may be articles, items, and products containing manufactured PCBs (e.g., accidental uncontrolled spills or releases, gradual leaks or emissions)
- Release from PCB-containing sealants, paints, finishes, building materials, and other features of the built environment
- Accidental release from PCB storage and disposal facilities during the handling of PCB wastes
- Emissions from combustion or incineration of materials containing PCBs
- Inadvertent by-product generation during poorly controlled combustion or certain chemical production processes (e.g., inks, dyes)

- Reservoirs of past PCB contamination and environmental cycling including contaminated sediments, soils, and sites (e.g., National Priority List Superfund sites, other uncontrolled reservoir sites, and AOCs)
- Disposal of PCB-containing consumer products into municipal or other landfills not designated to handle hazardous waste
- Illegal or improper disposal of PCB wastes (e.g., illegal dumping)
- Long-range transport (regional and international)
- Others (e.g., dispersive sources).

3. Existing PCB Management/Control Policies, Regulations, and Programs

3.1 United States

3.1.1 Existing Federal Statutes and Regulations

Multiple regulations have been established at the Federal level to limit the availability, usage, discharge, and overall number of PCB sources within the United States. In addition to Federal mandates, some of the Great Lakes States have issued more stringent regulations and processes to limit PCB emissions.

3.1.1.1 Toxic Substances Control Act (TSCA)

The most notable prohibition regulation for PCBs in the United States is the Toxic Substances Control Act (TSCA). Section 6(e), 15 U.S.C. § 2605(e) of the TSCA is devoted solely to PCBs. In 1979, this Act banned the manufacture, import/export distribution in commerce, and use of PCBs except under limited circumstances in the United States. Through TSCA, EPA regulates several classes of PCB equipment based on the concentrations of PCBs within the equipment. TSCA establishes the basis for regulating manufacture, use, storage, spill clean-up requirements, and disposal of PCBs, and PCB-containing equipment. Regulations codified pursuant to TSCA can be found in Title 40 of the Code of Federal Regulations Part 761 (40 CFR Part 761). The PCBs within dielectric fluids in all PCB electric equipment (e.g., transformers, capacitors and switches) are subject to regulation, and those at certain concentration ($\geq$ 500ppm PCB) must be registered with the EPA and local fire officials in order to be authorized for use. TSCA also provides EPA with the authority to require reporting, record-keeping, and testing for PCBs more broadly, such as at site-specific levels of detail (US EPA, 2016f).

Under TSCA, the EPA has authority to issue penalties for noncompliance with PCB regulations. The gravity of the penalty is based upon the nature, extent, and circumstances of the actual violation (US EPA, 1990). The presence of all known PCBs should be recorded under TSCA: in-use, in storage, within waste streams, or within spilled materials. An owner who discovers unregistered PCBs must register the equipment within 30 days (US EPA, 2004a). PCB items must be properly disposed within one year from the date when the item was declared waste or was no longer fit for use (US EPA, 2004a). PCB items in-storage must be placed in areas that meet specific criteria, including roof, walls, and floor material that can minimize PCB penetration (US EPA, 2004a). Clean-up of PCB spills and site remediation following a spill for both risk-based remediation and self-implemented remediation are outlined within the TSCA. Owners of PCB equipment are responsible for conducting equipment inspections on a regular basis and maintaining equipment inspection logs. Non-compliance with any PCB-related rules or regulations under TSCA may induce penalties by State or Federal entities.

In addition to TSCA, the Clean Air Act (CAA) and the Clean Water Act (CWA), the Safe Drinking Water Act, the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") also regulate PCB emissions in United States air, water, and land, respectively. Table 3-1 briefly outlines Federal regulations that pertain to PCBs.

Table 3-1. United States Federal PCB Regulations

REGULATION	SUMMARY OF ELEMENTS
TSCA SECTION 6(E) 40 CFR PART 761	Primary PCB regulation for manufacture, use, registration, testing, storage, spill clean-up requirements, site remediation (risk-based, self-implementing), decontamination, treatment, and disposal of PCBs, and PCB-containing equipment.
CLEAN AIR ACT 42 U.S.C. § 7401 ET SEQ. (1970) SECTION 112(C)(6)	Regulates air emissions from stationary and mobile sources and requires the identification and regulation of PCB sources.
CLEAN WATER ACT 33 U.S.C. § 1251 ET SEQ. (1972)	Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Authorized the National Pollutant Discharge Elimination System (NPDES), wastewater standards for industry, and water quality standards for contaminants within surface waters.
SAFE DRINKING WATER ACT 42 U.S.C. § 300F ET SEQ. (1974)	Authorizes EPA to establish minimum standards to protect all waters actually or potentially designed for drinking use. Requires all owners or operators of public water systems to comply with primary (health-related) standards. PCB maximum contaminant level goal (MCLG): 0 ppm; maximum contaminant level (MCL): 0.0005 ppm.
RESOURCE CONSERVATION AND RECOVERY ACT 40 CFR PARTS 262 - 265	PCB wastes are manifested using the RCRA Uniform Hazardous Waste Manifest. TSCA 40 CFR part 761 has recently been updated to reflect RCRA hazardous waste regulations. PCB waste handlers and generators must follow RCRA hazardous waste regulations (US EPA, 2016f). In addition, for States that consider PCBs to be hazardous waste, 40 CFR Parts 262-265, and any RCRA Subtitle C permits apply.
CERCLA OR "SUPERFUND" 42 U.S.C. § 9601 ET SEQ. (1980)	Gives the Federal government authority to respond to PCB emergencies and clean up uncontrolled or abandoned hazardous waste sites.

3.1.1.2 Clean Air Act (CAA)

Section 112(c)(6) of the CAA Amendments of 1990 requires that the EPA identify and regulate sources of PCBs. Therefore, through the CAA, the EPA has established the National Emissions Standards for

Hazardous Air Pollutants (NESHAP) that lists PCBs as one of 33 hazardous air pollutants (HAPs) that must be monitored and regulated (US EPA, 2016j).

3.1.1.3 Clean Water Act (CWA)

The CWA establishes the structure for regulating discharge of pollutants into, and restoring and maintaining the quality of the waters of the United States. Through the CWA, the EPA oversees State adoption of water quality standards and implementation of pollution control programs that regulate the release of PCBs into the nation's waters (33 U.S.C. §1251 *et seq.*, 1972). Title I of the Great Lakes Critical Programs Act of 1990 amended Section 118 of the CWA and put into place parts of the Great Lakes Water Quality Agreement of 1978. That law required EPA to establish water quality criteria for the Great Lakes for PCBs and 28 other toxic pollutants with levels that are safe for humans, wildlife, and aquatic life.

The CWA created the National Pollutant Discharge Elimination System (NPDES) permit program that authorizes States, Tribes, and territories to regulate point source pollutants that discharge into the waters of the United States through permits, administration, and enforcement. The Discharge Monitoring Report (DMR) Pollutant Loading online tool calculates pollutant loading from permit and DMR data from EPA's Integrated Compliance Information System for NPDES (https://cfpub.epa.gov/dmr/). Additional laws that may affect the NPDES permit process include, but are not limited to:

- National Environmental Policy Act (NEPA) – requires that agencies conduct environmental impact reviews for major Federal actions that would affect the quality of human environment.
- Fish and Wildlife Coordination Act - requires that regional administrators consult with United States Fish and Wildlife Service, Department of the Interior, and the appropriate State agency exercising jurisdiction over wildlife resources.
- Essential Fish Habitat Provisions of the Magnuson-Stevens Act – protects essential fish habitat through consultations with National Marine Fisheries Service.

3.1.1.4 Safe Drinking Water Act (SDWA)

In addition to the CWA, the Safe Drinking Water Act (SDWA) regulates PCBs within public water systems (42 U.S.C. §300f). While the EPA has a maximum contaminant level goal (MCLG) of zero PCBs at the entry point to the distribution system, the enforceable maximum contaminant level (MCL) for PCBs is 0.0005 ppm (US EPA, 2016m).

3.1.1.5 Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to create a framework for proper management of hazardous and non-hazardous solid wastes. Regulations, guidance, and polices have been developed by EPA to ensure the safe management and cleanup of solid and hazardous wastes, and programs to encourage source reduction and reuse (US EPA, 2017). PCB wastes are manifested using the RCRA Uniform Hazardous Waste Manifest. PCB waste handlers and generators must follow RCRA hazardous waste regulations (US EPA, 2016f).

3.1.1.6 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund")

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") gives the Federal government authority to respond to chemical emergencies and clean up uncontrolled or abandoned hazardous waste sites. In 2015, PCBs were ranked fifth out of 275 hazardous substances on the Agency for Toxic Substances and Disease Registry (ATSDR) Substance Priority List. CERCLA also requires that the EPA National Response Center be notified if more than one pound (454 grams) of PCB fluid is released (including, but not limited to, fires, spills, leaks, or other incidents causing release) into the environment within a 24-hour period (40 CFR Section 302.4).

Under the mandate of the Emergency Planning and Community Right-to-Know Act (EPCRA), all known PCB releases from facilities subject to the Toxic Release Inventory (TRI) that exceed applicable thresholds are reported to the TRI database. This database, maintained by EPA, is publicly available and intended to inform the general public regarding facilities that release toxic chemicals (US EPA, 2016c).

3.1.2 Existing State Regulations

TSCA establishes methods for handling, storage, treatment, and disposal of PCB wastes at the Federal level. However, individual State programs may add additional requirements to PCB wastes being disposed within the respective State. Table 3-2 outlines specifics for each of the Great Lakes States. While the State of Washington is not located within the Great Lakes basin, the state has conducted product testing for PCBs which provides useful information on levels of PCBs in consumer products. The Washington Department of Ecology tested 201 consumer products and found detectable levels of PCBs in 89% of samples; products tested included packaging, children's products and common consumer goods. Appendix C contains a full report of the Washington Department of Ecology's study of PCBs in consumer products, while Appendix D contains a summary of Washington's product testing results for PCBs.

Table 3-2. State Regulations for Handling, Storage, Treatment, and Disposal of PCB wastes in the Great Lake Region.

State	*Rules and Regulation Notes*
Indiana	PCB wastes are further regulated by State RCRA Subtitle D solid waste management rules (Indiana Administrative Code, 2016). Requirements for the handling, storage, and disposal of PCBs in Indiana are enforced through EPA Region 5 and the Indiana Department of Environmental Management. The Indiana Partners for Pollution Prevention provides a forum for discussing State environmental policies and programs. The full regulations are filed within Indiana Administrative Code Title 329 Solid Waste Management Division Article 4.1 Regulation of Wastes Containing PCBs (http://www.in.gov/legislative/iac/T03290/A00041.PDF).
Illinois	PCBs wastes are regulated by Federal TSCA rules, with additional State requirements concerning detection of PCBs at solid waste landfills, land disposal restrictions for liquid hazardous waste containing PCBs, land application of sludge containing PCBs, manifests, and annual reports. The Illinois Environmental Protection Agency Bureau of Land, Division of Land Pollution Control, administers and enforces PCB regulations within Illinois. Title V of the Illinois Environmental Protection Act and 35 Illinois Administrative

Table 3-2. State Regulations for Handling, Storage, Treatment, and Disposal of PCB wastes in the Great Lake Region (Continued)

State	*Rules and Regulation Notes*
	Code Subtitle G outline Illinois full PCB waste requirements (http://www.epa.illinois.gov/topics/waste-management/factsheets/pcb/index).
Michigan	PCB wastes are regulated through the Federal TSCA rules and are enforced through EPA Region 5 and the Michigan Department of Environmental Quality. PCB wastes in concentrations of 100 ppm or greater are regulated pursuant to Part 147, PCB Compounds of the Natural Resources and Environmental Protection Act, 1994 PA 451. The Michigan Administrative Code R 299.3316 requires that a manifest accompany all shipments of PCBs within Michigan (http://www.michigan.gov/documents/deq/deq-whm-hwp-uniform-manifest-requirements_213003_7.pdf).
Minnesota	PCB wastes are regulated through the Minnesota Hazardous Waste Rules administered by the Minnesota Pollution Control Agency (Minnesota Pollution Control Agency, 2010). In addition to Federal TSCA requirements, the State has added restrictions for PCB light ballasts, PCBs within small capacitors, caulking, shredder residue, and spill debris, and thermal treatment of PCB-containing wastes to limit PCB wastes at their source.
New York	New York's Great Lakes Action Agenda is a guide to promote ecosystem-based management practices in New York's Great Lakes Basin and includes a focus on eliminating discharges of persistent toxic substances (New York State, 2016)
Ohio	PCB wastes are regulated through the Ohio Environmental Protection Agency. In addition to Federal TSCA requirements, Ohio EPA requires owners and operators of sanitary landfill facilities to implement a written program for PCB and hazardous waste prevention and detection with the assistance of the Ohio EPA Office of Compliance Assistance and Pollution Prevention through Ohio Administrative Code 3745-27-19(L) (http://epa.ohio.gov/portals/34/document/guidance/gd_032.pdf).
Pennsylvania	The Pennsylvania Department of Environmental Protection Bureau of Waste Management, along with EPA Region 5, administers and enforces the Federal TSCA requirements and additional State-level regulations for disposal, storage, and monitoring. The Pennsylvania Office of Energy and Technology Development leads efforts for reducing pollution at its source. The Pennsylvania code Chapter 287, residual waste management general provisions, outlines the specific PCB-containing waste definitions and requirements (http://www.pacode.com/secure/data/025/chapter287/chap287toc.html).
Wisconsin	A "One Clean-Up" memorandum of agreement between the State of Wisconsin Department of Natural Resources and EPA Region 5 addresses all PCB remediation cases (Wisconsin Department of Natural Resources, 2014). The State has issued additional procedures for storage, collection, transportation, processing, and final disposal of PCB wastes through P2 requirements. Wisconsin State Legislator Chapter NR 157 – Management of PCBs and Products Containing PCBs (http://docs.legis.wisconsin.gov/code/admin_code/nr/100/157).

3.1.3 Proposed or Newly Enacted Statutes and Regulations

The EPA is currently reviewing comments received on an advance notice of proposed rulemaking (ANPRM) for the Reassessment of Use Authorizations for PCBs. A notice of proposed rulemaking (NPRM) is tentatively expected in October 2017 (US EPA, 2015a). The updated rules are intended to address the following areas:

- Use, distribution, marking and storage for reuse of liquid PCBs in electric equipment
- Improving the existing use authorization for natural gas pipelines
- Clarity in definitions and other regulatory "fixes."

The updated rules are also anticipated to include phase-out deadlines for all PCB electrical equipment. The potential timeframes were stated as follows in the ANPRM:

- By 2015, the use of all Askarel equipment ($\geq$100,000 ppm PCBs) should be eliminated, starting with equipment in high potential exposure areas. EPA is considering allowing exceptions case-by-case, based on hardship and no unreasonable risk. Exceptions may be granted based on an application, and approved exceptions may be published on the PCB website. The US continues to work toward this phase-out goal in 2017.
- By 2020, elimination of the use authorizations for all oil-filled PCB equipment ($\geq$500 ppm) and PCBs at $\geq$50 ppm in pipeline systems.
- By 2025, eliminate all use authorizations for any PCB equipment ($\geq$50 ppm) that remain authorized for use (US EPA, 2015a).

As of the time of this report, the NPRM had not yet been released. However, even with more stringent regulations on PCB-containing products, clean-up and remediation activities would extend beyond such a timeframe, and only address PCBs at standards cited within each program.

3.1.4 Pollution Prevention Actions

Pollution prevention actions have occurred through multiple non-regulatory programs that have been undertaken in the United States to encourage voluntary reduction of PCB usage. Appendix E contains the EPA's final draft National Action Plan for PCBs, prepared by the *Persistent, Bioaccumulative and Toxic Pollutants (PBT) PCB Work Group* under the direction of EPA headquarters.

3.1.4.1 Great Lakes Restoration Initiative (GLRI)

The Great Lakes Restoration Initiative (GLRI) is a United States initiative launched in 2010 for providing funds for accelerating efforts to protect and restore the Great Lakes ecosystem. Project plans that are anticipated to be conducted during the 2015-2019 fiscal years are included in the GLRI Action Plan II (Great Lakes Interagency Task Force, 2014). Not only does the GLRI Action Plan II outline an adaptive management framework for prioritizing projects, the plan also provides specific Measures of Progress for tracking the effectiveness of GLRI-funded projects. GLRI Action Plan II activities will focus largely upon cleaning up Great Lakes AOCs (including PCB contamination), preventing and controlling invasive species, reducing nutrient runoff contributing to algal blooms, and restoring habitat of native species.

3.1.4.2 Pollution Prevention (P2) Programs

The EPA and individual States have active Pollution Prevention (P2) programs that seek to reduce, eliminate, and/or prevent pollution at its source. The State of Minnesota has initiated a voluntary PCB phase-out initiative for electrical utilities. Regional and national P2 programs have also been initiated.

For instance, the National Pollution Prevention Roundtable (NPPR) and Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) each support P2 actions by providing national and regional venues for sharing information, developing programs, and implementing efforts to avoid, eliminate, and/or reduce pollution at the source.

3.1.5 Risk Management Actions

Under the GLRI, GLNPO assists in the removal of sediments containing PCBs and other pollutants under the Great Lakes Legacy Act (GLLA). The GLLA is a voluntary cost-share program within the United States designed to remediate contaminated sediments within the 43 designated Great Lakes AOC. Between 2004 and 2015, GLLA has remediated over 4 million cubic yards (3 million cubic meters) of contaminated sediment, a portion of which contained PCBs (US EPA, 2016g). Additional programs and authorities at State and Federal entities have previously and continue to coordinate on remediation of sediments contaminated with PCBs. Under the former Great Lakes Binational Toxics Strategy and other initiatives, EPA has been engaged in efforts to reduce risks to human health and the environment from exposure to PCBs.

3.1.6 Monitoring, Surveillance and Other Research Efforts

Environmental monitoring and surveillance in the Great Lakes has been conducted by several United States parties. Local, regional, institutional, Tribal, and Federal entities have conducted independent and cooperative studies assessing the conditions and status of the Great Lakes.

Many of the datasets have been placed within the Great Lakes Environmental Database (GLENDA). GLENDA is a database for the collection and storage of environmental data maintained by EPA's GLNPO. Air, water, biota, and sediment data are all compiled within the system for users of Great Lakes data (US EPA, 2016h). Science in the Great Lakes (SiGL) Mapper is an additional searchable database tool developed by the US Geological Survey (USGS) that allows Great Lakes stakeholders to coordinate and collaborate monitoring and restoration activities on the Great Lakes (US EPA, 2015b). These databases enable researchers to use historic data from across the region to solve complex chemical, biological, and physical relationships that might lead to more advanced methods for pollution identification and remediation actions.

The National Pollutant Discharge Elimination System (NPDES) permit program regulates point sources that discharge pollutants to waters of the United States. The EPA monitors all exceedances of NPDES permit effluent limits and records them in a publicly available on-line tool (US EPA, 2016i). Between the years 2012 and 2016, there have been 20 recorded exceedances of PCB effluent limits in effluents discharged within the Great Lakes States (Table 3-3). Due to exceedances of environmental quality guidelines in fish tissue and effluent discharges, continued efforts through remediation, pollution prevention and monitoring will be needed in the future.

Table 3-3. NPDES PCB Exceedances in the Great Lakes States, 2012 - 2016

EPA Region	*State*	*City*	*Facility*	*Facility Type*	*No. of PCB Exceedances*

EPA Region	*State*	*City*	*Facility*	*Facility Type*	*No. of PCB Exceedances*
3	Pennsylvania	Washingtonville	PPL Pontour LLC – Electrical Services	Non-Potable	2
3	Pennsylvania	Millville	Millville Boro WWTP – sewerage systems	Potable	6
5	Indiana	Bloomington	Dillman WWTP– Sewerage system	Potable	2
5	Indiana	Hammond	East Branch Grand Calumet Dredge Water Treatment System	Non-Potable	1
5	Indiana	Bedford	GM LLM – Aluminum Foundries	Non-Potable	2
5	Indiana	East Chicago	IN Harbor & Canal Confined Disposal Facility – Gasoline Service Station	Non-Potable	4
5	Michigan	Saginaw	Saginaw Township- Refuse system	Non-Potable	2
5	Ohio	Middletown	AK Steel Corp - Steel Works	Non-Potable	1

Source: US EPA (2016i)

3.1.6.1 State and Tribal Efforts

Each of the Great Lakes States publishes an annual fish consumption advisory for protecting its residents from PCB concentrations within fish. Annual state-level advisories are non-regulatory and are only meant for use as guidance or advice. The data used to generate consumption advisories are collected from annual fish sampling efforts, which are a collaborative effort among Federal, State, and local groups. For example, in Michigan, an annual fish contaminant monitor report is published as a collaborative effort by the EPA, US Fish and Wildlife Service, Michigan Department of Natural Resources-Fisheries Division, Michigan Department of Community Health, Michigan Department of Agriculture and Rural Development, the Grand Traverse Band of Ottawa and Chippewa Indians, Chippewa Ottawa Resource Authority, Keweenaw Bay Indian Community, Little Traverse Bay Bands of Odawa Indians, and the Great Lakes Indian Fish and Wildlife Commission (Michigan Department of Environmental Quality, 2014). Each of the Great Lakes States has a similar sport fish monitoring program that tracks the level of PCBs and other chemicals of concern within fish of the State's waters.

3.1.6.2 Federal Efforts

Great Lakes Specific Efforts. The EPA, through GLNPO, is mandated, via Section 118 of the Clean Water Act, "to establish a Great Lakes system-wide surveillance network to monitor the water quality of the Great Lakes, with specific emphasis on the monitoring of toxic pollutants." GLNPO operates a number of monitoring programs for toxic chemicals in Great Lakes media (fish, air, sediment, water) as part of its core mission. These long-term programs are focused on the tracking of trends of environmental pollutants, including PCBs, across the basin to assess environmental health. Additionally, GLNPO supports work on toxic chemicals, including PCBs, with other partners via grants, interagency agreements, and collaborations to address chemical issues, including PCBs, as they relate to human health.

The reporting of results from GLNPO programs and projects is conducted through a variety of mechanisms, including the State of the Lakes Reports (SOLEC), LAMPs, and peer-reviewed literature. Data are made public via EPA websites and databases, such as GLENDA.

Nation-wide Efforts. Additional ongoing Federal monitoring has been conducted by the National Coastal Condition Assessment (NCCA), a national monitoring program designed to assess the coastal conditions of the United States, including Great Lakes coastal waters. In 2010, as part of a national survey of coastal waters, 405 sites within the Great Lakes were assessed in collaboration with local, State, Tribal, and Federal partners. Sediment and fish tissue samples collected from across the nation were assessed for PCB concentrations using uniform methods to ensure direct comparability in the final dataset (US EPA, 2016a). As a component of NCCA, the Great Lakes Human Health Fish Tissue Study (GLHHFTS) has documented PCB concentrations from fish tissues collected within each of the Great Lakes (https://www.epa.gov/fish-tech/fish-tissue-data-collected-epa).

3.1.7 US EPA Guidelines and Standards

As stated in previous sections, there is an array of EPA and State regulations in effect for PCBs and PCB wastes. Table 3-4 provides a list of standards and recommendations that States and Federal agencies have published on PCB concentrations in workplace air, drinking water, environmental waters, and foodstuffs (CDC, 2014; US EPA, 2013; US EPA, 2016l).

Table 3-4. United States Standards and Recommendations for PCBs.

Agency	*Focus*	*Level*	*Comments*
Occupational Safety and Health Administration (OSHA)	Workplace Air	1,000 µg/m^3 for PCB mixtures 42% chlorinated 500 µg/m^3 for PCB mixtures 54% chlorinated	Both are Enforceable time-weighted averages (TWA) for the permissible exposure limit (PEL) to a worker over an 8-hour workday. Both standards cover all physical forms of PCBs: aerosol, vapor, mist, spray, dust
National Institute for Occupational Safety and Health (NIOSH)	Workplace Air	1.0 µg/m^3	Advisory for a 10-hour TWA
United States Food and Drug Administration (US FDA)	Food	0.2 - 3.0 ppm (all foods) 2.0 ppm (fish) 10 ppm (paper packaging)	Enforceable; Tolerance levels
United States Environmental Protection Agency (US EPA)	Human Health Criteria with Cancer Endpoint	6.4 X 10^{-8} ppm	Value for ingestion of drinking water and fish or just the ingestion of fish at the 10^{-6} cancer risk.
US EPA	Drinking Water	0.0005 ppm	Enforceable Maximum Contaminant Level (MCL). All Great Lakes States have promulgated this MCL into State rules.
US EPA	Surface Waters	freshwater: 1.4x10^{-5} ppm	Each represents total criteria on continuous concentrations for the nationally recommended Aquatic Life Criteria
US EPA	Great Lakes Wildlife Water Quality Standard (WQS)	7.4x10^{-8} ppm	Criteria within the Great Lakes Basin to Protect Wildlife
Illinois	WQS	2.6 x10^{-8} ppm	Human Health Standard; Title 35 Ill. Adm. Code 302.504
Indiana	WQS	6.8 x10^{-9} ppm	Human Cancer Drinking Water Criteria; Ind. Adm. Code 327 IAC 2-1.5-8
Ohio	WQS	2.6 x10^{-8} ppm	Human Health Drinking Water Values; Ohio Adm. Code Ch. 3745-1-33
Michigan	WQS	2.6 x10^{-8} ppm	Human Cancer Drinking Water Criteria with Cancer Endpoint, Mich. Adm. Rules 323.1057

Table 3-4. United States Standards and Recommendations for PCBs. (Continued)

Agency	*Focus*	*Level*	*Comments*
Wisconsin	WQS	3.0×10^{-9} ppm	Human Cancer Criteria for Public Water Supply; Wis. Adm. Code NR 105.08
Minnesota	WQS	4.5×10^{-9} ppm	Human Health Chronic Standard; Minn. Adm. Rules Ch.7052.0100
New York	WQS	1.0×10^{-9} ppm	Fish Consumption Health; New York Code 6 CRR-NY 703.5
New York	WQS	9.0×10^{-5} ppm	Water Source Health; New York Code 6 CRR-NY 703.5
Pennsylvania	WQS	3.9×10^{-10} ppm	Human Health Criteria; Penn. Code § 93.8e
Illinois	Wildlife WQS	1.2×10^{-7} ppm	Title 35 Ill. Adm. Code 302.504
Indiana	Wildlife WQS	1.2×10^{-7} ppm	Ind. Adm. Code 327 IAC 2-1.5-8
Ohio	Wildlife WQS	1.2×10^{-7} ppm	Ohio Adm. Code Ch. 3745-1-33
Michigan	Wildlife WQS	1.2×10^{-7} ppm	Mich. Adm. Rules 323.1057
Wisconsin	Wildlife WQS	1.2×10^{-7} ppm	Wis. Adm. Code NR 105.07
Minnesota	Wildlife WQS	1.22×10^{-7} ppm	Minn. Adm. Rules Ch.7052.0100
New York	Wildlife WQS	1.2×10^{-7} ppm	New York Code 6 CRR-NY 703.5
Pennsylvania	Wildlife WQS	1.2×10^{-7} ppm	Penn. Code § 93.8e

3.2 Canada

Although PCBs were never manufactured in Canada, they were widely used. Between 1929 and 1977, approximately 44,000 tons (40,000 metric tons) of pure PCBs were imported into Canada, mostly for use in dielectric fluids to cool and insulate electrical transformers and capacitors. PCBs were used in various other processes and products including heat-transfer, hydraulic systems, and plasticizers for industrial applications that were manufactured or imported before 1977 (ECCC, 2014).

3.2.1 Federal Management Measures

In 1976, Canada first classified and listed PCBs as toxic. Today, PCBs are listed on the Schedule 1 – List of Toxic Substances under CEPA, 1999. Since the late 1970's the government of Canada has adopted regulations to control various aspects of PCB use, manufacture, sale, import, export, transportation, storage, and destruction. These management measures also contribute towards meeting Canada's international commitments.

3.2.1.1 Chlorobiphenyls Regulations

The manufacture, process, import, and offer for sale of PCBs have been prohibited in Canada since 1977, first under the *Chlorobiphenyls Regulations*. The *Chlorobiphenyls Regulations* restricted the use of PCBs in specified equipment, if they were manufactured in or imported into Canada prior to 1977. In 1985, the *Chlorobiphenyls Regulations* were revised to set allowable concentration limits in specified electrical equipment and allowable concentrations and quantities of releases into the environment. The *Chlorobiphenyls Regulations* were repealed on September 5, 2008, with the entry into force of the current *PCB Regulations*.

3.2.1.2 Storage of PCB Material Regulations

Since 1988, the storage of PCBs in Canada has been controlled, first under the *Storage of PCB Material Regulations*, which prescribed the way wastes or equipment containing PCBs in a concentration of 50 mg/kg or more should be stored and managed in Canada. The *Storage of PCB Material Regulations* also prescribed storage site registration and labelling, as well as the reporting requirements for stored materials. The *Storage of PCB Material Regulations* was repealed on September 5, 2008, with the entry into force of the current *PCB Regulations*.

3.2.1.3 Export and Import of Hazardous Waste and Hazardous Recyclable Materials Regulations

These regulations allow for the import, export and transit of waste and hazardous recyclable material with a PCB concentration of 50 mg/kg or more, if a permit is obtained and if other requirements are met. The *PCB Regulations* (see below) prohibit the export or import of PCBs in concentrations of 2 mg/kg or more unless it is a permitted activity under these regulations or if the export or import is controlled by the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations or the PCB Waste Export Regulations.

3.2.1.4 PCB Waste Export Regulations

These regulations establish controls on the export of PCB waste in concentrations of 50 mg/kg or more. Export is permitted only for thermal or chemical destruction in authorized facilities located in the United States. The export of PCBs to countries other than the United States is prohibited. However, since 1997 the United States has prohibited the import of waste containing PCBs in concentrations of 2 mg/kg or more, unless specific conditions are met.

3.2.1.5 Federal Mobile PCB Treatment and Destruction Regulations

The *Federal Mobile PCB Treatment and Destruction Regulations* (1990) prescribed the approval process required for undertaking the treatment and destruction of PCBs on federal sites. This regulation was repealed on January 1, 2015, with the entry into force of the most recent amendments to the current *PCB Regulations*.

3.2.1.6 PCB Regulations

The *PCB Regulations* first came into force on September 5, 2008. The most recent amendments to the regulations came into force on January 1, 2015. The purpose of the regulations is to protect the health of Canadians and the environment by preventing the release of PCBs to the environment and by accelerating the phasing out of these substances. The previous and current phase-out deadlines are detailed within Table 3-5. The current *PCB Regulations* allow Canada to meet its international obligations as a party to both the United Nations Environment Programme's *Stockholm Convention on Persistent Organic Pollutants* (Stockholm Convention) and the United Nations Economic Commission for Europe's *Persistent Organic Pollutants Protocol* (2003) to the 1979 *Convention on Long Range Transboundary Air Pollution* (LRTAP).

Under the *PCB Regulations,* no person shall release into the environment:

- More than 1 g of PCBs from equipment in use (as defined in the Regulations);
- Any liquids containing PCBs at a concentration of 2 mg/kg or more apart from equipment in use; or
- Any solids containing PCBs at a concentration of 50 mg/kg or more apart from equipment in use.

Furthermore, no person shall, except as permitted in the regulations:

- Manufacture, export, or import PCBs or a product containing PCBs, in a concentration of 2 mg/kg or more;
- Offer for sale or sell PCBs, or a product containing PCBs, in a concentration of 50 mg/kg or more; or
- Process or use PCBs or a product containing PCBs

Activities that are permitted under the regulations are related to the following areas and subject to conditions specified in sections 7-17 of the regulations:

- laboratory analysis;
- research;
- electrical capacitors that are an integral part of a consumer product or fusion sealed and would be rendered inoperable and irreparable if the PCBs were removed;
- aircraft, ships, trains and other vehicles that contain PCBs only in communication, navigation or electronic control equipment or cables;
- coloring pigments;
- processing or recovering PCBs for the sole purpose of destroying them in an authorized facility that is authorized for that purpose;
- solid products used in a commercial or industrial activity containing PCBs in a concentration of less than 50 mg/kg;
- cables, pipelines that transport natural gas, petroleum or petroleum products and their associated equipment, fusion-sealed capacitors in communication or electronic control equipment;
- fusion-sealed capacitors containing PCBs for use in relation to communication tactical equipment or electronic control tactical equipment;
- liquids containing PCBs at a concentration of 2 mg/kg or less for servicing any equipment;
- equipment containing PCBs in a concentration of less than 50 mg/kg;
- Other specified equipment until the December 31, 2025, deadline for phase out.

Table 3-5. Canadian End-of-Use Deadlines for Equipment or Product Containing PCBs

Subject	*Deadline*

Subject	*Deadline*
Any equipment or product containing PCBs that is not covered by the end-of-use deadlines of December 31, 2009, or December 31, 2025, and that is not mentioned in permitted activities.	September 5, 2008
Equipment[1] containing PCBs in a concentration of 500 mg/kg or more that was in use on September 5, 2008, except if an extension was granted by the Minister.	December 31, 2009
Equipment[1] containing PCBs in a concentration of at least 50 mg/kg but less than 500 mg/kg that was in use on September 5, 2008, located in a prescribed site[2] except if an extension was granted by the Minister.	December 31, 2009
Equipment containing PCBs in a concentration of 500 mg/kg or more that was in use on September 5, 2008, with an extension granted by the Minister.	December 31, 2014
Equipment containing PCBs in a concentration of at least 50 mg/kg but less than 500 mg/kg located in a prescribed site [2] and was in use on September 5, 2008, with an extension granted by the Minister.	December 31, 2014
Equipment[1] containing PCBs in a concentration of at least 50 mg/kg but less than 500 mg/kg and was in use on September 5, 2008, and is not located at a prescribed site[2].	December 31, 2025
Light ballasts, pole-top electrical transformers and their pole-top auxiliary electrical equipment containing PCBs in a concentration of 50 mg/kg or more and was in use on September 5, 2008.	December 31, 2025
Current transformers, potential transformers, circuit breakers, reclosers and bushings that are located at an electrical generation, transmission or distribution facility containing PCBs in a concentration of 500 mg/kg or more and was in use on September 5, 2008.	December 31, 2025

[1] Electrical capacitors, electrical transformers, electromagnets (not used in the handling of food and/or feed), heat transfer equipment, hydraulic equipment, vapor diffusion pumps and bridge bearings.

[2] A prescribed site is a child care facility, hospital, senior citizens' care facility, preschool, primary or secondary school, drinking water treatment plant, or food or feed processing plant. Source: ECCC (2016a).

Owners of PCBs subject to the Regulations are required to report annually on the status of their inventory of PCB liquids and solids (i.e., what is in use, in storage, and/or sent for destruction). Owners of hazardous waste transfer sites and destruction facilities that process PCBs must also report annually on PCBs. Progress towards the end-of-use and destruction of PCBs is monitored by ECCC using these reports.

In 2014, 153 companies were responsible for 324 reports among 288 sites with PCBs in use, stored, or destroyed (Table 3-6). PCB owners reported 147 tons of PCBs in use, and 114 metric tons of PCBs in storage in Canada. PCB destruction facilities reported the destruction of a total of 575 metric tons of PCBs in 2014. As in previous years, the regions with the largest amounts of PCBs in use were Ontario (85.8%) and Quebec (13.95%) (ECCC, 2016b).

As shown in Table 3-6, the number of companies which reported continued to decrease in 2014. This coincides with a corresponding reduction in the number of reports and the total number of sites for which PCBs were reported in use, stored, or destroyed (ECCC, 2016b).

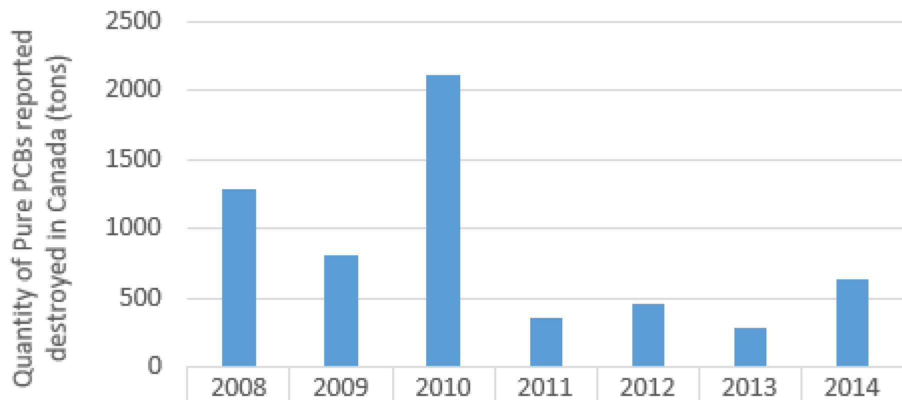
Table 3-6. Number of Canadian Companies, Reports, and Sites with Reportable PCBs from 2008 – 2014.

YEAR	COMPANIES	REPORTS	SITES
2008	404	846	776
2009	402	866	772
2010	366	801	721
2011	313	606	554
2012	272	552	499
2013	226	504	457
2014	153	324	288

SOURCE: ECCC (2016B)

Regulatees are required to report amounts of PCBs stored at their facility, sent to a transfer site, or sent for destruction. Materials containing PCBs can follow several paths once taken out of service. A regulatee can store them for one year in an approved PCB storage facility on-site, send them to a transfer site (where they can be stored for up to one year), or send them to a destruction facility (where they can be stored for up to two years prior to destruction).

Figure 3-1 represents data reported by PCB destruction facilities and does not include information reported by the owners of PCBs. Destruction facility information is considered to be more accurate since the actual quantities (in liters or kilograms) and concentrations of pure PCBs are measured prior to destruction in a given year, rather than estimates reported by PCB owners. From the time the PCB On-Line Reporting System began in 2008 to December 31, 2014, a total 5,940 tons (5,389 metric tons) of pure PCBs have been destroyed in Canada (ECCC, 2016b).



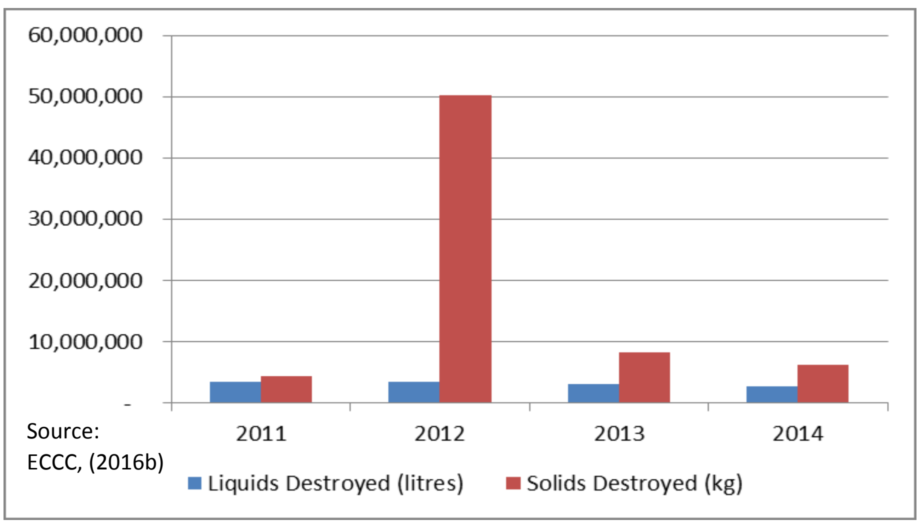
	2008	2009	2010	2011	2012	2013	2014
tons	1287	799	2104	362	463	289	634
metric tonnes	1168	725	1909	328	420	262	575

Year

Source: ECCC (2016b)

Figure 3-1. Quantities of Pure PCBs Destroyed in Canada 2008 – 2014

Large quantities of liquids and solids containing PCBs are processed for destruction annually. Typically, these materials are contaminated soils or solids that contain liquids with a PCB component (i.e., ballasts, pole top transformer carcasses). Figure 3-2 shows the total volume and weight of materials processed in



Canada between the years 2011 and 2014 that contained PCBs (ECCC, 2016b).

Figure 3-2. Total Volume/Weight of Material Processed (as part of PCB destruction) in Canada 2011 – 2014.

3.2.2 Provincial Management Measures

Ontario law (Regulations 347 and 362) includes PCB wastes (i.e., equipment, liquids, materials) as hazardous wastes (2016). As such, all PCB wastes must adhere to Ontario Ministry of Environment and

Climate Change (OMOECC) rules and regulations for storing and destroying PCB wastes (OMOECC, 2016).

3.2.3 Monitoring, Surveillance and other Research Efforts

ECCC conducts monitoring for PCBs within Great Lakes media including air, precipitation, fish, Herring Gull eggs, sediment, and water under several different initiatives, including the national Chemicals Management Plan. Additional monitoring is conducted under regional Great Lakes-specific monitoring and surveillance programs for air, precipitation, Herring Gull eggs, fish, sediment, and water. More specifically (subject to change from year-to-year):

- Air: 25 congeners using one active (Point Petre) and four passive samplers (Manitoulin Island/Evansville, Gros Cap, Georgian Bay Island National Park and Point Pelee);
- Precipitation: 64 congeners measured at 3 sites (Point Petre, University of Toronto and Burlington) once per month;
- Fish: Total PCBs in top-predator whole fish (Lake Trout and Walleye)
- Herring Gull Eggs: 35 congeners measured at 15 sites once annually;
- Sediment: Surface sediment and cores from one lake annually on a rotational basis;
- Water: Approximately 90 congeners in Great Lakes surface waters and connecting channels, one lake annually on a rotational basis.

An in-depth assessment of surface waters, surface sediments, and sediment cores are collected on a rotational basis from one Great Lake annually. Additional water and sediment samples may also be collected from the connecting channels of the annually assessed lake.

3.2.4 Canadian Environmental Quality Guidelines and Standards

Canadian and Provincial environmental quality guidelines for PCBs have been developed by the Canadian Council of Ministers of the Environment (CCME) and the Ontario Ministry of Environment and Climate Change (OMOECC) respectively. Environmental samples collected within the Great Lakes have exceeded these environmental quality guidelines established for fish and sediments. The Canadian environmental quality guidelines for PCBs and exceedances within the Great Lakes are presented in Table 3-7.

Table 3-7. Canadian Environmental Quality Guidelines for PCBs.

Environmental Quality Advisory, Guideline or Objective	Great Lakes Exceedances
Fish and Other Wildlife	
Fish Consumption Advisory (OMOECC, 2015): Edible portion: 0.105 ug/g (ww)	Yes
CCME Tissue Residue Guidelines (2001a; 2016): Mammal: 0.79 ng TEQ/kg diet (ww) Avian: 2.4 ng TEQ/kg diet (ww)	Yes
Sediment	
CCME Sediment Quality Guidelines for Freshwater (2001b; 2016):	Yes

Environmental Quality Advisory, Guideline or Objective	Great Lakes Exceedances
Predicted Effects Level: 277 ng/g Interim Sediment Quality Guideline / Threshold Effects Level: 34.1 ng/g Ontario Sediment Quality Guidelines (OMOECC, 2008): Lowest Effect Level: 70 ng/g Severe Effect Level: 530 ng/g organic carbon	
Surface Water	
Ontario Provincial Water Quality Objective Surface / Open Water: 1 ng/L	No

3.3 Binational Actions

3.3.1 Great Lakes Binational Toxics Strategy

The Great Lakes Binational Toxics Strategy (GLBTS) was a binational P2 endeavor from 1997 to 2007 that focused on the virtual elimination of PCBs, among other persistent, bioaccumulative, and toxic chemicals. The Strategy outlined a four-step process for addressing recognized knowledge gaps regarding the Great Lakes region: (1) gather information; (2) analyze current regulations, initiatives, and programs that manage or control substances; (3) identify cost-effective options to achieve further reductions; and (4) implement actions to work toward the goal of virtual elimination (US EPA and ECCC, 1997). Appendix B contains the Great Lakes Binational Toxics Strategy Management Assessment for PCBs, the final document on PCBs prepared under the Great Lakes Binational Toxics Strategy.

3.3.2 Lakewide Action and Management Plans

Additional binational PCB pollution prevention actions have been initiated through Lakewide Management programs for each Great Lake. Lakewide Action and Management Plan (LAMP)s are plans of action to assess, restore, protect, and monitor the ecosystem health of each Great Lake (US EPA, 2004b; US EPA, 2016d). As an example, the Lake Superior Zero Discharge Demonstration Program (ZDDP) was established in 1991 by the Lake Superior Binational Program (LSBP) with a goal of eliminating nine persistent, bioaccumulative, and toxic pollutants, including PCBs, from Lake Superior by 2020 (The Lake Superior Partnership, 2016). Under the Lake Superior ZDDP, an inventory of PCBs (equipment and waste containing PCBs) in the Lake Superior basin has been updated approximately every 5 years since 2000.

LAMP partners across the Great Lakes pursue P2 actions to remediate locations of historical PCB contamination, including sediments at designated AOCs, track the disposal and storage of PCBs, and seek to educate the public on PCBs (The Lake Superior Partnership, 2016).

3.3.3 Integrated Atmospheric Deposition Network

The Integrated Atmospheric Deposition Network (IADN) is a binational program that monitors the atmospheric deposition of toxic chemicals, including among others, PCBs (US EPA, 2016e). Each lake has one master station supplemented by satellite stations to provide more detailed deposition data. The goal of the IADN is to measure the atmospheric concentrations of select chemicals so that spatial and temporal variations can be determined and used to estimate deposition rates within the Great Lakes (Wu, et al., 2009). The IADN air monitoring data are currently posted in the ECCC NatChem database. Works is currently underway by Indiana University to create a data visualization tool for the IADN program.

The binational network has been monitoring atmospheric trends in the Great Lakes since 1990 with a comprehensive quality assurance quality control program. As such, the IADN dataset as a whole is considered globally as the 'golden standard' for data QA/QC in an air monitoring program for toxic chemicals.

3.4 International

Several frameworks have been established at the international level to limit the availability, usage and discharge, and the overall number of PCB sources.

3.4.1 United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (LTRAP)

The Convention on LRTAP, signed in 1979 between 34 Governments and the European Union (EU), was the first international legally binding instrument for dealing with air pollution on a regional basis. Both Canada and the United States ratified the Convention during its early years. Under the LRTAP

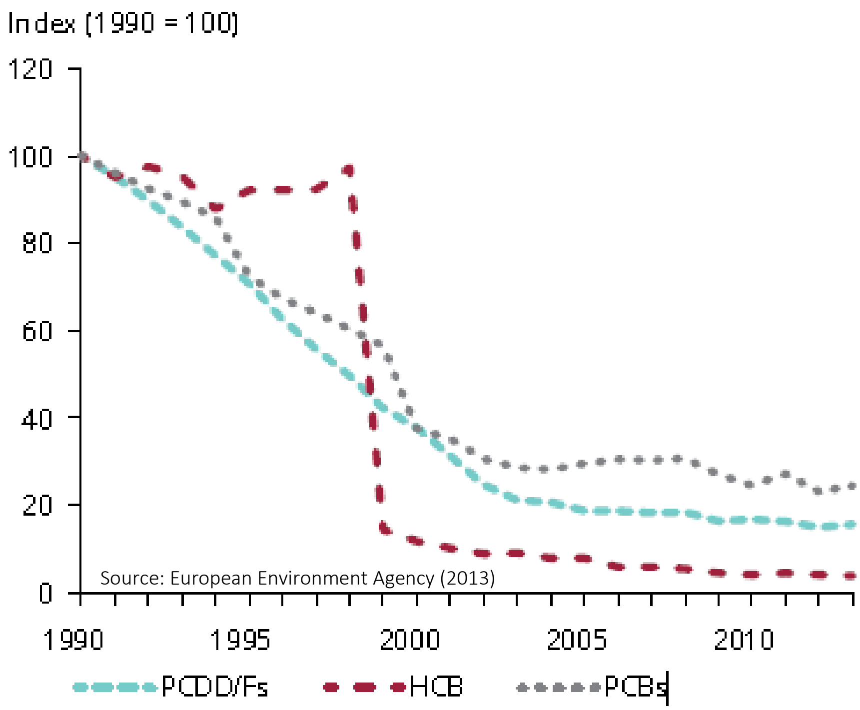


Figure 3-3. Emission Trends in the Energy Production and Distribution Sector by EU Member States.

Convention, members are obligated to report emissions data for several air pollutants, including PCBs (European Environment Agency, 2013). Reporting under the LRTAP Convention has shown a substantial decline in PCB emissions by the EU Member States since 1990 (Figure 3-3). The steady decrease is attributed to reductions in point-source emissions, particularly from industrial facilities and improved abatement techniques at wastewater treatment facilities and incinerators in metal refining and smelting industries (European Environment Agency, 2013). The latest LRTAP report cites that industrial processes and in-use products remain the largest PCB emissions sector, accounting for almost half of the reported emissions (European Environment Agency, 2013). The current *PCB Regulations* in Canada allow it to meet its international obligations as a party to LRTAP.

3.4.2 The Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention included PCBs as one of the original 12 persistent organic pollutants (POPs). All parties of the Stockholm Convention are banned from producing PCBs and are under obligation to stop using PCBs, except for existing in-use equipment. All PCB equipment that is currently in use is to be taken off-line by 2025. The overall PCB goal of the Stockholm Convention is to achieve environmentally sound management (ESM) of PCBs waste by 2028 through proper disposal or management of PCBs and PCB-containing materials (Secretariat of the Stockholm Convention, 2016). In 2015 there were an estimated 800,000 tons (725,000 metric tons) of PCB wastes globally that have been properly disposed or under ESM, and an estimated 2.4 million tons (2.2 million metric tons) of PCB oils and equipment globally remaining to be properly disposed (Secretariat of the Stockholm Convention, 2016). Canada signed and ratified the Convention in 2001, and it entered into force in 2004. The United States has signed the Convention but has yet to provide ratification, acceptance, approval or accension, and therefore in the U.S the Convention has not yet entered into force.

3.4.3 The Commission for Environmental Cooperation

The Commission for Environmental Cooperation (CEC) is a cooperative agreement between the three countries of North America: Canada, Mexico, and the United States. The CEC's mission is to facilitate collaboration and public participation in conservation, protection, and enhancement of the North American environment, specifically in the context of increasing economic, trade, and social links between the three countries. PCBs are considered persistent, bioaccumulative and toxic by the CEC. Thus, the CEC Council has prepared a North American Regional Action Plan (NARAP) to determine the level of contamination in the environment and in humans, to follow the trends over time, and to support PCB monitoring needs (CEC, 2015).

3.4.4 International Quality Guidelines and Standards

The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) have outlined international recommendations for allowable daily intake levels for PCBs withinin foodstuffs. Table 3-8 presents the international standards and recommendations for the maximum allowable PCB concentration within foodstuffs from WHO and FAO (CDC, 2014).

Table 3-8. International Recommendations for Allowable Daily Intake of PCBs from Food.

AGENCY	FOCUS	LEVEL	COMMENTS
WORLD HEALTH ORGANIZATION (WHO)	Food	0.006 ppm/day	Allowable daily intake
FOOD AND AGRICULTURE ORGANIZATION (FAO)	Food	0.006 ppm/day	Allowable daily intake

Note: ppm = mg PCBs / kg food. Source: CDC (2014)

4. Gap Analysis

There are a number of unknowns within both Canada and the United States in regards to unquantified PCB sources. The ongoing use of high-concentration PCBs in electrical equipment and other applications remains a potential source of atmospheric loading of PCBs to the Great Lakes for both nations. A better understanding of the volume of units, the concentration of PCBs within those units, and their estimated remaining service life is needed.

There are also potentially a large number of unreported PCB sources in both nations that may be releasing PCBs into the environment. For instance, abandoned/illegal waste sites, capacitors in light ballasts, and municipal landfills that accept low concentration (<50 ppm) or physically small PCB-containing equipment are largely unaccounted for (Canadian Environmental Law Association and Great

Lakes Centers, Undated). The same has been found for sewerage and natural gas systems, which can be a reservoir for PCBs. Identified AOCs within the Great Lakes are a concern as well. While the presence of AOCs in the United States, Canada, and overlapping binational areas are known, remediation efforts to contain the PCBs are still needed to reduce the number of PCB point sources.

Within the United States and its State and Tribal governments, limited resources are available for enforcement of PCB regulations. The limited number of PCB inspectors creates a gap in regulating businesses that may be handling, storing, recycling, or disposing of PCBs in a manner that is not protective of human health or the environment. This is especially important for businesses that are not regularly inspected for PCBs, such as scrap metal yards and recycling facilities within State jurisdiction that are exempt from United States Federal regulation under RCRA Subtitle C.

The amount of PCBs in products (e.g., small electrical equipment) and systems (e.g., sewerage systems, natural gas pipelines) is not well known. Due to a lack of information on PCBs in commercial and residential products and utility systems, sources of legacy PCBs may go unidentified and perpetuate the redistribution of legacy PCBs. Additional track down efforts across the Great Lakes would be needed to identify, monitor, and control such PCB sources (Niagara River Secretariat, 2007).

PCBs in Great Lakes air, precipitation, water, sediment, and fish and wildlife species are routinely monitored, however additional monitoring for PCBs in environmental media is needed in areas with the potential to contribute to or affect the Great Lakes Basin (e.g. the remainder of State areas not within the Basin, temporary storage within the Basin). Such additional monitoring should be conducted nationally, on time series and scales that allow for development of binationally comprehensive PCB data sets which can be used to further manage and reduce PCBs, particularly in cases involving products or sources distributed in commerce including and beyond the Great Lakes Basin.

Furthermore, there is a need to ensure that chemical data collected by Federal, State/ Provincial, First Nations, Tribal and other government programs are consistent, standardized, and structured to allow for improved binational monitoring for PCBs and PCB-containing products. Working to ensure better uniformity of data can be helpful in ensuring that independent data collection actions can be used collectively to address and identify remaining PCB concerns. For example, while PCB data are collected in various media (e.g., air, water, land, biota), there currently is no single repository for such data on a binational level in a structured way in which either government or external stakeholders can analyze the data to determine remaining concerns[1]. A binational repository would facilitate further research on PCBs, such as a PCB case study that assesses climate change impacts on toxic chemicals. PCBs is one of the most well-studied group of compounds in the Great Lakes region with multimedia monitoring time series that stretched back for 20+ years, thus it would be an ideal dataset for further analysis.

While many risk mitigation and management activities and efforts (e.g. remediation, characterization, fate-transport modeling) for PCBs are continuing under Federal and Provincial/State programs, there are

[1] The Canadian government has begun this effort and is currently working to transition their collective environmental monitoring and surveillance data into a newly developed ECCC Open Data Catalogue. Once complete all Canadian data will be centralized and stored in a single repository.

still needs and opportunities for risk mitigation and management activities, particularly for addressing the remaining uses and sources of PCBs in the environment, some of which continue to be identified (Hornbuckle, et al., 2006). Many programs currently under way would benefit from enhanced binational coordination and collaboration in the Great Lakes, such as the following:

- *Non-Liquid PCB-containing Products and Articles.* Currently in the United States, there are no restrictions on the use of non-liquid PCB-containing products that contain less than 50 ppm PCB, including but not limited to adhesives, caulk, coatings, grease, paint, rubber or plastic electrical insulation, gaskets, sealants, and waxes (US EPA, 2010a). A gap in user awareness of the presence of PCBs has been previously noted (US EPA, 2010b). Existing user-friendly documents are available (US EPA, 2010b). Additional user-friendly documents are needed to educate custodial staff, maintenance personnel, building owners, and the general public in identifying PCB-containing materials, and a proper method for cleaning and replacing PCB-containing light ballasts, caulks, etc. Additional outreach is also needed to educate the public and facilities staff on potential sources of PCBs in used oil.
    - *Porous Surfaces.* Currently in the United States there is a gap in the existing use authorization for porous surfaces (concrete) that have been previously contaminated by liquid PCBs. As the TSCA use authorizations currently stand, once porous surfaces are cleaned or encapsulated they may be reused anywhere for an indefinite period of time. While it is assumed that these conditions only exist in very restricted access locations, the current regulations do not evaluate for the effectiveness of preventing future exposure or for collecting data in aggregate on this issue (US EPA, 2010a; US EPA, 2011).
- *Addressing Non-Legacy PCBs.* Control strategies targeting non-legacy PCBs such as, inadvertently generated PCB congeners-11 are needed (Grossman, 2013; Khairy, et al., 2015). These non-legacy markers are not consistently sought, and thus may not be adequately quantified (Khairy, et al., 2015). Furthermore, control or measurement strategies currently in effect may not be appropriately designed for potential current use sources (Khairy, et al., 2015).
- *Uniform Fish Consumption Advice for the Great Lakes.* There is a need for a uniform method for determining fish consumption advice for the region as a whole. Currently, each State or Province independently establishes annual consumption recommendations for its residents, which can result in conflicting recommendations for a given lake and species (Great Lakes Commission, 2005).

5. Risk Mitigation and Management Options to Address Gaps

The actions highlighted herein represent both new and the continuation of current risk mitigation and management actions that will address the gaps outlined and may result in measurable (either qualitatively or quantitatively) human health and/or environmental benefits, or enhanced understanding of PCB sources, fate, and human health/environmental effects.

5.1 Regulations and Other Risk Mitigation and Management Actions

PCB equipment inventories should be maintained for both nations. The last PCB inventory assessment was conducted in 2010 in the United States and in 2015 in Canada (ITT, 2015). In Canada inventories are updated annually and the quantity of PCBs reported in use continues to steadily decline (ECCC 2016a). In the United States, a significant portion of the in-use equipment may have been retired since the last assessment. Therefore, a new inventory should be conducted to determine the quantity and concentration of PCB equipment within the Great Lakes region.

Canada has issued an end-of-use deadline of 2025 for many remaining types of in-use PCB-containing equipment including high-concentration light ballasts and pole top transformers; however equipment containing PCBs less than 50 mg/kg can be used indefinitely (Government of Canada, 2014; ITT, 2015). The United States currently does not have a phase-out deadline for current in-use equipment; however, an NPRM is tentatively expected in October 2017 (US EPA, 2015a). Attrition-based phase-out of equipment containing liquid PCBs is predicted to be complete by 2030 (US EPA, 2011).

The suite of risk management measures in place for PCBs should also be revisited to ensure they reflect the most current scientific knowledge available. For instance, literature has identified paints and sludge drying activities as two areas that could be further investigated to assess the potential need for regulatory action (Shanahan, et al., 2015). In-use architectural paint, as well as emissions from paint and pigment manufacturing facilities, are thought to contribute small, yet potentially significant PCB emissions. Similarly, initiatives to reduce PCB emissions associated with water reclamation sewage sludge drying facilities could address a major source of PCBs to the air, with the added benefit of reducing levels of other potentially harmful compounds (Shanahan, et al., 2015). Another area of investigation could be whether levels of PCBs in consumer products can and should be regulated. The results of the tests conducted by the State of Washington could be leveraged into whether regulatory action is warranted (Stone, 2016a; Stone, 2016c).

Summary of Regulations and Other Risk Mitigation and Management Recommended Actions

- Generate phase-out deadlines for current in-use equipment at the Federal level (US)
- Promote decommissioning with notification and safe disposal of PCB-containing equipment (US and CAN)
- Update and maintain inventory estimates for PCB-containing equipment (US and CAN)
- Review and update regulations to match current scientific understanding (US)
- Continue to remediate PCB-contaminated sites and sediments (US and CAN)

5.2 Compliance Promotion and Enforcement

It is recommended that additional resources be allocated to the enforcement of PCB regulations. In the United States, PCB inspectors need support from facility site owners, health and safety managers, and/or State regulatory agencies to aid in their ability to inspect locations with the potential to pose risks to human health or the environment from their use, release, transport, storage or disposal of PCBs. They also need support in assisting companies seeking to remove or phase-out their remaining PCB uses. One-on-one efforts to inform companies may both promote compliance and minimize the need for legal enforcement of TSCA rules. Under TSCA, the EPA has authority to issue penalties for noncompliance

with PCB regulations. The extent of the issued penalty is based upon the nature, extent, and circumstances of the actual violation (US EPA, 1990).

Potential penalties need to be clearly communicated to ensure that the threat of a fee-based violation does not hinder compliance when PCB sources are identified. Furthermore, monitoring, tracking, and enforcement strategies need to be developed to aid in distinguishing between legacy (PCBs produced before 1977) and non-legacy PCB sources. The non-legacy strategies should be developed for specific industries where PCBs are a known by-product (pigment production, paint manufacturing, papermaking processes, and titanium dioxide production) to ensure that compliance strategies are feasible and applicable to the overall processes.

Canada actively conducts compliance promotion and enforcement of the *PCB Regulations*. In 2014-2015, compliance promotion activities (e.g. fact sheets, telephone campaigns, conferences and meetings) focused on reaching out to influencers such as fire departments and building management companies, and to large electrical equipment owners such as electrical utilities and iron and steel mills. The purpose of these activities is to raise awareness about PCB equipment in sectors that may they have been previously unaware of or potentially misunderstanding the regulatory requirements for their operations.

Summary of Compliance Promotion and Enforcement Recommended Actions

- Enhance support to State and Tribal programs that complement or enhance baseline Federal program requirements via compliance promotion activities (US)
- Enhance support to PCB inspectors that regulate firms that may be handling, storing, recycling, or disposing PCBs (US)
- Enhance support to industry associations and firms who seek to phase out or improve risk management within their sector (US and CAN)
- Develop structured data systems and plans for PCB source, manifest and product tracking (US)
- Develop tracking and enforcement strategies for non-legacy PCB sources (US)

5.3 Pollution Prevention

The EPA has produced a series of information documents targeting school administrators, building owners, contractors, and building managers as a means of communicating how to manage and reduce exposure to PCBs in materials found in older buildings, including, but not limited to, adhesives, caulk, paint, and light ballasts (US EPA, 2016f; US EPA, 2016k). Additional user-friendly materials targeting specific public audiences may be appropriate to aid in preventing low-level PCB pollution from being incorporated into general solid waste streams, and providing awareness regarding potential PCB sources of health hazards.

The EPA has also developed the TRI database to track industrial progress in reducing waste generation. The TRI database should be maintained and leveraged to maximize P2 activities being conducted by industries within the Great Lakes region. Highlighting pollution prevention successes in the Great Lakes Basin may be beneficial in increasing awareness, coordinating awareness in similar sectors throughout the Basin, and furthering the reduction of PCBs within the environment. Waste reduction success stories may be noted in region-specific journals, websites, and/or at conferences.

Significant effort has been undertaken within Great Lakes AOCs to remediate contaminated sediments and revitalize the natural flora and fauna of these areas. However, PCB remediation in these areas is not complete and continued P2 efforts are needed to reduce the PCB loads within these areas.

Summary of Pollution Prevention Recommended Actions

- Enhance public outreach and educate the public and facility staff on potential sources of PCBs and proper actions to follow should products containing PCBs be found (US and CAN)
- Encourage industries to track their P2 activities and efforts in the TRI database or via P2 promotion activities (fact sheets, case studies) (US)

5.4 Monitoring, Surveillance, and Other Research Efforts

The EPA and ECCC have coordinated efforts to publish a report outlining efforts of State of the Lakes Ecosystem Conferences (ECCC and US EPA, 2014). Additional monitoring and surveillance reports have been published in peer-reviewed journals, websites, and social media. Each form of reporting is designed to target specific audiences to maximize the application of the results. Results of future monitoring efforts should continue to be published in multiple formats to effectively communicate changes observed within the Great Lakes region.

The 2011 State of the Great Lakes analysis concluded that the overall status of water quality in the Great Lakes is fair and that legacy chemical concentrations (including PCBs) within fish tissues are decreasing (ECCC and US EPA, 2014). The continuation of such efforts by the two nations will be invaluable for understanding the overall status of the Great Lakes Basin. Monitoring efforts undertaken by both nations should be continued and coordinated to aid in acquiring comparable analytical data that can be used to build a national and/or international decision-making framework. Such a framework would be useful in generating a region-wide fish consumption advisory or process. Currently, each State/Province produces its own fish consumption advisories for its respective jurisdiction. Creating a uniform method and/or advisory could reduce confusion and improve compliance by the public.

A source tracking initiative conducted in Canada that used a multimedia weight of evidence approach may have utility across the Great Lakes region as a whole to trace PCB sources. Project Trackdown identified several PCB sources within Canadian tributaries to the Great Lakes (Benoit, et al., 2016). Use of a multimedia weight of evidence approach in the United States and binational waters may provide more information on additional PCB point sources.

The development of a cost-effective and useful means of collecting PCB concentration from a variety of sources is essential. Liu, et al. (2016) recently demonstrated the utility of passive sampling methods to monitor concentrations of PCBs in air. Passive samplers could be used as a means to better understand the spatial distribution and behavior of PCBs while also quantifying their flux between air and water in the Great Lakes and the region as a whole. In addition, future monitoring efforts should be designed such that the resultant data can be compared among research teams and to historical data. These passive methods could be validated by ECCC, the EPA, and/or through other testing organizations, or through a field study/demonstration to increase the acceptance of the resultant data.

It is also necessary to acquire a better understanding of the impact on humans from exposure to non-liquid materials containing low levels (< 50 ppm) of PCBs, such as caulks, paints, and adhesives. In a similar manner, toxicology assessments are needed to determine remaining risks associated with porous surfaces that have been surface-cleaned or encapsulated due to known PCB contamination (US EPA, 2010a).

PCB monitoring in both biotic and abiotic environments in the Great Lakes represents some of the world's longest time series of POPs. When coupled with modelling, these datasets provide a significant opportunity to assess climate change and climate variation impacts on the regional environment and fate of PCBs. As climate change acts over decades, there is a need of long time series to verify and improve model predictions. Hence, monitoring data consistency is essential to achieve such prediction.

A study conducted by Bassil, et al. (2015) highlighted the need for a binational environmental and human health database structure for use by government, public health practitioners, academic researchers, and community groups to assess the communities in and around the Great Lakes Basin. The database should be populated with environmental information and human health survey information from the Great Lakes region, particularly focusing the available biomonitoring resources on vulnerable sub-populations within the region: young children, pregnant women, and First Nations/Tribal groups within the region (Bassil, et al., 2015). Such a database would be instrumental in integrating environmental and human health data for direct use by decision makers to make informed decisions that involve ecosystems and public health.

Summary of Monitoring, Surveillance, and Other Research Actions

- Continue to monitor PCBs in environmental media in the Great Lakes (air, precipitation, sediment, fish and other wildlife) and publish results in a variety of publications (e.g. on-line and open data portals, government reports and scientific journals) in order to maximize the intended audience (US and CAN)
- Use monitoring and modeling to better characterize select PCB sources as a basis for decision making with respect to potential actions, measuring progress, and formulating an international decision making framework (US and CAN)
- Develop uniform fish and wildlife consumption advice for the shared waters of the Great Lakes to reduce exposure to PCB contamination (US and CAN)
- Use existing data sources and exposure data to inform future strategic directions and plans (US and CAN)
- Develop more cost-effective tools for monitoring PCB concentrations from various sources (US and CAN)
- Determine the exposure impact of non-liquid materials containing low levels (<50ppm) of PCBs (US and CAN)
- Utilize Great Lakes datasets and apply to climate change analyses models (US and CAN)
- Create or modify current databases to include environmental information and human health survey information for use by government, public health practitioners, academic researchers, and community groups. (US)
- Conduct monitoring to identify water sources at appropriate detection limits to support water quality load-reduction decision-making and implementation. (US)

5.5 Domestic Water Quality

Domestic waters include all water used for indoor and outdoor household purposes. There is a need for reviewing existing standards to ensure that they are based on the latest science, to assist States/Provinces in identifying areas where standards are exceeded, and to ensure that all tools are used. Efforts should be taken to ensure that PCBs in these effluents do not cause exceedances of either downstream drinking water CWA or SDWA standards.

Summary of Domestic Water Quality Recommended Actions

- Review and update existing domestic water quality standards, if necessary (US)
    - Note: The drinking water MCL for PCBs is set at 0.0005 mg/l (500 ppt). In 2010, the Agency reviewed this standard under the Six-Year Review and determined that it was still appropriate and protective. (US)
- Prevent PCBs in effluent from impacting downstream drinking water supplies (US)
- Review total maximum daily loads (TMDLs) developed by states to determine reductions of PCBs (primarily from air deposition) needed to meet target fish tissue concentrations. In particular, EPA is currently reviewing Michigan's statewide PCB TMDL for inland waters, and Illinois' PCB TMDL for the Illinois portion of the Lake Michigan shoreline. (US)

6. Conclusions

Under Annex 3 of the Canada – United States GLWQA, PCBs have been identified as a CMC that originates from anthropogenic sources. While the overall concentration of PCBs within the environment has decreased since the 1970s, legacy concentrations of the persistent compounds remain in soils, water, air, biota tissues, wastes, waste oils, and certain in-use products throughout the Great Lakes Basin and globally. Binational efforts have made significant strides in reducing the incidence of PCB release to the environment and in cleaning up PCB-contaminated sites. Between the years 2004 and 2015, an estimated 4 million cubic yards (3 million cubic meters) of contaminated sediments within United States AOCs were remediated (US EPA, 2016g); however, PCB concentrations *still routinely exceed* environmental quality guidelines.

While measurable advancements have been made in limiting PCB releases and remediating previous PCB contamination, continued binational efforts are needed to reduce the risks that PCBs pose to human health and the environment. Continued focus is needed to implement and strengthen current regulations and update PCB equipment inventory estimates, revitalize enforcement of PCB regulations, increase pollution prevention actions, and continue outreach and education activities. Appendix F summarizes these activities, with roles and responsibilities.

Cooperative and coordinated measures taken by the two nations are needed to coordinate monitoring and surveillance efforts, maximize research initiatives to identify new PCB sources, and cost-effectively monitor and track PCB concentrations in multiple media (e.g. wastes, soil, water, air, tissues). A broad audience of Great Lakes stakeholders who are committed to protecting and restoring the Great Lakes ecosystem is encouraged to implement the risk mitigation and management options outlined in this document. Continued progress in seeking novel ways and/or improving upon existing ways to mitigate and manage PCB risks will improve the health of the ecosystem and residents of the Basin, and will preserve the quality of the Great Lakes for future generations.

Table 1: Summary of the Canada-U.S. Strategy for PCBs

Goal: to reduce the anthropogenic release of PCBs into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes				
Category of Action				
Regulations and Other Risk Mitigation and Management Actions	**Compliance Promotion and Enforcement**	**Pollution Prevention**	**Monitoring, Surveillance, and Other Research Efforts**	**Domestic Water Quality**
Strategic Actions				
Generate phase-out deadlines for current in-use equipment at the Federal level (US)	Enhance support to State and Tribal programs that complement or enhance baseline Federal program requirements via compliance promotion activities (US)	Enhance public outreach and educate the public and facility staff on potential sources of PCBs and proper actions to follow should products containing PCBs be found (US and CAN)	Continue to monitor PCBs in environmental media in the Great Lakes (air, precipitation, sediment, fish and other wildlife) and publish results in a variety of publications (e.g. on-line and open data portals, government reports and scientific journals) in order to maximize the intended audience (US and CAN)	Review and update existing domestic water quality standards (US)
Promote decommissioning with notification and safe disposal of PCB-containing equipment (US and CAN)	Enhance support to PCB inspectors that regulate firms that may be handling, storing, recycling, or disposing PCBs (US)	Encourage industries to track their P2 activities and efforts in the TRI database or via P2 promotion activities (fact sheets, case	Use monitoring and modeling to better characterize select PCB sources as a basis for decision making with respect to	Prevent PCBs in effluent from impacting downstream drinking water supplies (US)

Goal: to reduce the anthropogenic release of PCBs into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes				
Category of Action				
Regulations and Other Risk Mitigation and Management Actions	**Compliance Promotion and Enforcement**	**Pollution Prevention**	**Monitoring, Surveillance, and Other Research Efforts**	**Domestic Water Quality**
Strategic Actions				
		studies) (US)	potential actions, measuring progress, and formulating an international decision making framework (US and CAN)	
Update and maintain inventory estimates for PCB-containing equipment (US and CAN)	Enhance support to industry associations and firms who seek to phase out or improve risk management within their sector (US and CAN)		Develop uniform fish and wildlife consumption advice for the shared waters of the Great Lakes to reduce exposure to PCB contamination (US and CAN)	
Review and update regulations to match current scientific understanding (US)	Develop structured data systems and plans for PCB source, manifest and product tracking (US)		Use existing data sources and exposure data to inform future strategic directions and plans (US and CAN)	
Continue to remediate PCB-contaminated	Develop tracking and enforcement strategies for non-		Develop more cost-effective tools for	

Goal: to reduce the anthropogenic release of PCBs into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes				
Category of Action				
Regulations and Other Risk Mitigation and Management Actions	**Compliance Promotion and Enforcement**	**Pollution Prevention**	**Monitoring, Surveillance, and Other Research Efforts**	**Domestic Water Quality**
Strategic Actions				
sites and sediments (US and CAN)	legacy PCB sources (US)		monitoring PCB concentrations from various sources (US and CAN)	
			Determine the exposure impact of non-liquid materials containing low levels (<50ppm) of PCBs (US and CAN)	
			Utilize Great Lakes datasets and apply to climate change analyses models (US and CAN)	
			Create or modify current databases to include environmental information and human health survey information for use by government, public health practitioners,	

Goal: to reduce the anthropogenic release of PCBs into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes				
Category of Action				
Regulations and Other Risk Mitigation and Management Actions	**Compliance Promotion and Enforcement**	**Pollution Prevention**	**Monitoring, Surveillance, and Other Research Efforts**	**Domestic Water Quality**
Strategic Actions				
			academic researchers, and community groups. (US)	

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Appendix A - ITT Report

The Identification Task Team Binational Summary Report: Polychlorinated Biphenyls (PCBs) can be found on the worldwide web at: http://binational.net/wp-content/uploads/2015/05/EN-PCBs-Binational-Summary-Report-Final-Draft.pdf.

[Appendix A_ITT Report_2015.pdf] to be inserted into pdf version of this report.

Appendix B – GLBTS Final PCB Assessment

[Appendix B_GLBTS FINAL PCB Assessment_2007.pdf] to be inserted into pdf version of this report.

Appendix C – State of WA PCBs in Consumer Products

[Appendix C_State of WA PCBs in Consumer Products_2016.pdf] to be inserted into pdf version of this report.

Appendix D – State of WA Product Testing for PCBs

[Appendix D_State of WA Product Testing for PCBs_2016.pdf] to be inserted into pdf version of this report.

Appendix E – PCB PBT National Action Plan

[Appendix E_EPA PCB National Action Plan_2002.pdf] to be inserted into pdf version of this report.

Appendix F – Summary of Canada – US Strategies for PCBs

[Appendix F_PCB Strategy Summary Table_Final] to be inserted into pdf version of this report.