Binational Strategy for Polychlorinated Biphenyl (PCB) Risk Management

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

Prepared by the Governments of the United States and Canada

Disclaimer

The purpose of this document is to propose polychlorinated biphenyl (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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Executive Summary

The Canada-United States Great Lakes Water Quality Agreement (GLWQA) seeks to reduce the anthropogenic release of chemicals of mutual concern (CMCs), including polychlorinated biphenyls (PCBs), into the air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes. Under the GLWQA the Parties have agreed to adopt, as appropriate, the principles of virtual elimination and zero discharge for releases and control of CMCs.

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, industry, and the public in implementing risk mitigation and management options aimed at reducing PCBs in the Great Lakes region. The Parties and their partners will use this strategy as guidance to identify, prioritize, and implement actions to reduce CMCs. Strategy options are organized under five categories: Regulations and Other Risk Mitigation and Management Actions; Compliance Promotion and Enforcement; Pollution Prevention; Monitoring, Surveillance, and Other Research Efforts; and Domestic Water Quality. The Parties commit to incorporating, to the extent feasible, options outlined herein in their decisions on programs, funding, and staffing, but implementation would take place by agencies with mandates to undertake work in these areas. As noted in the GLWQA, the Parties' obligations are subject to the appropriation of funds in accordance with their respective procedures.

PCBs are a class of synthetic organic chemicals that were globally manufactured for use as superior insulators with long-term degradation resistance. Due to their high stability, accumulated PCBs can be found in sediments, waters, biological tissues, wastes, air, and certain in-use products. Their presence can cause a variety of harmful environmental and human health effects. While Canada and the United States have banned all manufacturing and importation of PCBs, PCB sources remain today and contribute to fish consumption restrictions and environmental degradation in the Great Lakes Basin. These concerns highlight why PCBs merit a Binational Strategy dedicated to reducing their presence in the Great Lakes Basin.

Accomplishments to date have been significant. Binational efforts have made appreciable strides in reducing new PCB releases through manufacture and importation bans, and re-emission by remediation of PCB-contaminated sediments at Canadian and United States areas of concern (AOC, e.g., Marathon, Ontario and Ashtabula, Ohio). However, PCB concentrations still routinely exceed environmental quality guidelines, and fish consumption advisories are still in effect for all the Great Lakes. Although there is an overall declining trend of PCBs in Great Lakes fish, the decline has slowed and the levels in fish still pose a risk to both wildlife and human health.

The Strategy identified three key gaps pertaining to risk mitigation of PCBs:

- Lack of a complete PCB inventory
- Lack of compliance assurance activities
- Lack of comprehensive and consistent monitoring of PCBs.

To address these gaps, this Binational Strategy document proposes multiple options as outlined in **ES Table A**. By implementing the options laid out in this Binational Strategy, stakeholders will be improving the health of the Great Lakes Basin and their respective communities.

ES Table A. Summary of the Canada-United States Strategy Options for PCBs

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**
Strategy Options				
Generate phase-out deadlines for current in-use equipment at the federal level (US) Promote decommissioning and safe disposal of PCB-containing equipment (Canada and US) Update and maintain inventory estimates for PCB-containing equipment and their disposal status (Canada and US) Review and update regulations to match current scientific understanding (US) Continue to manage PCB-contaminated sites and sediments (Canada and US)	Enhance support to State and Tribal programs that complement or augment baseline federal program requirements via compliance promotion activities (US) Enhance support to PCB inspectors who regulate firms that may be handling, storing, recycling, or disposing PCBs (US) Support industry associations and firms who seek to phase out or improve risk management within their sector (Canada and US) 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)	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 (Canada and US) Enhance public outreach and educate the public on how to obtain and implement site-specific fish consumption advisories (Canada and US) Encourage industries to track their P2 activities and efforts in the TRI database or via P2 promotion activities (fact sheets, case studies) (US)	Continue monitoring PCBs through human biomonitoring and 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 data portals, government reports, scientific journals) to maximize the audience (Canada and US) Use monitoring and modeling to characterize PCB sources as a basis for decision-making with respect to potential actions, measuring progress, and formulating an international decision-making framework (Canada and US) Develop uniform PCB fish and wildlife consumption advice for all waters of the Great Lakes (Canada and US) Use existing data sources and exposure data to inform future strategic directions and plans (Canada and US) Develop cost-effective tools for monitoring PCB concentrations from various sources (Canada and US) Determine exposure impact of non-liquid materials containing low levels (<50 ppm) of PCBs (Canada and US) Use Great Lakes datasets and models to determine how changes in temperature, water levels, precipitation, and climate trends affect chemical behavior in the Great Lakes (Canada and US) Create or modify current databases to include environmental 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)	Review and update existing domestic water quality standards (US), if necessary. [Note: The drinking water Maximum Containment Level for PCBs is set at 0.0005 mg/L. In 2010, the Agency reviewed this standard under the Six-Year Review and determined that it was still appropriate and protective.] (US) Minimize or eliminate (where possible) PCBs in effluent that could impact 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, US 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) Work with states to promote PCB reduction activities through the Municipal Separate Storm Sewer (MS4) and other water quality permitting programs in support of TMDLs (US)

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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
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
CHMS	Canadian Health Measures Survey
CMC	Chemicals of Mutual Concern
CSMI	Cooperative Science and Monitoring Initiative
CWA	Clean Water Act
DMR	Discharge Monitoring Report Pollutant Loading Tool
ECCC	Environment and Climate Change Canada
EPCRA	Emergency Planning and Community Right-to-Know Act
ESM	Environmentally Sound Management
EU	European Union
FAO	Food and Agriculture Organization
FNBI	First Nations Biomonitoring Initiative
GLBTS	Great Lakes Binational Toxics Strategy
GLENDA	Great Lakes Environmental Database
GLHHFTS	Great Lakes Human Health Fish Tissue Study
GLI	Great Lakes Initiative
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
IADN	Integrated Atmospheric Deposition Network
IARC	International Agency for Research on Cancer
ITT	Identification Task Team
LAMP	Lakewide Action and Management Plan
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
MS4	Municipal Separate Storm Sewer
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
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
POTW	Publicly Owned Treatment Works
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit
POP	Persistent Organic Pollutants
POTW	Publicly Owned Treatment Works
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SiGL	Science in the Great Lakes
SOLEC	State of the Lakes Ecosystem Conferences
TMDL	Total Maximum Daily Loads
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 EPA	United States Environmental Protection Agency
US FDA	United States Food and Drug Administration
USGS	United States Geological Survey
WHO	World Health Organization
WQS	Water Quality Standards
ZDDP	Zero Discharge Demonstration Program

1 Introduction

The purpose of Annex 3 of the Canada-United States Great Lakes Water Quality Agreement (GLWQA) is to reduce the anthropogenic release of chemicals of mutual concern (CMCs) into the Waters of the Great Lakes, recognizing: (1) the importance of life cycle management, (2) that knowledge and information are fundamental to sound management, (3) that CMCs may be managed at the federal, state, provincial, indigenous peoples, and local levels through a combination of regulatory and non-regulatory programs, (4) that international efforts may contribute to reductions from out-of-basin sources, and (5) that the public can contribute to achieving reductions. While there is no requirement in the GLWQA to set reduction targets, consideration should be given to existing guidelines and the work of other Annexes.

In 2016, the two governments designated polychlorinated biphenyls (PCBs) as one of eight CMCs. In designating PCBs as a CMC, the Parties have agreed that they pose a threat to the Great Lakes, that current management actions are insufficient, and that further action benefiting the Great Lakes Basin is warranted. These actions are documented in binational strategies that may include research, monitoring, surveillance and pollution prevention, and control provisions. The purpose of the binational strategies is therefore to reduce releases of CMCs by focusing efforts of Governments, agencies, and the Public in implementing risk mitigation and management actions. The United States Environmental Protection Agency (US EPA) and Environment and Climate Change Canada (ECCC) are the responsible government departments that administer the GLWQA between the two respective nations. Within the United States, the US EPA's Great Lakes National Program Office (GLNPO) coordinates these efforts. Within Canada, ECCC's Ontario Regional Director General's Office coordinates these efforts.

The Parties and their partners will use this strategy as guidance to identify, prioritize, and implement actions to reduce CMCs. Reductions will only be achievable with widespread on-the-ground action, but it will take time to implement actions to the extent that significant reductions are achieved, and it will take time for the aquatic environment to respond. Factors such as climate change, legacy sources, and changing human activities on the landscape make it difficult to predict the rate at which significant changes could be seen in the lakes. The ultimate success of the strategy depends on the combined efforts of the Great Lakes community. The strategy and its implementation will be reviewed on a regular basis and reported through the Progress Report of the Parties. While the GLWQA does not provide timelines for strategy implementation, the strategy should be reviewed periodically. Please note that during the time frame of re-evaluation, no new chemical nominations will be accepted.

This PCB strategy covers a list of 26 management options, in Canada and/or the United States, to address threats to water quality by reducing PCB releases. These options can be used to help identify, support, or coordinate ongoing or new projects. The options are organized under five categories: Regulations and Other Risk Mitigation and Management Actions; Compliance Promotion and Enforcement; Pollution Prevention; Monitoring, Surveillance, and Other Research Efforts; and Domestic Water Quality. The Parties commit to incorporating, to the extent feasible, respective actions in the CMC strategies in their decisions on programs, funding, and staffing. Implementation will take place, to the extent feasible, by agencies with mandates to undertake work in these areas. As noted in the GLWQA, the Parties' respective obligations are subject to the appropriation of funds in accordance with their respective procedures. Implementation of some CMC actions may be supported through other GLWQA Annexes, for example, Lake Superior Partnership projects to address chemical contaminants in the Lake Superior Lakewide Action and Management Plan (LAMP) under the Lakewide Management Annex.

2 Chemical Profile

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 prepared by the Identification Task Team (ITT) (2015b). A synopsis of this information is given herein.

2.1 Chemical Identity

PCBs are synthetic chemicals with the general chemical formula of $C_{12}H_{10-n}Cl_n$, where n = 1 to 10 = x+y. As shown in **Figure 1**, chlorine atoms 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. Most 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).

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).

2.2 Physical and Chemical Properties

PCBs were globally manufactured and used for their superior insulating properties, low flammability, high heat capacity, low chemical reactivity, and long-term degradation resistance. Most commercially available PCB mixtures (Aroclors) 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). Approximately 2% of the PCBs available in the United States did not follow this numerical coding.

Many chemical properties of select PCB commercial mixtures (Aroclors) are listed in **Table 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 (Erickson, 1997; ATSDR, 2000). These properties contributed to their usefulness as dielectric fluids in 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.

2.3 Environmental Fate and 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 or chemical), or accumulation (bioaccumulation or deposited sediments). PCBs in the environment transfer and cycle among air, water, animal tissues, and soil media, and can be easily transported on a global scale through the atmosphere (US EPA, 2016h).

Figure 2 illustrates many of the sources and pathways by which PCBs may circulate within the Great Lakes system (US EPA, 2016f). PCBs enter the Great Lakes ecosystem through urban and industrial sources, atmospheric deposition, groundwater migration, or sediment resuspension. In 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 in the Great Lakes Basin.

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

2.4 Sources and Releases of PCBs in the Great Lakes

PCBs do not occur naturally in the environment. PCB exposure and release sources in the Great Lakes are anthropogenic and may come from local (defined as Canada or the United States) or global sources via long-range transport.

2.4.1 Uses and Quantities in Commerce

Worldwide production of PCBs has been estimated to be one million metric tons (Erickson, 2001). Nearly 60% of these were produced in the United States by Monsanto before the 1979 ban. 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 (Hornbuckle et al., 2006; Csiszar et al., 2014). 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 was 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 in Canada (Government of Canada, 2014). The United States currently does not have a mandated end-of-use date.

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 (ECCC, 2008). The quantity of PCBs reported to be in use in Canada continues to steadily decline (**Figure 3**). 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, companies in Quebec reported 13.95%, and the rest of Canada reported 0.2% (ECCC, 2016).

The total quantity of PCBs still in use in the United States is not well known. The last inventory of PCB-containing electrical equipment was conducted in 2011 and it focused on transformers and capacitors that are subject to use authorization under the Toxic Substances Control Act (TSCA) (**Table 2**). 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 in the Great Lakes Basin. Current efforts have not surveyed for items not covered under TSCA, such as small capacitors and sealants, or tracked the disposal of PCBs. 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).

The US 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 3** outlines the most updated number of PCB transformers in the Great Lakes US 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 it 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 US 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, 2012b).

2.4.2 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 in 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, 2016c; Stone, 2016a). In one study, 60% of the consumer goods or packaging tested contained elevated concentrations of PCB-11 (Rodenburg et al., 2010; Stone, 2016c; Stone, 2016a; 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, 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 62,500 tons (56,700 metric tons), with an estimated PCB-11 load of 7,800 kg/year (Guo et al., 2014).

2.4.3 Release Sources

Legacy PCBs, those manufactured before 1979, may be found in existing PCB-containing equipment (e.g., transformers, capacitors) or within soils, landfills, architectural paints, waste oils, building materials, other items in 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).

The primary sources of PCBs to the Great Lakes Basin are (ITT, 2015b; US EPA, 2016h):

- 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 Areas of Concern [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 (local and global)
- Others (e.g., dispersive sources).

2.4.4 PCBs in Environmental Media

2.4.4.1 In Air

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 into the air between 1930 and 1970 (Oregon Department of Environmental Quality, 2003). In 2011, the National Emissions Inventory (NEI) recorded 8,988 pounds (4076 kg) of PCB emissions from the eight Great Lakes states (US EPA, 2016a), 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 in 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 per year (203 kg per year) (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 adding to 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).

2.4.4.2 In Surface Water

Water quality in the Great Lakes is measured regularly. Lake-wide, trends show the highest concentrations of total PCBs in Lakes Ontario and Erie followed by Lakes Huron and Michigan. Lake Superior has the lowest concentrations of PCBs (ITT, 2015). The highest PCB loadings are found near known contamination sources, such as the western basin of Lake Erie (ITT, 2015). In general, open water PCB concentrations are below water quality criteria levels.

2.4.4.3 In Sediments

PCB re-emission from contamination in 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., Marathon, Ontario and Ashtabula, Ohio). In addition to the 43 listed AOCs in the Great Lakes Basin, PCBs have been identified in 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 lake-wide surficial sediment averages over the last 25 years (1980 to 2005) have decreased by approximately 30% in 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 (total accumulation) in the Great Lakes were highest in Lake Erie, followed by Lake Ontario, then 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 in the PCB Binational Summary Report.

2.4.4.4 In Biota

A series of fish contamination studies was conducted in the lower 48-contiguous United States 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 nation-wide 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 in fish tissues, Lake Michigan Lake Trout was assessed as part of the Lake Michigan Mass Balance (LMMB). Based upon declines of atmospheric inputs, sediment cycling, and tributary loads, it has been estimated that the concentration of PCBs in Lake Trout (age 5.5) will reach the US EPA's wildlife protection level of 0.16 ppm[1] by 2030 and fish consumption protocol levels by 2035 (**Figure 4**) (Kreis et al., 2015). The modeling predictions of Kreis et al. (2015) are consistent with recent findings reported in the 2017 State of the Great Lakes Highlights Report (ECCC and US EPA, 2017). There is an overall declining trend of PCBs in Great Lakes fish, but the decline has slowed and the levels in fish still pose a risk not only to human health, but also to wildlife that consume Great Lakes fish. The ITT PCB report clearly documents the current situation and the following conclusions in the report are noted (ITT, 2015b).

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[1] US EPA wildlife protection level refers to total PCBs in fish tissue on a wet weight, whole fish basis (ITT, 2015b).

PCB concentrations in whole fish and other wildlife have declined significantly from the 1970s to the early 1990s, after which rates of decline slowed, and in some cases may have leveled off. Concentrations in fish remain above the EPA Wildlife protection value of 0.16 ug/g.

PCBs continue to drive fish consumption advisories in all five Great Lakes. While levels have declined significantly since the ban in the 1970s, recent rates of decline have slowed or leveled off. Further declines toward unrestricted consumption may rely upon the continuous removal of potential sources to the Great Lakes environment(ITT, 2015b).

Work conducted for the Lake Superior LAMP also concluded that total PCB concentrations in Lake Trout are decreasing; however, in 2013, the total PCB concentration found in 33 of 53 sampled Lake Superior Lake Trout still exceeded the 1987 GLWQA criteria value of 0.1 ppm (Lake Superior Partnership, 2016). The 2017 State of the Great Lakes Highlights Report Fish Consumption assessment notes that PCB concentrations in Lakes Erie and Huron have remained stable or are slightly increasing (ECCC and US EPA, 2017). These conclusions justify consideration of additional effort to reduce PCB exposure in the Great Lakes.

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, 2011).

2.5 High Level Summary of Risks

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, and endocrine system, as well as other health effects. Human studies have shown potential carcinogenic and non-carcinogenic effects from PCBs. The US 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 (ECCC, 2008; CDC, 2011; US EPA, 2016h). 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 in the Great Lakes region. Every Great Lakes state and the Province of Ontario have fish contaminant monitoring programs that issue fish consumption advice for their residents based on concern for exposure to PCBs from eating locally-caught fish.

Representatives from each of the Great Lakes states collaborated to form the Great Lakes Sport Fish Consumption Advisory Task Force to generate a protocol for determining consumption advice based on PCBs in fish. A health protection value was established in the protocol to keep the sport fish-associated dietary PCB ingestion below 3.5 µg PCB per day for an 70 kg adult (The Great Lakes Sport Fish Consumption Advisory Task Force, 1993). The protocol assumes a 70 kg person eats a 227 gram meal and a linear relationship between the body weight to meal size ratio to account for other body weights. Since these advisories were focused on an average adult, care must be taken when applying them to vulnerable populations.

While many states adhere to the guidelines developed by the Advisory Task Force (Indiana, Minnesota, New York, Ohio, Pennsylvania, 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 4**) (Michigan Department of Environmental Quality, 2014; OMOECC, 2015). Therefore, the advice given by different states/provinces may differ for the same lake and species in 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 consumption of one meal a month, 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 4**).

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

3.1 United States

3.1.1 Existing Statutes and Regulations

A multitude of regulations has been established at the federal, state, and local levels to limit the availability, usage, discharge, and overall number of PCB sources in the United States. In addition to federal mandates, some of the Great Lakes states, Tribes, and local governments (e.g., publicly owned treatment works [POTWs]) have issued more stringent regulations and processes to limit PCB releases. **Appendix A** presents tabular summaries of these regulations as they were available to the United States Federal government.

Section 303(d) of the Federal Clean Water Act (CWA) and the US EPA's regulations [40 CFR Part 130] require states to develop total maximum daily loads (TMDL) for all water bodies that are listed as impaired due to not meeting water quality standards (WQS). The TMDL process establishes the maximum amount of a specific pollutant (in this case PCBs) that a water body can receive without exceeding WQSs. Controls are designed and implemented to control pollutant sources and to reach the water quality goals of the TMDL. PCBs are no longer manufactured, but still cycle in the environment. Recent TMDLS focus implementable actions at points in the PCB cycle where releases of PCBs to the environment can be controlled, including legacy sites and collection points in stormwater systems; improper or illegal transportation; and repositories of PCB-contaminated waste. Implementation measures include preventative and best management practices and working with control programs that reduce releases of PCBs to the environment, such as TSCA, municipal separate storm sewer (MS4) pollution prevention measures, PCB removal from demolition sites, and product manufacturing that does not inadvertently generate PCBs. Over time, implementing activities to meet TMDL goals can reasonably be expected to result in proportional reductions in the water column, atmosphere, and eventually fish tissue concentrations.

In 1979, the Toxics Substances Control Act (TSCA) banned the manufacture, import/export distribution in commerce, and use of PCBs except under limited circumstances in the United States (e.g., sampling standards and specialty diagnostic equipment). Regulations codified pursuant to TSCA can be found in Title 40 of the Code of Federal Regulations Part 761 (40 CFR Part 761). Those regulations cover the use, storage, spill clean-up requirements, and disposal of PCBs, and PCB-containing equipment. The main historical uses of PCBs were in electrical, hydraulic, and heat transfer equipment. The PCBs within dielectric fluids in all PCB electric equipment (e.g., transformers, capacitors and switches) are subject to regulation, and those at certain concentrations (≥ 500ppm PCB) must be registered with the US EPA and local fire officials and labeled in order to be authorized for use. The regulations prohibit the use of the PCBs at concentrations of 500 ppm or greater in electrical equipment in several locations (e.g., PCB transformers cannot be used in or near food and feed operations and PCB large capacitors can only be used in a restricted access electrical substation or a contained and restricted access indoor location); and prohibit the use of PCBs at concentrations 50 ppm or greater in hydraulic or heat transfer systems. PCBs of 50 ppm or greater are regulated for storage and disposal.

3.1.2 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. EPA Regions have and may implement activities based on their priorities and available resources. Examples of actions include: accelerating decommissioning of PCBs, remediating contaminated sites and sediments, communicating risk to reduce exposure, and conducting monitoring as a basis for action.

The US 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 the 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.

3.1.3 Risk Management Actions

Under the Great Lakes Restoration Initiative (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 in the United States designed to remediate contaminated sediments within the 43 designated Great Lakes AOCs. Between 2004 and 2015, GLLA has remediated more than 4 million cubic yards (3 million cubic meters) of contaminated sediment, a portion of which contained PCBs (US EPA, 2016b). As of 2015, four AOCs in the United States have been delisted (Oswego River, Presque Isle Bay, White Lake, and Deer Lake), and management actions have been completed at another three (Ashtabula River, Waukegan Harbor, and Sheboygan River) (US EPA, 2017b). There are additional programs and authorities at state and federal entities that have previously and continue to coordinate remediation of sediments contaminated with PCBs. For instance, the Fox River Cleanup Project, a state-led Superfund project in Wisconsin has removed approximately 5.6 million cubic yards of PCB contaminated sediment from the Lower Fox River, which was identified as one of the largest contributors to the Lake Michigan mass balance study. Under the former Great Lakes Binational Toxics Strategy and other initiatives, the US EPA has been engaged in efforts to reduce risks to human health and the environment from exposure to PCBs. For example, in the United States, three major automobile manufacturers in the United States committed to remove 100% of their PCB equipment; three major steel producers reported on their PCB reduction efforts, with one committing to reduce high level PCBs in its electrical equipment by 95% by 2006; and ten major investor-owned utilities in the Great Lakes Basin indicated they would continue programs to remove their PCBs or that they had already phased out their PCB equipment.

As of 2015 there were only three active commercial PCB destruction facilities located in the Great Lakes Basin: two commercial landfills and one commercial PCB transformer decommissioning facility. **Figure 5** presents data reported by PCB destruction facilities for 2015, the last calendar year such data are available as of this report. In 2015, the amount of PCB-contaminated liquid and solid materials nationally disposed of was about 520 million kilograms (US EPA, 2015b). This amount is the weight of the liquid or solid material containing PCBs, and not the weight of the PCBs. The amount of PCB-contaminated liquid and solid materials disposed of in the three commercial PCB disposal facilities in the Great Lakes Basin was 220 million kilograms (US EPA, 2015b).

3.1.4 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 in the Great Lakes Environmental Database (GLENDA). GLENDA is a database for the collection and storage of environmental data maintained by US EPA's GLNPO. Air, water, biota, and sediment data are all compiled in the system for users of Great Lakes data (US EPA, 2016c). Science in the Great Lakes (SiGL) Mapper (https://sigl.wim.usgs.gov/sigl/) 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, 2015a). 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 US EPA, through GLNPO, is mandated, via Section 118 of the Clean Water Act (CWA), "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 several 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. GLNPO also 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 Great Lakes Human Health Effects Research Program and the Great Lakes Human Health Fish Tissue Study (GLHHFTS) are two such endeavors undertaken to characterize PCB exposure potential via consumption of Great Lakes fish (ATSDR, 2014; US EPA, 2017a).

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 US EPA websites and databases, such as GLENDA.

3.1.5 US EPA Guidelines and Standards

As stated in previous sections, there is an array of US EPA and state regulations in effect for PCBs and PCB wastes.

Table 5 provides a list of United States standards and recommendations that states and federal agencies have published on PCB concentrations in workplace air, drinking water, environmental waters, and foodstuffs (US EPA, 2013; CDC, 2014; US EPA, 2016g).

State and Tribal Efforts. Each of the Great Lakes states publishes an annual fish consumption advisory for protecting its residents from PCB concentrations in 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 US 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 in fish of the state's waters.

Nationwide 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 in 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, 2016f). As a component of NCCA, the GLHHFTS has documented PCB concentrations from fish tissues collected in each of the Great Lakes (https://www.epa.gov/fish-tech/fish-tissue-data-collected-epa).

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 Risk Management Actions

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 1970s 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 and PCB Waste Export 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.

The PCB Waste Export 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.

3.2.1.4 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, through the most recent amendments to the current PCB Regulations as it was determined that they were no longer necessary.

3.2.1.5 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 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.

Owners of PCBs subject to the Regulations are required to report 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. Based on information reported by PCB owners, 147 tons of PCBs were in use, and 114 metric tons of PCBs were in storage in Canada. Based on information reported by PCB destruction facilities, a total of 575 metric tons of PCBs were destroyed 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).

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).

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 6 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).

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 7 shows the total volume and weight of materials processed in Canada between the years 2011 and 2014 that contained PCBs (ECCC, 2016b).

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.

In Canada, there are currently no routine Great Lakes-specific programs to monitor human exposure to persistent chemicals. Therefore, nationwide studies and results of individual epidemiological studies undertaken in the Great Lakes are used as a means to evaluate PCB concentrations in humans in the Great Lakes Basin. The Canadian Health Measures Survey (CHMS), initiated in 2007, is a national survey led by Statistics Canada, in partnership with Health Canada and the Public Health Agency of Canada and includes assessment of blood, urine, and hair collected from survey participants for a wide variety of environmental chemicals (Statistics Canada, 2016). The CHMS has recently examined the mean blood concentrations of total PCBs in Canadians and the First Nations Biomonitoring Initiative (FNBI) examined the concentration of PCBs in the blood of Canadian First Nations populations in 2011 (AFN, 2013). Samples were assessed for 24 PCBs and Aroclor 1260. No comparison could be made between the two samples sets for 14 of the 24 PCBs as over 40% of the samples were below the limit of detection. For PCB 118, PCB 138, and Aroclor 1260 the FNBI levels were significantly lower than levels observed in the CHMS (AFN, 2013; Statistics Canada, 2016).

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 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 6.

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 2009 Biennial Report, one of the final documents addressing PCBs prepared under the GLBTS, with a summary of PCBs activities beginning on page 11.

3.3.2 Lake-wide Action and Management Plans

The purpose of the LAMP program is to coordinate efforts to assess, restore, protect, and monitor the ecosystem health for each of the Great Lakes (US EPA, 2004; US EPA, 2016e). CMCs will be considered as future priority for monitoring and surveillance through the Lake Partnerships.

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, 2016d). 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 in the Great Lakes (Wu et al., 2009). The IADN air monitoring data are currently posted in the ECCC NatChem database. Work 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 (QA/QC) program. As such, the IADN dataset is considered globally as the 'golden standard' for data QA/QC in an air monitoring program for toxic chemicals.

3.3.4 Cooperative Science and Monitoring Initiative

One aspect of the GLWQA is the establishment of a Cooperative Science and Monitoring Initiative (CSMI) Task Team through Annex 10. The charge of the CSMI is to implement a joint United States/Canadian effort to provide environmental and fishery managers with the science and monitoring information necessary to make management decisions for each Great Lake. A five-year rotating cycle in which the lakes are visited one per year is followed by an intensive CSMI field year, including connecting channels beginning in 2009. By studying one Great Lake per year, science and monitoring activities can focus on information needs not addressed through routine agency programs, and specific science assessments can be coordinated. Individual Lake Partnerships identify science needs according to the CSMI schedule, and the Task Team implements these recommendations, as appropriate.

3.4 International

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

3.4.1 United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution

The United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (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 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 (European Environment Agency, 2013). 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). The parties to the Stockholm Convention can no longer produce PCBs and are obliged to stop using the chemical. However, existing equipment that contains or is contaminated with PCBs may continue to be

used until 2025. The goal of the Stockholm Convention is to achieve environmentally sound management (ESM) of PCB waste by 2028 (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 of 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 of (Secretariat of the Stockholm Convention, 2016). Canada signed and ratified the Convention in 2001. The United States has signed, but not yet ratified the Convention. It entered into force in May 2004, when the fiftieth party submitted material indicating ratification, even though the United States is not a party to the Convention.

3.4.3 The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The Basel Conventions objective is to protect human health and the environment against the adverse effects of hazardous wastes. Canada signed and ratified the Convention in 1992 and the Convention entered into force in 1992. A key provision of the Convention is to promote the environmentally sound management of hazardous wastes, including wastes containing persistent organic pollutants (POPs).

The Conference of the Parties to the Basel Convention adopted technical guidelines on the environmentally sound management (ESM) of POP waste and technical guidelines on the ESM of PCB wastes in 2017 (UNEP 2017). These guidelines provide detailed guidance on reducing or eliminating POP releases to the environment from waste disposal and treatment processes and the identification and environmentally sound management of PCB wastes.

3.4.4 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 among 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).

3.4.5 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 in foodstuffs. Both the WHO and FAO have set 0.006 ppm/day as the international standard for maximum allowable daily intake level of PCBs in foodstuffs (CDC, 2014).

4 Gap Analysis

There are a number of unknowns in both Canada and the United States about 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 in those units, and their estimated remaining service life is needed.

Due to their extensive use in the past, there are potentially a number of unreported and/or unknown PCB sources in both nations that may be releasing PCBs into the environment (ITT, 2015b). 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 (US EPA, 2002; GLEAM, Undated). The same has been found for sewerage and natural gas systems, which can be a reservoir for PCBs. Identified AOCs in 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.

In 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 jurisdictions that are exempt from United States federal regulation under Resource Conservation and Recovery Act (RCRA) Subtitle C.

The level 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 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, Métis, and other government programs are consistent, standardized, and structured to allow for improved binational monitoring for PCBs and PCB-containing products. Working to provide 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.[2] A binational repository would facilitate further research on PCBs, such as a PCB case study that assesses climate change impacts on toxic chemicals. Current databases (e.g., SiGL, GLENDA, IADN, and CSMI) might be leveraged to create a single accessible repository. PCBs are among the most well-studied group of compounds in the Great Lakes region, with multimedia monitoring time series that stretch 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 State/Provincial programs, there are 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, 2010b). A gap in user awareness of the presence of PCBs has been previously noted (US EPA, 2010a). Existing user-friendly documents are available (US EPA, 2010a). Additional user-friendly documents are needed to educate custodial staff, maintenance personnel, building owners, and the 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. 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, 2010b; US EPA, 2011).

- *Addressing Non-Legacy PCBs.* Control strategies targeting non-legacy PCBs, such as inadvertently generated PCB congeners, 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).

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[2] 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.

- *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. The actions 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, 2015b). In Canada, inventories are updated generally on an annual basis, through reporting by the regulated community 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 comprehensive inventory should be conducted to determine the quantity and concentration of PCB equipment in 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, but are required to be disposed of in an approved manner (Government of Canada, 2014; ITT, 2015b). 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, 2016b; Stone, 2016a).

While the ultimate success of the strategy depends on the efforts of the Great Lakes community, it is suggested that the strategy and its implementation progress should be reviewed on a regular basis and reported through the Progress Report of the Parties.

Summary of Regulations and Other Risk Mitigation and Management Actions Strategy Options

- Generate phase-out deadlines for current in-use equipment at the federal level (US)
- Promote decommissioning and safe disposal of PCB-containing equipment (Canada and US)
- Update and maintain inventory estimates for PCB-containing equipment and its disposal status (Canada and US)
- Review and update regulations to match current scientific understanding (US)
- Continue to manage PCB-contaminated sites and sediments (Canada and US)

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 US 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).

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 have been previously unaware of or potentially misunderstanding the regulatory requirements for their operations.

Summary of Compliance Promotion and Enforcement Strategy Options

- Enhance support to state and Tribal programs that complement or augment 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)
- Support industry associations and firms who seek to phase out or improve risk management within their sector (Canada and US)
- 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 US 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, 2016h; US EPA, 2016i). 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. Outreach/education is also needed for fish consumption advisories, including where to obtain the most pertinent information and how to apply the advisories to individual consumers.

The US EPA has also developed the Toxic Release Inventory (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 in 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 in the environment. Waste reduction success stories may be noted in region-specific journals, websites, and/or at conferences. For example, the GLRPPR promotes information exchange and networking between P2 professionals in the Great Lakes regions of Canada and the United States.

While sediment remediation is not conducted basin-wide, areas with sediment concentrations that are deemed to pose risk to humans and/or wildlife are targeted for remediation. Significant effort has been undertaken in the 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 in these areas. Coordinating risk management goals to specific endpoints (e.g., minimizing the concentration of PCBs in local fish) may be helpful in future endeavors.

Summary of Pollution Prevention Strategy Options

- 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 (Canada and US)
- Enhance public outreach and educate the public on how to obtain and implement site-specific fish consumption advisories (Canada and US)
- 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 US EPA and ECCC have coordinated efforts to publish a report outlining efforts of State of the Lakes Ecosystem Conferences (ECCC and US EPA, 2011). 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, 2011). 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 in 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 concentrations 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 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 US 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, 2010b).

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 trends and climate variation impacts on the regional environment and fate of PCBs. As temperature, water levels and precipitation change over decades, there is a need for long time series to verify and improve model predictions. Hence, monitoring data consistency is essential to achieve such predictions.

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 in the region: young children, pregnant women, and First Nations/Métis/Tribal groups (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 Efforts Strategy Options

- Continue to monitor PCBs through human biomonitoring and 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) to maximize the audience (Canada and US)
- 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 (Canada and US)
- Develop uniform PCB fish and wildlife consumption advice for all waters of the Great Lakes (Canada and US)
- Use existing data sources and exposure data to inform future strategic directions and plans (Canada and US)
- Develop cost-effective tools for monitoring PCB concentrations from various sources (Canada and US)
- Determine exposure impact of non-liquid materials containing low levels (<50ppm) of PCBs (Canada and US)
- Use Great Lakes datasets and models to determine how changes in temperature, water levels, precipitation, and climate trends affect chemical behavior in the Great Lakes (Canada and US)
- Create or modify current databases to include environmental 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 wastewater effluents do not cause exceedances of either downstream drinking water CWA or Safe Drinking Water Act (SDWA) standards.

Summary of Domestic Water Quality Strategy Options

- 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)
- Minimize or eliminate (where possible) PCBs in wastewater effluent that could affect 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)
- Work with states to promote PCB reduction activities through the MS4 and other water quality permitting programs in support of TMDLs (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 in 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 2004 and 2015, an estimated 4 million cubic yards (3 million cubic meters) of contaminated sediments in United States AOCs were remediated (US EPA, 2016b); however, PCB concentrations *still routinely exceed* environmental quality guidelines. At the current rate of reduction, it has been estimated that the concentration of PCBs in Lake Michigan Lake Trout will reach the US EPA's wildlife protection level of 0.16 ppm by 2030 and fish consumption protocol levels by 2035 (Kreis et al., 2015).

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.

Cooperative and coordinated measures taken by the two nations are needed to coordinate monitoring and surveillance efforts, maximize research initiatives to identify previously unknown 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.

7 Tables

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

	Commercially Available PCB Mixtures							
Property	**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). *Toxicological Profile for Polychlorinated Biphenyls (PCBs).* US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

Table 2. *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 (2012d)

Table 3. *Summary of PCB Transformers by Great Lakes US EPA Regions.*

EPA Region	No. of Transformer Locations		Weight, kg		Weight, lb[a]	
	Total	With PCBs	Total	Average per Transformer with PCBs	Total	Average per Transformer with PCBs
2	832	801	848,192	1,059	1,868,265	2,332
3	1,364	1,152	2,934,891	2,548	6,464,518	5,612
5	3,719	3,555	7,229,502	2,034	15,924,014	4,479
Total	**5,915**	**5,508**	**11,012,585**	**5,641**	**24,256,797**	**12,423**

Source: US EPA (2012d)
[a] *Weight of PCBs in units of pounds was calculated from the weight in kilograms, as reported in the PCB Transformer Database.*

Table 4. *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)

Table 5. *United States Standards and Water Quality Criteria for PCBs*

Agency	Focus	Level	Comments
Occupational Safety and Health Administration (OSHA)	Human Health 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)	Human Health Workplace Air	1.0 µg/m^3	Advisory for a 10-hour TWA
US Food and Drug Administration (US FDA)	Human Health Food	0.2 - 3.0 ppm (all foods) 2.0 ppm (fish) 10 ppm (paper packaging)	Enforceable; Tolerance levels
US 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	Human Health Drinking Water	0.0005 ppm	Enforceable Maximum Contaminant Level (MCL). All Great Lakes states have promulgated this MCL into State rules.
Illinois	Human Water Quality Criteria (WQC)	2.6 x10^{-8} ppm	Human Health Standard; Title 35 Ill. Adm. Code 302.504
Indiana	Human WQC	6.8 x10^{-9} ppm	Human Cancer Drinking Water Criteria; Ind. Adm. Code 327 IAC 2-1.5-8
Ohio	Human WQC	2.6 x10^{-8} ppm	Human Health Drinking Water Values; Ohio Adm. Code Ch. 3745-1-33
Michigan	Human WQC	2.6 x10^{-8} ppm	Human Cancer Drinking Water Criteria with Cancer Endpoint, Mich. Adm. Rules 323.1057
Wisconsin	Human WQC	3.0 x10^{-9} ppm	Human Cancer Criteria for Public Water Supply; Wis. Adm. Code NR 105.08
Minnesota	Human WQC	4.5x10^{-9} ppm	Human Health Chronic Standard; Minn. Adm. Rules Ch.7052.0100
New York	Human WQC	1.0x10^{-9} ppm	Fish Consumption Health; New York Code 6 CRR-NY 703.5
New York	Human WQC	9.0x10^{-5} ppm	Water Source Health; New York Code 6 CRR-NY 703.5
Pennsylvania	Human WQC	3.9x10^{-10} ppm	Human Health Criteria; Penn. Code § 93.8e
US EPA	Wildlife Surface Waters	freshwater: 1.4x10^{-5} ppm	Total criteria on continuous concentrations for the nationally recommended Aquatic Life Criteria
US EPA	Wildlife WQC	7.4x10^{-8} ppm	Criteria within the Great Lakes Basin to Protect Wildlife
Illinois	Wildlife WQC	1.2x10^{-7} ppm	Title 35 Ill. Adm. Code 302.504
Indiana	Wildlife WQC	1.2x10^{-7} ppm	Ind. Adm. Code 327 IAC 2-1.5-8
Ohio	Wildlife WQC	1.2x10^{-7} ppm	Ohio Adm. Code Ch. 3745-1-33
Michigan	Wildlife WQC	1.2x10^{-7} ppm	Mich. Adm. Rules 323.1057
Wisconsin	Wildlife WQC	1.2x10^{-7} ppm	Wis. Adm. Code NR 105.07
Minnesota	Wildlife WQC	1.2x10^{-7} ppm	Minn. Adm. Rules Ch.7052.0100
New York	Wildlife WQC	1.2x10^{-7} ppm	New York Code 6 CRR-NY 703.5
Pennsylvania	Wildlife WQC	1.4x10^{-5} ppm	Penn. Code § 93.8e

Table 6. Canadian Environmental Quality Guidelines for PCBs.

Target	Environmental Quality Advisory, Guideline, or Objective		Great Lakes Exceedances
	Fish and Other Wildlife		
Human Consumption of Fish	Edible portion: 0.105 µg/g (ww)	OMOECC (2015)	Yes
Human Consumption of Wildlife	Tissue Residue Guidelines: Mammalian: 0.79 ng TEQ/kg diet (ww) Avian: 2.4 ng TEQ/kg diet (ww)	(2001b; 2016)	Yes
	Sediment		
Protection of Aquatic Life	Probable Effects Level: 277 ng/g Interim Sediment Quality Guideline/Threshold Effects Level: 34.1 ng/g	(2001a; 2016)	Yes
Protection of Aquatic Life	No Effect Level: 10 ng/g Lowest Effect Level: 70 ng/g Severe Effect Level: 530 ng/g organic carbon	(OMOECC, 2008)	
	Surface Water		
Protection of Aquatic Life	Surface / Open Water: 1 ng/L	OMECC (2016)	No

TEQ: Toxic Equivalents

8 Figures

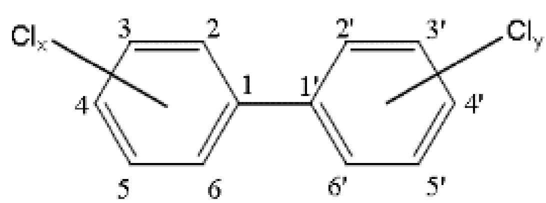


Figure 1. *General Chemical Structure of PCBs.*

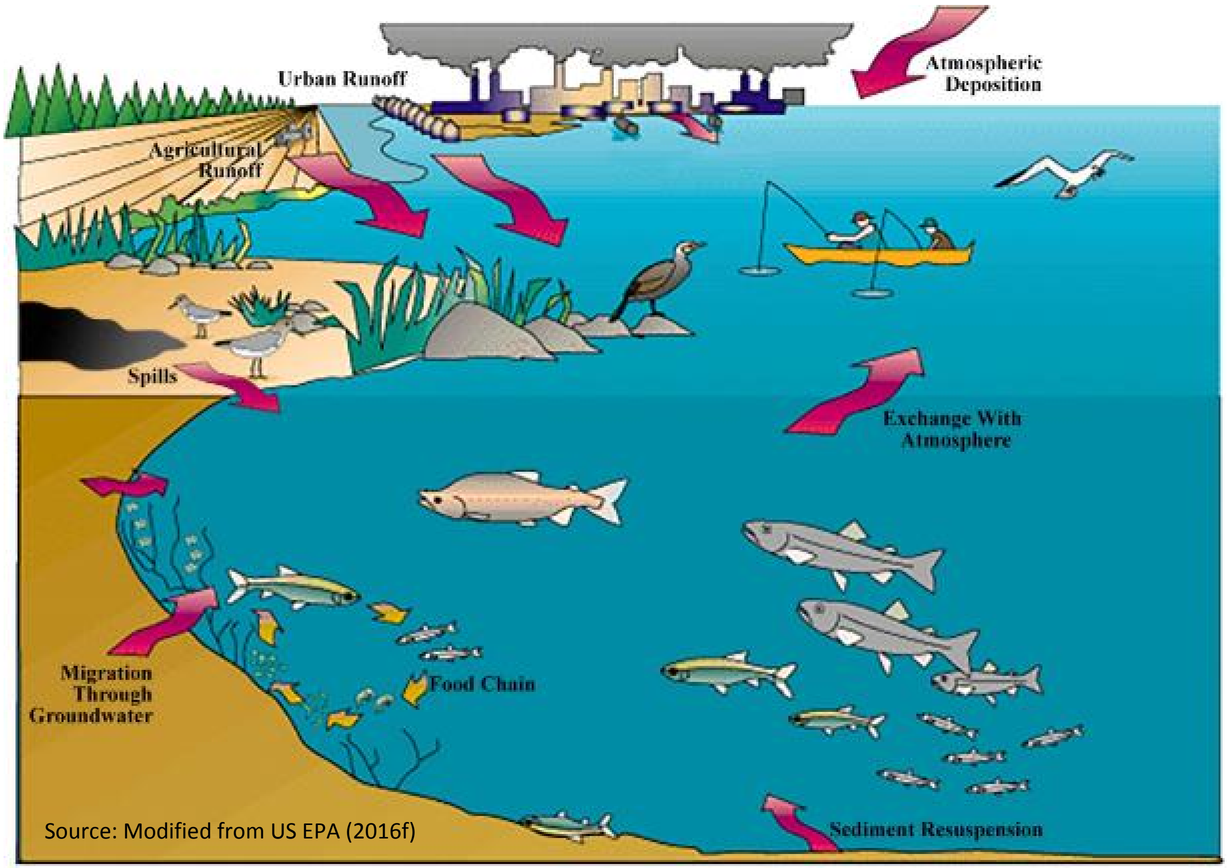
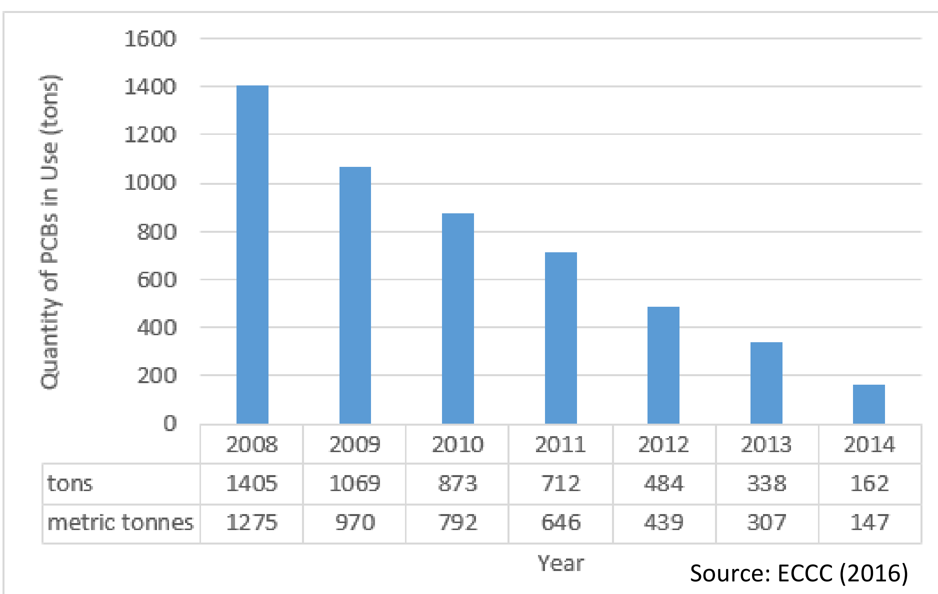


Figure 2. *Sources and Pathways of PCB Pollution in Aquatic Ecosystems.*



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

Figure 3. *Quantities of PCBs Reported in Use in Canada 2008 – 2014.*

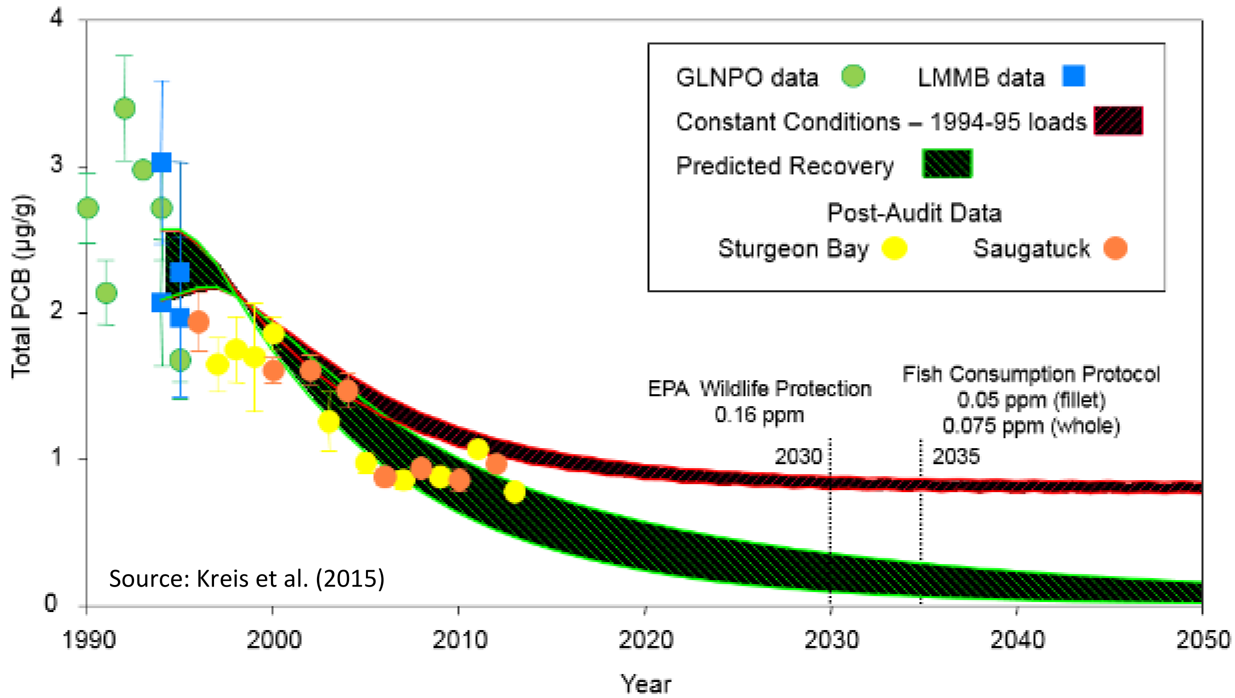


Figure 4. *PCB Forecasts for Lake Michigan Lake Trout.*

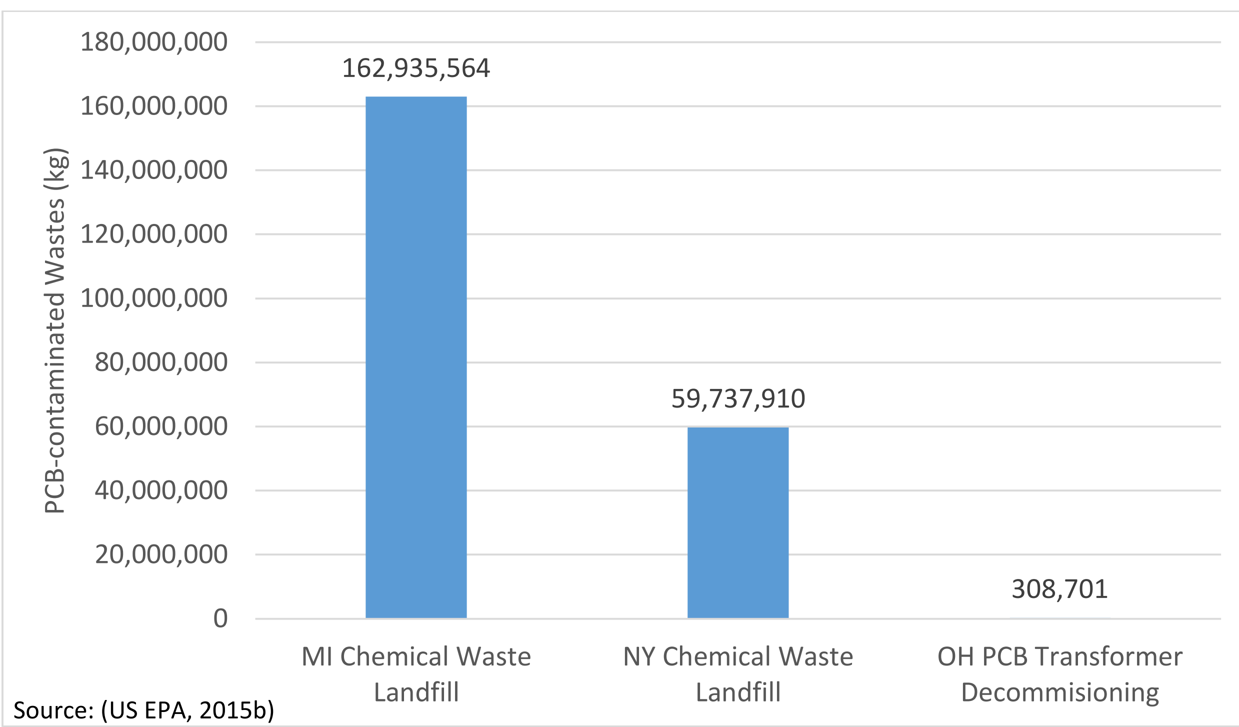


Figure 5. *PCB-Contaminated Wastes Destroyed in the Great Lakes Basin States in 2015.*

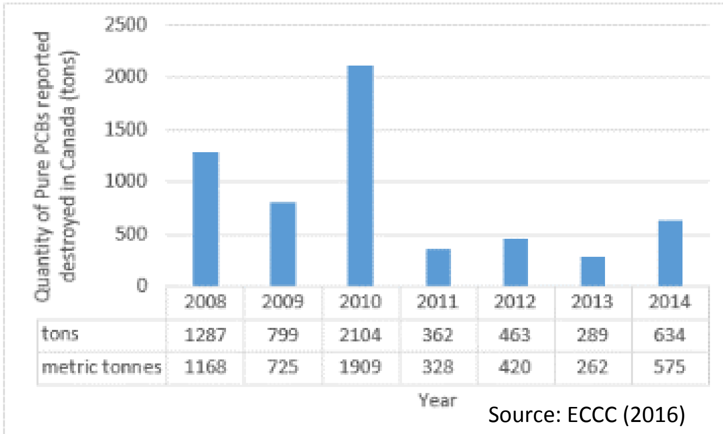


Figure 6. *Quantities of Pure PCBs Destroyed in Canada (2008-2014)*

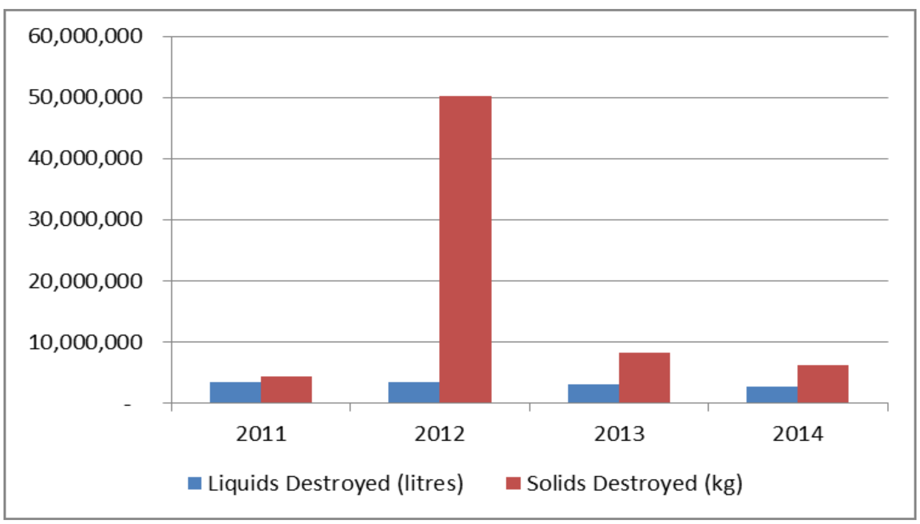


Figure 7. *Total Volume/Weight of Material Processed (as part of PCB destruction) in Canada (2011-2014)*

9 References

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Appendix A. US Federal and State PCB Regulations

The most notable prohibition regulation for PCBs in the United States is the Toxic Substances Control Act (TSCA). In addition to TSCA, the Clean Air Act (CAA) and the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") also regulate PCB releases in United States air, water, and land, respectively. **Table A-1** briefly outlines federal regulations that pertain to PCBs, with additional information in the text following.

Table A-1. *United States Federal PCB Laws and 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 US 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, 2016c). 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.

Toxic Substances Control Act (TSCA)

The most notable prohibition regulation for PCBs in the United States is 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 (e.g., sampling standards and specialty diagnostic equipment). Through TSCA, US EPA regulates several classes of PCB equipment based on the concentrations of PCBs in 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 concentrations ($\geq$ 500ppm PCB) must be registered with the US EPA and local fire officials in order to be authorized for use. TSCA also provides the US 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, 2016c).

Under TSCA, the US 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, 2004). PCB items must be properly disposed of within one year from the date when the item was declared waste or was no longer fit for use (US EPA, 2004). 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, 2004). 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.

Clean Air Act (CAA)

Section 112(c)(6) of the CAA Amendments of 1990 requires that the US EPA identify and regulate emissions of 187 hazardous air pollutants (HAPs), including PCBs (US EPA, 2017a). Under the CAA, the US EPA has also established the National Emissions Standards for Hazardous Air Pollutants (NESHAP). NESHAP lists PCBs as one class of 33 HAPs that poses a greater threat to public health in urban areas (US EPA, 2016b).

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 US 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. In 1995 the US EPA published Water Quality Guidance for the Great Lakes Watershed also known as the Great Lakes Initiative (GLI; https://www.epa.gov/gliclearinghouse). The GLI established water quality criteria for the Great Lakes for PCBs and 28 other toxic pollutants (US EPA, 2013).

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 the US 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.
- The National Pollutant Discharge Elimination System (NPDES) – a permit program that regulates point sources that discharge pollutants to waters of the United States. The US EPA monitors all exceedances of NPDES permit effluent limits and records them in a publicly available on-line tool (US EPA, 2016a). Between the years 2012 and 2016, there have been 20 recorded exceedances of PCB effluent limits in effluents discharged in the Great Lakes states (**Table A-2**). 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 A-2. *NPDES PCB Exceedances in the Great Lakes States, 2012 - 2016*

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

Safe Drinking Water Act (SDWA)

In addition to the CWA, SDWA regulates PCBs in public water systems (42 U.S.C. §300f). While the US 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, 2016d).

Resource Conservation and Recovery Act (RCRA)

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

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

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 US 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 the US EPA, is publicly available and intended to inform the general public regarding facilities that release toxic chemicals (US EPA, 2014).

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 of in the respective state. **Table A-3** outlines specifics for each of the Great Lakes states. While the State of Washington is not located in the Great Lakes Basin, the state has conducted product testing for PCBs that 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 (Stone, 2016b; Stone, 2016a).

Table A-3: 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 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 US 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 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 US 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 (https://www.pca.state.mn.us/sites/default/files/w-hw4-62.pdf).
New York	New York's Great Lakes Action Agenda promotes 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). PCB wastes are regulated through the New York State Department of Environmental Conservation. In addition to Federal TSCA requirements, New York considers all solid wastes containing 50 ppm by dry weight or greater of PCBs as hazardous wastes, excluding small capacitors (http://www.dec.ny.gov/regulations/8765.html).
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 US 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 US 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).

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Appendix B. Great Lakes Binational Toxics Strategy 2009 Biennial Report

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