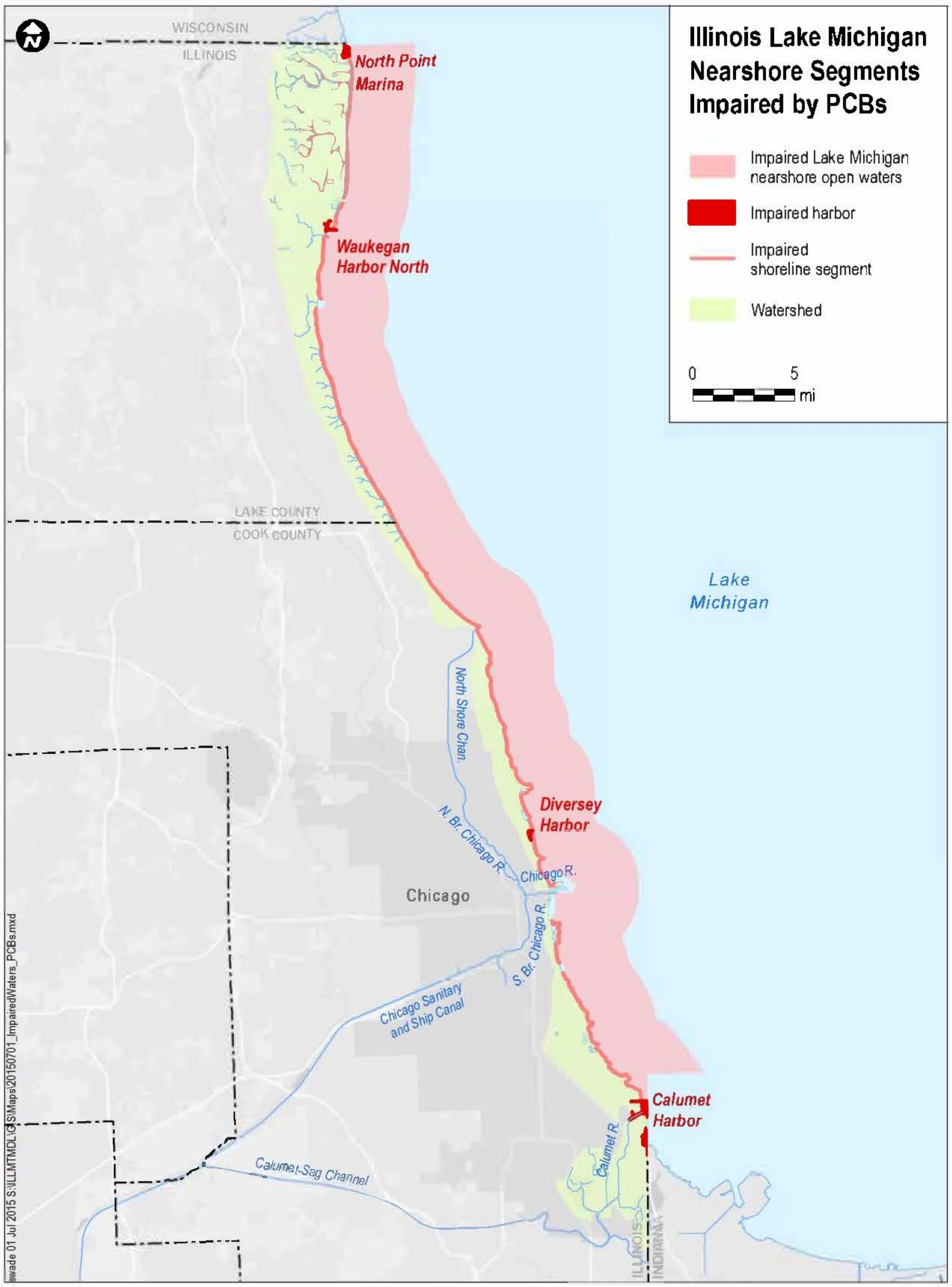
Illinois
Environmental
Protection Agency

Bureau of Water P.O.
Box 19276 Springfield,
IL 62794-9276
www.epa.illinois.gov

April 2019

IEPA/BOW/IL-2019-003

Illinois Lake Michigan Nearshore Watershed PCB TMDL Report



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PCB TMDL Development for the Illinois Lake Michigan Nearshore Watershed, Illinois

This file contains the following documents:

1) U.S. EPA Approval letter and Decision Document for the Final PCB and Mercury TMDL Report
2) PCB TMDL Report

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 18 2019

REPLY TO THE ATTENTION OF:

WW-16J

Sanjay Sofat, Chief
Bureau of Water
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, Illinois 62794-9276

Dear Mr. Sofat:

The U.S. Environmental Protection Agency (EPA) has completed its review of the Final Illinois Lake Michigan Nearshore PCB and Mercury Total Maximum Daily Loads (TMDL) Reports, and all the accompanying documentation, submitted by the Illinois Environmental Protection Agency (IEPA) to EPA for approval. The Illinois Lake Michigan Nearshore PCB and Mercury TMDLs address a total of 56 waterbody segments impaired by PCBs and mercury in fish tissue and the water column. The waterbodies are identified in Appendix A of the enclosed EPA Decision Document.

The TMDLs meet the requirements of Section 303(d) of the Clean Water Act and EPA's implementing regulations at 40 C.F.R. Part 130. EPA hereby approves Illinois' 112 TMDLs for PCBs, and mercury. EPA's review of Illinois' compliance with each statutory and regulatory TMDL requirement is described in the enclosed Decision Document.

We wish to acknowledge the State's effort in submitting these TMDLs and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Mr. Peter Swenson, Chief of the Watersheds and Wetlands Branch, at 312-886-0236.

Sincerely,

Joan M. Tanaka

Joan M. Tanaka
Acting Director, Water Division

Enclosure

cc: Abel Haile, IEPA

TMDL: Illinois Lake Michigan Nearshore PCB and Mercury TMDL
Effective Date: APR 1 8 2019

Decision Document for Approval of
The Illinois Lake Michigan Nearshore PCB and Mercury TMDL Reports

Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 C.F.R. Part 130 describe the statutory and regulatory requirements for approvable TMDLs. Additional information is generally necessary for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations, and should be included in the submittal package. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable. These TMDL review guidelines are not themselves regulations. They are an attempt to summarize and provide guidance regarding currently effective statutory and regulatory requirements relating to TMDLs. Any differences between these guidelines and EPA's TMDL regulations should be resolved in favor of the regulations themselves.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal should identify the waterbody as it appears on the State's/Tribe's 303(d) list. The waterbody should be identified/georeferenced using the National Hydrography Dataset (NHD), and the TMDL should clearly identify the pollutant for which the TMDL is being established. In addition, the TMDL should identify the priority ranking of the waterbody and specify the link between the pollutant of concern and the water quality standard (see section 2 below).

The TMDL submittal should include an identification of the point and non-point sources of the pollutant of concern, including location of the source(s) and the quantity of the loading, e.g., lbs/per day. The TMDL should provide the identification numbers of the NPDES permits within the waterbody. Where it is possible to separate natural background from non-point sources, the TMDL should include a description of the natural background. This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation. The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

(1) the spatial extent of the watershed in which the impaired waterbody is located;
(2) the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;
(4) present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable.

Comment:

1.1 Watershed Characterization: TMDL Spatial Extent and Scope

The Illinois Lake Michigan Nearshore (ILMN) TMDLs for mercury and polychlorinated biphenyls (PCBs) cover a long, narrow, area within Lake and Cook Counties, Illinois. The watershed includes portions of the municipalities of Winthrop Harbor, Zion, Beach Park, Waukegan, North Chicago, Lake Bluff, Lake Forest, Highwood, Highland Park, Glencoe, Winnetka, Kenilworth, Wilmette, Evanston, Chicago, and Burnham. Some of the watershed drains directly to Lake Michigan, but most of the watershed is highly urbanized and has been altered extensively to drain away from the lake, as explained in Section 1.2 of this Decision Document. The impaired nearshore open water segment is 180 square miles in size, extending 5 km into Lake Michigan from the Illinois shoreline, with Lake Michigan serving as its eastern boundary as shown in Figures 1 and 2 of this Decision Document. The total length of the shoreline segments[1] in the study area is approximately 63.5 miles, with individual segment lengths ranging from 0.07 to 5.5 miles.

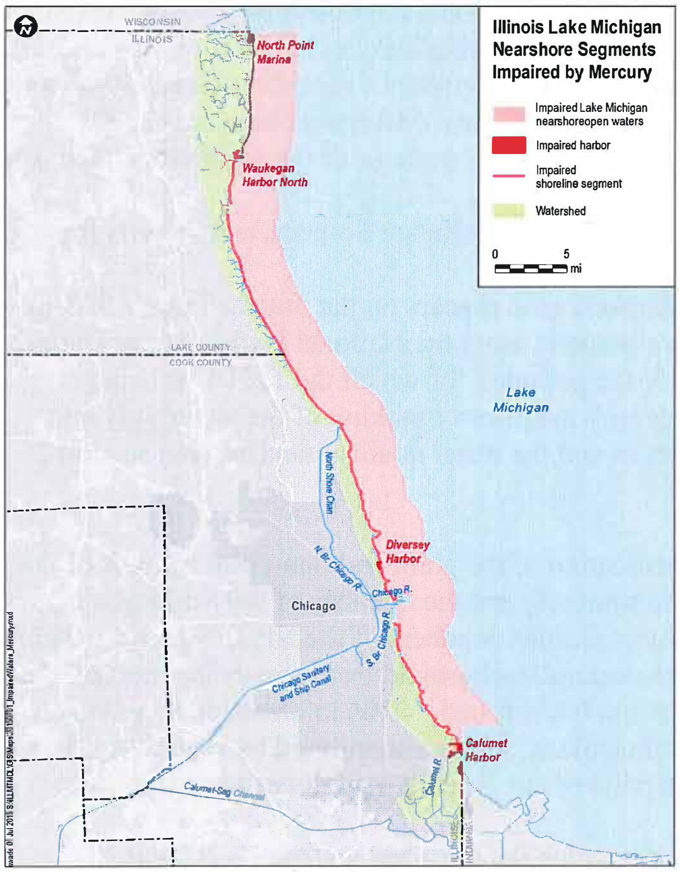


Figure 1. Mercury TMDL Impaired Mercury Segments (Figure 2.3 of the mercury TMDL)

Interspersed with the shoreline segments are four harbors:

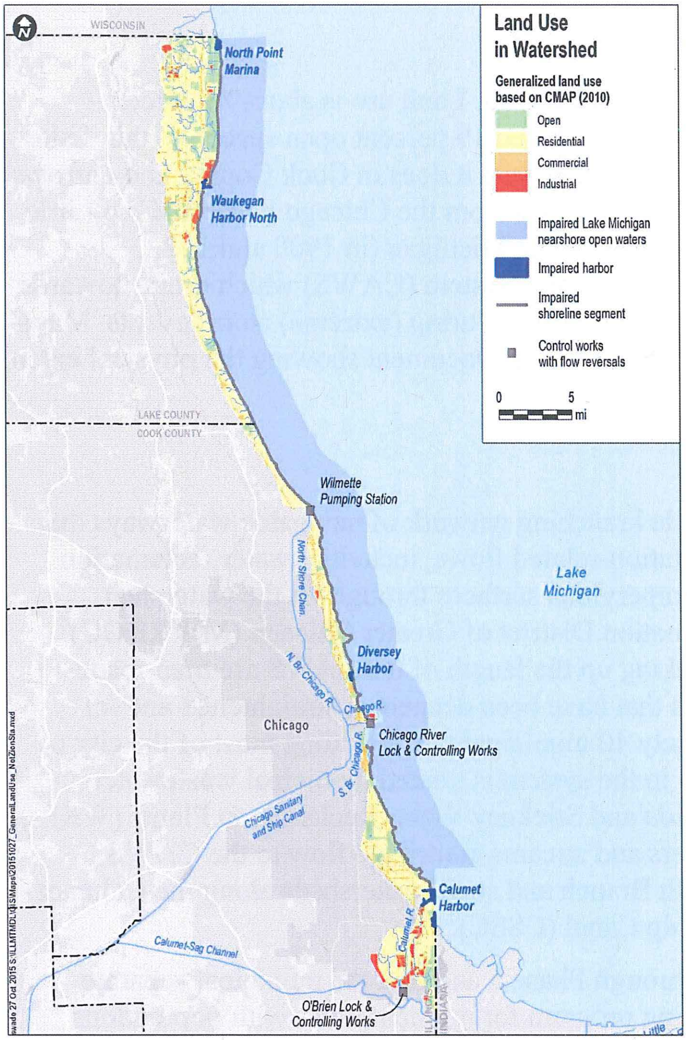
Waukegan Harbor North (~0.07 sq.mi.), North Point Marina (~0.12 sq. mi.), Diversey Harbor (~0.05 square miles), and Calumet Harbor (~2.4 sq. mi.). These harbors are also shown in Figures 1 and 2 of this Decision Document.

1.1 TMDL Scope:

The impaired waters of the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs are included on the Illinois Integrated Water Quality Report and Clean Water Act Section 303(d) list (Illinois EPA, 2014), and impairments are described in further detail in Section 2 of this Decision Document. Appendix A of this Decision Document contains a full listing of the impaired segments and causes. There are two separate TMDL submittals, one for mercury and one for PCBs. Because of the similar watersheds and pollutant transport mechanisms, the

[1] The term *shoreline segment* is used in this document, because not all of the segments have beaches.

Figure 2. PCB TMDL Land Use (Figure 2.5 of the PCB TMDL)



two TMDLs are addressed in one Decision Document. A TMDL Direct Proportionality Approach is used to link fish tissue concentrations endpoints directly to air deposition loads (see Section 3.2 of this Decision Document). Illinois EPA used a simple method to calculate stormwater loadings by aggregating urban areas by land use and applying a single concentration to stormwater runoff for each land use in the study area. By treating the study area segments as a single area[2,3] Illinois EPA was able to quantify a proportional relationship between a target concentration in fish tissue and the corresponding allowable PCB and mercury air deposition loads to the entire study area.

TMDL Scope: PCBs

The Illinois Environmental Protection Agency's (Illinois EPA's) PCB TMDL addresses fifty-one shoreline segments, one nearshore open water segment and 4 harbors that have been identified as impaired due to PCB concentrations in fish (56 total segments). The Waukegan Harbor North segment is also listed as impaired due to PCB concentrations in the water column. All segments in the study area were considered together as one area to calculate the PCB TMDL.

TMDL Scope: Mercury

Similar to the PCB TMDL, the scope of the mercury TMDL covers the 56 nearshore shoreline, harbor, and open water segments impaired due to mercury in fish in the areas shown in Figure 1 of the Decision Document. All waters were considered together to calculate the mercury TMDL.

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[2] "simple methods are compilations of expert judgement and empirical relationships between physiographic characteristics of the watershed, in general rely on large scale aggregation." EPA Compendium of Watershed-scale Models for TMDL Development Section 1.2, Classification of Watershed Scale Models. Pg. 2-3.

[3] Ibid, Section 2.3.1 Simple Methods, Pg. 13

The mercury TMDL quantifies the pollutant load reductions needed to reduce mercury levels in fish tissue and the water column so that the waterbodies can meet water quality standards.

1.2 Watershed Characterization

The study area watershed is complex and largely developed. Land use is about 73 percent residential, 4 percent industrial, 4 percent commercial, and 19 percent open space. Within Lake County, the watershed boundary extends inland farther than it does in Cook County and narrows near the south end of Lake County. This is because flows from the Chicago River and the Little and Grand Calumet River were diverted away from Lake Michigan (in 1900 and 1922, respectively) and drain into the Chicago Area Waterway System (CAWS) which drains towards the Des Plaines River, except in the case of elevated flows during (extreme) storm events. Maps of the CAWs are provided in Appendix F of this Decision Document showing the physical extent and the waterways composing the CAWS.

Chicago Area Waterway System (CAWS)

Illinois EPA defines the CAWS as a 76.3-mile branching network of navigable waterways that convey a variety of point-source and precipitation-related flows, including water reclamation plant effluents and stormwater runoff from impervious surfaces throughout the watershed. According to the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)[4], approximately 75 percent of waterbodies making up the length of the CAWS are man-made canals, and the remainder are natural streams that have been deepened, straightened and /or widened. The MWRDGC serves approximately 40 municipalities including most of the city of Chicago. Over 70 percent of the annual flow in the system is treated municipal wastewater effluent from the Calumet, Lemont, North Side and Stickney Water Reclamation Plants (WRPs) owned and operated by the MWRDGC. Rivers and streams contribute flow to the CAWS, including the Grand Calumet River, the North Branch and small watersheds along the Calumet - Sag Channel (CSC) and Chicago Sanitary Ship Canal (CSSC).

The Clean Water Act regulates stormwater through Phase 1 and 2 of the municipal separate storm sewer systems (MS4) NPDES permitting program for municipalities with populations greater than 100,000 (Phase 1), and smaller municipalities (Phase 2), along with other entities designated by the State.[5] There are numerous small stormwater drainage inputs along the CAWS including areas served by storm sewers (parking lots, roof top drains, etc.) from several municipalities and Illinois DOT drainage facilities. Almost 100% percent of the study area watershed lies within an MS4 city or village or regulated entity, as discussed in greater detail in Section 1.4 of this Decision Document. There are also small streams and ravines in the study

[4] Metropolitan Water Reclamation District of Greater Chicago.

[5] Phase 1 of the MS4 permit program was issued in 1990. Phase 2, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage, usually under general permits, for their stormwater discharges. *Watershed Academy Web: Introduction to the Clean Water Act.*

area watershed that carry intermittent stormwater and surface drainage directly to Lake Michigan.

In addition to the MS4s, a total of 255 combined sewer and stormwater systems from study area WRPs can experience combined sewer overflows (CSOs) resulting in the discharge of stormwater and untreated sewage to the CAWS during periods of elevated flows.[6] The CSO collection area is approximately 375 square miles[7] (see CSO map, Appendix F of this Decision Document). The CAWS usually flows toward the Des Plaines River watershed and away from the study area during normal and smaller storm events. The flow of water in the CAWS is artificially controlled by hydraulic structures. When extreme storm events occur, the flow is reversed through the O'Brien Lock and Controlling Station, the Chicago River Lock and Controlling Station, and the Wilmette Pumping Station and discharged into Lake Michigan to alleviate flood conditions. Any PCBs or mercury in stormwater and CSOs that discharge into the CAWS can contribute to the impairment of the Lake Michigan Nearshore TMDL study area when severe storms require the locks to be opened and flows are passed through the control works into Lake Michigan. These events occur infrequently. A Consent Decree between the Chicago MWRD and EPA to ameliorate these events and improve the water quality of the CAWs, is described in the Reasonable Assurance section of this Decision Document.

Study Area Harbors

Waukegan Harbor is a manmade harbor about 40 miles north of Chicago in Waukegan, Illinois and is used for both industrial and recreational activities (IDNR, 2012). The area was contaminated by PCBs which Outboard Marine Corporation (OMC) used in hydraulic fluids at its boat motor manufacturing plant (EPA, 2014). An estimated 300,000 pounds of PCBs were discharged into the harbor by OMC between 1961 and 1972.

The site is on the National Priorities List and the United States and Canadian governments identified it as an Area of Concern (AOC) in the 1980s. The EPA and partner Agencies performed remediation actions that removed roughly one million pounds of PCBs in soils, industrial facilities, and sediment from the OMC site and Waukegan Harbor, respectively, in the 1990's (EPA, 2015c). Illinois EPA states in the PCB TMDL that in 2002, EPA and Illinois EPA determined, through risk assessment, the remediation standards for PCB concentrations that would meet the ecological target of lowering the levels of PCB concentration in sport fish tissue to levels seen in open lake sport fish. The resulting target for PCB concentrations in sediment were 0.25 to 1.0 ppm (IDNR, 2012). In 2012 and 2013, an additional 124,000 cubic yards of contaminated sediment were removed from Waukegan Harbor (EPA, 2015c). The Waukegan Harbor Area of Concern Habitat Management Plan (IDNR, 2012) defines the PCB target for the Waukegan Harbor open water unit as "reduce PCB levels in Waukegan Harbor sediments to 0.2 ppm."

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[6] 2008. MWRDGC R &D Department. Report No. 08-15R Description of the Chicago Waterway System for the Use Attainability Analysis. (March 2008) CSO information is available at https://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/reports/Monitoring_and_Research/pdf/2008/08-15%20Description%20of%20CWS%20Report%20for%20UAA.pdf

[7] Ibid, p.6

Winthrop Harbor is home to North Point Marina, the largest marina on the Great Lakes (IDNR, 2015a).

Diversey Harbor is in Lincoln Park, adjacent to Lake Shore Drive. Due to bridge restrictions, the harbor can only accommodate power boaters (Chicago Harbors, 2015).

Calumet Harbor and River include an approach channel and outer harbor channels that are located primarily in Indiana (and which are not part of the Illinois TMDL). They also include the entrance channel and river channel in Illinois and extend approximately 6.7 miles up the Calumet River to Lake Calumet (USACE Chicago and Rock Island Districts, 2015). Calumet Harbor is a deep draft commercial harbor that is protected by 12,153 linear feet of steel sheet pile and timber crib breakwater structures (USACE Detroit District, 2015). This is the largest of the study area's four impaired harbors, and Calumet Harbor and River is the third busiest port on the Great Lakes by tonnage, moving an annual average of over 14 million tons of commodities (USACE Detroit District, 2015). At Calumet Harbor and River, an average of approximately 50,000 cubic yards of sediment are dredged annually, and this dredging requirement is expected to continue (USACE Chicago and Rock Island Districts, 2015).

1.3 Problem Characterization

PCBs Problem Characterization

Illinois EPA characterized PCBs as a class of synthetic, chlorinated organic chemicals that were produced and used because of their insulating and stable properties prior to being banned in 1979. It is estimated that over half of the U.S. production of PCBs occurred between 1960 and 1974. Many technical mixtures and different trade names were used throughout the production period (e.g., Aroclor, Askarel, Inerteen, etc.). In 1979, EPA banned commercial PCB production, but PCBs may be present in a wide range of products and materials produced before 1979 (discussed further in the PCB TMDL, Appendix C: Historic PCB Uses and Sources). There are no known natural sources of PCBs, however, they continue to be produced inadvertently as a manufacturing byproduct of many chlorinated organic compounds.

PCBs and Fish Consumption

Illinois EPA characterized human exposure through the consumption of fish as the principal public health concern related to the assessed impairment for these waters related to Illinois EPA's fishable designated use (Illinois EPA, 2014). PCBs have been demonstrated to cause cancer, and to have a variety of other adverse health effects on the immune system, reproductive system, nervous system, and endocrine system (EPA, 2015). PCBs are persistent in the environment and tend to accumulate in sediments and concentrate and bioaccumulate in living tissues.

Illinois EPA has identified 56 nearshore beach/shoreline, harbor and open water segments in the Illinois Lake Michigan Basin that are impaired for fish consumption use due to concentrations of PCBs in fish tissue or aquatic life use (Illinois EPA, 2014). These impaired waters are included in the Illinois Integrated Water Quality Report and Clean Water Act Section 303(d) list (Illinois

EPA, 2014). Appendix B of the PCB TMDL contains a complete list of the impaired segments and causes.

Although median PCB concentrations in top predator fish have declined since PCB production was banned, PCB fish advisories remain in place for all five Great Lakes (EPA, 2015a). Fish tissue concentrations in all the Great Lakes remain above the 1987 Great Lakes Water Quality Agreement target of 0.1 mg/kg wet weight (EPA, 2012). Illinois EPA uses EPA data in Figure 2-1 in the PCB TMDL to show 7-percent annual declines in total PCBs in lake trout from Lake Michigan.

Atmospheric Deposition of PCBs to the Water Column

According to Illinois EPA, the Integrated Atmospheric Deposition Network (IADN), created in 1990, is a joint venture of Environment Canada, the Ontario Ministry of the Environment, and the EPA's Great Lakes National Program Office. IADN consists of a master monitoring station located on each of the five Great Lakes and several satellite stations, including one in Chicago. The atmospheric gas phase PCB concentrations observed over Chicago continue to be much higher than concentrations measured over the main Lake Michigan open water and at other IADN stations (Buehler and Hites, 2002), even though gas phase PCB concentrations in Chicago have decreased by about half between 1996 and 2003. Total PCB concentrations in precipitation and gas phase over Chicago are about an order-of-magnitude higher than over the Sleeping Bear Dunes in Michigan, as shown in the TMDL (from Sun et al., 2006).

The Lake Michigan Mass Balance Study (Green et al., 2000) and the Atmospheric Exchange Over Lakes and Oceans Study (AEOLOS) (Simcik et al., 1997; Zhang et al., 1999) confirmed that a combination of prevailing westerly winds off Chicago and an elevated rate of PCB gas phase emissions over the city led to elevated gas phase PCB concentrations for about 20-40 km off the Chicago shoreline. These elevated gas phase PCB concentrations consequently lead to increased absorption fluxes, i.e. the transfer of gas phase PCBs from the atmosphere to the water column.

Mercury Problem Characterization

Illinois EPA characterizes the mercury problem in Section 2.1 of the mercury TMDL. Mercury is a naturally-occurring metal that is prevalent throughout the global environment and in Illinois. Mercury exists in three forms: elemental mercury, inorganic mercury, and organic mercury. Illinois EPA discussed how the various forms of mercury move through the environment and explained that mercury properties and behavior in the environment depend on the form it takes in the environment (Section 2.1 of the Mercury TMDL). Numerous sources of mercury from both natural and anthropogenic origins release mercury to the atmosphere. Once released, mercury cycles between land, water, and the atmosphere.

Mercury and Fish Consumption

Illinois EPA characterized mercury's neurotoxic properties as posing a danger to both humans (especially the young) and wildlife in the mercury TMDL's Problem Statement (Section 2.1). One of the major routes of human exposure is through consumption of the methylated mercury (MeHg) found in contaminated fish (Clarkson and Magos, 2006). Illinois EPA noted in the mercury TMDL that even low levels of prenatal MeHg exposure may cause early childhood neurocognitive effects (Karagas et al., 2012). In the United States alone, it is estimated that over 300,000 newborns each year may be at risk of adverse neurodevelopmental effects due to *in utero* exposure to MeHg (Mahaffey et al., 2004). Human exposure through the consumption of fish poses a public health concern which has resulted in mercury-related fish consumption advisories in Illinois and all the eight Great Lakes states. Illinois EPA described the Fish Contaminant Monitoring Program (FCMP) in Illinois which uses a 0.06 mg/kg fish tissue concentration as the reference level for issuing a "one meal per week" fish consumption advisory. All segments in the TMDL study area are classified as Not Supporting for fish consumption use due to mercury, and Waukegan Harbor North is also classified as Not Supporting for aquatic life use. How these segments are identified is further defined in Section 3 of the mercury TMDL. The Illinois Lake Michigan mercury TMDL addresses mercury impairments in 56 nearshore beach/shoreline, harbor, and open water segments. Appendix B of the mercury TMDL contains a full listing of the mercury-impaired segments covered by this TMDL and causes of impairment.

The Mercury Cycle: Atmospheric Mercury, Deposition, and Methylation

Illinois EPA stated, in Section 2.1 of the mercury TMDL, that much of mercury loading in the study area waterbodies is a result of atmospheric deposition. Illinois EPA highlighted the tendency of elemental mercury, when emitted to the upper atmosphere, to be transported long-distances from its source. Illinois EPA provides references in Section 2.1 of the mercury TMDL, that support the atmosphere being the most important pathway for the transport and dispersion of mercury (Fitzgerald et al., 1998; Mason et al., 1994; Mason and Sheu, 2002). Section 1.6 of the Decision Document and Section 2.1.1 of the mercury TMDL provide further information on the atmospheric deposition of mercury over time. In addition, previously deposited mercury can be re-emitted from terrestrial and aquatic surfaces through natural processes including biomass burning and emissions from soil, inland waters, oceans, and vegetation. Airborne mercury returns to the terrestrial and aquatic environments via wet and dry deposition, where it undergoes complex biogeochemical cycling. Inorganic mercury can combine with carbon to form methylmercury (MeHg) under certain environmental conditions in a process called methylation. The formation of MeHg is an important step in mercury cycling (Ullrich et al., 2001) because MeHg can be bio-accumulated through the food web, reach high concentrations in aquatic organisms and eventually result in the primary mechanism for methylmercury exposure of animals and humans through the consumption of fish.

1.4 PCB and Mercury Source Assessments

Variations in Sample Analysis for PCBs and Mercury

Illinois EPA presents results from the PCB and mercury TMDL source assessments in Section 4 of the PCB and mercury TMDLs (Table 3 of this Decision Document). Contaminant monitoring required by NPDES permits and reported by certified laboratories must use analytical methods approved by EPA under 40 CFR Part 136. EPA has approved several analytical methods to measure PCBs and mercury in water that can be used for a variety of study and regulatory purposes.

The lowest concentration that can be reliably measured is called a "detection limit" (DL). Illinois EPA identified DLs in the TMDLs when data used in the TMDLs were below the detection limit. EPA provides the DLs in Sections 1.5, 1,6, and throughout the Decision Document when the TMDL uses them to determine as an upper bound to a range of loading estimates.

Illinois EPA assessed pollutant sources with data that was collected and analyzed during different time periods, using varied methods and equipment. EPA approves sample analysis methods for compliance and other uses and prescribes the steps that must be performed for each analysis method as well as equipment type, and a range of conditions and constraints needed to produce a reliable pollutant concentration measurement. Among these conditions and constraints are: instrument limitations, equipment interference, varying filtration types and extraction solvents. EPA's periodic updates and modifications of each of its approved methods allow pollutants to be measured at progressively lower concentrations. For example, EPA approved mercury analysis methods 245.1, and 245.2 for mercury analysis in 1974. Both have been commonly used in the NPDES program permit compliance determination. The range for the method 245.2 is documented as measuring mercury concentrations as low as 0.2 µg/L (200 ng/L)[8].

EPA notes in the approved mercury analysis method 1631E (2002), that "the method detection limit (MDL) (40 CFR 136, Appendix C) for Hg has been determined to be 0.2 ng/L when no interferences are present."[9] An MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%), and extra caution in sample handling (Section 1.5 of Method 1631E).

EPA has also noted in Sections 1.5 and 1.6 of the Decision Document when Illinois EPA used off-site monitoring results generated with updated sensitive analysis methods to estimate loads for PCBs and mercury stormwater sources to provide addition information for the MS4 source assessments.

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8 http://www.caslab.com/EPA-Methods/PDF/EPA-Method-2452.pdf accessed 2/27/2019

9 The sensitivity of Methods 245.1 and 245.2 are well above the water quality criteria now adopted in most states (and criteria included by EPA in the Final Water Quality Guidance for the Great Lakes System) for the protection of aquatic life and human health, (generally in the range of 1 to 50 ng/L). Method 1631E, with a quantitation level of 0.5 ng/L, supports the measurement of mercury at these levels.

Common Elements of PCB and Mercury MS4 Source Assessments

Illinois EPA provided point source assessment information for MS4 sources that is common to both the PCB and Mercury TMDLs. Information that is similar for PCBs and mercury is presented together in Section 5 of this Decision Document, to avoid duplication.

Stormwater discharges are regulated under the NPDES MS4 program (i.e., Phase I and Phase II communities). All the municipalities listed above in this Decision Document's Spatial Extent and Scope Section except Burnham have MS4 permits for discharges to Lake Michigan, and 100% percent of the study area watershed lies within an MS4 city or village or regulated entity. The MS4 permits include these municipalities, together with the MS4 permits for the Cook County Highway Department, Illinois Department of Transportation, Lake County, Shields Township, and Waukegan Township (permit numbers presented in Table B-1 in Appendix B of the Decision Document). Because the study area watershed has no site-specific data for stormwater PCB or mercury loads ((MWRDGC, 2015), Illinois EPA estimated the stormwater pollutant loads for both PCB and mercury based on the drainage area, stormwater runoff quantity, and stormwater pollutant concentration from samples outside the watershed. Runoff quantity was calculated using the method developed by the Metropolitan Washington Council of Governments (MWCG) (Schueler, 1987) as:

$$R = P * Pj * Rv$$

where:

R = Annual runoff (inches),
P = Annual rainfall (inches), estimated as 36.1 inches, based on the average annual rainfall reported for Chicago Midway Airport 3 SW for the 1929-2013 period
Pj = Fraction of annual rainfall events that produce runoff (set to the default of 0.9)
Rv = Runoff coefficient.

Rv is a function of impervious cover in the study area watershed calculated using Geographic Information System (GIS) analysis to determine land use categories: commercial (0.71), industrial (0.54), and residential (0.37). The following runoff coefficients resulted from these impervious cover values: commercial (0.69), industrial (0.54), and residential (0.38). The area of the contributing watershed was calculated as 99.6 square miles, broken down as 3.82 square miles commercial, 4.05 square miles industrial, and 91.73 square miles residential.

1.5 PCB Sources and Baseline Source Assessment

Illinois EPA explained that PCBs may still exist in a wide range of products and materials produced before the 1979 ban, including electrical, heat transfer, and hydraulic equipment; plasticizers in paints, plastics, and rubber products; pigments, dyes, and carbonless copy paper; and many other industrial applications (EPA, 2015). Despite the ban, PCBs continue to be produced inadvertently as a manufacturing byproduct of many chlorinated organic compounds.

Illinois EPA explored all readily available information to identify the current sources of PCBs to the study area water, including: point sources (NPDES-permitted municipal, industrial, and stormwater dischargers), and nonpoint sources (e.g., atmospheric deposition, runoff from Superfund and other contaminated sites).

Illinois EPA found the most significant sources to the TMDL study area to be atmospheric loading and hydrodynamic transport of PCBs from the open water of Lake Michigan (Section 4.2 of the PCB TMDL). Atmospheric PCBs are deposited to the main body of Lake Michigan water and are transported into the study area by a process called hydrodynamic transport (Section 4.1 of the TMDL). Illinois EPA estimated the loadings from each source using the data gathered. The estimates for the atmospheric and hydrodynamic transport to the study area produced a range of current loadings as explained below. Resuspension and pore water diffusion of PCBs from bed sediments were found to be small contributors. The remaining source categories could only be roughly estimated, because all available data for those sources were below laboratory detection limits. Below is a summary of how the loads for each source were estimated.

Illinois EPA grouped all the segments into one study area and analyzed total current and target PCB loads to the study area rather than examining each impaired waterbody segment separately. This was done to 1) make the best use of the available fish tissue data, 2) support the development of targeted reductions for sources to the entire study area, and 3) evaluate the overall impact of and to properly account for large, ubiquitous sources to Lake Michigan (see additional details on fish tissue data in Section 3 of the Decision Document). The sections in the TMDL containing additional detail on the methods used are as follows

Nonpoint Sources

- Hydrodynamic transport - Section 4.1
- Atmospheric loading - Section 4.2.1- 4.2.3
- Resuspension and/or pore water diffusion of PCBs from bed sediments- Section 4.6

Point Sources

- MS4 stormwater loading-Section 4.3
- Flow reversals from the Chicago Area Waterways-Section 4.4
- Other point source discharges -Section 4.5

Hydrodynamic Transport of PCB Loads

Illinois EPA describes the open water of Lake Michigan as a source of PCBs to the project study area in Section 4.1 of the PCB TMDL. The predominant flow patterns in Lake Michigan circulate counter-clockwise near the study area (Beletsky and Schwab, 2001; Beletsky et al. 1999). Illinois EPA used results from a set of hydrodynamic transport models called the NOAA Great Lakes Coastal Forecasting System[10] (GLCFS) to predict the annual average flow of Lake Michigan water into the study area (1,810 m^3/s). Illinois then multiplied the flow times a range of

[10] A set of models that simulate and predict the two- and three-dimensional structure of currents, temperatures, winds, waves, and ice in the Great Lakes using a 4-km^2 grid size.

concentration results, from an estimated open lake PCB concentration of 140 pg/L[11] (EPA Great Lakes Aquatic Contamination Survey data, 2004), to a PCB concentration in the lake near Chicago of 233 pg/L (Venier et al., 2014). The final range of possible net PCB baseline load values through hydrodynamic transport from north to south[12] entering the study area was found to be 8-13 kg/yr. Illinois EPA described another estimate that could be used as a baseline estimate of PCB loadings to Lake Michigan from the Lake Michigan Mass Balance Study The study estimated that if the lake followed a "continued slow recovery", the average lake PCB concentration could be reduced to 80 pg/L by 2014 (see Figure 4-2 in PCB TMDL). If this were the case, the annual PCB load from the open lake to the study area would be 4.6 kg/yr. Illinois EPA used 4.6 kg/yr, as a lower bound hydrodynamic loading estimate for an estimated range of 4.6 - 13 kg/yr.[13]

Atmospheric PCB Loading:

Illinois EPA used an annual atmospheric PCB concentration, along with the surface area of the study area waterbodies and the mass transfer rate, to calculate a PCB loading rate from atmospheric sources. Illinois EPA focused on gas deposition as the dominant atmospheric PCB loading component to the study area, and quantified PCB deposition using atmospheric gas phase PCB concentration and the mass transfer coefficient which controls the rate at which PCBs pass through the air-water interface (Section 4.2.2 of the TMDL).

As Illinois EPA explained in Section 4.2 of the TMDL, PCBs from atmospheric sources are delivered to the study area via wet deposition, dry deposition, and gas phase deposition. Gas deposition is a transfer of PCBs across the air-water interface that occurs when atmospheric gas phase PCB concentrations exceed the equivalent dissolved phase PCB concentrations in the water column. Gas phase deposition in the Chicago area of Lake Michigan greatly exceeds wet and dry deposition (Miller et al., 2001). Great Lakes research shows that at least 90 percent of total air deposition of PCBs to the lakes is in the form of gaseous PCB absorption into the Great Lakes surface, and that wet and dry deposition account for less than 10 percent (Green, et.al., 2000).

There are two available data sets measuring atmospheric PCB concentration: The Integrated Atmospheric Deposition Network (established 1990) and the AEOLOS.[14] The data from both are highly variable as they are strongly correlated to wind directions and seasons (temperature).

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[11] This number has been corrected from the value 1.40 pg/L in the original Illinois Lake Michigan Nearshore TMDL. See email record, May 11, 2018 between Christine Urban, EPA, David Dilkes, Limnotech, and Abel Haile, Illinois EPA.
[12] Ibid.
[13] http://www.epa.gov/med/grosseile_site/LMMBP/pcbs.html)
[14] The AEOLOS project, administered through the EPA Great Lakes National Program Office and the Office of Research and Development, was designed to study atmospheric deposition in the Great Waters. EPA and scientists from the Universities of Minnesota, Michigan, Maryland, Delaware, and the Illinois Institute of Technology began the project in 1993 to determine the contributions of urban source categories to measured atmospheric concentrations and deposition, and the air-water exchange of contaminants and their partitioning into aquatic phase.

Illinois EPA considered two data integration methods to develop an annual atmospheric PCB concentration over the study area: the Simcik method (1997) and the Zhang method (1999).

Illinois EPA selected the Simcik integration methodology (Simcik et al., 1997) which integrates concentration measurements of atmospheric PCBs for various conditions, resulting in an annual average concentration over the study area of 529 pg/m^3. The Simcik data set contained 25 nearshore, over-lake PCB measurements (1994-1995), which cover multiple discrete measurements over three seasons and a range of wind conditions. Illinois EPA used the results from the Simcik study as the basis for the annual average atmospheric PCB concentrations over the study area because the data set used in this study was more specific to the study area. The Zhang et al. (1999) data represented the average atmospheric concentration over the larger, southern quarter of Lake Michigan (356 pg/m^3).

PCB Mass Transfer Rate at the Air-Water Interface

Illinois EPA used the data integration methodology by Zhang (et al., 1999), for determining the PCB mass transfer rate at the air-water interface which was needed to determine a PCB loading rate from atmospheric sources (see Section 4.2.2 of the PCB TMDL). The Zhang method uses empirical regressions of the data to estimate an annual atmospheric PCB concentration as a function of environmental conditions. Illinois EPA explained in Section 4.2.2 of the TMDL that the Zhang dataset contains hourly wind speed and water temperature readings necessary to calculate that the mass transfer rate calculation (Zhang et al, 1999). The results of their analysis showed an annual gross absorptive flux of PCBs of 300 kg/yr in response to an annual average atmospheric PCB concentration of 356 pg/m^3. Illinois EPA's flux calculation represented the 16,000 km^2 surface area of the southern quarter of Lake Michigan used in Zhang's study. Illinois EPA normalized their calculation statistically, on an areawide basis resulting in an annual mass transfer rate of 300 kg/yr per 356 pg/m^3 per 16,000 km^2 [(=5.3 x 10^{-5} kg/km^2/yr / (pg/m^3)] (Section 4.2.2 of the PCB TMDL).

PCB Atmospheric Loading Rate

Illinois describes in Section 4.2.3 of the PCB TMDL how it merged a selected atmospheric gas phase concentration with information on the mass transfer rate to estimate a 2015 atmospheric loading rate. The data from Simcik et al. (1997) showed an annual average atmospheric PCB concentration over the study area of 529 pg/m^3 for the period of 1994-1995. Observed atmospheric PCB concentrations throughout the Great Lakes in general, and over the Chicago area in particular, have decreased over that period. Available research shows a range of half-life values for atmospheric PCB concentrations. Sun et al. (2006) calculated a half-life of 7.7 years in the Chicago area, and Venier and Hites (2010b) calculated that atmospheric PCBs around the Great Lakes were decreasing with a half-life of 17 years. Depending upon which decay rate is assumed, the estimated 2015 PCB concentration ranges from 87 to 234 pg/m^3. Illinois combines the mass transfer rate at the air-water interface defined in Section 4.2.2 of the PCB TMDL and a surface area of 473 km^2 for the study area waterbodies, to give a range of current atmospheric loading of 2.1 to 5.8 kg/year.

NPDES Facilities Permitted for PCB

Illinois EPA explains in Section 4.5 in the PCB TMDL how the contributions of NPDES sources in the study area were considered for the TMDL. Three individual NPDES permits in the watershed have permit special conditions for PCBs: Zion Station (IL0002763), Winnetka Power Generation Station (IL0002364), and Midwest Generation LLC Waukegan (IL0002259). All of these permits state "There shall be no discharge of PCBs."

Zion Station (IL0002763) also has permit monitoring requirements for PCBs. Available effluent PCB measurements (2009-2015) for Zion Station were less than the 0.001 mg/ L (1000 ng/L or 1,000,000 pg/ L) detection limit. Illinois EPA calculated an upper bound load estimate of less than 5 kg/yr by multiplying the average facility flow of 3.6 MGD from Zion Station by the detection limit concentration of 0.001 mg/L. The result is presented in Table 1 in the Decision Document.

MS4 Stormwater PCB Sources

Illinois EPA estimated PCB loads from MS4s using the method discussed above in Section 1.4 of this Decision Document (Common Elements of PCB and Mercury MS4 Source Assessments) because site-specific data were not available to quantify current/existing stormwater PCB loads for the study area watershed (MWRDGC, 2015). The loading was determined using an annual estimated rainfall of 36.1 inches, and the area of the contributing watershed calculated as 99.6 square miles broken down by land use.[15] Illinois EPA used an actual PCB concentration value of 0.00000727 mg/L (7,270 pg/L) from the City of Spokane[16] to estimate the urban stormwater load to the study area. Spokane has a land use distribution similar to the study area watershed.[17] The estimated stormwater PCB base load for the study area equaled 0.62 kg/yr, or 0.0017 kg/day.

Chicago Area Waterways Source PCB Load Estimate Using CSO Information

Limited site-specific PCB concentration data were available to estimate loads from the CAWS during flow reversals. Site-specific 2013 PCB data for the CAWS collected by the MWRDGC near the control works were lower than detection level (less than 0.3 µg/L). Illinois EPA calculated two load estimates. The first was based on measured flow and detection limit concentration levels. Illinois EPA used the detection limit of 0.3 µg/L (300,000 pg/L) as an upper-bound estimate of PCB concentration and the average 2010-2014 annual volume of water entering Lake Michigan through the three locks for a gross estimate of < 45.68 kg/yr (0.125 kg/day).

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[15] It was conservatively assumed that all the runoff generated within the study area watershed drained to Lake Michigan, although as described in Section 1.2 above, the runoff usually flows to the CAWS and away from the lake except under certain conditions related to large storm events.
[16] Based on samples collected between 2012-2014 (2014).
[17] 73 percent residential, 4 percent commercial, and 19 percent open space

The second load estimate was based on measured flow from the Illinois study area, and measured PCB levels from the Spokane River Watershed, Washington, which has similar land uses. Illinois EPA reasoned that the PCB concentration in CAWS flow reversals is similar to actual measurements in urban areas with similar land uses, such as Spokane Washington, which is subject to a WQS of 170 pg/L and a more sensitive analysis method, EPA method 1668[18] (detection limit of 0.01-0.5 ng/L). Illinois EPA estimated the PCB loading from the CAWS flow reversals by multiplying the same site-specific flow data[19] times the observed average PCB concentration of 12,420 pg/L for CSOs to the Spokane River, resulting in a PCB loading estimate of less than 1.9 kg/yr, or 0.005 kg/day. Illinois EPA determined that the second load estimate of <1.9 kg/yr more accurately represents the loading from CAWS, and therefore this value was used in the TMDL.

Comparing PCB Loads

Table 1 below compares PCB loads from various sources. Illinois EPA found the most significant sources to the TMDL study area to be hydrodynamic transport of PCBs from the open water of Lake Michigan, and atmospheric loading.

Data for the remaining sources were limited. As a result, Illinois EPA estimated current/existing loads from stormwater, other point source discharges, and flow reversals from the CAWS. Because all available data for those sources were below laboratory detection limits, the estimates involved multiplying anticipated flows from these sources by the detection limit, which is the upper bound of this value. Literature-based estimates for these sources indicate that they are likely to be minor contributors to the study area.

Table 1. PCB Loads to the Study Area (from Table 4.2 of the PCB TMDL)

Process	Data Sufficiency	Estimated Magnitude
Hydrodynamic Transport from Main Body of Lake Michigan	Acceptable	4.6 to 13 kg/yr
Atmospheric Loading[20]	Acceptable	2.1 to 5.8 kg/yr
MS4 Stormwater Loading	Limited. Rough estimate made using literature-based concentrations	0.62 kg/yr
Other Point Source Discharges[21]	Limited. Estimate of upper bound; all available data are non-detectable	<< 5 kg/yr

[18] Fernandez, Arianne. 2012. Spokane River Urban Waters Source Investigation and Data Analysis Progress Report (2009-2011), Washington DOE Publication No. 12-04-025 September 18, pg 12.
[19] It was assumed that CSOs comprise a significant portion of the CAWS flows. Note that the actual composition of flows in the CAWS during periods of flow reversals is unknown. (MWRDGC, 2015b)
[20] Range based on half-life value used, as described in Section 4.2.3.
[21] The number is based on the detection level for the monitored data times the flow from one facility (Zion) with monitoring data. Email between EPA and David Dilkes, May 16, 2018.

Process	Data Sufficiency	Estimated Magnitude
Flow Reversals from the CAWs	Limited. Estimate of upper bound; all available data are non-detectable.	<<1.9 kg/yr
Resuspension and/or Pore Water Diffusion of PCBs from Bed Sediments	Limited. Estimated using site-specific sediment concentrations combined with literature values for diffusion rates.	0.012 kg/year

Site-specific data sufficiency in Table 1 above is characterized as limited by Illinois EPA indicating the use of literature values and/or measurements less than the detection level) for the majority of the processes of concern, with hydrodynamic transport and atmospheric loading being the only sources quantified with existing data.

1.6 Mercury Sources and Baseline Source Assessment

Illinois EPA provided an assessment of the potential current and legacy sources of mercury released to the study area in Section 4 of the mercury TMDL. Because of its diverse properties, mercury has been used in household, commercial, medical, and industrial applications including: medical instruments and equipment, fluorescent lights, electrical switches and relays, and dental amalgam.

In 2004, EPA estimated that U.S. manufacturers use 500-600 metric tons of mercury annually as part of their production processes or to create products that rely on mercury's chemical and physical properties.

Illinois EPA evaluated a number of potential sources bringing mercury into the study area in Section 4 of the mercury TMDL:

- Hydrodynamic transport - Section 4.1
- Atmospheric loading - Section 4.3
- MS4 stormwater loading -Section 4.2
- Flow reversals from the CAWS (Section 4.4)
- Other point source discharges

Mercury Hydrodynamic Transport

Illinois EPA used the outputs from the NOAA Great Lakes Coastal Forecasting System (GLCFS) model to estimate hydrodynamic transport between Lake Michigan and the nearshore open water segment. The GLCFS is a set of models that simulate and predict the two- and three-dimensional structure of currents, temperatures, winds, waves, and ice using the Modified Princeton Ocean Model, developed by NOAA's Great Lakes Environmental Research

Laboratory and Ohio State University (NOAA, 2015). The predominant flow patterns in Lake Michigan circulate counter-clockwise in the vicinity of the study area (Beletsky and Schwab, 2001; Beletsky et al., 1999). Illinois EPA used the results from the GLCFS model for the study area to estimate mercury loads to the northern edge of the study area using the annual average flow into the study area (1,810 m3/s; USGS, undated) and averaged mercury concentrations from the main body of Lake Michigan measured outside the study area (0.18 ng/L). Illinois EPA multiplied this concentration by flow to produce a net mercury load of 10.3 kg/yr entering the study area due to transport from Lake Michigan.[22] Illinois EPA noted that atmospheric deposition is the dominant source of mercury into the main body of Lake Michigan, such that reductions attained through this TMDL to control atmospheric loads will also help control loading from Lake Michigan.

Mercury Atmospheric Deposition

Anthropogenic sources of mercury released to the atmosphere include power plants, metals manufacturing facilities, caustic soda production plants, active or abandoned mines, ore processing facilities, incinerators for medical, urban and industrial wastes, cement plants, and chemicals production facilities. Natural sources include geological processes (AMAP/UNEP, 2013).

Illinois EPA discussed the decline of mercury emissions in the U.S., and in the Great Lakes over the past several decades due to the implementation of pollution control technologies in Section 2 of the mercury TMDL. Illinois EPA discussed the increase in mercury emissions from Asia largely due to expanding energy generation from coal-fired power plants (Pirrone et al., 2010; Wilson et al., 2010; UNEP, 2013).

Illinois EPA focused on the contribution of Illinois sources in Section 4 of the mercury TMDL. Illinois EPA used results from EPA's Regional Modeling System for Aerosols and Deposition (REMSAD; EPA, 2008) to obtain the total atmospheric mercury deposition focusing on the nearshore TMDL study area including open waters, harbors and portions of the watershed draining directly to study area waters. Illinois EPA used REMSAD, a "three-dimensional grid model," to simulate both wet and dry deposition of mercury and calculate the concentrations of both inert and chemically reactive pollutants in the atmosphere that affect pollutant concentrations" (EPA, 2008). It should be noted that REMSAD tracks emissions from selected emission sources, or groups of sources, and quantifies their contributions to mercury deposition throughout a specified area and simulation period. The mercury emissions of NRG/Midwest Generation, LLC, a coal-fired power plant in Waukegan that operates within the study area, were included in the REMSAD simulations.

Illinois EPA used REMSAD simulations to estimate the mass of mercury from all sources that contributed to deposition to the study area (i.e., Lake Michigan nearshore). The total estimated atmospheric[23] deposition was 23 kg/yr (Section 4.2 of the mercury TMDL). REMSAD estimated

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[22] Email between EPA and David Dilkes, May 16, 2018.

[23] The REMSAD was applied at a national scale. The year 2001 was chosen as the annual simulation year because REMSAD model inputs (emissions and meteorology) were primarily derived from the 2001 Clean Air Interstate Rule (CAIR) database, which EPA used in the evaluation of the CAIR and the Clean Air Mercury Rule.

that Illinois sources contribute 37 percent of the 23 kg/yr atmospheric mercury deposition to the study area, as shown in the pie chart in Figure 4.2 of the mercury TMDL. The Waukegan power plant was estimated to contribute 9.4% of the modeled Illinois deposition (0.82 kg/yr based on 2001 data). REMSAD estimated that sources outside of the state of Illinois (U.S. States, Canada, Mexico and background) were responsible for 61 percent of mercury deposition to the project study area. Another 2 percent was estimated to come from previously deposited mercury that has been volatilized from water, land, or vegetation.

Illinois EPA presented results from the 2002 National Emissions Inventory (NEI),[24] as shown in Figure 3 of this Decision Document. Coal-fired electric utilities contributed over 70 percent of the total airborne mercury emitted from Illinois sources (Section 4.2.2 of the mercury TMDL). Other notable mercury source categories in Illinois include: emissions from primary and secondary metal production; various industrial processes; fuel combustion for industrial, commercial, and residential purposes; waste incinerators including hazardous and medical waste combustors; and cement and lime manufacturing. Illinois EPA plans for addressing these sources are discussed in Section 8 of this Decision Document.

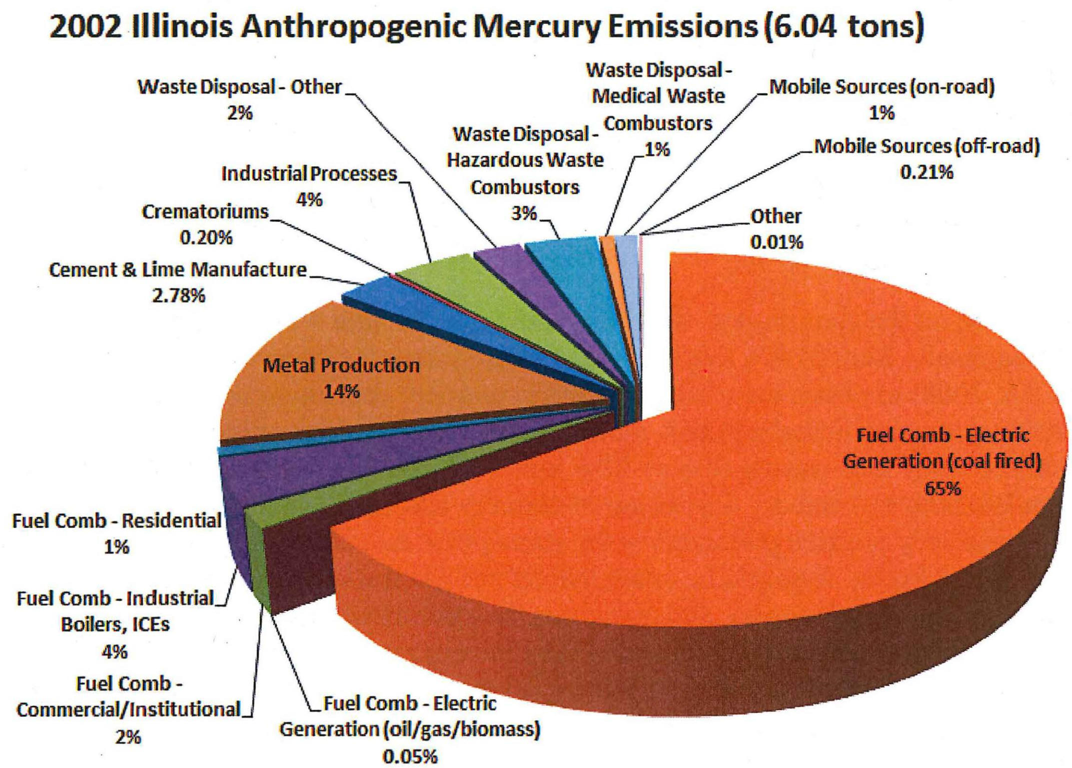

Figure 3. Anthropogenic Sources of 2002 Mercury Air Emissions to the Atmosphere from Illinois (Source: NEI, 2002)

[24] Time period is consistent with the REMSAD modeling period.

NPDES Permitted Facilities

Illinois EPA identified the North Shore Water Reclamation District (NSWRD) Waukegan Water Reclamation Facility as the only facility in the study area with an individual NPDES permit containing mercury effluent limits. Five additional individual permits include mercury monitoring requirements but do not contain effluent limits.

The permit for the NSWRD Waukegan Water Reclamation Facility (IL0030244) contains an average annual mercury concentration limit of 0.0000013 mg/L (1.3 ng/L), which is consistent with the most stringent water quality standards for the study area waterbodies. The estimated annual average mercury load for this facility equals the permitted load of 0.04 kg/yr (0.00024 lbs/day at the design average flow)

Five individual NPDES permits contain mercury monitoring requirements (see Table 7-5 of the mercury TMDL). The Illinois EPA plan for these facilities is discussed in *Mercury Reasonable Assurance,* Section 8.3 of the Decision Document.

Municipal Separate Sanitary Sewer Systems (MS4s)

Illinois EPA listed the municipalities in the study area with MS4 permits in Section 2.2.1 of the mercury TMDL, stating that all of the listed municipalities except Burnham have MS4 permits to discharge to Lake Michigan (see Section 1.1 of this Decision Document). Ninety-three percent of the study area watershed lies within an MS4 city (including Chicago) or village. The MS4 permits for these municipalities, together with the MS4 permits for the Cook County Highway Department, Illinois Department of Transportation, Lake County, Shields Township, and Waukegan Township, cover close to 100 percent of the study area.

To estimate stormwater mercury loads, Illinois EPA conservatively assumed that all the runoff generated within the study area watershed drains to Lake Michigan (both the predominant MS4 discharge and small nonpoint source load). Illinois EPA has no available site-specific MS4 concentration data, so Illinois EPA estimated stormwater mercury loads for the study area watershed (Section 4.3 of the TMDL), by multiplying stormwater runoff depth by the study area drainage area, and by a stormwater mercury concentration. Stormwater mercury concentration was calculated using the method developed by the MWCG (Schueler, 1987) (Section 4.3 of the mercury TMDL) as discussed in Section 1.4 of this Decision Document. The area of the contributing watershed was calculated as 99.6 square miles, broken down as 3.82 square miles commercial, 4.05 square miles industrial, and 91.73 square miles residential. Illinois EPA based its load estimate on USGS measurements of mercury concentration in stormwater for the Columbia River Basin, Washington and Oregon (2009-2010) (Section 4.3 of the mercury TMDL). The Illinois EPA used the average of reported concentration values for total mercury, which equaled 37.17 ng/L. The estimated study area stormwater mercury load equaled 6.96 lbs/year (3.16 kg/yr).

Chicago Area Waterways Mercury Sources

According to Illinois EPA, flow in the CAWS is composed of treated sewage effluent, CSO, and stormwater runoff. See Watershed Characterization in the Decision Document (above) for the physical description of the CAWS. A gate reversal occurs adjacent to the lock structure and involves small volumes of water. A lock reversal occurs when the locks are opened during severe storms. Lock reversals allow a much greater volume of water to flow into Lake Michigan than a gate reversal. Lock reversals allow flow from the CAWS to discharge to Lake Michigan through the O'Brien Lock, Chicago River Lock, and Wilmette Lock control works shown in Figure 4.5 of the TMDL (also see Appendix F of this Decision Document).

The amount of measured flow and site-specific concentration data from flow reversals is limited. Illinois estimated loads entering the study area from periodic flow reversals of the CAWS by performing two load calculations. One Illinois estimate used site-specific flow and mercury concentration data, and the other used a set of mercury measurements from a location outside of the study area which provided additional information to build a better estimate.[25]

The MWRDGC conducted water quality sampling in the CAWS during flow reversals in 2013, including measurements of mercury.[26] However, loads from this data source could not be accurately characterized because all mercury concentration measurements were lower than the detection limit.

Instead, Illinois EPA estimated a range mercury loads from 0.099 kg/yr to 0.56 kg/yr resulting from flow reversals. The lower load value was estimated based on low level mercury measurements taken in the Chicago River (average = 6.5 ng/L, when values less than detection are set equal to the detection level of 0.5 or 10 ng/L depending on sample analysis method used) and reported MWRDGC flow volumes. The higher value was estimated based on MWRDGC flow volumes and Columbia River stormwater concentrations (37.17 ng/L). Illinois EPA concluded in Section 4.6 of the mercury TMDL that no determination could be made for stormwater loading, or flow reversals from the CAWS, because site-specific mercury concentration data were either below detection limits or not available. Illinois EPA suggested that estimates based on literature values, (i.e., reference concentration values from the Columbia River) used to calculate loads indicate that these sources are relatively small contributors to study area loads. Illinois EPA did not rule out the potential of stormwater or CAWS contributions to make up a larger portion of mercury loads to individual harbors (Section 4.6 of the mercury TMDL).

Comparing Mercury Loads

The results from the Illinois source assessment in Section 4 of the mercury TMDL, are provided below in Table 2. Illinois EPA found the most significant sources to be hydrodynamic transport

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[25] MWRDGC Website, Flow Reversal Data 1985 to 2017 accessed last (March 5, 2019) http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting_the_environment/Combined_Sewer_Overflows/pdfs/Reversals.pdf

[26] EPA Methods 136.3 accessed 12/28/18, https://www.ecfr.gov/cgi-bin/text-idx?SID=a6bb8a02b6d783f9356758b5ff0ed106&mc=true&node=pt40.25.136&rgn=div5#se40.25.136_13

of mercury from the open water of Lake Michigan, and atmospheric loading. As previously discussed, no definitive determination could be made for stormwater loading, individual permitted point source discharges, or flow reversals from the CAWs, because site-specific mercury concentration data are either below detection limits or not available. Because all available data for those sources were below laboratory detection limits, the estimates involved multiplying anticipated flows from these sources by the detection limit, which represent the upper bound loading values. Estimates of these sources using reference concentration information, such as the Columbia River stormwater concentrations, were also made and indicate that they are likely to be minor contributors to the study area.

Table 2. Mercury Loads to the Study Area

Process	Data Sufficiency[a]	Estimated Magnitude
Hydrodynamic transport from main body of Lake Michigan	Acceptable	10.3 kg/yr
Atmospheric Loading	Acceptable	23.24 kg/yr
MS4 Stormwater Loading	Limited. Rough estimate made using literature-based concentrations	3.16 kg/yr
Flow Reversals from the Chicago Area Waterways	Limited. All available data are non-detectable; A range of rough estimates were made using Chicago River data and literature-based concentrations	0.099 kg/yr - 0.56 kg/yr
Other Point Source Discharges (Individual Permitted)	Acceptable	0.04 kg/yr

* Reproduced from the Illinois Lake Michigan Nearshore Mercury TMDL Table 4-3

Conclusion: *EPA reviewed the Illinois Nearshore PCB and Mercury TMDLs and finds that the TMDL documents submitted by Illinois EPA adequately describe the impaired water bodies, pollutants of concern, priority (medium) and pollutant sources that are addressed by these TMDLs, based upon available data and information. Illinois EPA identified the waters impaired by PCBs and mercury in the latest Integrated Report submittal, using data from various State programs. The State compiled all readily available information including NPDES data, air emissions data, Lake Michigan nearshore and open water data, and fish tissue data, etc. to identify sources of PCBs and mercury. EPA also finds that the State adequately defined how various key terms were used in the TMDL, such as "air deposition" and "hydrodynamic transport." Illinois EPA also described complex urban watershed characteristics, such as the Chicago Area Waterways and Harbor areas, and adequately supports the approaches used in the development of the TMDL. EPA has concluded that Illinois EPA's characterizations of the nonpoint source loads (including hydrodynamic transport, and air deposition) as primary sources of PCBs and mercury loads in the TMDL are adequately supported by their loading estimates and available data.*

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

The TMDL submittal must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative Air water quality criterion, and the antidegradation policy (40 C.F.R. §130.7(c) (1)). EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

The TMDL submittal must identify a numeric water quality target(s) – a quantitative value used to measure whether the applicable water quality standard is attained. Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard (WQS). The TMDL expresses the relationship between any necessary reduction of the pollutant of concern and the attainment of the numeric water quality target. Occasionally, the pollutant of concern is different from the pollutant that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as Dissolved Oxygen (DO) criteria). In such cases, the TMDL submittal should explain the linkage between the pollutant of concern and the chosen numeric water quality target.

Comment:

2.1 Introduction to Water Quality Standards and Targets

Depending on the designated use being addressed, TMDL targets may be based on human health, aquatic life, or wildlife criteria (EPA, 2011). TMDL targets are established at levels that attain and maintain the applicable WQS, including designated uses, numeric and narrative criteria, and antidegradation policy [40 CFR§130.7(c)(1)]. Where possible, the water quality criterion for the pollutant causing impairment is used as the numeric water quality target when developing the TMDL.

Illinois analyzed available biological, physiochemical, physical habitat, toxicity, and other available data to evaluate each assessment unit against the State's assessment criteria. The degree to which each assessment unit meets its designated uses is defined as: Fully Supporting (good), Not Supporting (fair), or Not Supporting (poor). A waterbody in which at least one applicable use is not fully supported is considered to be impaired.

The waterbodies in the PCBs and Mercury TMDL fall into the Lake Michigan Basin category of Illinois' water quality standards (Illinois EPA, 2014). This category includes all tributaries of Lake Michigan, harbors, and open waters of the Illinois portion of the lake (Illinois Administrative Code (35 IAC 302.501-595, Subpart E). The applicable WQS for the TMDL are designed to protect Lake Michigan Basin aquatic life, human health, and wildlife. Waters of the Lake Michigan Basin must be free from any substance, or any combination of substances, in concentrations toxic or harmful to human health, or to animal, plant, or aquatic life (35 IAC 302.540). The TMDL targets for PCBs and mercury in this TMDL must be consistent with water quality criteria developed to protect the fish consumption and aquatic life uses. The standards for PCBs and mercury are described in Section 2.3 of this Decision Document.

The Fish Consumption Designated Use (PCBs and Mercury)

Illinois EPA based the reductions in sources identified in the Lake Michigan mercury and PCB TMDLs, on attaining a fish tissue target value to meet its human health narrative standard (35 IAC 302.540). Illinois' fish consumption use is associated with all waterbodies in the State, and assessment is based on (1) waterbody-specific fish-tissue data and (2) fish-consumption advisories issued by the multi-agency[27] Illinois Fish Consumption Monitoring Program (FCMP). The FCMP uses a risk-based process developed in the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Anderson et al. 1993).[28] The Protocol requires the determination of a Health Protection Value (HPV) for a contaminant, which is used to calculate the fish tissue concentration of that contaminant that will be protective of human health (based on range of meal consumption frequencies).[29]

Because all of the assessment units addressed in the PCB and mercury TMDLs are impaired for the fish consumption use, a HPV for fish consumption was used in both TMDLs to derive the TMDL fish tissue contaminant targets for PCBs and mercury. Illinois' lowest fish tissue concentration HPVs for fish consumption are the HPVs for sensitive populations (which include pregnant or nursing women, women of child-bearing age, and children under the age of 15). For PCBs the fish consumption HPV for sensitive populations is 0.05 μg/kg/day.[30] The fish consumption HPV for sensitive populations for mercury is 0.10 μg/kg/day.[31]

Aquatic Life Uses (PCBs and Mercury)

Waters are assessed for aquatic life use (ALU) using available data for the most recent three years. For Lake Michigan open waters and harbors, if two or more samples exceed the acute aquatic life criterion, the waters are considered impaired. If more than 10 percent of the samples exceed the chronic aquatic life criterion, the waters are considered impaired.

2.2 PCB Water Quality Standards

Numeric PCB TMDL Target: Fish Consumption Use

TMDL submittals must include numeric water quality targets, which are quantitative values used to measure whether or not applicable WQS are being attained. Illinois uses a target fish tissue PCB concentration to determine support of its Fish Consumption Use for the PCB TMDL. The HPV for fish consumption is 0.05 μg/kg/day. Based on this HPV, the lowest PCB fish tissue

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[27] From Illinois Department of Public Health website Factsheet "Fish Advisories in Illinois"

[28] "Designated Use Support" - Section 3.2 of the PCB TMDL and Section in Mercury TMDL

[29] Consumption frequencies range from unlimited consumption to "do not eat"

[30] 2018 Illinois EPA Draft CWA Integrated Report, Table C-14 and C-15

[31] Illinois EPA. 2006. Technical Support Document for Reducing Mercury Emissions from Coal-Fired Electric Generating Units. Table 4.2 Current Human Health-Based Concentrations in Fish Tissue for Issuing consumption Advisories due to Mercury (Mg/Kg in fillets, et weight), P. 53.

concentration that triggers a fish consumption advisory is 0.06 mg/kg for all species (Section 3.2 of the PCB TMDL). Illinois uses the fish consumption advisories triggered by the 0.06 mg/kg concentration to assess whether waters are fully supporting the fish consumption use or are considered to be impaired.

Illinois used a PCB fish tissue concentration target (0.06 mg/kg) to determine reductions necessary to address impaired waters and to thus achieve the fish consumption designated use standard for the Lake Michigan Basin (USEPA, 2011). Illinois noted in the TMDL that the fish tissue assessment concentration was derived independently of the State's numeric water column criteria for PCBs (Section 3.2 of the PCB TMDL).

Numeric PCB Standards for the Water Column

Illinois EPA's numeric water quality criteria are developed to protect the designated uses of surface water. The criteria for PCBs were adopted by the State of Illinois as part of the Great Lakes Water Quality Initiative (GLI). The criteria for PCBs in surface waters of the Lake Michigan basin are 120 pg/L for the protection of wildlife, and 26 pg/L for the protection of human health [35 IAC 302.504(e)]. Only one water in the PCB TMDL is listed for water column impairment. As discussed in Section 3.3 of the Decision Document, Illinois EPA demonstrated that meeting the reduction in PCB loadings necessary to meet the TMDL targets for the fish tissue in a select fish species would also meet the water column concentration target.

2.3 Mercury Water Quality Standards

Numeric TMDL Mercury Target for Fish Tissue

Illinois uses a HPV for mercury of 0.10 µg/kg/day for fish consumption by sensitive populations. An extensive database of studies of the health effects of methyl mercury was used to develop the HPV, which is used as the starting point for issuing a "one meal per week" advisory. This concentration was derived by the Great Lakes Fish Advisory Task Force and accepted by the Great Lakes states for use in their sport fish advisory programs. Based on the 0.10 µg/kg/day HPV, the lowest fish tissue concentration that would result in a fish consumption advisory is 0.06 mg/kg for all species. The State of Illinois uses this concentration to assess support of the fish consumption use and to trigger a fish consumption advisory.

Numeric Mercury Standards for Surface Waters

The WQS for mercury in surface waters of the Lake Michigan Basin are 0.0013 µg/L (or 1.3 ng/L) for the protection of wildlife, 0.0031 µg/L (or 3.1 ng/L) for the protection of human health, and 1.7 µg/L (1,700 ng/L) and 0.91 µg/L (910 ng/L) for the protection of aquatic life from adverse effects due to acute and chronic toxicity, respectively [35 IAC 302.504(e)]. These standards were adopted by the State of Illinois as part of the Great Lakes Water Quality Initiative and apply to all waters of the Lake Michigan Basin (Section 3.1 of the mercury TMDL).

In Section 3.3 of the mercury TMDL, Illinois demonstrated that if a water complies with the TMDL fish tissue target, it will also meet the water quality targets (i.e., water column concentrations) to protect human health and wildlife (for all waters addressed by the TMDL), and the aquatic life criteria for Waukegan Harbor. Illinois applied published bioaccumulation factors (BAFs) for the Great Lakes to demonstrate the relationship between pollutant concentration in the water column and resulting fish tissue contamination (USEPA, 1995). The water column concentration corresponding to the fish tissue TMDL target of 0.06 mg/kg mercury was calculated to equal 0.43 ng/L. This is lower (more stringent) than the most stringent WQS for mercury; the wildlife criterion (1.3 ng/L). EPA agrees that reductions in mercury achieving the TMDL target fish tissue concentration will result in water column concentrations that will comply with applicable water quality criteria to protect human health and wildlife.

EPA finds that the TMDL document submitted by Illinois EPA adequately identifies the WQSs that are impaired, and the TMDL endpoint needed to attain each WQS. All the assessment units addressed in these TMDLs are impaired for the fish consumption use for PCBs and mercury. EPA finds that it is appropriate for Illinois to use a fish tissue concentration target of 0.06 mg/kg for both PCBs and mercury, to determine source reductions necessary to address the impairments (i.e. to achieve the fish consumption designated use standard) for PCBs and mercury in the study area, and to ensure that the Lake Michigan Basin standards are met. Using the value which triggers a fish consumption advisory (0.06 mg/kg) is appropriate for both contaminants, because the value is derived using the HPVs for fish consumption, and because fish advisories are directly linked to the determination of waterbody impairment. A fish tissue concentration value represents the primary source of contaminants affecting human health.[32] *EPA agrees that Illinois' use of published BAFs is reasonable, and that if a water meets the TMDL fish tissue target concentration for PCBs and Mercury of 0.06 mg/kg in fish tissue, it will also meet the water quality targets (i.e., water column concentrations), including the human health and wildlife criteria described above (for all waters addressed by the TMDL), and will also meet the aquatic life criteria for mercury in Waukegan Harbor.*

3. Loading Capacity - Linking Water Quality and Pollutant Sources

A TMDL must identify the loading capacity of a waterbody for the applicable pollutant. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). If the TMDL is expressed in terms other than a daily load, e.g., an annual load, the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen. The TMDL submittal should describe the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

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32 Note: setting the Target fish tissue to achieve a water quality standard of 26 pg/L would also comply with the wildlife 120 pg/L standard.

The TMDL submittal should contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling. EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

TMDLs must take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe their approach to estimating both point and non-point source loadings under such critical conditions. In particular, the TMDL should discuss the approach used to compute and allocate non-point source loadings, e.g., meteorological conditions and land use distribution.

Comment:

3.1 Data Supporting the PCB and Mercury TMDLs

The TMDL project team representing the Illinois EPA, EPA Region 5, and sub-contractor Limnotech under contract to Baker, Inc., led a webcast on September 17, 2014, to help identify additional studies or data sets relevant to the project. Agencies contacted for data included the EPA Great Lakes National Program Office (GLNPO); EPA Office of Research and Development, Grosse Ile, Michigan; EPA Superfund Division; EPA Water Division; Illinois EPA Toxicity Assessment Unit, Illinois EPA Bureau of Water; Illinois FCMP; Illinois Department of Natural Resources (IDNR); Wisconsin Water Science Center of the U.S. Geological Survey; National Oceanic and Atmospheric Administration (NOAA); Environment Canada; Area of Concern project managers; USACE; U.S. Navy; Waukegan Citizens Advisory Group; North Shore Sanitary District; Illinois Lake Michigan Fisheries Program; and researchers at Loyola University and the University of Iowa.

Data collected in the open water of the Lake Michigan Nearshore were used to assess the nearshore and the 51 shoreline segments. These segments are collectively referred to as being within the "nearshore open water/shoreline TMDL zone."

PCB Fish Tissue Concentration Data.

Illinois EPA considered fish tissue PCB concentration data for 164 samples (2000 to 2012) for 16 species of fish, to determine a current PCB tissue concentration which represents all impaired fish. The results are reported in Table 5-1 of the PCB TMDL.

Table 3. Study Area Fish Fillet Mean Sample Concentration for PCBs (mg/kg)

Species	Count	Mean	Species	Count	Mean
Carp	52	4.329	Smallmouth Bass	7	0.172
Lake Trout	30	0.811	Pumpkinseed Sunfish	3	0.183
Black Bullhead	3	1.027	Alewife	6	0.187
Rock Bass	10	0.276	Round Goby	3	0.137

Species	Count	Mean	Species	Count	Mean
Sunfish	7	0.189	Yellow Perch	22	0.092
Largemouth Bass	4	0.225	Brown Trout	1	0.659
Bloater	7	0.270	Rainbow Trout	2	0.152
white Sucker	6	0.237	Rainbow Smelt	1	0.100

Table 4. Study Area Fish Fillet Mean Sample Concentration for Mercury (mg/kg)

Species	Count	Mean (mg/kg)
Largemouth Bass	3	0.2800
Smallmouth bass	7	0.1096
Rock Bass	9	0.1023
White sucker	4	0.0528
Sunfish	5	0.0328
Black bullhead	2	0.0550
Rainbow trout	2	0.0638
Brown Trout	1	0.1030

Carp tissue PCB data are not available for every impaired segment. The number of carp tissue samples available ranges from zero samples in Diversey Harbor, Calumet Harbor and the nearshore open water/shoreline, to 40 samples in Waukegan Harbor (Table 5-2 of the PCB TMDL).

Mercury Fish Tissue Concentration Data

During the period between 2000 and 2012, there were 33 samples for fish tissue mercury concentrations available across 8 species of fish. Due to a lack of data for several harbors and the nearshore open water/shoreline zone, Illinois EPA extrapolated the existing fish data across the sites in certain TMDL zones that have a limited number of fish samples. Although only three samples exist for largemouth bass (each are composites of 5 fish), and all from a single marina, their use as a target species is reasonable given the data available and is further explained in Section 5.1 of the mercury TMDL.

3.2 Introduction to Fish Tissue-Based (FTB) Proportionality Approaches For PCBs And Mercury

Illinois uses a similar rationale for its fish tissue-based approaches for both PCBs and mercury in its Lake Michigan Nearshore TMDLs. Illinois EPA described the FTB proportionality approach in Section 5.1 of both the PCB and Mercury TMDLs as linking atmospheric pollutant loads directly to fish tissue concentrations. The FTB proportionality approach was patterned after TMDLs that were developed in the Great Lakes states and other states,[33] that used empirical zero-dimensional, steady-state modeling approaches.

33 Minnesota Pollution Control Agency (MPCA, 2007), statewide mercury and PCB TMDLs developed by the Michigan Department of Environmental Quality (LimnoTech, 2013; LimnoTech, 2012), which drew from the work of Jackson et al. (2000), and a regional mercury TMDL for the Northeast United States (CDEP et al., 2007).

Key assumptions of the FTB approach outlined in the TMDL (Section 5.1) include: 1) a reduction in PCB concentration levels in the air, or a reduction in mercury emissions will result in a proportional reduction in the overall PCB or mercury deposition rate, respectively; 2) the reduced deposition rate will ultimately result in a proportional decrease in contaminant loading to waterbodies; and 3) a reduction in PCB or mercury loading into waterbodies will result in a proportional decrease in fish tissue PCB or mercury concentrations.

Application of the FTB proportionality approach requires the establishment of 1) a target fish tissue concentration (Section 3.3 of the Decision Document (for PCBs) and 2.4.1(for mercury)), 2) selection of an appropriate fish species which is used to measure the reduction needed, and

3) calculation of a reduction percentage, for meeting the needed reduction in the selected fish species, also referred to as a reduction factor (RF).

To calculate a percent reduction, Illinois EPA first calculated a baseline fish-tissue contaminant concentration in a selected target fish species for each contaminant. Illinois EPA then quantified the reductions needed in both the fish tissue PCB and mercury baseline concentration to reach the target fish tissue PCB and mercury concentration. Illinois EPA then used the percent reduction needed in fish to calculate the needed reduction in baseline pollutant/atmospheric sources.

3.3. FTB Proportionality Approach to PCB TMDL Development

Selection of a PCBs Fish tissue Target

Illinois EPA described how a direct proportionality approach can be used to link sources with resulting concentrations in fish tissue and the water column in Section 5.1 of the Illinois Lake Michigan Nearshore PCB TMDL. EPA supports the use of this approach when there is not sufficient data to support more complex methods. As stated above Illinois EPA uses the HPV for PCBs to determine a fish tissue concentration (0.06 mg/kg) that will be protective of human health (Section 3.3 of the TMDL and Section 2.3 of the Decision Document) for a variety of meal frequencies, and for sensitive populations.

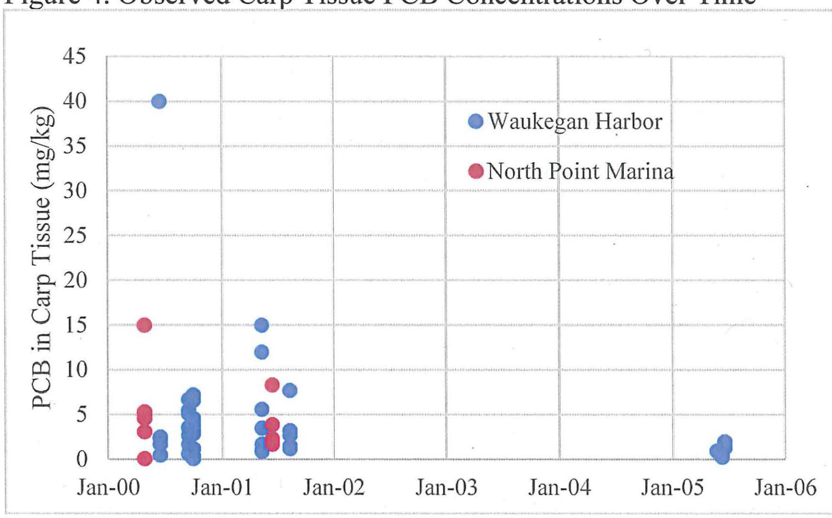
Appropriate Fish Species to Represent the Baseline PCB Load

Illinois EPA described its selection of a species of fish from which to calculate a fish tissue concentration baseline in Section 5.1.1 of the PCB TMDL. That species was used to calculate fish tissue PCB reductions. These reductions will be needed to meet standards in the entire impaired fish community.

Illinois EPA considered the following in its selection of an appropriate fish species: 1) the target species current PCB tissue concentration should be high enough that percent reductions in the target species will also achieve the target concentrations in other species when applied, 2) the sample size and scope must represent the project area; and 3) the influence of legacy effects (past contamination that is not due to current sources of loading).

Illinois EPA selected carp as the species to represent baseline fish tissue PCB concentrations and to use for calculating the needed reductions in PCB concentrations to attain TMDL goals. The high PCB concentrations in carp tissue and the widespread sample data for carp made them a reasonable choice for the target species (Section 5.1.1 of the TMDL). Illinois EPA carefully considered its selection of carp for use in the fish tissue-based, direct proportionality approach because carp may reflect historical PCB loads more than other fish because: carp are benthic feeders and receive much of their PCB exposure from bottom sediments and pollutant concentrations in bottom sediments respond more slowly to pollutant load reductions when compared with fish that are exposed to pollutant concentrations in the water column. The FTBP approach assumes that only current loads are reflected in fish tissue concentrations, and Illinois EPA considered several methods to account for fish tissue PCB data that may reflect exposure to legacy sources. Illinois EPA decided that the only viable approach for removing the influence of legacy sources on existing PCB data was to use the most recent dataset for fish tissue PCBs concentrations to represent existing concentration when calculating the needed decrease in percent fish-tissue concentration (5.1.2 of the PCB TMDL). Illinois observed this in the carp tissue data available for this TMDL, (see Figure 4 in the Decision Document).

Figure 4. Observed Carp Tissue PCB Concentrations Over Time



Illinois determined that the observed decrease in carp tissue concentrations over time represents a decreasing importance of legacy sources in the later data (possibly a reflection of several actions taken prior to 2005 after Waukegan Harbor PCBs were discovered). Illinois used the average of the most recent data for the current fish tissue baseline (2005 average = 1.13 mg/kg).

FTB Proportionality Approach - Percent Reduction Calculations for PCBs in Carp and Trout)

Section 5.3.1 in the PCB TMDL explains how Equations 5-1 and 5-2 in the PCB TMDL can be rearranged to calculate a required percentage reduction in fish tissue:

$$\% \, Reduction = 100 \times \left(C_{fish,current} - C_{fish,target}\right) / C_{fish,current} \qquad \text{(P 5-7)}$$

Where:

$C_{fish,current}$ = current PCB concentrations in fish (mg/kg)

$C_{fish,target}$ = target PCB concentrations in fish (mg/kg)

Illinois EPA used equation 5-7 to calculate the required percent reductions necessary to meet fish tissue targets in carp by subtracting the 0.06 mg/kg fish tissue target concentration from current observed carp tissue data (2005 average) of 1.13 mg/kg. Dividing by 1.13 mg/kg and multiplying by 100 yields the required 94.7 percent reduction in fish tissue concentration, which could also be applied as a percent reduction in the (corresponding) atmospheric PCB load. IEPA also applied Equation 5-7 of the PCB TMDL to the average PCB concentration of all lake trout data (0.811 mg/kg) to calculate a required load reduction of 92.6 percent. The word "current" in Equation 5-7 of this PCB Decision Document is the same as "baseline" throughout the PCB TMDL document.

Percent Reduction Calculations for the Gas- Exchange Model (GEM) Proportionality Approach

In Section 5.3.2 of the PCB TMDL, Illinois EPA used the results from the GEM approach (Section 5.2 of the PCB TMDL) to estimate the required percent reduction in PCB loadings necessary to meet the TMDL targets for the carp and lake trout tissue targets calculated above, as well as demonstrate attainment of the water column concentration target. The load reduction required to meet the water column total PCB concentration target can be determined using the following equation:

$$\%\ Reduction = 100\ x\ (C_{atm,current} - C_{atm,target})/C_{atm,current} \qquad \text{(P 5- 8)}$$

Where:

$C_{atm,current}$ = current atmospheric PCB concentrations (pg/m^3)

$C_{atm,target}$ = atmospheric PCB concentrations necessary to meet water column criterion, as defined by (pg/m^3)

Illinois EPA concluded in Section 4.2.3 of the TMDL that the atmospheric concentration data supplied by Simcik et al. (1997) provided the best estimate of nearshore over-lake PCB concentration measurements, as of 1994-1995. Illinois EPA adjusted the 1994-1995 data to the 2005 baseline year by using a PCB concentration half-life of 7.7 years to extrapolate a 2005 Chicago-area atmospheric PCB concentration of 197 pg/m^3 (Section 5.3.2 of the PCB TMDL). Illinois used Equation P 5-3 to show that an atmospheric concentration of 82 pg/m^3 was required to attain an equilibrium equivalent water column standard of 26 pg/L (Section 5.2.1 of the PCB TMDL). Inserting the baseline concentration of 197 pg/m^3 and the target concentration of 82 pg/m^3 in equation P 5-8 of the PCB TMDL results in a required reduction percentage of 58 percent.

Application of a biota sediment accumulation factor (BSAF)[34], (grams organic carbon/grams lipid) in Section 5.2.3 of the PCB TMDL showed that a water column PCB concentration of 26 pg/L would be expected to result in a carp tissue concentration of 0.0585 mg/kg, which is essentially equal to the fish tissue target of 0.06 mg/kg selected for the PCB TMDL. For this reason, the 58 percent reduction in atmospheric concentration determined above as necessary to meet the water column target for PCBs would also be required to meet the carp tissue target

Application of the Trophic Level 4 bioaccumulation factor in Section 5.2.4 of the PCB TMDL indicates that a water column PCB concentration of 56 pg/L would result in attainment of the tissue target of 0.06 mg/kg. This water column concentration corresponds to an atmospheric PCB concentration of 177 pg/m^3. Using the current concentration of 197 pg/m^3 and the target

34 This value was not available for the study are and Illinois EPA used Green Bay as a reference site for this value.

concentration of 177 pg/m^3 in Equation P 5-8 results in a required reduction percentage of 10 percent.

Final Percent Reduction Determination for PCBs

The results of the calculations above indicate that reductions vary depending upon the approach used, and whether or not the impacts of legacy PCBs were considered (Section 5.3.3 of the PCB TMDL). To ensure that the WQS and designated uses are attained, Illinois EPA chose the most conservative (greatest) reduction for PCBs. Illinois EPA determined that a 94.7 percent reduction resulting from the fish tissue-based approach for carp should be used as the basis for the PCB TMDL because:

- The uncertainty in these percent reduction estimates is high for several reasons including a limited availability of fish tissue samples. Using an upper bound of the range of reduction percentages, provides an implicit margin of safety (MOS) to account for this uncertainty.
- The GEM approach resulted in a lower calculated percent reduction, because GEM uses reference information rather than site specific data and considers only current atmospheric sources. The FTBP approach resulted in a calculated 94.7 percent reduction using site specific data which may reflect the influence of historical and non-atmospheric loads. Figure 5-3 in the TMDL indicates that the 94.7 percent reduction would reach the target fish tissue level of 0.06 mg/kg decades earlier than the 58 percent reduction in atmospheric PCB concentration estimated by the GEM approach[35] (Figure 5 in the Decision Document).

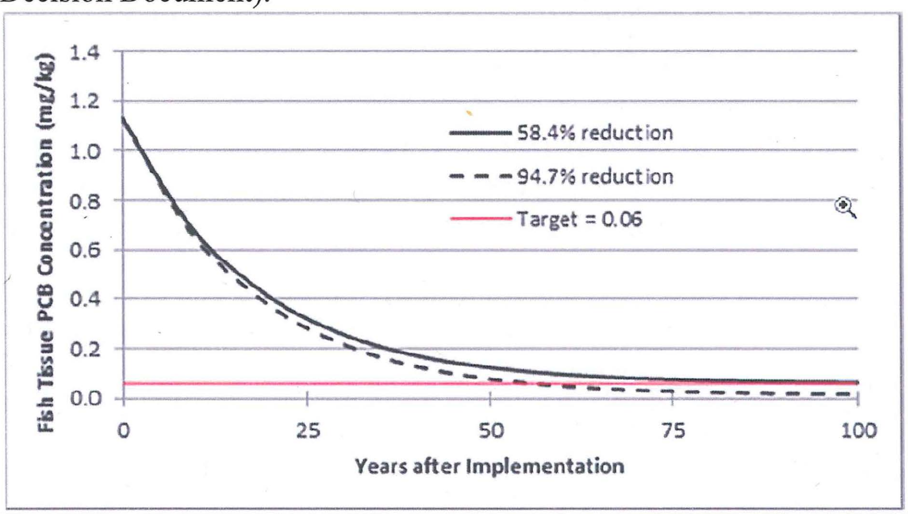


Figure 5. Fish Tissue PCB Concentration Over Time Under Two Reduction Scenarios

35 As illustrated in Figure 5-3 of the TMDL.

3.6 Calculating PCB Baseline Load and Annual Loading Capacity

Illinois used the equation to establish the loading capacity of receiving waters:

TMDL= Baseline Load x (1-RF) (P 6-2)

Where: Baseline load = total source load during the baseline year of 2005 (including all air sources and NPDES permitted discharges of PCBs);
RF = Reduction Factor (percent reduction of 94.7%)

The baseline load, also referred to as the current or existing load, represents the sum of existing nonpoint and point source loads of PCBs to the waters within the TMDL study area for the baseline year. The calculation is based upon the 2005 PCB source data, which coincided with the 2005 data used to calculate the existing fish tissue concentration value (see Section 3.2 in the Decision Document).

Illinois first used equation P 6-2 of the PCB TMDL to establish the total maximum annual load based on an annual average. Illinois calculated in Section 4.1 of the PCB TMDL that PCB loading from the main body of Lake Michigan to the study area (hydrodynamic transport) ranges from 4.6 to 13 kg of PCB per year. Direct atmospheric exchange to the study area was calculated to range from 2.1 to 5.8 kg/yr. These loads are expressed as ranges because atmospheric loads are decreasing over time.

Illinois EPA normalized the range of calculated loads using the baseline year of 2005, resulting in a hydrodynamic transport load to the study area of 7.4 kg/yr of PCB, and a direct atmospheric load of 4.9 kg/yr yielding totaling 12.3 kg/yr, the current nonpoint source load for 2005 (Section 6.1 of the PCB TMDL).

Illinois EPA used equation P 6-2 of the PCB TMDL to calculate the total maximum yearly load using the RF of .947 to yield a TMDL (loading capacity) of 0.65 kg/yr based on annual averages.

0.65 kg/yr = 12.3 kg/yr x (1 – 0.947) (P 6-3)

Point sources such as regulated wastewater and stormwater discharges, and discharges permitted under Phase I and Phase II of the NPDES stormwater (MS4) program, are not included in the baseline loading allocation. No data with detectable PCB concentrations were available for any of the NPDES permitted wastewater discharges in the study area, and no data are available for the stormwater discharges. The source assessment conducted in Section 4 of the PCB TMDL document indicated that these sources are likely a very small contributor to existing PCB loads to the study area (Table 4-2 of the PCB TMDL). Point sources will receive a WLA, however, to ensure that future loads do not lead to a WQS violation.

PCB Total Maximum Daily Load (Loading Capacity)

To express the maximum yearly load as a maximum daily load, the Illinois EPA assessed the intra-annual variability for the most significant source categories separately. The variability in atmospheric loading was calculated by taking the highest observed single-day atmospheric PCB concentration in Simcik et al. (1997), and dividing that concentration by the annual average concentration to get a ratio for daily maximum to annual average concentration of 2.1, using the equation:

(Total annual load) x Ratio of (atmospheric: total load) x Ratio of (daily maximum concentration: annual average concentration) ÷ 365 days/yr = Maximum daily atmospheric load[36] (P 6-4)

Illinois populates this equation as follows: The calculation of the total annual yearly PCB load of 0.65 kg/yr is found in Section 6.2 of the PCB TMDL and Section 3.6 of this Decision Document.

0.65 kg/yr x (4.9/12.3)
x 2.1*÷ 365 days/yr
= 0.0015 kg/day

* daily maximum concentration: annual average concentration

The components of the ratio of atmospheric to total load made up of the direct atmospheric load of 4.9 kg/yr and hydrodynamic transport of 7.3 kg/yr are found in Table 5 of the Decision Document. This results in a maximum daily load attributable to direct atmospheric exchange of 0.0015 kg/day.

In the case of the load from the open lake, Illinois EPA reasonably assumes that Lake Michigan PCB concentrations do not vary substantially over the course of a year, so the daily load for transport from Lake Michigan is calculated as the annual load divided by 365:

(Total annual load) x Ratio of (transport load: total load) ÷ 365 days/yr
= Maximum daily Lake Michigan transport load

(P 6-5)

Application of equation 6-5 in the PCB TMDL results in a maximum daily load attributable to transport from Lake Michigan of:

0.65 kg/yr x (7.4/12.3) ÷ 365 days/yr
= 0.0011 kg/day

The maximum daily loading capacity is the sum of those two loads, or 0.0026 kg/day. This daily allowable load of PCBs is expected to result in meeting the fish tissue target for PCBs of 0.06 mg/kg, and over time, to attain the WQS.

Table 5. PCB Loading Capacity Components

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[36] Illinois EPA gives the example of a year where the average daily loading rate from atmospheric sources is 0.00071 kg/day. Under normal seasonal variations in atmospheric concentrations, this loading rate can be as high as 0.0015 kg/day on the worst day of the year, but seasonal variations dictate that atmospheric loading will be much less than the average value on other days of the year. PCB TMDL 2016, page 43.

TMDL Components	Result
Reduction Factor	94.7%
Final TMDL	
Loading Capacity (LC)	0.0026 kg/day
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.000006 kg/day
Load Allocation (LA)	0.0026 kg/day

3.6 Illinois Nearshore Mercury TMDL Development

Fish Tissue-Based Approach for Mercury TMDL

Illinois used a fish tissue-based approach for linking pollutant loads directly to fish tissue concentrations for the mercury TMDL. This proportionality approach is based on the assumption that there is a linear relationship between mercury levels in air and water, along with a bioaccumulation factor (BAF) to relate fish tissue concentrations to water column concentrations. The basic assumptions for the mercury TMDL are similar to those that apply to the FTB approach used in the Lake Michigan Nearshore PCB TMDL (See Section 3.0 of this Decision Document for the 3 key assumptions regarding the relationship between air, water and fish tissue for this approach). The Illinois mercury TMDL is similar in approach to the Minnesota Statewide Mercury TMDL (MPCA, 2007).

The mercury concentrations in fish that result from the mercury loading to the Lake Michigan Nearshore waters are expressed as shown in equation Hg 5-1 in the mercury TMDL (USEPA, 2001; CDEP et al., 2007):

$$C_{fish_{t1}} = BAF\ x\ C_{water_{t1}} \qquad \text{(Hg 5-1)}$$

Where:

$C_{fish_{t1}}$ and $C_{water_{t1}}$ represent mercury concentrations in fish (mg/kg) and water (mg/L) at time t1, respectively.

The mercury TMDL uses a bioaccumulation factor (BAF),[37] which relates the concentration of mercury in surface water to the corresponding concentration of mercury in fish as measured by mercury concentration in fish tissue. At a future time t2, equation Hg 5-1 of the mercury TMDL becomes:

$$C_{fish_{t2}} = BAF\ x\ C_{water_{t2}} \qquad \text{(Hg 5-2)}$$

Where:

$C_{fish_{t2}}$ and $C_{water_{t2}}$ represent mercury concentrations in fish and water at that future time t2, respectively, and $C_{fish_{t2}}$ is for a fish that is the same age, length, and species as for $C_{fish_{t1}}$

[37] This is a constant when mercury concentrations change over time, but all other parameters (i.e., age, length, and species) remain constant.

Illinois EPA combined the equations mathematically and then rearranged them to get equation 5-3 of the mercury TMDL:

$$\frac{C_{fish_{t1}}}{C_{fish_{t2}}} = \frac{C_{water_{t1}}}{C_{water_{t2}}} \qquad \text{(Hg 5-3)}$$

Section 3.1 of this Decision Document explains Illinois EPA's key assumption under the proportionality approaches that water column mercury concentrations are proportional to mercury air deposition load. Based on that assumption the above equation can be expressed as shown in Equation Hg 5-4 of the mercury TMDL:

$$\frac{C_{fish_{t1}}}{C_{fish_{t2}}} = \frac{L_{air_{t1}}}{L_{air_{t2}}} \qquad \text{(Hg 5-4)}$$

Where:

$L_{air_{t1}}$ and $L_{air_{t2}}$ are the air deposition mercury loads to the waterbody at time t1 and t2, respectively.

Thus, EPA finds it reasonable that, assuming long-term steady-state conditions, a linear relationship exists between mercury levels in air, water, and fish concentrations, and that fish tissue reductions will likely occur in direct proportion to source load reductions. EPA has approved TMDLs where this approach has been used as an alternative to more complex models, which require a more robust dataset.[38]

Illinois EPA explains steady-state conditions as follows: The long-term fish tissue concentration reductions that are proportional to reductions in atmospheric deposition are not expected to occur immediately. Rather, Illinois EPA expects that the proportional response will be seen over the long term, once the systems have achieved a steady state. The simple modeling approach used in the mercury TMDL represents long-term average fish tissue concentrations expected to occur in response to long-term loading reductions. This is consistent with several more complex dynamic ecosystem scale models such as the Mercury Cycling Model (MCM) and IEM-2M model. Both models assume that, at steady state, reductions in fish concentrations will be proportional to reductions in mercury inputs (USEPA, 2001, Atkeson et al., 2003). The E-MCM6 model to the Florida Everglades predicted a linear relationship between atmospheric mercury deposition and mercury concentrations in largemouth bass (Atkeson et al., 2003). In this study, mercury levels in largemouth bass were predicted to attain 90 percent of their long-term steady state response in about 30 years, given continued reductions in mercury loads.[39]

Section 2.3 of the Decision Document explains how Illinois developed a target mercury concentration in fish (0.06 mg/kg). The following describes how Illinois determined a fish tissue baseline concentration to compare with the target fish tissue concentration and the percentage reduction needed to reduce levels to meet the goals of the TMDL.

[38] Minnesota Mercury TMDL (2007), Michigan Statewide Mercury TMDL (2018), Northeast States Regional Mercury TMDL (2005)

[39] E-MCM is the modified version of MCM developed for the Florida Everglades.

Selection of an Appropriate Fish Species to Represent Current Mercury Load

Illinois EPA explains the species selection process in Section 5.1.1 of the mercury TMDL. Illinois chose largemouth bass as the target species for this TMDL because it represents a top-predator species and it has the highest mean mercury concentrations of the fish species that Illinois EPA evaluated (See Table 4, in Section 3.1 of the Decision Document). All three largemouth bass tissue samples (each are composites of 5 fish), which have a mean mercury concentration of 0.28 mg/kg, were collected in North Point Marina. Illinois EPA extrapolated the fish tissue mean mercury concentration values from the sites with available concentration data to the nearshore open water/shoreline zone and the harbor sites that lacked concentration data. EPA finds the use of largemouth bass as a target species to be reasonable given the data available, because largemouth bass had the highest mercury concentration and because it represents a top-predator species. Illinois also explained that setting a percent reduction that will reduce a largemouth bass mercury concentration from 0.28 mg/kg to the target concentration would result in fish with lower mercury concentrations meeting state water quality standards.

3.7 Calculating the Required Mercury Percent Reduction:

Illinois calculated the load reduction required to reach the fish tissue target concentration for mercury in Section 5.2 of the mercury TMDL. The first step in solving equation Hg 5-5* of the mercury TMDL (below) was to subtract the target fish tissue mercury concentration (of 0.06 mg/kg) from the existing mean mercury concentration in fish tissue (0.28 mg/kg, average mercury concentration of all largemouth bass). Solving equation Hg 5-5* resulted in a RF of 0.7857. Illinois EPA multiplied the RF by 100 resulting in a 78.57 percent reduction.

$$Reduction\ Factor\ (RF) \ = \ C_{fish,current} - C_{fish,target}) \Big/ C_{fish,current} \quad (Hg\ 5-5)\ *$$

$$\%\ Reduction \quad = 100\ x\ \ C_{fish,current} - C_{fish,target}) \Big/ C_{fish,current} \quad (Hg\ 5-5)$$

$$78.57\ \% \ = 100\ x\ \ (\ 0.28 mg/kg - .06\ mg/kg)\ /\ (.28 mg/kg)$$

* The mercury TMDL associates both the calculation of the reduction factor and percent reduction with equation 5-5. EPA presents the equations for calculating these two values separately for clarity.

Where:

$C_{fish,current}$ = Current mercury concentrations in fish (mg/kg)
$C_{fish,target}$ = Target mercury concentrations in fish (mg/kg)

3.8 Calculation of Baseline Load and Annual Loading Capacity

A TMDL represents the assimilative capacity (LC) for a receiving water, expressed as the daily loads from nonpoint and point sources, as well as a margin of safety (MOS). Illinois EPA determined the maximum loading capacity for waters in the Illinois Lake Michigan Nearshore study area in Section 6 of the mercury TMDL. Illinois used equation Hg 6-2 in the Decision Document to calculate the loading capacity:

$$\text{TMDL} = \text{Baseline Load} \times (1 - \text{RF}) \qquad \text{(Hg 6 -2)}$$

The "reduction factor" (RF) is the amount the existing mean mercury fish tissue concentration must be decreased to achieve the target fish tissue mercury concentration (equation Hg 6-2 in this Decision Document). Illinois EPA describes in Section 6.1 in the mercury TMDL the steps it followed to calculate a baseline mercury load by adding the loads of mercury from point and nonpoint sources (including all air sources and NPDES-permitted discharges of mercury) to establish the mercury load for the baseline year (2001). Illinois EPA explained in Section 5.2 of the mercury TMDL that the year 2001 was selected as a baseline year based on the availability of atmospheric modeling results for 2001.

Illinois EPA notes in Section 6.1 of the mercury TMDL, that atmospheric sources of mercury can contribute directly to the study area via atmospheric deposition, or indirectly to the main body of Lake Michigan, with subsequent transport into the study area. The overall mercury baseline load is the sum of the existing nonpoint and point source loads of mercury for the baseline year. Table 4-3 of the Mercury TMDL displays the estimated loads from NPDES and Nonpoint mercury sources.

Available data reviewed by Illinois EPA contained no detectable mercury concentrations for any of the NPDES discharges in the study area. Illinois EPA explains that it did not include these sources in the baseline mercury load. The lack of detectable mercury concentration sample results in the study area made it difficult to estimate an accurate current/baseline NPDES load for the study area. Illinois EPA concluded from these estimates that these sources are likely a minor contributor as compared with the nonpoint sources (Table 4 of the Decision Document, Section 4.6 of the Mercury TMDL). Illinois EPA assumes that loads to the study area come mainly from the air, based on these estimates and because diffuse, or nonpoint, sources of mercury contributed to the study area largely consist of atmospheric deposition either falling directly to the study area or to the main body of Lake Michigan, with subsequent transport into the study area. Illinois EPA gives the stormwater point sources a WLA to ensure that these source loads do not lead to a WQS violation, as explained in the mercury WLA Section 5 of the Decision Document.

Illinois EPA selected 2001 as a baseline year, because atmospheric modeling results were available for 2001 (Section 5.2 of the mercury TMDL). Illinois EPA first calculated the baseline load as an annual average load. As explained in Section 6.6 of the mercury TMDL, the TMDL's goal is to address long-term mercury bioaccumulation in fish tissue, and there is a lag between the time that mercury enters the environment, and when it results in the bioaccumulation in fish. EPA finds using annual averages acceptable for calculating a baseline load, as the cumulative impacts are of greater concern for the consumption use than short term impacts. Illinois EPA expresses the results as a daily maximum in the final TMDL.

Illinois EPA presents its calculation of the hydrodynamic transport of mercury from the main body of Lake Michigan to the study area in Table 4-3 of the mercury TMDL. Illinois EPA calculates that transport as resulting in a load of 10.27 kg of mercury per year. Illinois EPA determined that direct atmospheric deposition contributed 23.24 kg/yr of mercury to the study area. The sum of these load values is the total nonpoint source load of 33.51 kg/yr for the baseline year of 2001.

Table 6. Baseline Mercury Load for 2001 (Mercury TMDL Table 6-1)

Portion of Baseline Mercury Load	Load
Point Source Load	No detectable concentration
Nonpoint Source Load	33.51 kg/yr
Total Baseline Load (2001)	33.51 kg/yr

Illinois also defined the percentage of atmospheric mercury nonpoint source loadings that come from anthropogenic and natural sources. Natural sources cannot be controlled and therefore cannot be counted toward the reductions needed to reach standards. Illinois EPA calculated the anthropogenic versus the natural portion of nonpoint source loading to the study area by using the 2001 deposition rate found in the REMSAD modeling results for the Lake Michigan Nearshore study area of 32.1 $\mu g/m^2$ (Section 6.1 of the mercury TMDL), and the Minnesota Mercury TMDL (2007) annual pre-industrial deposition rate of 3.7 $\mu g/m^2$ (Swain et al., 1992)[40]. to calculate the percentage of anthropogenic versus natural sources of mercury for the study area. Illinois EPA calculated mercury loading to the Illinois Lake Michigan nearshore to be 88 percent anthropogenic and 12 percent natural. Applying these percentages to the total nonpoint source load of 33.51, Illinois EPA estimated anthropogenic mercury loading contributions to be 29.49 kg/yr (0.081 kg/day), or 88 percent, and natural source contributions to be 4.02 kg/yr (0.0011 kg/day,) or 12 percent.

The baseline total source load is the sum of the point source load and the nonpoint source load for 2001. As discussed above, Illinois EPA determined that the most dominant sources of mercury to the study area are from the air and open lake (which can also be treated as air deposition to open waters) and treated the baseline load for 2001 as equivalent to the nonpoint source load. The baseline load for 2001 is 33.51 kg/yr (Table 6.1 of the mercury TMDL).

3.9 Mercury Total Maximum Daily Load (Loading Capacity)

In Section 6.2 of the mercury TMDL, Illinois EPA describes how it calculated the TMDL LC using the total baseline load above and the RF (defined in Section 5.2 of the mercury TMDL).

[40] 3.7 $\mu g/m^2$ is consistent with the Lake Michigan pre-industrial deposition rate of 3.1 $\mu g/m^2$ inferred by Rossmann (2010) in a study of the Lake Michigan nearshore. The study shows consistency between different venues of research. Illinois Lake Michigan Nearshore Mercury TMDL Report, 2016, LimnoTech, page 38.

Figure 1 of the Decision Document presents Illinois EPA's calculation applying equation Hg 6-2 in this Decision Document to obtain an annual load. The annual load is then divided by 365 days

$$\text{TMDL}^{*} = \text{Baseline Load}^{*} \times (1\text{-RF}) \quad \text{(Hg 6-2)}$$

$$7.18 \text{ kg/yr} = 33.51\text{kg/yr} \times (1 - 0.7857)$$

$$7.18 \text{ kg/yr/ (365 days/year)} = 0.020 \text{ kg/day}$$

* annual numbers are then expressed as a "daily load"

to translate the result to a daily load. This yields a TMDL of 0.020 kg/day (0.043 lbs./day).

Figure 6. Mercury TMDL Loading Capacity Calculation

Achieving the loading reductions in the TMDL is expected to result in in the waters within the study area meeting the fish tissue target for mercury of 0.06 mg/kg and attaining WQS. Illinois' method of dividing the annual load by 365 to determine a maximum allowable daily load is consistent with other Mercury TMDLs (MPCA, 2007, CDEP et al., 2007).

Table 7. Mercury TMDL Summary

TMDL Components	Result
Reduction Factor	78.57%
Final TMDL	
Loading Capacity (LC)	0.02 kg/day
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.0004 kg/day
Load Allocation (LA)	0.02 kg/day

3.10. PCB and Mercury Seasonal Variation

EPA explains in Section 6.6 of the PCB and mercury TMDLs that both PCBs and mercury concentrations in the atmosphere and water column can fluctuate seasonally, but that because water and fish PCB and mercury concentrations respond very slowly to changes in atmospheric loads, essentially no variation in fish PCB and mercury concentrations occurs as a result of seasonal variations in atmospheric concentrations. However, due to the extremely slow response time of water and fish concentrations to changes in atmospheric loads, the PCB and mercury concentrations in the fish represent an integration of all temporal variation up to the time of sample collection. Variability in fish-tissue PCB and mercury concentrations are more likely influenced by differences in size, diet, habitat, and other undefined factors that are expected to be greater in sum than seasonal variability (MPCA, 2007).

Illinois EPA used a simple fish tissue based (FTB) proportionality model to establish a cause and effect relationship between the numeric target and identified pollutant sources. EPA finds the approach reasonable because the available data do not support a more complex modeling method. The FTB approach allowed Illinois EPA to link PCB and mercury loads to surface *water directly to accumulated concentrations measured in the tissues of select fish species, and to establish a target percent reduction in fish tissue for PCBs and mercury. Illinois EPA's explanation for selecting carp and largemouth bass to represent the current fish tissue concentrations and needed reductions in PCBs and mercury (respectively) in all fish is reasonable. Illinois EPA also translated the 94.7 percent and 78.6 percent reductions needed (for PCBs and Mercury, respectively) in the fish tissue into a proportionate reduction in air and water sources, expressing the result as daily loads.*

Illinois EPA compared the results from the FTB approach in the PCB TMDL with results from the GEM approach to explore the influence of historic sources, which are not accounted for in assumptions of the FTB approach. GEM combines theoretical and empirically-based equations and BAFs to link loads from the air to PCB concentrations in the water column and fish tissue. Illinois EPA noted that GEM does not require existing fish tissue concentration data and it is not influenced by the legacy effect inherent in the existing carp tissue data, which removes the influence of legacy sediment in determining a percent reduction. The GEM approach did not contraindicate the FTB method. Illinois EPA also used GEM to confirm that atmospheric load reductions would result in the water column meeting the Illinois WQS and the target for PCB concentrations in fish tissue. Illinois EPA adequately demonstrated that diffuse sources of gas phase PCBs and mercury in the atmosphere over the surface of the Lake Michigan Nearshore study area, and contributions transported into the study area from the waters of the open lake are the largest current contributors of PCBs and mercury to the study area. Illinois EPA provided adequate basis for deriving necessary percent reductions and the loading capacity from the sum of these nonpoint sources for both the PCBs and mercury TMDLs. Illinois EPA adequately supported its evaluation of the quantity and accuracy of available data and its estimation of loads from point sources of mercury and PCBs using data from similar areas and assigned a waste load allocation for these sources that is within the rounding error of the total LC. Illinois EPA adequately accounts for seasonal variation, and adequately discusses the approach to computing and allocating source loadings considering a variety of complex watershed characteristics. EPA finds that the Illinois Lake Michigan nearshore PCB and Mercury TMDLs adequately identify the loading capacities of 0.0026 kg/day for PCBs and 0.020 kg/day for mercury.

4. Load Allocations

EPA regulations require that a TMDL include LAs, which identify the portion of the loading capacity attributed to existing and future non-point sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Where possible, load allocations should be described separately for natural background and non-point sources.

Comment:

4.1 PCB Load Allocation

Illinois EPA calculated a loading capacity of 0.0026 kg/day in Section 6.2 of the PCB TMDL. The loading capacity is based on a 94.7 percent reduction in atmospheric PCB concentration determined by Illinois EPA to be necessary to attain PCB levels that are protective of designated uses. There are two components of the loading capacity (LC): direct atmospheric exchange of PCBs to the study area and transport of PCBs into the study area from Lake Michigan (which also originate from atmospheric deposition). In Section 6.4 of the PCB TMDL, Illinois EPA equates the LA to the LC of 0.0026 kg/day as the data available for point sources in the study area are limited, and Illinois EPA estimates the loadings from such sources to be much smaller than the nonpoint sources. (Section 3.9 of the Decision Document).[41] EPA finds this assessment to be reasonable. Additionally, over 90% of the area is MS4, and reductions in atmospheric deposition would likely reduce contaminants washed off and carried into stormwater.

Table 8. PCBs Load Allocation
(PCB TMDL Table 6-3)

Portion of Load Allocation	Result
Direct atmospheric exchange	0.0015 kg/day
Transport from Lake Michigan	0.0011 kg/day
TOTAL	0.0026 kg/day

Illinois EPA pointed out that dynamic atmospheric mixing processes make it difficult to identify and quantify the origin of atmospheric PCBs from outside of Illinois. Instead, Illinois EPA calculated the portion of PCBs from inside the state to be 73 percent of the study area's atmospheric PCB loading. Illinois EPA determined, therefore, that 27 percent of the PCB load is coming from out-of-state sources.

4.2 Mercury Load Allocation

The mercury load allocation (LA) is presented in Section 6.4 of the mercury TMDL. The LA is essentially equivalent to the mercury LC of 0.02 kg/day calculated in Section 6.2 of the mercury TMDL.[42] Illinois EPA treated atmospheric deposition (including the hydrodynamic transport of deposited mercury into the study area from Lake Michigan) as the primary source of mercury to the study area, which is explained above in the Section entitled: Calculation of a Baseline Mercury Load and Relative Source Contributions in this Decision Document. This Section also explains why Illinois EPA used 89 percent as the anthropogenic portion of diffuse loadings from atmospheric and hydrodynamic transport of mercury to the study area. The mercury load attributed to natural sources is 0.011 kg/day[43] (Section 6.1 of the mercury TMDL, Section 3.9 of the Decision Document). Illinois EPA concluded that the reductions needed to achieve the LA for atmospheric deposition must be achieved by reducing the anthropogenic sources of mercury deposition. As discussed in Section 4.2 of the TMDL (and the Section 1 source review of this

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[41] A portion of the load capacity will be allocated to point sources, but this portion is within the round-off error of load allocation

[42] "A portion of the loading capacity will be allocated to point sources, but this portion is within the round-off error of load allocation." (See 6-4 of the Mercury TMDL)

[43] The value 4.02 kg/yr divided by 365 d/yr

Decision Document), the contribution of both in-state and out-of-state sources of mercury deposition in Illinois is provided by the REMSAD modeling results.

Illinois EPA considered the anthropogenic components of the LA when assessing where mercury reductions are possible. Illinois calculates the required reductions from anthropogenic sources, by dividing the its determined reduction of 79 percent (Section 5.2 of the mercury TMDL) by the percentage of contribution from the anthropogenic sources (88 percent). Section 6-4 of the mercury TMDL calculates the required reduction in the anthropogenic deposition at 89.29 percent. The table below identifies the portion of the anthropogenic nonpoint source loads that can be attributed to in-state and out-of-state loads.

Table 9. Mercury Load Allocation (Mercury TMDL Table 6-5.)

Mercury Load Allocation for In-State and Out-of-State Deposition Sources	
In-State Contribution to LA[a]	0.0036 kg/day
Out-of-State Contribution to LA[b]	0.0160 kg/day
Necessary Reduction from Anthropogenic Emission Sources	89.29%

Note: numbers may not sum exactly due to rounding

[a] Anthropogenic sources only

[b] Anthropogenic and natural sources

Illinois EPA assumes that reductions from out-of-state sources will be consistent with those required for in-state sources to meet the reductions necessary to attain WQS. Illinois EPA also recognizes the importance of reducing in-state sources, even though reducing in-state mercury concentrations alone will not attain compliance with WQS.

Illinois EPA established the load allocation for PCBs and mercury as being equivalent to the loading capacity. Section 3 of the Decision Document provided the basis for treating atmospheric deposition as the primary source of PCBs and mercury to the study area. Illinois EPA includes in this category the deposition from the atmosphere to the open waters of Lake Michigan that is transported to the study area. Illinois EPA also considered the portion of the source load that could not be controlled from natural sources for mercury (there are no natural sources of PCBs). EPA finds that the simple approach used by Illinois EPA to set reductions is adequate. EPA agrees that the description of the LA and needed reductions, are reasonable. Illinois EPA describes a reasonable approach that will, over time, result in needed reductions in fish tissue PCBs and mercury to reach target reductions to achieve the appropriate water quality designated uses in waters covered by the TMDL.

5. Wasteload Allocations (WLAs)

EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40

C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit.

The individual WLAs may take the form of uniform percentage reductions or individual mass-based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. These individual WLAs may be adjusted during the NPDES permitting process. If the WLAs are adjusted, the individual effluent limits for each permit issued to a discharger on the impaired water must be consistent with the assumptions and requirements of the adjusted WLAs in the TMDL. If the WLAs are not adjusted, effluent limits contained in the permit must be consistent with the individual WLAs specified in the TMDL. If a draft permit provides for a higher load for a discharger than the corresponding individual WLA in the TMDL, the State/Tribe must demonstrate that the total WLA in the TMDL will be achieved through reductions in the remaining individual WLAs and that localized impairments will not result. All permittees should be notified of any deviations from the initial individual WLAs contained in the TMDL. EPA does not require the establishment of a new TMDL to reflect these revised allocations as long as the total WLA, as expressed in the TMDL, remains the same or decreases, and there is no reallocation between the total WLA and the total LA.

Comment:

A table identifying study area entities with individual PCB and mercury NPDES permits is included in Appendix B of the Decision Document. Appendix B also lists the MS4 permittees in the study area.

5.1 WLA for PCB -NPDES Permitted Facilities

Illinois EPA identified three individual NPDES-permitted dischargers with PCB permit conditions. in Section 6.3 of the PCB TMDL. The entities along with their associated permit numbers are listed in Appendix B of this Decision Document. Although measured data were limited in quantity or showed results below detection limits, Illinois EPA determined through estimation of potential relative loads that point source PCB loads were small compared to nonpoint source loads, either current or future loads. Illinois EPA established WLAs for these sources based on attainment of WQS at the point of discharge, to ensure that these sources maintain compliance with WQS and avoid causing or contributing to violation of the WQS.

As noted in Section 1 of this Decision Document, Illinois EPA explained in Section 4.5 in the PCB TMDL how the contributions of NPDES sources in the study area were considered for the TMDL. Three individual NPDES permits in the watershed have permit special conditions for PCBs: Zion Station (IL0002763), Winnetka Power Generation Station (IL0002364), and Midwest Generation LLC Waukegan (IL0002259). All of these permits state "There shall be no discharge of PCBs."

In addition to the "no discharge of PCBs" special permit condition, Zion Station (IL0002763) also has permit monitoring requirements for PCBs. All available effluent PCB measurements (2009-2015) for Zion Station were less than the 0.001 mg/ L (1000 ng/L or 1,000,000 pg/ L) detection limit. Illinois EPA multiplied the average facility flow of 3.6 MGD from Zion Station by the detection limit concentration of 0.001 mg/L.[44] Table 1 in the Decision Document shows the resulting upper bound load estimate as less than 5 kg/yr. Illinois EPA concluded that it could not accurately quantify current loads for these sources because data were not available for the three facilities.

Because of the "no discharge" requirement in the NPDES permits, the three facilities (Zion Station (IL0002763), Winnetka Power Generation Station (IL0002364), and Midwest Generation LLC Waukegan (IL0002259)) were assigned a WLA = 0.

Illinois EPA identified three NPDES-permitted facilities that have Special Conditions for PCBs. The three individual permits state, "there shall be no discharge of PCBs," and Illinois EPA set their WLA as zero, consistent with their existing permits.

WLA for PCB -Municipal Separate Storm Sewers (MS4s)

Stormwater discharges are regulated under the NPDES MS4 program (i.e., Phase I and Phase II communities). With the exception of Burnham, all of the municipalities listed above in this Decision Document's Spatial Extent and Scope Section have MS4 permits for stormwater discharges to Lake Michigan, and 100% percent of the study area watershed lies within an MS4 city or village or regulated entity. The MS4 permits include these municipalities, together with the MS4 permits for the Cook County Highway Department, Illinois Department of Transportation, Lake County, Shields Township, and Waukegan Township (permit numbers presented in Table B-1 in Appendix B of the Decision Document). Because the study area watershed has no site-specific data for stormwater PCB or mercury loads ((MWRDGC, 2015), Illinois EPA estimated the stormwater pollutant loads for both PCB and mercury based on the drainage area, stormwater runoff quantity, and stormwater pollutant concentration from samples outside the watershed. Runoff quantity was calculated using the method developed by the Metropolitan Washington Council of Governments (MWCG) (Schueler, 1987) as:

$R = P \times Pj \times Rv$

where:

R = Annual runoff (inches),
P = Annual rainfall (inches), estimated as 36.1 inches, based on the average annual rainfall reported for Chicago Midway Airport 3 SW for the 1929-2013 period
Pj = Fraction of annual rainfall events that produce runoff (set to the default of 0.9)
Rv = Runoff coefficient.

Rv is a function of impervious cover in the study area watershed calculated using Geographic Information System (GIS) analysis to determine land use categories: commercial (0.71), industrial (0.54), and residential (0.37). The following runoff coefficients resulted from these impervious cover values: commercial (0.69), industrial (0.54), and residential (0.38). The area of the contributing watershed was calculated as 99.6 square miles, broken down as 3.82 square

[44] David Dilkes, email 5/16/18.

miles commercial, 4.05 square miles industrial, and 91.73 square miles residential.

Illinois EPA determined an aggregate WLA for 20 MS4-permitted entities by multiplying the total daily stormwater flow delivered to the study area from the MS4 entities (calculated in Section 4.3 of the PCB TMDL) by a concentration equal to the water quality standard to convert it to a load. This results in a stormwater MS4 WLA of 0.0022 kg/yr (0.000006 kg/day). Illinois EPA did not assign individual WLAs to each MS4 entity; rather, Illinois EPA determined the WLA for all entities as an aggregate WLA (Table B-1 in Appendix B of the Decision Document).

Because the PCB WLA for the three individual permits is zero (consistent with their existing permits that state, "There shall be no discharge of PCBs"), the total PCB WLA was set equal to the MS4 WLA: 0.0022 kg/yr (0.000006 kg/day).

5.2 WLA for Mercury -NPDES Permitted Facility

Illinois EPA presents the mercury waste load allocations in Section 6.3 of the mercury TMDL. The NSWRD Waukegan Water Reclamation Facility (IL0030244) is the only individual NPDES permit in the TMDL study area with mercury limits (see Appendix B in this Decision document). The WLA for this facility is set equal to its permitted mercury load of 0.04 kg/year, which translates to 0.0001 kg/day at design average flow Table B-1 in Appendix B of the Decision Document.

WLA for Mercury - Municipal Separate Storm Sewers (MS4s)

Illinois EPA discusses MS4 permits in Section 4.3 of the mercury TMDL. The list of permits is presented in Table 6-2 in the TMDL and Appendix B in this Decision Document. Site-specific mercury data were not available for the permitted MS4 stormwater discharges in the study area watershed (MWRDGC, 2015). Illinois EPA estimated existing loads using the product of runoff, the study area drainage area, and an assumed mercury concentration from stormwater sampling conducted outside of the TMDL watershed. Illinois EPA assumed that all stormwater runoff generated within the TMDL watershed drains to Lake Michigan. The results indicated that runoff from MS4s is a very small contributor to existing mercury loads to the segments.

Section 6.3 of the mercury TMDL explains that some of the mercury in stormwater may originate from air deposition (accounted for under LA) or other sources that are not easily quantified. Illinois EPA assigned an aggregate wasteload allocation to entities with MS4 permits in the project study area, to ensure that MS4s do not cause or contribute to future violations of the water column standard of 1.3 ng/l. Illinois determined the MS4 WLA by multiplying the stormwater flow delivered to the study area from these sources (calculated in Section 4.3) by a concentration equal to the WQS to convert it to a load. This results in a stormwater MS4 WLA of 0.11 kg/yr or 0.0003 kg/day Table B-1 in Appendix B of the Decision Document. Illinois EPA's permitting process will address reductions and loads for permitted entities. Best management practices for MS4 mercury reductions are discussed in Section 7 of the TMDL.

EPA finds that the PCB and mercury WLAs submitted by Illinois EPA for the NPDES-permitted facilities in the Illinois Lake Michigan Nearshore TMDLs satisfy all requirements of this element. The contributions of PCBs and mercury to the TMDL study area from point sources are difficult to accurately quantify because existing sample results are limited, or below detection limits. Illinois EPA estimated the NPDES-permitted contributions for this TMDL to be a small portion of the total load in comparison to nonpoint sources, using PCB and mercury concentration data from areas outside the study area (discussed in Section 3 and 4 of the Decision Document). These areas had samples that were analyzed using sensitive analytical techniques capable of measuring results at a lower concentration. Small PCB and mercury WLAs are assigned to the NPDES sources to address any future exceedances of the TMDL targets in the event additional information, such as samples analyzed using a more sensitive detection limit or reductions from other sources, show point sources to be a larger proportion of the total load.

6. Margin of Safety (MOS)

The statute and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Comment:

6.1 PCB Margin of Safety

For this PCB TMDL, Illinois used an implicit MOS by selecting the method for calculating percent reduction that resulted in the higher and therefore more conservative reduction percentage. The MOS is implicit because carp tissue data were used as the basis for calculating required reduction percentages. Illinois also calculated the necessary percentage reduction in fish tissue, using lake trout tissue PCB concentrations. Lake trout are less likely to be influenced by legacy effects, spending less time feeding among bottom sediments, resulting in much lower tissue concentrations and required reduction percentages. Calculating the reductions to achieve the TMDL targets based on the species with highest average PCB tissue concentration incorporates an implicit MOS into the analysis, as the required reduction for other species will probably be less.

6.2 Mercury Margin of Safety

Illinois EPA used an implicit MOS for this mercury TMDL because the modeling approach being applied does not account for fish tissue concentration that may come from legacy effects, so percent reductions from the atmosphere could be higher than necessary to compensate for legacy effects. Illinois EPA selected the most recent available largemouth bass data for use in this TMDL. Because the average life span of largemouth bass is 16 years (TPWD, 2015), the fish tissue data likely reflect historically higher mercury loads to some extent, and a longer period to bioaccumulate resulting in a larger percent reduction than if shorter-lived species were used. Largemouth bass is also a large, high level predator species that concentrates a greater amount of mercury than other species, and some species will be below the target concentration level after reductions aimed at reducing concentrations in largemouth bass.

Illinois EPA explained how the MOS is implicit and based upon conservative assumptions used throughout the PCB and Mercury TMDLs. EPA finds that the TMDL document submitted by Illinois EPA adequately identifies the margin of safety for PCBs by using a 97.4 percent and an 88 percent mercury reduction, respectively, in current sources across the state which were derived using species that have higher value fish tissue PCB and mercury concentrations such that, when the reduction target us met, most species will be at or below the TMDL target concentrations in fish. EPA also finds that Illinois EPA adequately identified the margin of safety by its choice of high-level predator species with multiple characteristics that contribute to greater concentration of mercury.

7. Seasonal Variation

The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variations. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Comment:

7.1 PCBs Seasonal Variation

Illinois EPA's approach in the Lake Michigan Nearshore PCB TMDL accounted for the influence of seasonal variations because the fish tissue PCB concentration target incorporates the variation of PCB concentrations in the atmosphere and water column that occur over the seasons. Concentrations in the atmosphere and water column can fluctuate seasonally. PCBs accumulate in fish tissue more slowly than seasonal fluctuations in the water and air occur, because the bioconcentration of PCBs in fish tissue takes place over the course of years. The increases in fish do not correspond to seasonal variations. This represents an integration of all temporal variation up to the time of fish tissue sample collection. Variability in fish tissue PCB concentrations is more likely influenced by differences in size, diet, habitat, and other undefined factors that are expected to be greater in sum than seasonal variability (MPCA, 2007).

7.2 Mercury Seasonal Variation:

As described in section 6.6 of the Mercury TMDL, mercury concentrations in the atmosphere and water column can fluctuate seasonally related to a number of factors influenced by seasonal conditions; however, response time of water and fish concentrations to changes in atmospheric loads, is extremely slow. The mercury concentration in the fish represents an integration of all the variations in atmospheric mercury concentration up to the time of sample collection. Thus, seasonal variations are accounted for in Illinois EPA's approach. Certain waterbodies and fish species are more likely to bioaccumulate mercury because of individual water chemistry characteristics and the biochemistry of individual fish species. Variability in fish tissue mercury concentrations is more likely influenced by differences in size, diet, habitat, and other undefined factors that are expected to be greater in sum than seasonal variability (MPCA, 2007).

EPA finds that the Mercury and PCB TMDL documents submitted by Illinois EPA adequately accounts for seasonal variation for mercury and PCBs due to air deposition across the study area.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Discharge Elimination System (NPDES) permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an approved TMDL.

When a TMDL is developed for waters impaired by both point and non-point sources, and the WLA is based on an assumption that non-point source load reductions will occur, EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that non-point source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

EPA's August 1997 TMDL Guidance also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by non-point sources. However, EPA cannot disapprove a TMDL for non-point source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.

Comment:

8.1 PCB TMDL and Mercury TMDL Reasonable Assurance

Illinois EPA identified air deposition as the most significant source of PCBs and mercury to the Lake Michigan Nearshore surface waters study area, either through direct deposition to the waters of the study area, or through deposition to portions of Lake Michigan's surface that are transported into the study area (hydrodynamic transport). Illinois EPA noted that atmospheric PCB and mercury loads can be reduced through the targeted reduction of PCBs in Illinois, limiting the amount of PCBs that volatilize into the atmosphere. Illinois EPA stated in the mercury TMDL that it is important to reduce all possible sources of mercury, as mercury cycles from atmosphere to surface water. Further, mercury from the atmosphere that is deposited on impervious area and runs off in stormwater can be intercepted by Best Management Practices (BMPs) and prevented from continuing to cycle through natural and engineered systems by adjusting existing controls that remove other stormwater pollutants (Section 7.1 of the Mercury TMDL). Similarly, Illinois EPA explains that point source stormwater loads of PCBs can be controlled either by reducing the amount of PCBs entering the stormwater system and/or treating the stormwater itself (Section 7.1 of the PCB TMDL). Mercury's behavior in the environment is different than PCBs because under certain conditions mercury is methylated in the environment which influences the rate of bioaccumulation in fish.[45] Illinois EPA recognized the importance of reducing all possible sources of PCBs and mercury to address the tendency of both contaminants to cycle between media and bio-accumulate in fish tissue.

Illinois EPA plans to identify locations where PCBs and mercury can be controlled, and to remove the contaminants via BMPs at the points where they can be used most effectively to provide reasonable assurance of attaining required reductions. (Section 7.1, PCB and mercury TMDLs). Illinois EPA has described monitoring that can identify areas likely to contain sinks or sources of PCBs and mercury in Section 9 of the Decision Document.

The details for identifying appropriate BMPs, community engagement and scheduling are presented in Section 10 (Implementation) of this Decision Document. Illinois EPA also provided an outline of actions for reducing PCBs in the study area with examples of how they plan to blend the BMP approach with existing programs and information generated by PCB and mercury reduction efforts.

MS4 Stormwater Reasonable Assurance for PCBs and Mercury

Illinois EPA established a WLA associated with MS4 stormwater discharges of 0.000006 kg/day for PCBs (Section 6.3 in the PCB TMDL), and 0.0003 kg/day for mercury (Section 6.3 in the mercury TMDL). "40 CFR 122.44 (k) provides states with the authority to establish conditions requiring (implementation of) BMPs in NPDES permits. Illinois EPA plans to initiate Minimum Control Measures for PCBs and mercury in their MS4 permits to achieve reductions in PCBs and mercury that are consistent with the Lake Michigan Nearshore TMDLs to prevent PCBs and mercury from reaching impaired waters via stormwater.

Illinois EPA explained in Section 7.4.1 in the PCB and mercury TMDLs that the MS4 General Permit IL40 requires all regulated construction sites to have a stormwater pollution prevention plan that meets the requirements of the MS4 General Permit ILR40. Part IV of General NPDES Permit No. ILR10 requires that management practices, controls, and other provisions be at least as protective as the requirements contained in the Illinois Urban Manual, 2014, or as amended, including green infrastructure techniques where appropriate and practicable. In addition, there are requirements for meeting TMDL allocations:

[45] Figure 2-2 in the mercury TMDL depicts how mercury enters and cycles through ecosystems, biomagnifies up the food web, and bioaccumulates in fish and wildlife (Evers et al., 2011).

> "If a TMDL allocation or watershed management plan is approved for any waterbody into which you discharge, you must review your stormwater management program to determine whether the TMDL or watershed management plan includes requirements for control of stormwater discharges. If you are not meeting the TMDL allocations, you must modify your stormwater management program to implement the TMDL or watershed management plan within eighteen months of notification by Illinois EPA of the TMDL or watershed management plan approval."

Within 60 days of TMDL approval, Illinois EPA will mail copies of the approved TMDLs to MS4 communities and permittees along with a menu of best management practices for implementation of the TMDL. The General Permit Part III[46], Special Condition (C) requires the MS4 Permittee to comply with the WLA when a TMDL is developed for that particular watershed within 18 months following notification by Illinois EPA once the TMDL is approved. It should be noted that Federal TMDL regulations require that permits be consistent with TMDL WLAs, but do not specify how States should implement them in their permitting and other programs.

A "Menu of BMPs for MS4s and MS4 Communities" was proposed by Illinois EPA and can be found in Appendix D and C of the Illinois EPA PCB and Mercury TMDL, and in Appendix C of this Decision Document. Illinois EPA states that the BMPs can be adopted, as appropriate, as minimum measures for permits to be consistent with the WLA contained in the TMDL. Illinois EPA intends to incorporate them into the MS4 General Permit by reference.

Illinois EPA also described PCB and mercury BMPs in Sections 7.2 of the PCB and Mercury TMDLs. Illinois EPA noted in the TMDLs that appropriately identified and installed BMPs will prevent the release and transport of PCBs and mercury and reduce their presence in surface waters. For example, atmospheric mercury and PCBs that are deposited onto impervious materials, surface water or soils, can be transported via stormwater into Lake Michigan. Most of the BMPs can be implemented as part of local stormwater management plans or in MS4 permits and are further detailed in Section 10 of this Decision Document.

8.2 PCB Reasonable Assurance

Illinois EPA proposed to work in collaboration with others to reduce the number of potential PCB sources to Lake Michigan. Illinois EPA adapted a list of actions and BMPs proposed by the Washington Department of Ecology (2014) for identifying and addressing these sources. Illinois EPA's proposed actions and BMPs in Section 7.4.1 of the PCB TMDL are summarized below.

1. In partnership with communities and stakeholders in the study area, assessment of schools and other public buildings for the presence of PCB-containing building materials. Identification of buildings most likely to contain PCBs based on age, type of construction and scope of any past remodeling.

46 According to Illinois EPA the re-issued MS4 General Permit became effective on March 1, 2016.

a. Surveying and assessing PCB-containing lamp ballasts in schools and other public buildings. Encourage replacement with more energy efficient PCB–free fixtures. Use of data from item 1 above to identify those buildings where PCB-containing light ballasts are likely still in use, with schools as a priority. Visual inspection to identify lamp ballasts with PCBs. Combining PCB removal with increasing energy efficiency where possible.
b. Finding avenues to provide information to government building managers about the importance of removing ballasts and programs aimed at replacing fixtures with more energy efficient fixtures. Providing technical and informational reports for proper handling of PCB containing fixtures.

2. Identifying, developing and promoting BMPs for containment of PCB-containing materials in buildings currently in use and those slated for demolition.

    a. Working with USEPA Region 5, Illinois EPA, local governments, the Waukegan Harbor Advisory or other local citizen organizations in the TMDL study area to identify outreach materials developed to prevent PCB exposure from building materials and prevent their release into the environment.
    b. Identifying additional audiences for outreach and avenues for informational material distribution.
    c. Creating a connection to EPA's Green Demolition Initiative by providing added information on potential for PCB-containing materials in demolitions. Circulating through established channels for green demolition materials to appropriate contractors and businesses engaged in demolition activities in Illinois Nearshore Lake Michigan TMDL area.

3. Learning more about what products contain PCBs and promote the use of processes that do not inadvertently generate PCBs. (Unpermitted non-point releases, such as from consumer products, are becoming increasingly important to control to reduce overall PCB delivery).
    a. Starting with the EPA report (1982) identifying 70 manufacturing processes likely to inadvertently generate PCBs, and efforts in the Great Lakes to reduce PCBs. Identifying existing information about PCBs in pigments and dyes, which are potential sources of PCBs to the environment. Identifying potential audiences in the TMDL area for sharing information to develop alternative purchasing options that don't have potential to release PCBs [Note that a list is being developed by Washington Department of Ecology and Green Chemistry Northwest].
    b. Working with EPA and other government partners to promote alternatives to supplies that contain PCBs and share with partner green purchasing programs.

4. Surveying and identifying "retirement" dates of electrical equipment that contains more than 2 ppm PCB. (From 1929 to 1979 the production of PCBs in the US was

approximately 1.4 billion lbs. (600,000 metric tons), with the largest use for electrical equipment (EPA, 1994). Federal regulations focus on transformers with more than 500 ppm PCBs.) Identifying funding to collect and properly dispose of this equipment with concentrated PCBs.

5. Using a best management practices approach to reduce PCBs in the study area by effectively managing discharges of PCBs from NPDES permitted stormwater sources, including MS4s (see MS4 Stormwater Reasonable Assurance for PCBs and Mercury in Section 8.1 of the Decision Document for more detail.

6. Compiling a list of materials to use for conducting a public educational campaign. Identify and utilize avenues in cooperation with stakeholders for distributing to the public. (Refer to Appendix E of the PCB TMDL for resource information and Appendix E for a list of study area stakeholder groups.)

PCB Individual NPDES-Permitted Dischargers

Even though Illinois EPA estimates point source PCB loads to be small compared to current nonpoint source loads, they conclude that it is important to ensure that these loads will not cause or contribute to a violation of the WQS after reductions of nonpoint sources occur. Illinois EPA established WLAs of zero for the three individual NPDES-permitted dischargers, consistent with their existing permits that state "there shall be no discharge of PCBs." (Section 6.3 of the PCB TMDL)

PCBs Great Lakes Projects and Activities

In Section 7.4.2 Illinois EPA describes Great Lakes projects and activities that continue to achieve improvements in the water quality of the Great Lakes. The Great Lakes Water Quality Agreement between the United States and Canada (1972) was updated in 2012 to identify and manage current water quality threats to the Great Lakes. Several priority areas, called "Annexes," commit the U.S. and Canada to addressing specific issues relevant to this PCB TMDL:

- Annex 1 Areas of Concern: Restore beneficial uses at AOCs like Waukegan Harbor and implement Remedial Action Plans.
- Annex 2 Lake Management: Develop a Lake-wide Management Plan for Lake Michigan in 2019.
- Annex 3 Chemicals of Mutual Concern: Reduce anthropogenic release of certain chemicals. including PCBs. In February 2014, both the U.S. and Canada committed to the continued monitoring of PCBs in the Great Lakes and to coordinate PCB reduction efforts.

The Great Lakes Restoration Initiative has provided funding to U.S. agencies and stakeholders for investing in the Great Lakes. Eleven Federal agencies developed the GLRI Action Plan II for

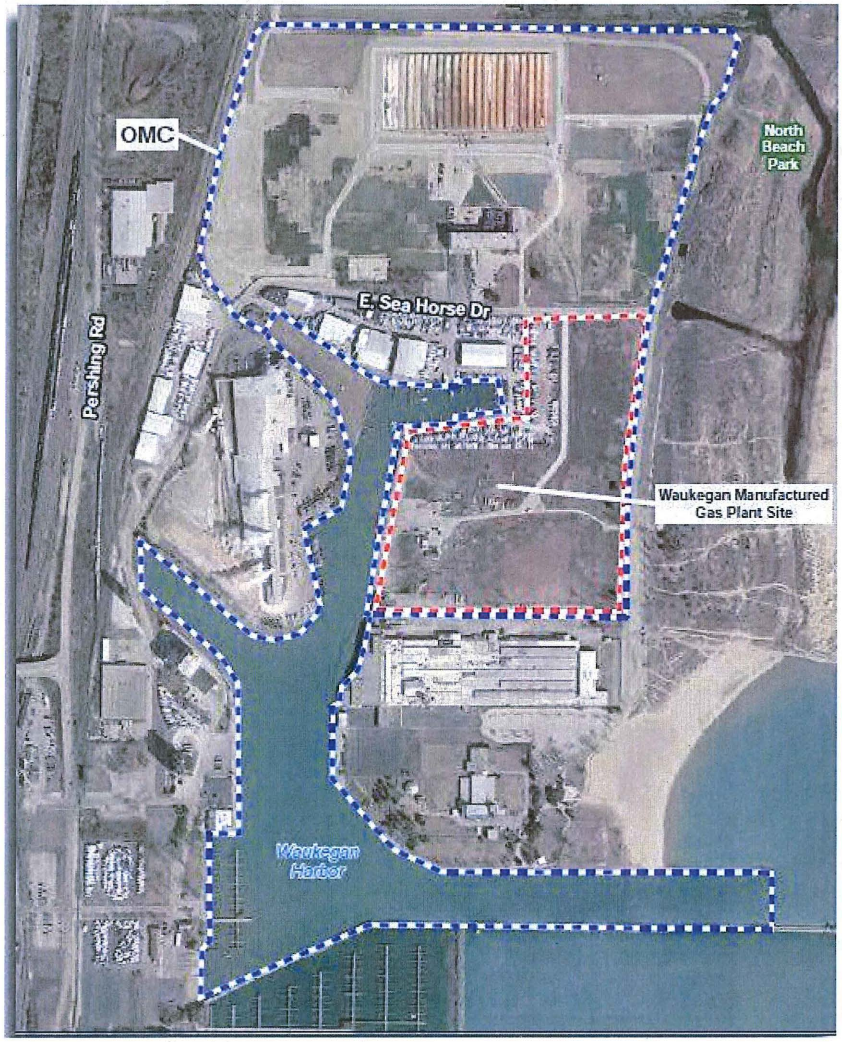
2015 through 2019 and one of the plan's focuses is on cleaning up of AOCs, including PCBs in Waukegan Harbor. (Figure 7-1).

Waukegan Harbor AOC

Waukegan Harbor is the largest PCB-contaminated Superfund site on the Great Lakes and has undergone a series of clean up actions to reduce the total PCBs in the environment and achieve Superfund targets (see Section 1.2 of the Decision Document). The Waukegan Harbor AOC/OMC Superfund site consists of four cleanup units. PCBs are found in the Waukegan Harbor and on the OMC Plant 2 units. The history of ongoing clean up at the site includes:

- The cleanup of sediment with a PCB concentration of 50 ppm followed by lowering the goal to less than 1 ppm. The site will remain an AOC until the 1 ppm goal is met (IDNR, 2011); The continuing operation and maintenance of three PCB containment cells and associated treatment mechanisms by the City of Waukegan from 1992 to 2005, under EPA oversight;
- The Waukegan Harbor Area of Concern Habitat Management Plan (IDNR, 2012 which defines the PCB target for Waukegan Harbor open water unit as "reduce PCB levels in Waukegan Harbor sediments to 0.2 ppm;"
- Hydraulic dredging of sediment with residual contamination from the harbor by EPA completed in July 2013. The sediment was pumped to the OMC Plant 2 property for storage in a consolidation facility to fully clean the harbor.

Figure 7. Waukegan Harbor AOC (Source: USEPA, 2014)



EPA finds Illinois EPA's assurance that the continuing efforts to clean up Waukegan OMC site will result in reductions of PCB concentrations in and around the site is reasonable and that these efforts will contribute to achieving the PCB targets in the TMDL. It is also reasonable to assume that the site's regulatory status as both an AOC and Superfund site will result in clean up actions by EPA, Illinois EPA and partners that will continue until program goals for the sites are met.

8.3 Mercury TMDL Reasonable Assurance

In the Mercury TMDL, Illinois EPA concludes that the largest source of mercury to the study area is from the air. Emissions from coal-fired electric utilities (discussed in TMDL Section 4.2.2), which are the largest source of airborne mercury deposited to study area waters, are permitted through Federal and State clean air programs. The Reasonable Assurance discussion in Section 7.4 of the TMDL focuses on the mercury air reductions called for in the Mercury Air Toxics Standards (MATS) under the Federal Clean Air Act authority, Illinois State Regulation, and other air controls. Section 7.4 of the TMDL also identifies water, waste and other programs at the state and Federal level that reduce mercury emissions through a variety of controls.

In Section 7 of the TMDL Illinois EPA also identifies "potential sources to target for control" and a suite of appropriate BMPs for reducing mercury loads, implementation and existing activities to reduce mercury, funding opportunities, monitoring, and a schedule. Highlights of the schedule for these implementation activities are part of the Decision Document's Reasonable Assurance discussion.

Mercury - State Atmospheric Regulations

As Illinois EPA showed in Section 6 of the TMDL, reductions in anthropogenic sources outside of Illinois are needed to achieve the TMDL target mercury concentration for fish tissue of .06 mg/kg. Illinois EPA's achievement of the TMDL goal is dependent upon regional and global mercury emission reductions.

By 2005, mercury emissions from medical waste incinerators and municipal waste combustors had declined by more than 90 percent (Figure 4-3 from the TMDL) due to implementation of regulatory controls required by the Clean Air Act Amendments in the late 1990's (Section 4 of the TMDL). As a result, mercury emissions from power plants and coal-fired power plants became the single largest source of mercury emissions nationwide and in the Great Lakes region (Evers et al., 2011; Schmeltz et al., 2011).

In 2007, the State of Illinois promulgated the Illinois Mercury Rule (35 Ill. Adm. Code Part 225) to reduce mercury and other pollutants. The Illinois Mercury Rule required emissions to be reduced by approximately 90% statewide by 2015. Mercury emissions from coal-fired power plants in Illinois were estimated at 7,700 pounds per year in 2006 and are currently estimated to be less than 600 pounds per year, when also accounting for the retirement of 18 coal-fired units in Illinois since 2007. Each coal-fired electric generating unit at the NRG/Midwest Generation, LLC in Waukegan Illinois is equipped with a mercury control system consisting of activated carbon injection, an electrostatic precipitator, and a dry sorbent injection system. The facility currently operates two coal-fired electric generating units (numbered 7 and 8). In 2012, unit 8 was found to have around 94% efficiency in reducing mercury emissions. This facility is currently in compliance with the Illinois mercury rule. Illinois EPA expects that seven more units will be retired statewide or converted to natural gas, adding to mercury emission reductions by the end of the decade. Several of these units are in the Great Lakes Basin area. It is reasonable for Illinois EPA to anticipate that these changes in the control of mercury through installation of pollutant control improvements will result in mercury emission reductions, based on the response of other combustion source reductions as described above. Illinois EPA adequately supports its expectation that mercury reductions from these sources will be reflected in fish tissue over time, assuming a proportional relationship to emission reductions.

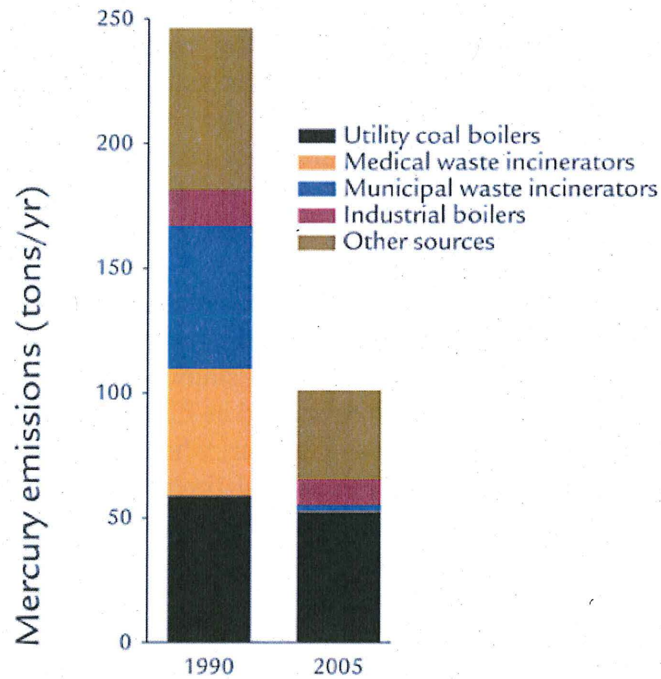
National Mercury and Air Toxics Standards (MATS)

Illinois EPA points out how air sources of mercury that are outside of State of Illinois regulatory authority may also be addressed over time through National level programs. On February 16, 2012, EPA published the first ever national standard, known as the Mercury and Air Toxics Standards (MATS)[47] to reduce mercury and other toxic air pollutants from coal- and oil-fired power plants covered by these standards. The final rule established power plant emission standards for mercury which EPA expects to result in preventing about 90 percent of the mercury in coal burned in power plants across the nation from being emitted to the air electric generating units (EGUs). Nationwide, there are about 1,400 coal and oil-fired EGUs. Existing sources were

[47] http://www3.epa.gov/mats/basic.html

given up to 4 years to comply with MATS. The MATS rule requires that installation of any needed treatment equipment be in operation and meeting emissions standards by the April 2015 deadline. The power plant operated by NRG/Midwest Generation, LLC in Waukegan, Illinois is currently in compliance with MATS.

Figure 8. Total U.S. Anthropogenic Mercury Emissions 1990 vs. 2005 (Source: Evers et al., 2011)



Other large sources (See Source Assessment in the TMDL (Section 1), that were regulated under the Clean Air Act (CAA) of 1990, have shown major reductions in mercury emissions. EPA agrees with Illinois EPA's assertion that there is reasonable assurance that the reduction target for U.S. out-of-state and regional sources will be addressed over time, and that compliance with the Illinois mercury rule and the MATS will contribute significantly to reductions in fish tissue concentrations called for in this TMDL.

Table 10. Sources of Mercury Emissions in the U.S.

Industrial Category	1990 Emissions tons per year (tpy)	2005 Emissions (tpy)	Percent Reduction
Power Plants	59	53	10%
Municipal Waste Combustors	57	2	96%
Medical Waste Incinerators	51	1	98%

Source: https://www.epa.gov/mats/cleaner-power-plants#controls - Accessed 8/15/17

Water Programs – Potential Illinois Point Sources of Mercury

Illinois EPA summarizes the status of facilities that are controlled under the Clean Water Act, and other requirements in Section 6.3 of the mercury TMDL. The Waukegan Water Reclamation Facility (IL0030244) is described by Illinois EPA as having a permitted mercury load of 0.04

kg/year, which translates to 0.0001 kg/day (0.00024 lbs/day) at design average flow. The WLA in the TMDL for this facility is set equal to the permitted mercury load of 0.04 and therefore is consistent with the NPDES permit.

Section 4.5 of the mercury TMDL identifies five individual NPDES permits that contain mercury monitoring requirements (see Table 7-5, Schedule for Implementation). If mercury is measured above detection levels based upon the prescribed analysis methodology in the permit, for example method 1631E Section 11.1.1.2. digestion procedure (DL1.0 ng/L), the permittee will be required to implement mercury reduction actions and source analysis and meet mercury water quality standards. Illinois EPA will require these NPDES permit holders (through their permit) to determine if their facility adds to the mercury load. Facilities that add to the mercury load will receive an effluent limit and will be required to meet the limit or develop and implement a cost-effective mercury waste minimization plan if one is not already in place to ensure mercury discharges from point sources do not exceed the WLA (Mercury TMDL Section 7.4.1).

State Waste Programs

Several examples of Illinois state law and the date specific requirements affecting mercury in product waste are included below:

- 2004: Thermometers (except those in health care facilities) and novelty products (Illinois Public Act 093-0165)
- 2005: Limits purchase of mercury-containing products in schools (K-12) (Illinois Public Act 093-0964)
- 2007: Electrical switches and relays (Illinois Public Act 093-0964)
- 2008-2012: Prohibit Scientific instruments containing mercury (e.g., barometers, pressure transducers, pyrometers); cosmetics containing mercury (Mercury-added Product Prohibition Act 410 ILCS 46)
- 2008: Automobile switch removal associated with waste processing (Illinois Public Act 094-0732)
- 2008: Sale and installation of mercury climate control thermostats (Public Act 95-452)
- 2009: Sale and distribution of cosmetics, toiletries, or fragrances containing mercury (Illinois Public Act 95-1019)
- 2011: Requires manufacturers to supply collection points for recycling mercury-containing thermostats with goal of collecting 40,000 thermostats by 2020. (Illinois Public Act 096-1295).
- 2012: Mercury-added Product Prohibition Act (Illinois Public Act 97-1107) Amended to ban sale and distribution of zinc air button cell batteries (Environmental Protection Act 415 ILCS 5/22.23c);
- 2016: Requires removal of mercury thermostats from commercial buildings prior to demolition. (Illinois Public Act 99-122/Senate Bill 679)

Federal Waste Regulation - Coal Combustion Residuals

Section 7.4.2. of the TMDL discusses Coal Combustion Residuals (CCR) rules which regulate the disposal of CCR as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA). The residues (or "coal ash") are created when power plants burn coal and are captured by pollution control technologies. Coal ash is known to contain mercury. EPA published a final rule on April 17, 2015 to regulate the waste from existing and new CCR units as solid waste under the RCRA's subtitle D which took effect on October 19, 2015[48]. Provisions within the rules address: 1) the risks from structural failures of CCR surface impoundments, 2) groundwater contamination from the improper management of CCR in landfills and surface impoundments and 3) fugitive dust, by requiring CCR Landfills or CCR surface impoundments be closed if they cannot meet performance or structural integrity criteria. Two coal combustion residual (CCR) surface impoundments (Waukegan (IL0002259, East Ash Pond and West Ash Pond) are located in the project study area at the Midwest Generation, LLC facility, and have self-reported as meeting the inspection criteria. The rule provides reasonable assurances that measures will be taken to prevent accidental catastrophic releases from potential sources of mercury to the study area.[49]

The Implementation and Monitoring Sections (10 and 9, respectively) of this Decision Document, and the corresponding Sections in the TMDL, supply supplemental information to support community outreach and actions, and contain the Illinois EPA's anticipated schedule for implementation steps, the reasonable assurance for this TMDL.

Illinois EPA adequately identified reasonable assurances that reductions needed to eliminate impairments due to PCBs and mercury, that result from air deposition, MS4s/stormwater, hydrodynamic transport, legacy and other sources impacting the study area will occur. Illinois EPA identified a community process for using numerous institutional actions and BMPs for addressing diffuse sources of PCBs and mercury, by enhancing existing regulatory programs such as the CWA MS4 permit process. Illinois EPA also provided detailed information about ongoing progress towards reducing the largest potential sources of PCBs and mercury cycling in the environment. These reduction activities involve both legacy sources that continue to contribute to air concentration of contaminants (the clean-up of Waukegan Harbor/OMC PCBs) and the reductions in contaminants through regulation of air sources of mercury, and management of combustion, and inadvertent generation of by-products from various industrial processes (waste containing mercury at the Waukegan Midwest Generation, LLC, pigment manufacturing). Recent reductions, or those scheduled to occur soon after the writing of this decision document, may not be reflected in target fish tissue concentrations immediately, but fish tissue is expected to meet the Illinois Mercury TMDL targets once mercury reductions work their way through the food web in the study area. Compliance and other programs designed to reduce mercury in the project area also contain monitoring requirements to track progress toward the achievement of the mercury TMDL targets.

[48] Corrected in Federal Register/Vol. 80. No. 127/Thursday July 2, p 37989

[49] The rule is a "self-implementing rule" meaning that there is no direct federal oversight, and States and citizens are relied upon to monitor and report on rule implementation.

Additional information and best practices developed under other studies and efforts will be shared with Illinois EPA to enhance existing actions in the Lake Michigan Nearshore study area. As noted above, PCB gas phase levels have dropped since the PCB prohibition in 1977 and the Waukegan Harbor Clean-up. Similarly, mercury air emissions have dropped since air controls took effect. EPA agrees it is reasonable to conclude that these efforts and others will continue to result in the reduction of PCBs and mercury.

9. Monitoring Plan to Track TMDL Effectiveness

EPA's 1991 document, Guidance for Water Quality-Based Decisions: The TMDL Process (EPA 440/4-91-001), recommends a monitoring plan to track the effectiveness of a TMDL, particularly when a TMDL involves both point and non-point sources, and the WLA is based on an assumption that non-point source load reductions will occur. Such a TMDL should provide assurances that non-point source controls will achieve expected load reductions and such a TMDL should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring and leading to attainment of water quality standards.

Comment:

9.0 Post TMDL Data Collection

Illinois EPA discusses the post-TMDL monitoring that will be used to evaluate progress towards attaining the TMDL targets in Sections 7.5 of both the PCB and mercury TMDLs. Illinois EPA will focus on monitoring for PCBs in: fish tissue, the atmosphere, air emissions, and surface water (through NPDES permits). Illinois EPA discusses future monitoring for mercury in: fish tissue, the atmosphere, air emissions, surface water and groundwater. The monitoring actions for PCBs and mercury are summarized in this Decision Document in Tables 14 and 15, respectively.

Illinois EPA suggested that institutional BMPs and pollution prevention efforts be applied to NPDES MS4, RCRA or TSCA regulated waste sources to prevent PCBs and mercury from reaching surface waters, and that monitoring for these programs be evaluated for contaminant reductions[50] There are several ongoing programs designed to reduce mercury and PCB loads in the Great Lakes that track and publish contaminant-specific trend information for contaminant clean-ups and remediation and pollution prevention projects such as Lakewide Management Plans and Areas of Concern/Superfund. These programs may be useful vehicles for funding and tracking PCB and mercury reduction efforts in water, soils, air, sediment, and fish.

9.1 State PCB Fish Tissue Monitoring

Illinois EPA describes the state's monitoring program (Illinois EPA 2014a) in Section 7.5.1 of

[50] For examples see: Section 7.2.1, Table 7-1, and Appendix B of the PCB TMDL; and Section 7.2.1, Section 7.4.3, and Table7- 1 of the mercury TMDL.

the PCB TMDL. Illinois EPA monitors fish tissue PCBs in predator species collected every 3-5 years from four Lake Michigan harbors as part of its FCMP. The results are used to assess the status of existing fish consumption advisories or issue new advisories. There are PCB consumption advisories for 10 species of fish in Lake Michigan and 4 species have advisories specific to Waukegan North Harbor. Fish tissue PCB data from the FCMP can be used to assess progress toward meeting the TMDL target. Illinois EPA will assess these data as they are available to determine if PCB concentrations are decreasing (see excerpt from monitoring Table 7-4 below).

National and International PCB Atmospheric Monitoring

The United States and Canada jointly maintain the Great Lakes IADN Program, which is one of GLNPO's long-term monitoring programs. PCB measurements have been collected for gas phase PCBs and precipitation at the Chicago site since 1993. Gas phase measurements are taken for 24 hours every 12 days, and precipitation samples are collected monthly using an automated sampler. PCB concentrations measured at this IADN station can be used to assess atmospheric PCB concentrations over time for the study area and Lake Michigan.

State PCB Water Monitoring

The Illinois EPA began implementing its redesigned Lake Michigan monitoring program (LMMP) in May 2010.[51] Illinois EPA conducts sampling as a part of this program which includes: a nearshore survey, harbor monitoring, public water supply/fixed station monitoring, and beach monitoring. PCBs are part of the laboratory and field parameter assessment and are analyzed as site specific parameters for all but groundwater and public water supply. Beach monitoring is conducted by local municipalities and county health departments. Section 7.5 of the PCB TMDL discusses post TMDL data collection and data for fish tissue, atmospheric PCBs, air emissions, and groundwater that will be used to evaluate progress towards attaining the TMDL target. Illinois EPA also provided a list monitoring actions for PCB permitted facilities. (See the Implementation Section in this Decision Document).

Table 1. PCB Schedule and Monitoring Components (PCB TMDL Table 7-4)

Monitoring Activity	Schedule
Illinois Fish Contaminant Monitoring Program	Each year, fish samples are collected from four Lake Michigan open water stations and analyzed for PCBs. In addition, every 3-5 years, fish samples are collected from four Lake Michigan harbor stations and analyzed for PCBs. Harbors targeted for sampling include Calumet, Jackson, Waukegan North and North Shore Marina.
Atmospheric Monitoring (IADN) at Chicago	PCB measurements have been collected since 1993, and no end date is planned. Gas phase measurements are made every 12 days. Precipitation samples are collected monthly.

51 Illinois EPA, The Illinois Water Quality Monitoring Strategy for 2015-2020, Appendix A (2014a)

Mercury Atmospheric Monitoring

In Section 7.5.2 of the Mercury TMDL, Illinois EPA discusses post TMDL air data collection and use of the data to evaluate progress towards attaining the TMDL target. Total mercury in precipitation has been monitored weekly through the Mercury Deposition Network since 1996. The closest site to the study area watershed is at the Indiana Dunes National Lakeshore. Additional monitoring data for Lake Michigan atmospheric mercury deposition may also be available through the Canadian Atmospheric Mercury Measurement Network. Illinois EPA plans to rely on data collected, compiled and analyzed through these programs to assess changes in mercury concentrations over time. Illinois EPA will use a 2002 emissions inventory as the baseline to track progress in source reductions, as it is the closest in time to the MCM modeled year. EPA finds Illinois EPA's choice of the 2002 emissions inventory to be a reasonable choice for comparison, as it is closest in time to the 2001 baseline.

Waste Program Mercury Monitoring

Monitoring is required for CCRs that are regulated under the Federal RCRA Title D statute, but the rule is "self-implementing," meaning that there is no direct federal oversight. States and citizens are relied upon to monitor and report on rule implementation. Operators of CCR units must maintain a publicly available website of compliance information, including, for example, annual groundwater monitoring results, corrective action reports, fugitive dust control plans and closure completion notifications.

Table 2. Mercury Schedule and Monitoring Components (Mercury TMDL Table 7-5)

Monitoring Activity	Schedule
Water Permit Monitoring	
NSWRD Waukegan Water Reclamation Facility (IL00030244) Permit Schedule 2016 for a duration of 5 years.	Annual average mercury load of 0.04 kg/yr (0.00024 lbs/day) based on design average flow, which is consistent with the TMDL. This permit also includes a monitoring requirement of 1 day/month (composite sample), and calculation of a rolling annual monthly average mercury value.
Fort Sheridan Landfills 6 and 7 (IL0072231) Expired 11/30/14	Report quarterly stormwater sampling for mercury on DMRs
Calumet Transload Railroad, LLC (IL0002593) Expires 01/31/2017	Report quarterly stormwater sampling for mercury on DMRs. If mercury is measured above detection levels, the permittee would have to do mercury reduction and source analysis to meet mercury water quality standards. Any change in permit status would be addressed during the next permit renewal cycle

Advanced Disposal Services Zion Landfill, Inc. (IL0067725) Expires 09/30/2020	Report quarterly stormwater sampling for mercury on DMRs. If mercury is measured above detection levels, the permittee would have to do mercury reduction and source analysis to meet mercury water quality standards. Any change in permit status would be addressed during the next permit renewal cycle
Midwest Generation, LLC Waukegan (IL0002259) Expires 03/31/2020	Report quarterly sampling for mercury on DMRs. If mercury is measured above detection levels, the permittee would have to do mercury reduction and source analysis to meet mercury water quality standards. Any change in permit status would be addressed during the next permit renewal cycle.
KCBX Terminals Company (IL0071625) Expires 04/30/2018	Quarterly mercury sampling (with limitations described in Special Condition 11 of the NPDES Permit). If mercury is measured above detection levels, the permittee would have to do mercury reduction and source analysis to meet mercury water quality standards. Any change in permit status would be addressed during the next permit renewal cycle
Monitoring Programs	
Illinois Fish Contaminant Monitoring Program	Illinois EPA plans to start analyzing mercury in yellow perch collected from two Lake Michigan open water stations. In addition, every 3-5 years, predator fish samples are collected from four Lake Michigan harbor stations and analyzed for mercury. Calumet, Jackson, Waukegan North and North Shore Marina Harbors are targeted for sampling.
Groundwater monitoring	2010 – ongoing. Quarterly monitoring and Illinois EPA review of data from seven on-site groundwater wells at the Waukegan Power Station.
Mercury Deposition Network	1996 – ongoing. Weekly monitoring of total mercury in precipitation occurs through the Mercury Deposition Network. The closest site to the study area watershed is at the Indiana Dunes National Lakeshore.
National Emissions Inventory	Every three years, EPA prepares the NEI for every state, providing a comprehensive and detailed estimate of air emissions of both Criteria and Hazardous air pollutants from all air emissions sources. The NEI is based primarily on emission estimates and emission model inputs provided by state, local, and Tribal air agencies for sources in their jurisdictions, and is supplemented by data developed by the EPA.
Rule Compliance and Monitoring (Air)	
Mercury and Air Toxics Standards (MATS) Rule 40 CFR Part 63, Subpart UUUUU - National Emissions Standards for Hazardous Air Pollutants: Coal and Oil-Fired Electrical Utility Steam Generating Units	MATS standard compliance date: April 30, 2015 An affected source must maintain records of monthly mercury emissions and submit quarterly reports and semi-annual compliance reports to Illinois EPA. Any deviations from applicable 40 CFR Part 63, Subpart UUUUU requirements must be submitted with the semi-annual compliance reports. The source is required to keep records and conduct annual relative accuracy test audits (RATA) of the continuous monitoring systems and report the results of the RATA to the Illinois EPA within 45 days.
Illinois mercury rule, 35 IAC Part 225	Affected coal-fired sources are required to continuously monitor and record mercury emissions from each stack or common stack associated with an

90% Reduction Requirement	Electric Generating Unit. Affected sources of an EGU must maintain records of the monthly emissions of mercury from the EGU, and monthly allowable emissions of mercury from the EGU if complying with the 90% reduction requirement. An annual compliance certification must be submitted to Illinois EPA. EGUs must report deviations from applicable requirements within 30 days of their discovery. (See RA Section in Decision Document)
Waste Monitoring	
Resource Conservation and Recovery Act's Subtitle D. Coal Combustion Residual Rule	January 2016 – January 2019. Among other things, additional requirements related to structural integrity, groundwater monitoring and corrective action, demonstration of meeting location restrictions, closure of inactive units. Operators of CCR units must maintain a publicly available website of compliance information for example, annual groundwater monitoring results, corrective action reports, fugitive dust control plans and closure completion notifications.

Illinois has provided an adequate description of its monitoring to assess the progress towards meeting the targets in the TMDLs. Illinois will continue to rely on IADN Great Lakes Atmospheric Monitoring program and required monitoring that is a part of implementing regulatory control programs to assess progress in meeting water quality standards for PCBs and mercury. A well-developed FCMP is available to determine the extent of fish consumption impairments in the state to assess the progress toward TMDL fish tissue concentration targets. Illinois EPA, IDNR and IDPCH will continue to monitor fish tissue samples as part of the Illinois Fish Advisory effort.

10. Implementation

EPA policy encourages Regions to work in partnership with States/Tribes to achieve nonpoint load allocations established for 303(d)-listed waters impaired by non-point sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that non-point source LAs established in TMDLs for waters impaired solely or primarily by non-point sources will in fact be achieved. In addition, EPA policy recognizes that other relevant watershed management processes may be used in the TMDL process.

Comment:

10.1 Implementing BMPs for Both Point and Nonpoint Sources

Illinois EPA described a number of BMPs as appropriate for use to reduce PCB and mercury loads from a variety of locations and sources in Section 7 of the TMDL. Illinois EPA selected BMPs that are designed to remove PCBs and mercury from both point and nonpoint sources, including from MS4 stormwater runoff (Section 7.2, PCB and Mercury TMDLs). Illinois EPA described the implementation points, and sources and pathways for PCBs and mercury BMPs in

Table 7.1[52] of both the PCBs and mercury TMDLs. Table 7.1 presents this information for two types of BMPS: institutional and treatment. Illinois EPA presented the effectiveness of institutional and treatment BMPs in reducing contaminant loads to receiving waters in Table 7-2 of both the TMDLs. The tables discussed in this paragraph can be found in this Decision Document's Appendix D. Further detail is provided below for different varieties of BMPs.[53]

Illinois EPA proposes in both the PCB and Mercury TMDLs, to establish a watershed workgroup with interested communities in the study area. The workgroup would develop a watershed plan and a more detailed schedule for selecting and implementing specific BMPs for a variety of problems. Working with partners, Illinois EPA believes it could use or adjust the existing budget and grant programs to implement appropriate mercury and PCB BMPs. Illinois EPA suggested that the Chicago Clean Sweep Pilot could serve as a model for educating Chicago-area businesses on the identification and proper management and disposal of mercury and PCBs at a reduced cost. Illinois EPA suggested that the program could be revitalized depending on community interest in pursuing funding.

10.2 Institutional BMPs for PCBs and Mercury

The purpose of institutional BMPs is to avoid the continued use, inadvertent production, release or volatilization of PCBs and mercury in the environment. Illinois EPA focused on information sharing and governmental practices to help businesses and the general public avoid, clean up and properly dispose of products containing PCBs and mercury. Illinois EPA plans to assist and work collaboratively with municipalities, community members, organizations and existing watershed workgroups when implementing institutional BMPs outlined in the PCB and mercury TMDLs. The PCB and mercury TMDLs contain information to help identify and remove legacy and current sources of PCBs and mercury to surface waters including: air sources, municipal stormwater systems, legacy sources, accidental releases and others. (Section 7.1 of both TMDLs). These materials also describe proper disposal of contaminants.

Illinois EPA proposed the following actions (Section 7.1-7.7 of the PCB and mercury TMDLs).

- Prevent the release of PCBs and mercury from buildings (for PCBs identify buildings by construction date, and for mercury, those scheduled for demolition) by educating school administrators and demolition contractors about locations where contaminants may be found in schools, and buildings slated for demolition.
- Disseminate information to the public about the potential sources of mercury and PCBs, what to do with them if discovered, and safer alternatives. Information should be shared with buyers and suppliers of industrial equipment, consumers, and residents who fish for recreation or subsistence, to increase their awareness of fish advisories and the fish species that contain the highest concentrations of PCBs and mercury. Educate those more

52 BMP Application for Controlling PCBs in Urban Areas Relative to Sources, San Francisco Estuary Institute, 2010

53 Program Assessment Effectiveness for BMPs Source: San Francisco Estuary Institute, 2010

likely to come into contact with PCBs or mercury.

- Continue to implement existing collection programs for waste-containing PCBs or mercury that enable government- or non-profit-run programs to accept mercury and/or PCB-containing products and waste (Section 7.4.3 of the mercury TMDL).
- Clean up illegally dumped waste, such as old drums, electrical equipment, or building demolition material, for example caulk or paint that may contain PCB-contamination. Review local/regional laws regulating waste disposal, and revise as necessary: this could include implementing fines for improperly disposing of mercury and PCBs and sharing information on safer alternatives for lighting, paint, caulk, thermometers, etc.
- Conduct targeted street sweeping to target sources of PCBs or mercury to prevent from being washed down streets and entering storm drains.
- Identify or Create Educational Materials to support outreach, for example,
    - mercury dental amalgam management BMP brochure
    - fact sheet to show Illinois consumers what products contain mercury, what should be recycled, and where.
    - Removal of old equipment using appropriate disposal of PCB or mercury-containing materials from demolition of buildings.

Electrical Equipment

- Conduct a survey of the state's utilities and other owners of electrical equipment to confirm the presence of PCBs in transformers inventoried in the Illinois EPA database mentioned above (EPA 2011a). Provide technical assistance where requested for disposal and replacement of the contaminated fluid (Washington State Department of Ecology, 2014).
- Promote wider/higher use of recycling facilities to reduce the risk of mercury discharging from fluorescent light bulbs switches, instruments, etc. into Lake Michigan (can apply to homeowners and businesses).
- Help operators safely use drum top crushers according to regulation for volume reduction of spent fluorescent lamps.
- Reduce mercury use in hospitals (promote existing Green Health Partnership).

10.3 Treatment BMPs for PCBs and Mercury

MS4 Stormwater Systems

Illinois EPA will work with MS4 communities, to select feasible BMP s and implementation plans, considering practical and financial resources.

Treatment control BMPs will help MS4s meet permit requirements. These engineered options are installed or built within the existing storm sewer infrastructure to capture sediment containing PCBs and mercury and prevent them from being discharged to Lake Michigan

Federal TMDL regulations require that permits be consistent with TMDL WLAs, but do not specify how States should implement them in their permitting and other programs.

Many of the BMPs discussed in the TMDL and this Decision Document, particularly those applicable to stormwater, can be applied to both the PCB and Mercury TMDLs. BMPs are effective at treating a range of contaminants and are not limited to controlling mercury or PCB loads. For example, the stormwater MS4 and Treatment BMPs are found in Appendices C and D of this Decision Document.

Below are BMPs that can be applied at three different locations within the stormwater systems :

Pipe entrance

- Capture of pollutants before they enter stormwater pipes
- Includes infiltration trenches, basins, retention and reuse (rain barrels or underground tanks), ponds, detention basins, swales, buffer strips, bioretention

Installed within MS4 pipes:

- Includes filters, screens, wet vault[54], hydrodynamic separators
- Usually have high maintenance requirements and can sometimes back up flow when not maintained properly

End of pipe

- Includes sedimentation basins, constructed wetlands, or diversion of flow to treatment at wastewater treatment plants

Maintenance BMPs suggested by Illinois EPA include street sweeping, jet vacuuming separate stormwater systems, and mitigating stormwater flow from direct drainage areas by using green infrastructure measures.

Illicit Mercury Discharges

In Section 7.5.5 of the Mercury TMDL Illinois EPA proposes that an illicit discharge survey should be conducted on storm sewers and surface waters, emphasizing discharges to Lake Michigan, if occurrence of these discharges of mercury are suspected. The survey is a systematic screening of stormwater outfalls for illicit discharge and is required by Illinois' Stormwater NPDES General Permit for Discharges from Small MS4s. The outfall surveys are followed by investigations in the stormwater conveyance system to locate and address the source of any dry weather discharges.

10.4 Implementation Schedules

Illinois EPA provided an implementation schedule for both the PCB and Mercury TMDLs, respectively. Current NPDES permits (PCB TMDL Table 7-4) will remain in effect until the permits are re-issued, provided Illinois EPA receives the NPDES permit renewal application

[54] A wet vault is a permanent pool of water in a vault that rises and falls with storms and has a constricted opening to let runoff out. Its main treatment mechanism is settling of contaminated solids.

prior to the expiration date of the existing NPDES permit. Illinois EPA plans to incorporate the WLAs into the permits upon reissuance. The schedules, reproduced from the TMDLs, are presented below.

Table 13. Schedule for Implementation (PCB TMDL Table 7-4)

Activity	Schedule
Stakeholder Engagement	
Working with stakeholders and workgroups to engage partners in TMDL-recommended strategies.	Much of the TMDL area lies within an MS4 service area. Illinois EPA will encourage watershed groups to work with local permittees to prioritize problems, select BMPs and participate in the planning and design of the BMP projects that will meet TMDL target endpoints. Illinois EPA will share TMDL recommended implementation plans with other state agencies. BMPs are found in Section 10, and Decision Document and TMDL Appendices.
Permitting	
General NPDES Permit (No. ILR40) MS4 Stormwater Expires 02/28/21	Following notification by Illinois EPA of the TMDL approval, the permittee must modify their stormwater management program to implement the TMDL recommendation, if the permittee determines they are not meeting the TMDL allocations within eighteen months of the notification date. Additional details are found in the General NPDES Permit ILR40, Part III Special Conditions C.
Zion Station (IL0002763) Expires 02/28/18	Continue current PCB monitoring requirements and report results on monthly discharge monitoring report forms. Any change in permit requirements will be addressed during the next permit renewal cycle.
Winnetka Power Generation Station (IL0002364) Expires 08/31/18	In future permit renewal cycles, the permit may be revised to require monitoring to verify compliance with water quality standards.
Midwest Generation, LLC Waukegan (IL0002259) Expires 03/31/2020	In future permit renewal cycles, the permit may be revised to require monitoring to verify compliance with water quality standards.
Waukegan Harbor AOC	Ongoing regulatory action and funding until clean-up goals are met.

Potential Funding Sources

Illinois EPA includes the same table of available funding opportunities in Section 7.3 of both the PCBs and Mercury TMDLs. The table included EPA, National Institute of Health, National Oceanographic and Atmospheric Institute and Illinois EPA as possible sources of funding for implementing the BMPs discussed in the Implementation Section.

Table 14. Mercury TMDL Implementation Schedule (Table 7-5 in the mercury TMDL)

Stakeholder Engagement	
Working with stakeholders and workgroups to engage partners in TMDL-recommended strategies.	Much of the TMDL area lies within an MS4 service area. Illinois EPA will encourage watershed groups to work with local permittees to prioritize problems, select BMPs and participate in the planning and design of the BMP projects that will meet TMDL target endpoints. Illinois EPA will share TMDL recommended implementation plans with other state agencies. BMPs are found in Section 10, and Decision Document and TMDL Appendices.
Water Permitting	
General NPDES Permit (No. ILR40) MS4 Stormwater Expires 02/28/21	Following notification by Illinois EPA of the TMDL approval, the permittee must modify their stormwater management program to implement the TMDL recommendation, if the permittee determines they are not meeting the TMDL allocations within eighteen months of the notification date. Additional details are found in the General NPDES Permit ILR40, Part III Special Conditions, Subpart C.
NSWRD Waukegan Water Reclamation Facility (IL00030244) Permit expected to be issued in 2016 for a duration of 5 years.	Annual average mercury load of 0.04 kg/yr (0.00024 lbs/day) based on design average flow, which is consistent with the TMDL. This permit also includes a monitoring requirement of 1 day/month (composite sample), and calculation of a rolling annual monthly average mercury value.

EPA does not approve TMDL implementation plans. The plans outlined in the TMDL documents submitted by Illinois EPA offer a clear explanation of its ideas for the implementation efforts to address PCB and mercury source reductions in the study area and responds to concerns raised by the public (see Section 11 of this Decision Document. Illinois has a well-developed FCMP to determine the extent of fish consumption impairments in the state. Illinois EPA also provided BMP source identification in order to facilitate implementation. Illinois EPA provides a schedule for reaching out to the public, planning, and implementing actions that are expected to reduce PCBs and mercury from regulated and unregulated sources. EPA finds that Illinois EPA's implementation submission in this review element contains resources that will be useful for initiating a planning process with the public.

11. Public Participation

EPA policy is that there should be full and meaningful public participation in the TMDL development process. The TMDL regulations require that each State/Tribe must subject calculations to establish TMDLs to public review consistent with its own continuing planning process (40 C.F.R. §130.7(c) (1) (ii)). In guidance, EPA has explained that final TMDLs submitted to EPA for review and approval should describe the State's/Tribe's public participation process, including a summary of significant comments and the State's/Tribe's responses to those comments. When EPA establishes a TMDL, EPA regulations require EPA to publish a notice seeking public comment (40 C.F.R. §130.7(d) (2)).

Provision of inadequate public participation may be a basis for disapproving a TMDL. If EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Comment:

Illinois EPA held a public meeting on January 13, 2016 (6:00 pm) at Waukegan Public Library (Bradbury Room), Waukegan, Illinois, and on January 14, 2016 (10:00 am) at the EPA- Region 5 Office in Chicago, Illinois. Each meeting provided the public with an opportunity to comment on the final draft PCB and mercury TMDL reports, and to provide additional information for inclusion that could be used in the final TMDL development process.

Illinois EPA placed a public notice (PN) in the Chicago Tribune and the Waukegan Lake County Sun, announcing the availability of the TMDLs for public review and comments. Both papers circulate widely throughout the Chicago metropolitan area, and the Lake Michigan Nearshore Study area from the border of Cook County through the Wisconsin State line. The public notice gave the date, time, location, and purpose of the meetings. The announcements also provided reference for obtaining additional information about the study area watershed, the TMDL Program, and other related issues.

The PN was mailed to NPDES and MS4 Permittees, environmental groups, and other organizations in the watershed by first class mail. The draft TMDL Report was available for review at the Waukegan Public Library in Waukegan, Illinois and on the Illinois EPA's website at http://www.epa.illinois.gov/public-notices/index. Twenty-two people in Waukegan and six people in Chicago attended the public meetings.

Illinois EPA representatives, and an EPA staff member conducted the public meetings and the TMDL contractors assisted by providing the technical details for the public notice drafts of the PCB and Mercury TMDL reports. Comments were accepted during the public comment period from January 15 through February 16, 2016.

The responsiveness summaries in Appendix F of the PCB TMDL and Appendix E of the mercury TMDL address substantive questions and comments on the Public Notice version of the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs that were provided for review during the public comment period. A summary of the comments is provided below along with Illinois EPA's response.

The Summary of Comments

The responsiveness summary in Appendix F of the TMDL addresses questions and comments on the Public Notice Version of the Illinois Lake Michigan Nearshore PCB and Mercury Total Maximum Daily Load (TMDL) Reports. Illinois EPA accepted comments during the public comment period from January 15 through February 16, 2016.

Illinois EPA responded to a total of 32 comments on topics including: methods for addressing the sources that contribute to water, air, and land-based concentrations of PCBs and mercury; and the applicability of permits to contaminant sources. The major comments are summarized below.

Air Source Targeting and Available Controls

Illinois EPA received several comments asserting that the draft TMDL did not adequately address mercury emissions from the NRG/Midwest Generation, LLC coal-fired power plant in Waukegan. Commenters believed the plant was still a significant contributor to the mercury pollution in Lake Michigan despite its installation of activated carbon injection treatment to reduce mercury air emissions. Commenters advocated for enhancing the plant's existing controls and installing a baghouse to capture mercury and small particulates and further reduce mercury loads.

The Illinois EPA Bureau of Air reported to the Bureau of Water that NRG/Midwest Generation, LLC (Waukegan-Power Plant) was in compliance with state and federal laws and regulations for air mercury emissions. In response to the Bureau of Water's status request, the Bureau of Air also reported that the Waukegan Power Plant units are complying with the federal Mercury and Air Toxics Standard (MATS) which requires power plants to use maximum achievable control technology (MACT) and achieve the degree of reduction associated with that technology. Each unit at the Waukegan facility is equipped with the required control systems to reduce mercury emissions by 90 percent in accordance with 35 Ill. Adm. Code Part 225. Illinois EPA reported that Both units are in compliance with all regulations and permit requirements regulating mercury releases to the environment.

Run-Off From Coal Piles And Coal Ash Storage

Commenters expressed a number of concerns to Illinois EPA regarding Waukegan coal plant's coal piles, coal transport system (conveyors, etc.), and the coal ash ponds at the Waukegan plant including: their proximity to Lake Michigan; precipitation weathering of coal in piles and in train cars adjacent to water bodies and groundwater; the transport and release of leachate from this area into the Lake Michigan watershed; the airborne release of mercury in dust from coal. Commenter recommendations included covering piles and train cars, installing monitoring wells, and monitoring and evaluating leachate for evidence of mercury releases. Illinois EPA responded that the coal pile is sprayed with water to control fugitive dust to meet air permit requirements and the runoff is collected and subject to sediment and oil removal prior to discharge. Groundwater monitoring data for mercury has been collected at NRG/Midwest Generation, LLC (Waukegan Power Plant) since November 2010. In addition, groundwater sampling results from seven on-site monitoring wells are submitted to Illinois EPA. Illinois EPA reported that all results for mercury have been non-detect, with a reporting limit of 0.0002 mg/L and results from groundwater monitoring from the coal pile area demonstrate no impact to groundwater associated with mercury. The coal ash pond water from the lined impoundments is treated, sampled and discharged in accordance with the NPDES permit, as is water contacting transfer equipment, and there is no indication of leachate discharge from the lined ash ponds. Two coal combustion residual (CCR) surface impoundments in the study area are covered by a final EPA rule effective October 19, 2015. The final rule requires that operators of CCR units maintain a publicly available website of compliance information and groundwater monitoring results, corrective action reports, fugitive dust control plans and closure completion notifications.

Commenters also asked Illinois EPA to investigate the potential for gas phase PCBs emissions from sludge piles, and sewage sludge drying beds to contribute to annual PCB emissions in the watershed. Illinois EPA agreed to follow up on this potential source to better understand and address this issue. Illinois EPA received a suggestion that the Chicago Clean Sweep program be revitalized to educate Chicago-area businesses about identifying, managing and properly disposing of PCBs and Mercury. Illinois EPA agreed that the program could serve as a model for interested communities. Illinois EPA placed information in Appendix D of the PCB TMDL, and the Reasonable Assurance and Implementation Sections of the TMDLs that could be useful to communities if they undertake efforts to safely dispose of PCB and mercury-containing wastes.

Available Controls of Water Sources and NPDES Permit Comments

Commenters made suggestions related to monitoring and controlling potential water sources of PCBs and mercury. Commenters requested that Illinois EPA set permit limits and monitoring requirements for potential sources of PCB and mercury loads to Lake Michigan and establish a process for identifying MS4 pipe discharges in need of contaminant controls and controlling mercury and PCB loads leaving these pipes. In addition, the commenters requested that IEPA include provisions in permits requiring new construction to place BMPs at the stormwater pipe entrance.

Illinois EPA responded that wastewater treatment facilities in the Illinois Lake Michigan TMDL Waters hed (refer to Table 6-2 in the TMDL reports) are not allowed to discharge PCBs, as stated in their individual NPDES permits and may be given effluent limits or monitoring requirements in their respective NPDES permits if they have the potential to discharge mercury to Lake Michigan and its tributaries. The current NPDES Permit No. IL0030244 for North Shore Water Reclamation District - Waukegan Water Reclamation Facility does not have mercury limits or monitoring requirements. However, the draft NPDES permit for this facility does contain mercury limits for a discharge to Waukegan North Ditch (Outfall BO2), which is a tributary to Lake Michigan and the TMDL report was revised to include a wasteload allocation to be consistent with the TMDL study and the draft NPDES permit.

Illinois EPA's general MS4 stormwater permit holders do not have limits or monitoring requirements for mercury or PCBs at this time (Section 4.3 of the mercury TMDL). However, the General Permit Part III- Special Condition (C) requires the MS4 permit to be consistent with a TMDL WLA within 18 months of notification by Illinois EPA of TMDL approval. Illinois EPA described the NPDES permit requirements for PCBs and Mercury in the study area in the Responsiveness Summaries and the PCBs and mercury TMDLs. Many of the BMPs suggested by the commenters (filters, screens, wet vault, and hydrodynamic separators, etc.) are contained in the MS4 General Permits and the Illinois Urban Manual (2014). Illinois EPA referred commenters to information on implementation of stormwater management practices in the TMDLs: Section 7 in both TMDLs, Appendix B of the mercury and C of the PCB TMDLs respectively, and the Reasonable Assurance and Implementation Sections in the TMDLs.

Monitoring

Commenters urged Illinois EPA to initiate new monitoring activities, and to develop a monitoring plan for the study area. Suggestions included: taking additional samples from wastewater, industrial sources, and groundwater; tracking waste stream data, and making data available to the public. Commenters suggested that Illinois EPA collect more fish tissue data and use activated carbon methods to measure mercury concentration in the ecosystem. Illinois EPA responded that they will continue to work with IDNR to conduct more fish monitoring (depending on funding) and explore other monitoring options when developing future Water Quality Monitoring Plans. Illinois EPA provided the web address of the monthly discharge monitoring reports (DMRs) for the regulated municipal and industrial wastewater treatment facilities in the watershed. http://dataservices.epa.illinois.gov/dmrdata/dmrsearch.asp
Illinois EPA's website provides information regarding air quality, drinking water quality, and land pollution control programs at http://www.epa.illinois.gov/citizens/index
IEPA made several changes to the draft TMDL as a result of the submitted comments. These changes included a new map of source locations, a schedule for implementation in Section 7 of the TMDLs, and revised language as necessary in the TMDL. These changes are discussed in Appendix E of the TMDL.

EPA finds that the TMDL document submitted by Illinois EPA adequately documents the public participation needed to develop the TMDL, and that Illinois EPA appropriately addressed comments received from the public. The comments are summarized in the TMDL's, Appendix E. The TMDLs were available to the public for 30 days following public meetings on January 13 and 14. Illinois EPA State Calendar.

12. Submittal Letter

A submittal letter should be included with the TMDL submittal and should specify whether the TMDL is being submitted for a technical review or final review and approval. Each final TMDL submitted to EPA should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter, whether for technical review or final review and approval, should contain such identifying information as the name and location of the waterbody, and the pollutant(s) of concern.

Comment:

Illinois EPA submitted a package containing two Final Lake Michigan Nearshore TMDLs by email on April 25, 2016. The cover letter, signed by Ryan McCreery, Illinois EPA Deputy Director, explicitly stated that the enclosed documents were final and requested the review and approval of the Illinois Lake Michigan Nearshore PCB and mercury TMDLs in Appendix A of each TMDL, and as described under the TMDL scope in this Decision Document. The submittal also contained a response to public comments on the Public Notice Draft Illinois Lake Michigan Nearshore PCB and Mercury TMDL.

Illinois EPA's submittal addresses 56 Illinois Lake Michigan nearshore/beach/shoreline, harbor and open water segments that are impaired due to concentrations of mercury and PCBs in fish tissue, for a total of 112 impairments. The designated use that is impaired in each of these waters is fish consumption. One segment (Waukegan Harbor North) is also impaired for aquatic life use for PCBs and mercury. The Table in Appendix A of this Decision Document lists the impairments addressed by this TMDL.

EPA finds that Illinois EPA's letter and the final PCB and mercury TMDL Reports submitted by Illinois EPA, adequately identify the waterbodies submitted for approval, water quality impairments addressed by each TMDL, and a TMDL, WLA, LA and MOS to address the impairments found in Appendix B of the TMDL, and Appedix A o f this Decision Document.

13. Conclusion

The Illinois Lake Michigan Nearshore PCB and mercury TMDLs quantify pollutant load reductions needed to reduce PCB and mercury levels in fish tissue and the water column so that the waterbodies can meet WQS. Illinois EPA based each TMDL upon the assumption that fish tissue contaminant concentrations for PCBs and mercury respond proportionally to reductions in atmospheric PCBs and mercury loadings. This approach resulted in a fish tissue target concentration of 0.06 mg/kg for both PCBs and mercury. Illinois EPA described the sources of atmospheric deposition of PCBs and mercury in the study area as being local, regional, national and global. Illinois EPA determined that atmospheric PCB sources from Illinois must be reduced by 94.7% from 2005 levels to meet the fish tissue goal (Table ES-1). Illinois EPA also determined that atmospheric mercury sources from Illinois must be reduced by 78.57% from 2001 levels to meet a fish tissue target concentration (Table ES-1). Reductions are necessary from mercury sources within Illinois and in other U.S. states.

After a full and complete review, the EPA finds that the Illinois Lake Michigan Nearshore PCB and mercury TMDLs satisfy all the elements of approvable TMDLs. This approval is for a total of 112 TMDLs. The approval addresses nearshore, shoreline, harbor and open water segments that are impaired due to concentrations of PCBs and mercury in fish tissue and the water column (Illinois EPA, 2014).[55] One segment (Waukegan Harbor North) is also impaired for aquatic life use due to both PCBs and mercury. These impaired waters are included on the 2014 Draft Illinois Integrated Water Quality Report and Clean Water Act (CWA) Section 303(d) list (Illinois EPA, 2014).

EPA's approval of these TMDLs extends to the water bodies that are identified in Appendix A of this Decision Document with the exception of any portions of the water bodies that are within Indian Country, as defined in 18 U.S.C. Section 1151. EPA is taking no action to approve or disapprove TMDLs for those waters at this time. EPA, or tribes with 303(d) TAS authority as appropriate, will retain responsibilities under the CWA Section 303(d) for those waters.

Table 15. Summary of the Illinois PCB TMDL Components

TMDL Components	Results
Target Level and Reduction Factor	
Target Fish PCB Concentration (Fish Tissue Residue Value)	0.06 mg/kg
Baseline PCB Concentration for Carp	1.13 mg/kg
Reduction Factor	94.7 %
PCB Load for Baseline Year 2005	
Point Source Load	No detectable load
Nonpoint Source Load	12.3 kg/yr
Transport from main body of Lake Michigan	7.4 kg/yr
Direct atmospheric load	4.9 kg/yr
Total Baseline Load	12.3 kg/yr
Final TMDL	
Loading Capacity (LC)	0.0026 kg/day
Necessary Reduction from Atmospheric Sources	94.7%
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.000006 kg/day
Load Allocation (LA)	0.0026 kg/day
PCB Load Allocation for In-State and Out-of-State Deposition Sources	
In-State Contribution to LA[a]	0.0019 kg/day
Out-of-State Contribution to LA[b]	0.0007 kg/day

Numbers may not sum exactly due to rounding
[a] Calculated as 73% of LA [b] Calculated as 27% of LA

[55] Listed in Appendix A of this Decision Document, and in Appendix B of the Mercury

The components of the PCB TMDL are summarized in Table 5 of the Decision Document (Table 6-5 of the PCB TMDL). The components of the mercury TMDL are summarized in Table 7 of the Decision Document (Table 6-5 of the Mercury TMDL).

Table-16. Summary of Illinois Mercury TMDL Components

TMDL Components	Result
Target Level and Reduction Factor	
Target Fish Mercury Concentration (Fish Tissue Residue Value)	0.06 mg/kg
Baseline Mercury Concentration for Largemouth Bass	0.28 mg/kg
Reduction Factor	78.57%
Mercury Load for Baseline Year 2001	
Point Source Load	No detectable concentration
Nonpoint Source Load	33.51 kg/year
Total Baseline Load	33.51 kg/year
Final TMDL	
Loading Capacity (LC)	0.02 kg/day
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.0004 kg/day
Load Allocation (LA)	0.02 kg/day
Mercury Load Allocation for In-State and Out-of-State Deposition Sources	
In-State Contribution to LA[a]	0.0036 kg/day
Out-of-State Contribution to LA[b]	0.0160 kg/day
Necessary Reduction from Anthropogenic Emission Sources	89.29%

Note: numbers may not sum exactly due to rounding

[a] Anthropogenic sources only

[b] Anthropogenic and natural sources

References can be found in Appendix H

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Appendix A: List of Waters Included in TMDL

Table A-1. PCB and Mercury-Impaired Segments Addressed by the Illinois Lake Michigan Nearshore TMDL Approval

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	North Point Beach	IL_QH-01	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park North	IL_QH-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan North Beach	IL_QH-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan South Beach	IL_QH-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park South	IL_QH-09	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Bluff Beach	IL_QI-06	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Forest Beach	IL_QI-10	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rosewood Beach	IL_QJ	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Park Ave. Beach	IL_QJ-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Glencoe Beach	IL_QK-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Tower Beach	IL_QK-06	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lloyd Beach	IL_QK-07	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Maple Beach	IL_QK-08	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Elder Beach	IL_QK-09	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Kenilworth Beach	IL_QL-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Gilson Beach	IL_QL-06	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Greenwood Beach	IL_QM-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lee Beach	IL_QM-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lighthouse Beach	IL_QM-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Northwestern University Beach	IL_QM-06	Fish consumption

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	Clark Beach	IL_QM-07	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	South Boulevard Beach	IL_QM-08	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Touhy (Leone) Beach	IL_QN-01	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Loyola (Greenleaf) Beach	IL_QN-02	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Hollywood/ Ostermann Beach	IL_QN-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Foster Beach	IL_QN-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Montrose Beach	IL_QN-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Juneway Terrace	IL_QN-06	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rogers Beach	IL_QN-07	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Howard Beach	IL_QN-08	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Jarvis Beach	IL_QN-09	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Pratt Beach	IL_QN-10	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	North Shore/Columbia	IL_QN-11	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Albion Beach	IL_QN-12	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Thorndale Beach	IL_QN-13	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	North Ave. Beach	IL_QO-01	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Fullerton Beach	IL_QO-02	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Webster Beach	IL_QO-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Armitage Beach	IL_QO-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Schiller Beach	IL_QO-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Oak St. Beach	IL_QP-02	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Ohio St. Beach	IL_QP-03	Fish consumption

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	12th St. Beach	IL_QQ-01	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	31st St. Beach	IL_QQ-02	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	49th St. Beach	IL_QR-01	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Jackson Park/63rd Beach	IL_QS-02	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rainbow	IL_QS-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	57th St. Beach	IL_QS-04	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	67th St. Beach	IL_QS-05	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	South Shore Beach	IL_QS-06	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Calumet Beach	IL_QT-03	Fish consumption
Nearshore open water/shoreline	Lake Michigan Open Water	Open waters Lake Michigan Nearshore	IL_QLM-01	Fish consumption
North Point Marina Harbor	North Point Marina Harbor	North Point Marina Harbor	IL_QH	Fish consumption
Waukegan Harbor	Waukegan Harbor	Waukegan Harbor North	IL_QZO	Fish consumption, Aquatic life
Calumet Harbor	Calumet Harbor	Calumet Harbor	IL_3S	Fish consumption
Diversey Harbor	Diversey Harbor	Diversey Harbor	IL_QZI	Fish consumption

Appendix B: Waste Load Allocations

NPDES Permitted Facilities That Are Part of the Illinois Lake Michigan Nearshore WLAs For Mercury and PCB TMDLs

Table B-1. (Summarized from the Illinois Lake Michigan Nearshore TMDL)

Type of Permit	Place Name (MS4 permit)	Permit Number	Contaminant WLA	
			Hg (kg/day)	PCBs (kg/day)
MS4	Beach Park	ILR400164	0.0003(b)	0.000006 (b)
MS4	Chicago	ILR400173		
MS4	Cook County Highway Department	ILR400485		
MS4	Evanston	ILR400335		
MS4	Glencoe	ILR400198		
MS4	Highland Park	ILR400352		
MS4	Highwood	ILR400353		
MS4	Kenilworth	ILR400214		
MS4	Lake Bluff	ILR400366		
MS4	Lake County	ILR400517		
MS4	Lake Forest	ILR400367		
MS4	North Chicago	ILR400402		
MS4	Shields Township	ILR400123		
MS4	Waukegan	ILR400465		
MS4	Waukegan Township	ILR400148		
MS4	Wilmette	ILR400473		
MS4	Winnetka	ILR400476		
MS4	Winthrop Harbor	ILR400477		
MS4	Zion	ILR400482		
MS4	Illinois Department of Transportation	ILR400493		
Individual	Zion Solutions LLC	IL0002763		NDA (0)

Type of Permit	Place Name (MS4 permit)	Permit Number	Contaminant WLA Hg (kg/day)	PCBs (kg/day)
Individual	Winnetka Power Generation Station	IL0002364		NDA (0)
Individual	Midwest Generation LLC Waukegan	IL0002259		NDA (0)
Individual	NSWRD Waukegan Water Reclamation Facility (a)	IL L0030244	0.0001	

(a) At design average flow.
(b) An aggregate WLA (.0003 kg/day x total aggregate flow volume) is assigned to entities with MS4 permits in the project study area. NDA = No Discharge Allowed

The PCB TMDL establishes WLAs for MS4s and three individual NPDES-permitted dischargers, to ensure that PCB loadings from these sources attain WQS. Entities in the study area with MS4 permits are listed along with three individual NPDES permits for facilities which currently have PCB limits in their permits.

Appendix C Menu of BMPs in the Mercury and PCB TMDLs for MS4s and MS4 Communities

Taken from Appendix D of the PCB TMDL and Appendix C of the Mercury TMDL

In the Illinois Lake Michigan Nearshore Mercury TMDL, Illinois EPA is proposing an approach that uses best management practices (BMPs) to control and reduce discharges of PCBs and mercury. EPA has proposed this approach to effectively reduce discharges of PCBs and mercury from permitted sources, including MS4s. The authority to establish BMP conditions in NPDES permits is provided in 40CFR 122.44 (k).

ILLINOIS EPA proposes the following example language which can be incorporated into MS4 permits, as adapted from Appendix B 3.1 Specific Recommendations for Areas of Permitted MS4s Contributing to Surface Water Discharges to the Spokane River or Little Spokane River.

MS4-1. Evaluate levels of PCBs/mercury in stormwater in areas of the MS4 to identify areas more likely to contribute PCBs/mercury to surface waters based on any available information.

MS4-2. Evaluate levels of PCBs/mercury in solids, at a quantitation level for total PCBs/mercury appropriate for identifying these areas using an EPA-approved test method.

MS4-3. Prioritize BMPs that are related to reducing or eliminating PCBs/mercury in stormwater in areas of the MS4 more likely to contribute PCBs/mercury to surface waters, based on any available information, including but not limited to the following:

- Previous and ongoing PCBs/mercury monitoring.
  Includes monitoring for PCBs/ mercury in sediment traps, catch basins, and in stormwater suspended particulate matter (SSPM) at frequencies and locations adequate to assess and identify sources of PCBs/mercury to municipal stormwater.
- Nearby toxics cleanup sites with PCBs/mercury as a known contaminant.
- Business inspections and compliance records.

MS4-4. Remove accumulated solids from drain lines (including inlets, catch basins, sumps, conveyance lines, and oil/water separators) in priority areas of the MS4 at least once during the permit cycle.

MS4-5. Work with partners to remove of any identified legacy PCBs/ mercury sources within the MS4 as soon as practicable.

MS4-6. Purchase preferred products with the lowest practicable PCBs/mercury concentrations for products that are likely to contact municipal stormwater.

MS4-7. Collaborative efforts are encouraged to comply with PCBs/mercury source control requirements to achieve reductions sought in the TMDL.

MS4-8. The permits should include the following requirements for new development and redevelopment disturbing one acre or more:

-Site design to minimize impervious areas, preserve vegetation, and preserve natural drainage systems.

-On-site stormwater management.

CCMS4-1. The permits should address possible contributions of PCBs/mercury to the MS4 from businesses within the areas served by the MS4 as follows:

-The permits should require the establishment and maintenance of a database of inspections and status of compliance with applicable State and federal laws and local ordinance related to PCBs/mercury in stormwater, for businesses within the area served by the MS4.

-Based on the information in the database and other available information, the permits should require the permittees to identify businesses that are likely to contribute PCBs/ mercury to the MS4 and to follow up with such businesses and appropriate regulatory agencies to develop and implement BMPs to reduce contributions of PCBs/mercury to the MS4 from such businesses.

Appendix D: BMP Application for Controlling Mercury in Urban Areas Relative to Sources

Table 7-1. BMP Application for Controlling
Mercury in Urban Areas Relative to Sources (Source: San Francisco Estuary Institute, 2010)

	Implementation Points								Applicable sources and pathways	
	Dispersed								Hg	
Best Management Practice (BMP) Category	Private homes	Public lots, schools, hospitals, govt bldgs and research institutions	Private offices and businesses	Other private lots and industrial yards	On the street	Start of pipe	Within pipe	End of pipe	Sources	Pathways
Institutional BMPs										
Education and outreach	√	√	√	√					IUP,ID,HW,BDR	
Volunteer cleanup efforts	√	√	√	√	√				IUP,ID,HW,BDR	
Recycling	√	√	√	√					IUP,ID,HW,BDR	
Amnesties	√	√	√	√					IUP,ID,HW,BDR	
Product Bans/product replacement	√	√	√	√					IUP,ID,HW,BDR	
Enforcement			√	√					OI,IUP,ID,HW,BDR	
Sweeping		√	√	√	√				A,OI,RF,RD,BDR	RI,VT,FT,W
Washing (streets/footpaths)		√	√	√	√				RD,BDR	RI,VT,FT,W
Illicit waste dumping cleanup					√	√	√	√	OI	RI
Stormwater conveyance maintenance				√		√	√	√	A,ID,RF	RI,VT,FT,W
Treatment BMPs										
Infiltration trench		√	√	√		√			A,OL,RF	RI,VT,FT,W
Infiltration basin		√	√	√		√			A,OL,RF	RI,VT,FT,W
Retention and reuse/irrigation	√	√	√			√		√	A,OL,RF	RI,VT,FT,W
Wet Pond		√	√	√		√			A,OL,RF	RI,VT,FT,W
Constructed wetland		√	√	√		√		√	A,OL,RF	RI,VT,FT,W
Extended detention basin		√	√	√		√		√	A,OL,RF	RI,VT,FT,W
Vegetated swale		√	√	√		√			A,OL,RF	RI,VT,FT,W
Vegetated buffer strip		√	√	√		√			A,OL,RF	RI,VT,FT,W
Bioretention (rain garden/green roof)	√	√	√	√		√			A,OL,RF	RI,VT,FT,W
Media filter		√	√	√			√		A,OL,RF	RI,VT,FT,W
Water quality inlet		√	√	√			√		A,OL,RF	RI,VT,FT,W
Wet vault		√	√	√			√		A,OL,RF	RI,VT,FT,W
Hydrodynamic separation		√	√	√			√		A,OL,RF	RI,VT,FT,W
Drain insert		√	√	√			√		A,OL,RF	RI,VT,FT,W
Flow diversion to wastewater treatment								√	All sources	All pathways

True sources: deposition= A
Source areas: Old industrial - OI, Hg products still in use = IUP, Illegal disposal - ID, Recycling facilities = RF, Road deposits = RD, Home and work place = HW
Building demolition and remodeling = BDR
Transport pathways: Runoff from impervious surfaces = RI, Vehicle tracking = VT, Foot tracking = FT, Wind = W

Applicable sources and pathways	
PCBs	
Sources	Pathways
F.OI,IUP,ID,HW,BDR	
F,OI,IUP,ID,HW	
OI,IUP.HW	
F,OI,IUP,HW	
F.OI,IUP,ID,HW,BDR	
A.OI.RF.RD.BDR	RI,VT.FT.W
RD,BDR	RI,VT,FT,W
OI,ID	RI
A.OI.ID.RF	RI.VT.FT.W

Figure D-1 Sources and Pathways of PCBs

Table 7-2. BMP Application for Controlling Mercury in Urban Areas Relative to Sources (Source: San Francisco Estuary Institute, 2010)

Best management practice (BMP) category	Most applicable effectiveness assessment outcome levels					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	Documenting activities	Raising awareness	Changing behavior	Reducing loads from sources	Improving runoff quality	Protecting receiving water quality
Institutional BMPs						
Education and outreach	√	√	√			
Volunteer cleanup efforts	√			√		
Recycling	√			√		
Amnesties	√			√		
Product Bans / product replacement	√			√		
Enforcement	√	√	√	√		
Sweeping	√			√		
Washing (streets/footpaths)	√			√		
Illicit waste dumping cleanup	√			√		
Stormwater conveyance maintenance	√			√	√	
Treatment BMPs						
Infiltration trench	√			√	√	
Infiltration basin	√			√	√	
Retention and reuse / irrigation	√			√	√	
Wet Pond	√			√		
Constructed wetland	√			√		
Extended detention basin	√			√		
Vegetated swale	√			√	√	
Vegetated buffer strip	√			√	√	
Bioretention (Rain garden / green roof)	√			√	√	
Media filter	√			√		
Water quality inlet	√			√		
Wet vault	√			√		
Hydrodynamic separation	√			√		
Drain insert	√			√		
Flow diversion to wastewater treatment	√			√	√	√

True sources: deposition= A
Source areas: Old industrial - OI, Hg products still in use = IUP, Illegal disposal - ID, Recycling facilities = RF, Road deposits = RD, Home and work place = HW Building demolition and remodeling = BDR
Transport pathways: Runoff from impervious surfaces = RI, Vehicle tracking = VT, Foot tracking = FT, Wind = W

Appendix E: Gas-Exchange Model (GEM) Proportionality Approach

Illinois used a second proportionality approach for PCBs, called a Gas-Exchange Model (GEM) Direct Proportionality Approach. This approach is based on a gas phase equilibrium equation combined with bioaccumulation factors (BAFs) and the result is independent of legacy sediment effects. The GEM proportionality approach also yields an estimate of needed percent reductions in PCBs for comparison with the FTB approach. Illinois uses the alternate approach to verify whether the reduction in loads to meet fish tissue numbers will also meet the 26 pg/L target for PCBs in the water column for the protection of human health that has been adopted by the State of Illinois as part of the Great Lakes Water Quality Initiative (GLI). These approaches are addressed separately in the PCB Section of the Decision Document below.

GEM Proportionality Approach to PCB TMDL Development

As explained in Section 3.1 of the Decision Document, Illinois used a second proportionality approach in the TMDL which applies theoretical and empirically-based equations to link atmospheric loading to the resulting PCB concentrations in fish tissue, as well as in the water column (Section 5.2 of the PCB TMDL). The approach does not require existing fish tissue concentrations and is therefore, not influenced by the legacy effect inherent in the existing carp tissue data. The GEM proportionality approach consists of the following steps:56

1. Determine atmospheric PCB concentration needed to comply with WQS (water column).
2. Define the relationship between sediment and water column PCB concentrations.
3. Use published biota-sediment accumulation factors to define the relationship between sediment and carp tissue PCB concentrations.
4. Use published bioaccumulation factors to define the relationship between water column PCB and lake trout tissue PCB concentrations

The application of each step to the Illinois Lake Michigan Nearshore PCB TMDL is described below.

1. Determine the Atmospheric PCB Concentration To Comply With WQS (water column).

Section 5.2.1 of the TMDL presents the linkage between atmospheric PCB concentrations and water column concentrations, identifying what the atmospheric concentration would be at steady state, when the water column PCB concentration is at the water quality criteria for the water column of 26 pg/L. Illinois with support from LimnoTech, used Henry's Law, a basic chemistry gas law, which states that the amount of a gas that dissolves in a liquid is directly proportional to the partial pressure (i.e. gas phase concentration) of that gas in equilibrium with that liquid. This is expressed mathematically in the TMDL as:

$$p = kH\ c \qquad \text{(5-3 of the PCB TMDL)}$$

p = the partial pressure of the gas above the solution
kH = a chemical constant termed the Henry's Law constant
c = the concentration of the dissolved gas in solution

[56] All relationships are for steady-state concentrations.

Illinois and the contractor define the atmospheric PCB concentration that will result in compliance with WQS (26 pg/L) by adapting[57] equation 5-3 for PCBs and solving the equation58 to get a Henry's Law constant of 1.09 x10-04 atm*m3/mol at ambient temperature.

kH = p/c
=1.09 x 10-04 atm*m3/mol

Using 0.67 as the fraction of dissolved PCB in the water column (taken from the MICHTOX model, USEPA, 2006), Illinois EPA and Limnotech found this Henry's Law constant to result in an atmospheric concentration of 82 pg/m3 which is the equilibrium equivalent of a water column standard of 26 pg/L.

2. Define The Relationship Between Steady State Sediment PCB and Water Column Concentrations

In Section 5.2.2 of the TMDL Illinois defines the linkage between water column concentrations and sediment concentrations.

The ratio between sediment and water column PCB concentrations can be defined as shown in equation 5-4 (Chapra, 1997):

$$C2/C1 = (VsFp1 + VdFd1) / (k2Z2 + Vr + Vb + VdFd2) \qquad (5\text{-}4)$$

C2/C1 = ratio of sediment PCB concentration to water column PCB concentration
Vs = solids settling velocity (m/day)
Fp1 = fraction of PCB in particulate form - water column
k2 = PCB decay rate in sediments (1/day)
Z2 = sediment layer thickness (m)
Vr = sediment resuspension velocity (m/day)
Vb = sediment burial velocity (m/day)
Vd = diffusion velocity
Fd1 = fraction of PCB in dissolved form - water column
Fd2 = fraction of PCB in dissolved form - sediments

Illinois populates equation 5-4 with steady state coefficient values estimated for Southern Lake Michigan during the development of the MICHTOX Lake Michigan Mass Balance Project (USEPA, 2006; Endicott, 2005; and Endicott et al., 2005). The values are listed in Table 5-3 in

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[57] The adaptations taken for this TMDL consisted of: 1) using a Henry's Law constant representative of the mixture of PCB congeners present in the Great Lakes (LimnoTech, 2004); 2) using an annual average temperature of 10 °C taken from USEPA (2006) MICHTOX model results for Lake Michigan; and 3) using fraction dissolved PCB in the water column of 0.67, also taken from the MICHTOX (USEPA, 2006) modeling. Further detail on this procedure can be found in section 5.2.1 in the TMDL.

[58] Henry's Law applies to a single chemical at a constant temperature, while PCBs represent a mixture of individual chemicals, and the temperature of Lake Michigan varies seasonally. It also predicts only the dissolved phase PCB concentration in water, while total PCB concentrations consist of both dissolved and particulate forms.

the TMDL. Illinois EPA used a number of these factors59 to calculate a steady state sediment/water column PCB ratio of 9.61 x 104. Illinois combined this ratio with the water column water quality standard for PCBs of 26 pg/L, resulting in a sediment PCB concentration of 2.50 x 10-3 g/m3.

3. Relationship between Steady State Sediment PCB and Fish Tissue PCB Concentrations

In Section 5.2.3 of the TMDL Illinois used a biota sediment accumulation factor (BSAF) to define the relationship between steady-state carp tissue PCB concentrations and sediment PCB concentrations. BASFs describe the bioaccumulation of sediment-associated organic compounds or metals into tissues of ecological receptors. Illinois used the following equation (Burkhard, 2009) to calculate concentrations of PCBs in fish tissue attributable to sediments:

$$C_{FISH} = \frac{BSAF.\,C_{SED}.\,F_L}{F_{SOC}} \qquad (5\text{-}5)$$

Where:

C_{FISH} = the chemical concentration in the organism (µg/kg wet weight)
$BSAF$ = the biota sediment accumulation factor (g organic carbon/g lipid)
C_{SED} = the chemical concentration in surficial sediment (µg/kg dry weight)
F_L = the lipid fraction of the organism (g lipid/g wet weight)
F_{SOC} = the fraction of the sediments as organic carbon (g organic carbon/g dry weight).

USEPA (2015d) has a database containing over 20,000 BSAFs for organic chemicals from 20 locations across the country. Illinois EPA uses a median BSAF of 3.3 g organic carbon/g lipid from the database for Lake Michigan at Green Bay, Wisconsin. Illinois EPA identified a median carp fillet lipid content of 8.85 percent using the carp data from the TMDL project database.

Illinois used Equation 5-5 of the PCB TMDL to calculate that a carp tissue PCB concentration of 0.0585 mg/kg would be expected for a water column PCB concentration equal to the water quality standard of 26 pg/L. Illinois notes that the TMDL is protective of the water column water quality standard and would also be protective of carp tissue concentrations (TMDL target 0.06 mg/kg).

The MICHTOX model indicated that results could vary within a factor of two (likely more when applied to harbors) and the lipid content of individual carp fillets used to calculate the average varied over several orders of magnitude.

4. Relationship between Steady State Water Column PCB and Lake Trout Tissue PCB Concentrations

In Section 5.2.4 of the PCB TMDL, Illinois EPA calculates a lake trout tissue PCB concentration of 0.028 mg/kg being expected in for a water column PCB concentration equal to the water quality standard of 26 pg/L (2.6 x 10-8 mg/L). Lake trout is not the species selected to determine fish tissue concentration reductions for this TMDL. However, quantifying the relationship

[59] solids settling, resuspension and burial velocities (m/day), fraction of PCB in the waterbody in dissolved and particulate forms, PCB rate of decay and sediment layer thickness

between lake trout tissue PCB content and the water column demonstrates that the FTB proportionality method would be protective of tissue concentrations in lake trout, a species that is largely influenced by exposure to PCBs in the water column.

Introduction to Percent Reduction calculation.

In Section 5.3 of the PCB TMDL, Illinois EPA calculates the required reduction percentage necessary to attain each TMDL target. It also provides a recommendation for which reduction percentage should serve as the basis for the PCB TMDL.

Illinois determined a baseline year of 2005 for this PCB TMDL for the following reasons:

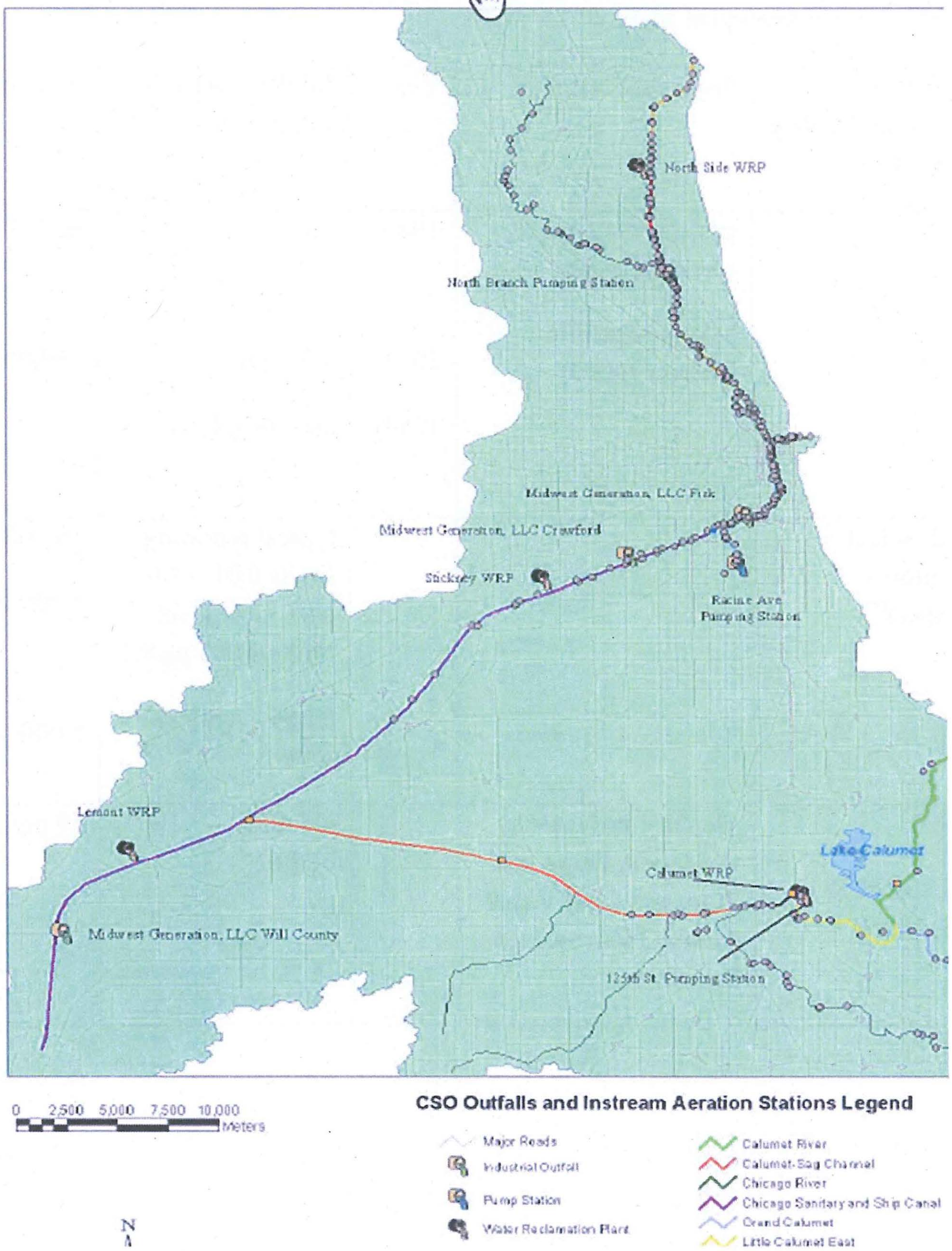
- The carp tissue data used in the fish tissue-based approach were all collected in 2005.
- The lake trout tissue data used in the fish tissue-based approach were all collected between 2000 and 2009.
- The two scientific papers that document the decline in atmospheric PCB concentrations since the 1979 PCB ban (Venier and Hites, 2010b; Sun et al., 2006) are based on data sets that end in 2007 and 2003, respectively. Using a baseline of 2005 is consistent with these studies.

Appendix F: Visual Representations of Chicago Area Waterways.

The Chicago UAA analysis of 2011, Section 4, pages 4-8

The map below identifies the location of instream aeration stations and significant point source inputs such as water reclamation plants, CSO pumping stations and power generating facilities. The impacts of wet weather and CSO discharges were evaluated using rainfall data from Midway and O'Hare airports and discharge volume data provided by the MWRD for the CSO pumping stations. The pumping station discharges to the waterways when the TARP CSO capture system is near capacity. Changes in dissolved oxygen concentrations were assessed in response to rainfall and/or CSO discharge events using continuous time series (hourly) plots of rainfall, DO and temperature data for 36 stations distributed throughout the waterways. Similar assessments were made using monthly grab E.coli bacteria data.

Figure 4-3 - CSO Outfalls and Instream Aeration Stations Legend



Appendix G: PCB and Mercury Analysis Methods and Their Detection Limits

Table G-1. EPA Analytical Methods for PCBs

EPA PCB Analytical Method Number	Procedure Name	Year	Method Detection Limit	Pico grams
608 608.3	gas chromatograph chromatograph/ halogen-specific detector (HSD)	1984 2014 1984	.065 µg/L 150 ng/L 30 -36µg/L	65,000.00 pg/ L 150,000 pg/L
8082 (select arochlors - cheaper)[60]			typical reporting limits 0.01 – 1.0 µg/L (low level limits 0.005 µg/L) 5 ng/L typical for water	10,000 pg/L - 1,000,000 pg/L 5,000 pg/L
1668A (All 209 PCB congeners)	Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry		.05 ng/L – 100 ng/L61	50 pg/L [62]

[60] EPA. 2017. CWA §136 Rule Update

[61] EPA. 2002Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

[62] Pace Analytical Services, Inc., www.pacelabs.com accessed 2/4/2019, 1700 Elm Street, STE 200, Minneapolis, MN 55414.

Table G-2. EPA Analysis Methods for Mercury

EPA Hg Analytical Method Number	Procedure Name	Year	Method Detection Limit	Pico grams/L
245.3	Cold Vapor Technique	(1974)		200,000 pg/L
		(1994)	0.2-10 µg /L.	10,000,000pg/L
245.7	Cold Vapor Absorption Spectrometry			1000 pg/L
		(2005)	1-50 ng/L	50,000 pg/L
1631E	Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry	(2002)	.05 ng/L – 100 ng/L[63]	50 pg/L [64]

[63] Ibid.

[64] Pace Analytical Services, Inc., www.pacelabs.com accessed 2/4/2019, 1700 Elm Street, STE 200, Minneapolis, MN 55414.

Appendix H: Illinois Lake Michigan Nearshore PCB and Hg TMDL Review References (References can also be found in PCB and Hg TMDLs)

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Illinois Lake Michigan (nearshore) PCB Final TMDL Report

Prepared for:
USEPA
Contract No. EP-C-12-052,
Task Order No. 0003
Final Report
April 2019

Michael Baker INTERNATIONAL
LimnoTech
Water Environment | Scientists Engineers

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List of Acronyms

AOC	Area of Concern
AEOLOS	Atmospheric Exchange Over Lakes and Oceans Study
BAF	Bioaccumulation Factor
BMP	Best Management Practice
BSAF	Biota-Sediment Accumulation Factor
CAWS	Chicago Area Waterway System
CFR	Code of Federal Regulations
CSO	Combined Sewer Overflow
DL	Detection Level
FCMP	Fish Contaminant Monitoring Program
GIS	Geographic Information System
GLCFS	Great Lakes Coastal Forecasting System
GLI	Great Lakes Water Quality Initiative
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
HPV	Health Protection Value
IADN	Integrated Atmospheric Deposition Network
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
LA	Load Allocation
LC	Load Capacity
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NPDES	National Pollutant Discharge Elimination system
NOAA	National Oceanic and Atmospheric Administration
OMC	Outboard Marine Company
PCB	Polychlorinated Biphenyl
RF	Reduction Factor

TCE	Trichloroethylene
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WLA	Wasteload Allocation
WQS	Water Quality Standards
WCP	Waukegan Manufactured Gas and Coke Plant

Executive Summary

Polychlorinated biphenyls (PCBs) are a set of 209 synthetic chlorinated organic compounds (congeners) produced in the form of complex mixtures called Aroclors for industrial use in the United States from 1929 to the late 1970s. PCBs have been demonstrated to cause cancer, as well as a variety of other adverse health effects on the immune system, reproductive system, nervous system, and endocrine system (United States Environmental Protection Agency (USEPA), 2015). Although the commercial production of PCBs was banned in 1979, PCBs remain a concern due to their ability to persist in the environment and bioaccumulate in living tissues. Human exposure through the consumption of fish is the principal public health concern with PCBs in the environment.

PCB concentrations in Great Lakes top predator fish are declining, but PCB fish advisories remain in place for all five Great Lakes (USEPA, 2015a). This Total Maximum Daily Load (TMDL) report addresses PCB impairments in 56 waterbody segments located in the Illinois Lake Michigan nearshore. Appendix B lists specific waterbody segments covered by this TMDL.

The atmosphere is the primary source of PCB loads to the study area waterbodies, either via direct atmospheric input to these waterbodies or by transport into the study area from the main body of Lake Michigan (which is controlled by atmospheric sources). A TMDL has been developed to address PCB impairments in the nearshore Lake Michigan waterbodies. Based on a target fish tissue concentration of 0.06 mg/kg, which is generally considered safe for human consumption by Illinois Environmental Protection Agency (IEPA), this TMDL report sets a goal for reducing atmospheric PCB loading by 94.7 percent, relative to the baseline year of 2005.

Atmospheric deposition of PCBs in the study area comes from local, regional, national and global sources. Based on the assumption that fish PCB concentrations will respond proportionally to reductions in atmospheric PCB loadings, a TMDL and reduction goal was developed to meet the target fish tissue concentration of 0.06 mg/kg. Atmospheric PCB sources from Illinois must be reduced by 94.7% from 2005 levels to meet this goal (Table ES-1). Reductions are necessary from PCB sources within Illinois and in other U.S. states, and from global sources. However, this TMDL only addresses reductions from Illinois sources. Progress on achieving this goal in Illinois will be tracked through the analysis of PCBs in fish collected within the project study area.

Table ES-1. Summary of TMDL Components

TMDL Components	Results
Target Level and Reduction Factor	
Target Fish PCB Concentration (Fish Tissue Residue Value)	0.06 mg/kg
Baseline PCB Concentration for Carp	1.13 mg/kg
Reduction Factor	94.7 %
Final TMDL	
Loading Capacity (LC)	0.0026 kg/day
Necessary Reduction from Atmospheric Sources	94.7%
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.000006 kg/day
Load Allocation (LA)	0.0026 kg/day
PCB Load Allocation for In-State and Out-of-State Deposition Sources	
In-State Contribution to LA [a]	0.0019 kg/day
Out-of-State Contribution to LA[b]	0.0007 kg/day

Numbers may not sum exactly due to rounding

[a] Calculated as 73% of LA

[b] Calculated as 27% of LA

1 Introduction

Section 303(d) of the Federal Clean Water Act and the USEPA's Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations [CFR] Part 130) requires states to develop Total Maximum Daily Loads (TMDLs) for all category 5[1] waterbodies that are not meeting Water Quality Standards (WQS) for a specific pollutant. These waterbodies are included on a state's 303(d) list. The TMDL process establishes the allowable loadings of a pollutant to a waterbody based on the relationship between pollution sources and water quality conditions of a waterbody. This allowable loading represents the maximum quantity of a pollutant that the waterbody can receive without exceeding WQS. The TMDL process provides states with the basis for establishing water quality-based controls, which provide the pollutant reductions necessary for a waterbody to attain WQS (USEPA, 1991).

Within the Illinois Lake Michigan Basin, IEPA has identified 56 nearshore beach/shoreline, harbor and open water segments that are impaired due to concentrations of PCBs in fish tissue and the water column (IEPA, 2014). All of these waterbody segments are impaired for fish consumption use, and one segment (Waukegan Harbor North) is also impaired for aquatic life use. These impaired waters are included on the Illinois Integrated Water Quality Report and Clean Water Act Section 303(d) list (IEPA, 2014).

The scope of this TMDL covers the 56 nearshore beach/shoreline, harbor and open water segments impaired due to PCBs. It quantifies the pollutant load reductions needed to reduce PCB levels in fish tissue and the water column so that the waterbodies can meet WQS.

The report covers each step of the TMDL process and is organized as follows:

- Section 2. Background
- Section 3. Applicable WQS and TMDL targets
- Section 4. Source assessment
- Section 5. Modeling approach
- Section 6. TMDL development
- Section 7: Implementation plan and monitoring recommendations
- Section 8: Public participation

[1] Category 5 means available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

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2
Background

This section provides background information for PCB TMDL development. It is divided into the following sections:

- Problem statement
- Study area and impaired waterbodies
- Data compilation and assessment of water quality

2.1 Problem Statement

PCBs are a set of 209 synthetic chlorinated organic compounds (congeners) produced in the form of complex mixtures called Aroclors for industrial use in the United States from 1929 to the late 1970s. PCBs were used in insulation fluids in electrical transformers and generators, fluorescent lamp ballasts, caulk, and carbonless copy paper production. In 1979, USEPA banned commercial PCB production, but PCBs may be present in a wide range of products and materials produced before the 1979 ban, including electrical, heat transfer, and hydraulic equipment; plasticizers in paints, plastics, and rubber products; pigments, dyes, and carbonless copy paper; and many other industrial applications (USEPA, 2015). There are no known natural sources of PCBs. However, they continue to be produced inadvertently as a manufacturing byproduct of many chlorinated organic compounds.

PCBs have been demonstrated to cause cancer, as well as having a variety of other adverse health effects on the immune system, reproductive system, nervous system, and endocrine system. (USEPA, 2015). PCBs are relatively persistent and have a tendency to accumulate in sediments and concentrate and bioaccumulate in living tissues. Human exposure through the consumption of fish is the principal public health concern with PCBs in the environment.

2.1.1 Recent PCB Trends

Median PCB concentrations in top predators continue to decline since PCB production was banned; however, concentrations in all the Great Lakes remain above the 1987 Great Lakes Water Quality Agreement target of 0.1 mg/kg wet weight (USEPA, 2012). A log-linear regression of USEPA data shows 6-percent annual declines in total PCB in lake trout from Lake Michigan (USEPA, 2012; Figure 2-1).

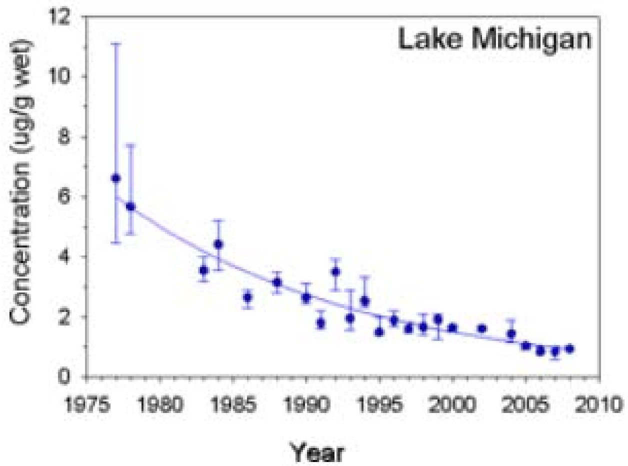


Figure 2-1. Total PCB (Median and Inter-Quartile Range) Concentrations for Composited Lake Michigan Whole Body Lake Trout (adapted from McGoldrick et al., 2012 as presented in USEPA, 2012)

The Integrated Atmospheric Deposition Network (IADN), created in 1990, is a joint venture of Environment Canada, the Ontario Ministry of the Environment, and the USEPA's Great Lakes National Program Office. IADN consists of a master monitoring station located on each of the five Great Lakes and several satellite stations, including one in Chicago. One of the goals of IADN is to determine whether the concentrations of toxic organic compounds in air and precipitation near the Great Lakes are changing as a function of time. Total gas phase concentrations of PCBs measured by IADN show a general decrease between 1992 and 2002 (USEPA, 2015b; Figure 2-2). The rate of decline for the Lake Michigan IADN site at Sleeping Bear Dunes, Michigan(1991-1997) and the IADN site at Chicago (1997-2003) is approximately 7 percent per year (Sun et al., 2006), which is similar to the rate of decline in Lake Michigan lake trout (Figure 2-1).

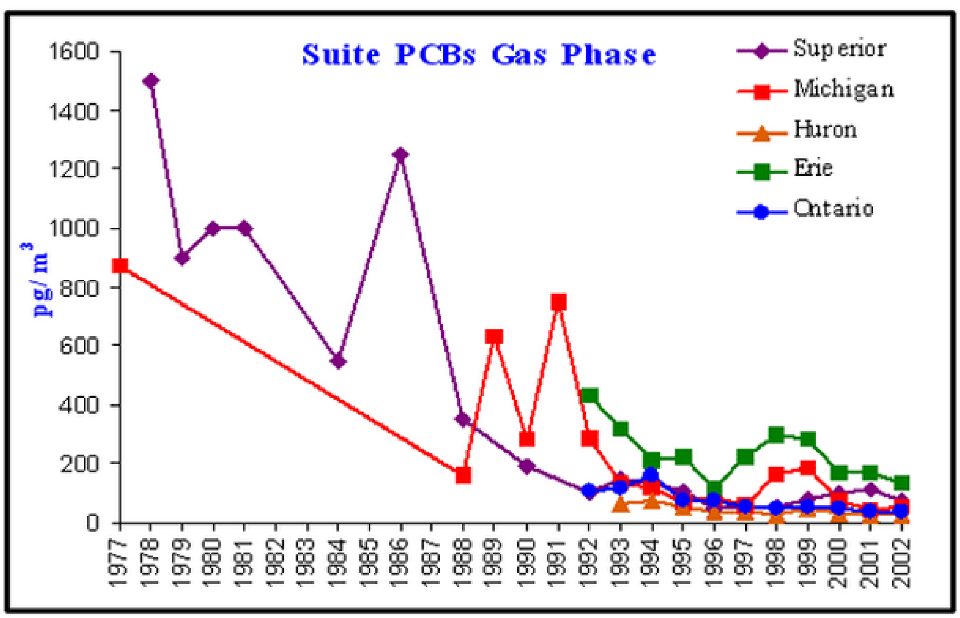
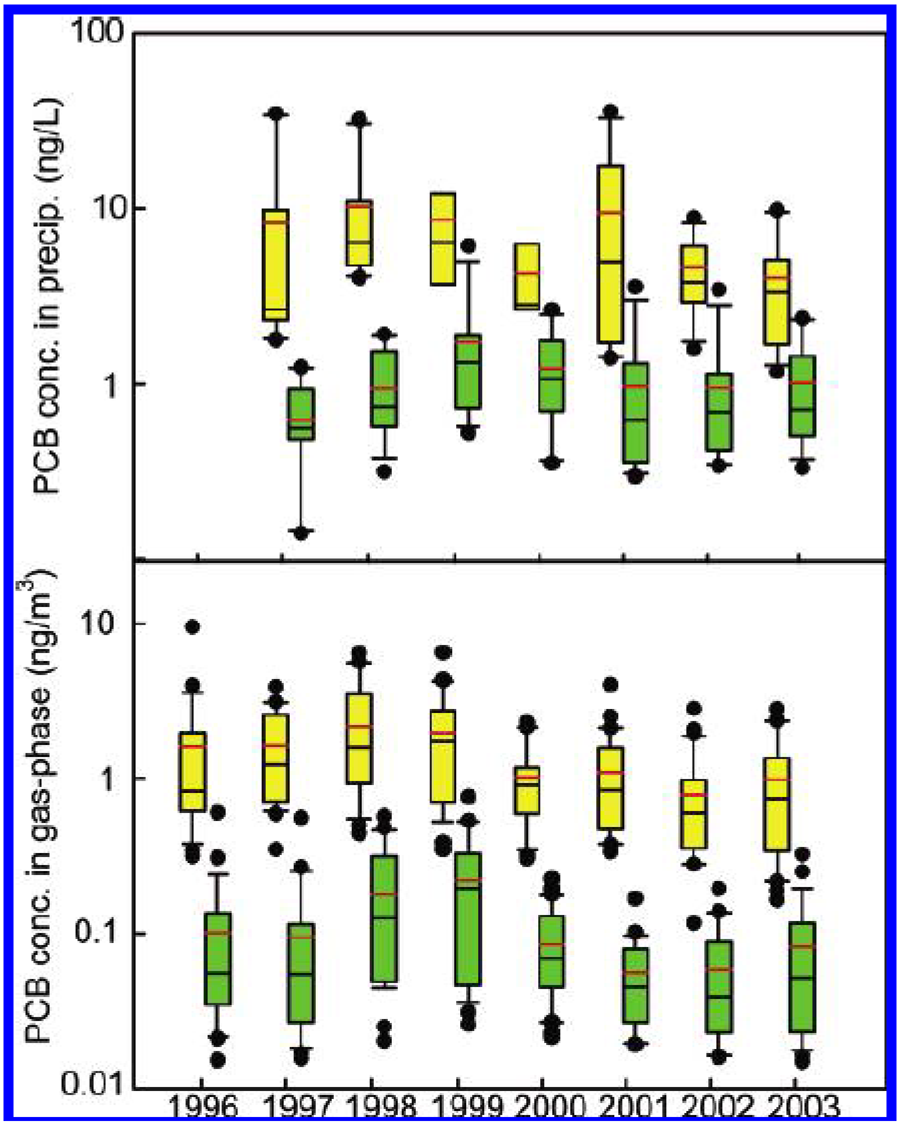


Figure 2-2. Time Trend of PCB Gas Phase Atmospheric Concentrations at Great Lakes IADN Stations (Source: USEPA, 2015b)

Gas phase PCB concentrations in Chicago have decreased by about half between 1996 and 2003. However, the atmospheric gas phase PCB concentrations observed over Chicago continue to be much higher than concentrations measured over the main Lake Michigan open water and at other IADN stations (Buehler and Hites, 2002). Total PCB concentrations in precipitation and gas phase over Chicago are about an order-of-magnitude higher than over Sleeping Bear Dunes (Figure 2-3). Studies during the Lake Michigan Mass Balance Study (Green et al., 2000) and the Atmospheric Exchange Over Lakes and Oceans Study (AEOLOS, Simcik et al., 1997; Zhang et al., 1999) confirmed that a combination of prevailing westerly winds off Chicago and an elevated rate of PCB gas phase emissions over the city led to elevated gas phase PCB concentrations for about 20-40 km off the Chicago shoreline. These elevated gas phase PCB concentrations consequently lead to increased absorption fluxes, i.e. the transfer of gas phase PCBs from the atmosphere to the water column.



The horizontal lines represent the 10th, 50th, and 90th percentiles; the red lines are the means; the boxes represent the 25th to 75th percentiles; outliers are shown individually

Figure 2-3. Total PCB Concentrations in Precipitation (top) and Atmospheric Gas Phase (bottom) for Chicago (yellow) and Sleeping Bear Dunes (green) IADN Master Stations (from Sun et al., 2006)

2.2 Study Area and Impaired Waterbodies

The project study area, shown in Figure 2-4, includes one nearshore open water segment, 51 beach/shoreline segments, and four harbors that are identified by IEPA (IEPA, 2014) as being impaired due to PCBs. All 56 impaired water segments are in Lake and Cook Counties, Illinois. The fish consumption use is *Not Supporting* for all segments, and the aquatic life use is also *Not Supporting* for Waukegan Harbor North. Appendix B contains a complete list of the impaired segments and causes.

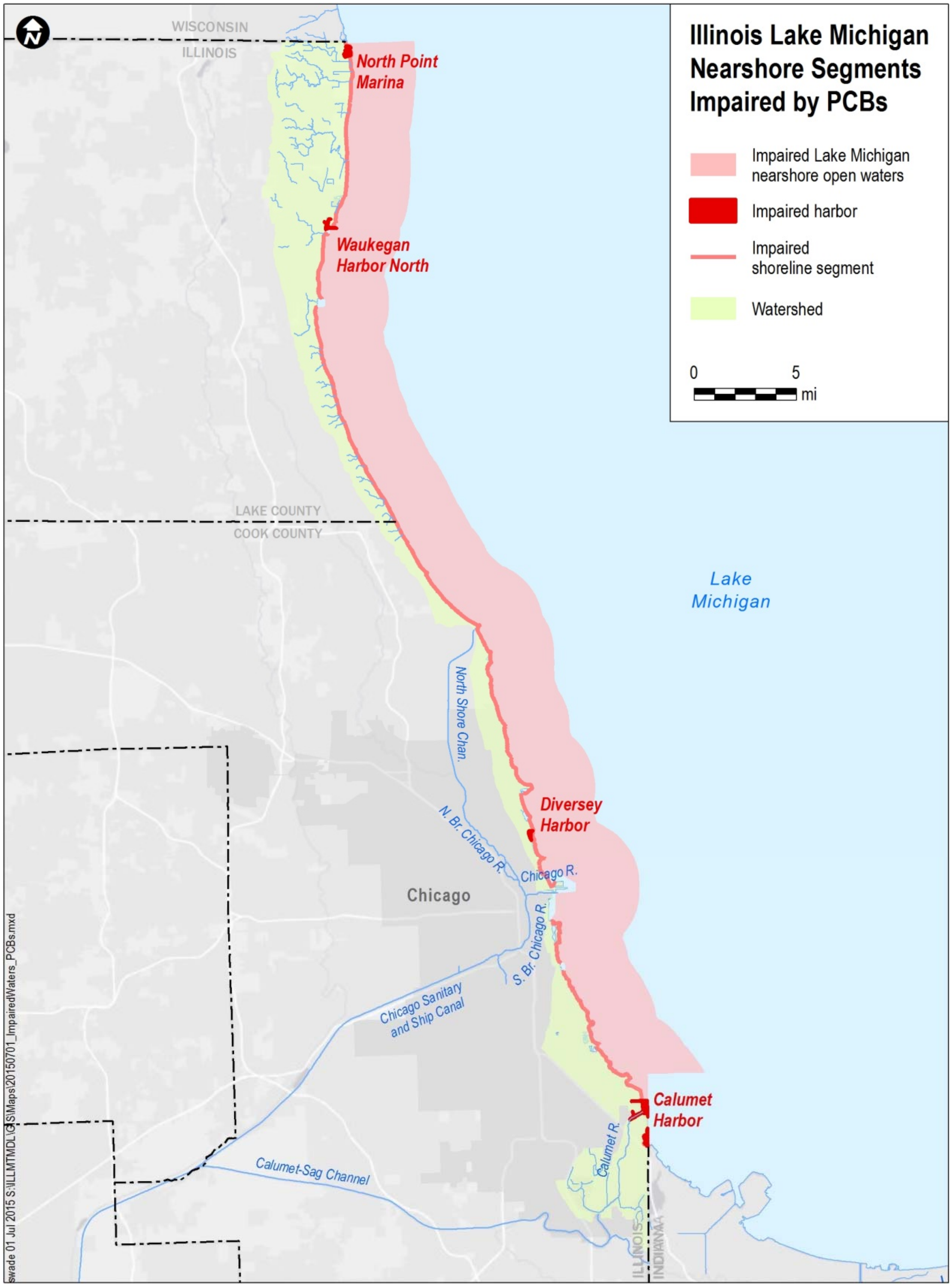


Figure 2-4. Project Study Area and Impaired Segments

2.2.1 Watershed Description

The study area watershed is long and narrow and encompasses roughly 100 square miles within Lake and Cook Counties, Illinois, that drain to Lake Michigan. The study area watershed is highly developed, and land use is roughly distributed as 73 percent residential, 4 percent industrial, 4 percent commercial, and 19 percent open space. The watershed includes portions of the following municipalities: Wilmette, Winnetka, Kenilworth, Winthrop Harbor, Chicago, Burnham, Highland Park, Lake Bluff, Beach Park, Highwood, Waukegan, North Chicago, Zion, Evanston, Glencoe, and Lake Forest. All of the listed municipalities except Burnham have Municipal Separate Storm Sewer System (MS4) permits to discharge to Lake Michigan. The MS4 permits for these municipalities, together with the MS4 permits for the Cook County Highway Department, Illinois Department of Transportation, Lake County, Shields Township, and Waukegan Township (permit numbers presented in Table 6-2) cover roughly 100 percent of this drainage. A number of additional National Pollutant Discharge Elimination System (NPDES) -permitted point sources are located in the watershed. Three of these permits have a Special Condition which is written as, “There shall be no discharge of PCBs.”

The waterbodies within the watershed are generally small streams and ravines that carry intermittent stormwater and surface drainage to Lake Michigan. Within Lake County, the watershed boundary extends inland farther than it does in Cook County, narrowing near the south end of Lake County due to the diversion of flows into the Chicago Area Waterway System (CAWS). The CAWS is heavily altered from its natural state, including a diversion of the Chicago River (in 1900), and the Little and Grand Calumet River (in 1922) away from Lake Michigan via the CAWS. The CAWS is a major component of the study area, comprising both manmade and natural waterways. In addition to navigation, these waterways convey a variety of point-source and precipitation-related flows, including water reclamation plant effluents, combined sewer overflows (CSOs), and stormwater runoff. While the direction of flow in the CAWS is typically toward the Des Plaines River watershed and away from the study area waterbodies, extreme wet weather conditions can create storm flows large enough to cause flow reversals in the CAWS and discharge into Lake Michigan. These discharges occur via three control works locations: the Wilmette Pumping Station, the Chicago River Lock and Controlling Works, and the O’Brien Lock and Controlling Works on the Calumet River (Figure 2-5). These discharges from the CAWS to Lake Michigan are of interest because PCBs in stormwater and CSO, which discharge into the CAWS, can contribute to the impairment of the Lake Michigan study area waters.

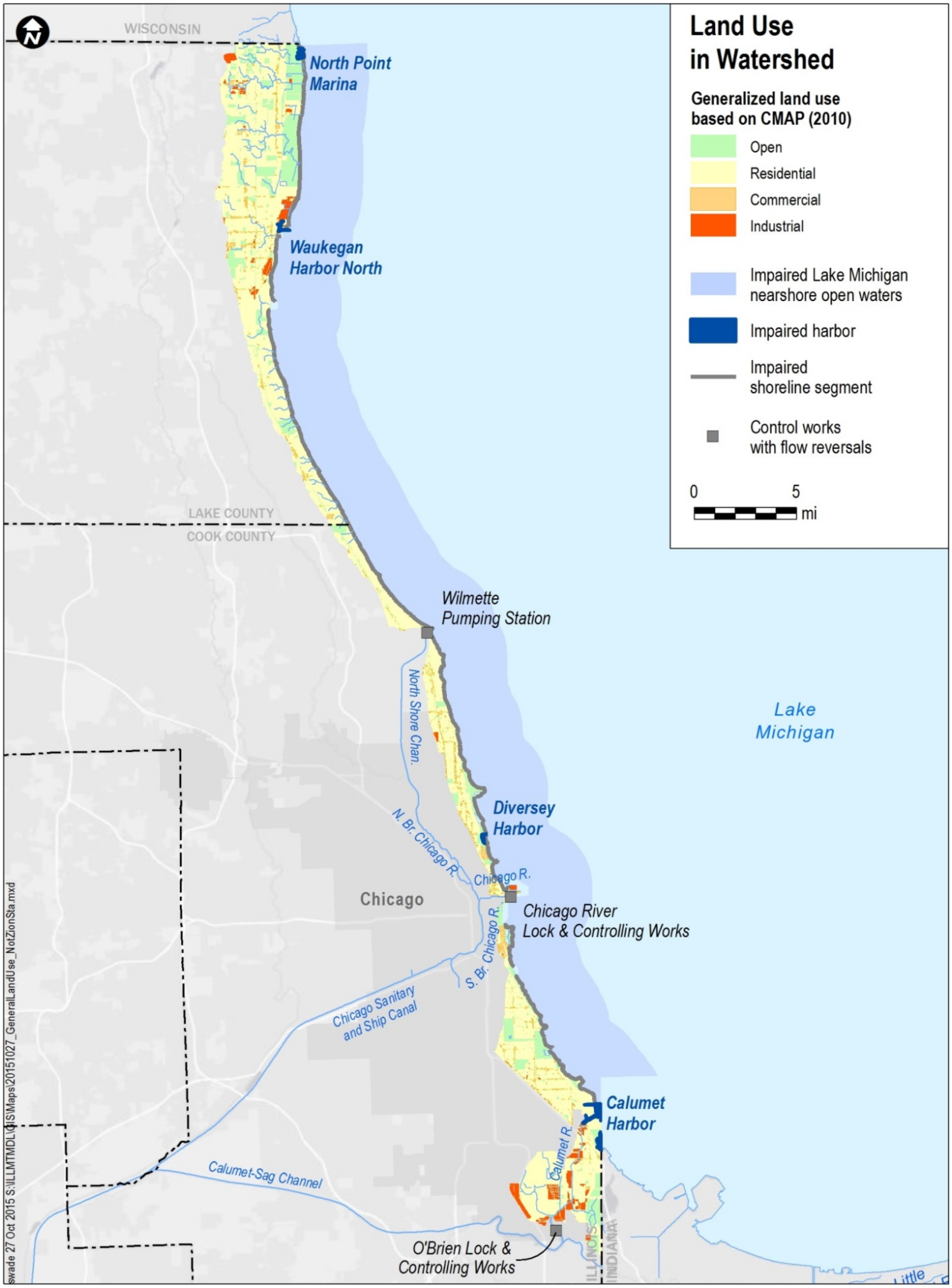


Figure 2-5. Study Area Land Use

2.2.2 Impaired Individual Waterbody Descriptions

A total of 56 segments are impaired due to PCBs. The impaired nearshore open water segment is 180 square miles in size, extending 5 km into Lake Michigan from the Illinois shoreline, with Lake Michigan serving as its eastern boundary (Figure 2-5). Additionally, 51 shoreline (beach) segments have been identified as impaired due to PCBs. The term *shoreline segment* is used in this document, because not all of the segments have beaches. The total length of these shoreline segments is approximately 63.5 miles, with segment lengths ranging from 0.07 to 5.5 miles.

Interspersed with the shoreline segments are four harbors that are impaired due to PCBs: Waukegan Harbor North (~0.07 square miles), North Point Marina (~0.12 square miles), Diversey Harbor (~0.05 square miles), and Calumet Harbor (~2.4 square miles). These harbors, shown in Figure 2-6, are described briefly below.

Waukegan Harbor, a federally authorized navigation project in Waukegan, Illinois, is used for both industrial and recreational activities (Illinois Department of Natural Resources (IDNR), 2012). This manmade harbor is approximately 40 miles north of the city of Chicago. The United States Army Corps of Engineers (USACE) has been involved with dredging operations at this harbor since 1889. With the exception of some intermittent harbor deepening projects, the vast majority of the dredging operations have focused on maintaining navigable conditions, primarily within the approach channel (USACE Chicago District, 2013), which is beyond the extent of the impaired area shown in Figure 2-5. In 1975, PCBs were discovered in Waukegan Harbor sediments. An estimated 300,000 pounds of PCBs were discharged into the harbor by Outboard Marine Corporation (OMC) between 1961 and 1972. The site was added to the National Priorities List in the early 1980s, and in 1981, the United States and Canadian governments identified Waukegan Harbor as an Area of Concern (AOC). In 1992 and 1993, roughly one million pounds of PCBs were removed during remediation activities at the Outboard Marine Corporation site and Waukegan Harbor, including the removal of 32,000 cubic yards of contaminated sediments from the Waukegan Harbor AOC (USEPA, 2015c). In 2002, USEPA and IEPA determined, through risk assessment, the remediation standards for PCB concentrations that would meet the ecological target of lowering the levels of PCB concentration in sport fish tissue to levels seen in open lake sport fish. The resulting target for PCB concentrations in sediment were 0.25 to 1.0 ppm (IDNR, 2012). In 2012 and 2013, an additional 124,000 cubic yards of contaminated sediment were removed from Waukegan Harbor (USEPA, 2015c). The Waukegan Harbor Area of Concern Habitat Management Plan (IDNR, 2012) defines the PCB target for Waukegan Harbor open water unit as “reduce PCB levels in Waukegan Harbor sediments to 0.2 ppm.”

North Point Marina, in Winthrop Harbor, Illinois, is the largest marina on the Great Lakes (IDNR, 2015a). **Diversey Harbor** is in Lincoln Park, within Lake Shore Drive. Due to bridge restrictions, Diversey Harbor can only accommodate power boaters (Chicago Harbors, 2015).

Calumet Harbor and the Calumet River include an approach channel, an outer harbor channel, an entrance channel, and a river channel. The approach and outer harbor channels are located primarily in Indiana. The entrance channel and river channel are located in Illinois and extend approximately 6.7 miles up the Calumet River to Lake Calumet (USACE Chicago and Rock Island Districts, 2015). Calumet Harbor is a deep draft commercial harbor that is protected by 12,153 linear feet of steel sheetpile and timber crib breakwater structures (USACE Detroit District, 2015). This is the largest of the study area’s four impaired harbors, and Calumet Harbor and River are the third busiest port on the Great Lakes by tonnage, moving an annual average of over 14 million tons of commodities (USACE Detroit District, 2015). At Calumet Harbor and River, an average of approximately 50,000 cubic yards of sediment are dredged annually, and this dredging requirement is expected to continue (USACE Chicago and Rock Island Districts, 2015).

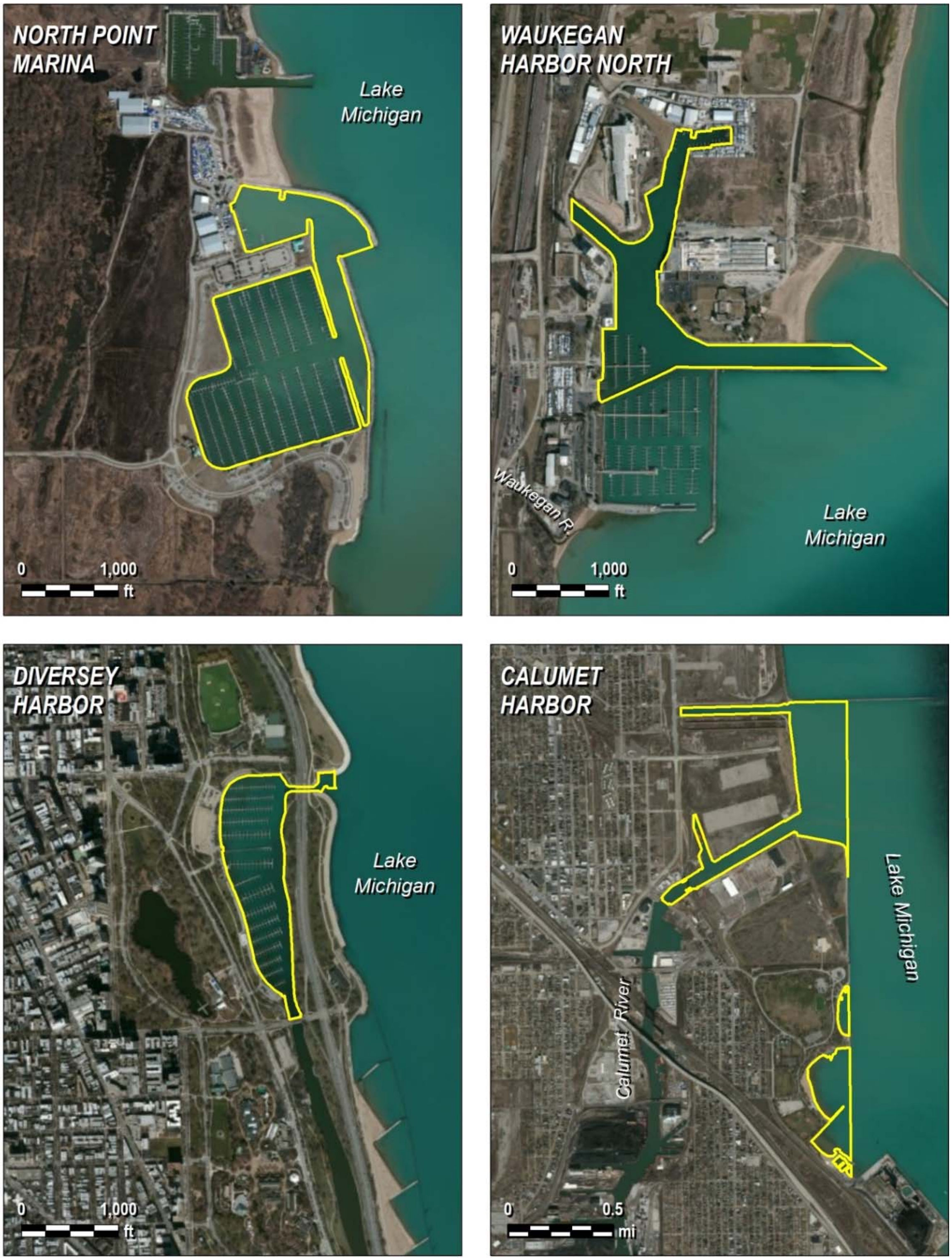


Figure 2-6. Impaired Harbor Segments

2.3 Data Compilation and Assessment of Water Quality

Water column, fish, and sediment data collected from 2000 to the present were inventoried, compiled, and reviewed to form the project database for the PCB TMDL. Data were reviewed to ensure they were relevant to the project and met the quality objectives and criteria outlined in the project's Quality Assurance Project Plan (LimnoTech, 2014).

The potentially useful sources of data were identified based on project team knowledge, including much input from IEPA and USEPA staff, internet queries, and communication with agencies and Great Lakes researchers familiar with the project study area. In addition, the project team led a webcast on September 17, 2014, to present the objectives of the study to a much broader audience and to solicit input on additional studies or data sets that could be relevant to this project. The project team followed up on all leads identified as a result of the webcast.

Agencies contacted for data included the USEPA Great Lakes National Program Office (GLNPO); USEPA Office of Research and Development, Grosse Ile, Michigan; USEPA Superfund Division; USEPA Water Division; IEPA Toxicity Assessment Unit, IEPA Bureau of Water; Illinois Fish Contaminant Monitoring Program (FCMP); IDNR; Wisconsin Water Science Center of the U.S. Geological Survey; National Oceanic and Atmospheric Administration (NOAA); Environment Canada; Area of Concern project managers; USACE; U.S. Navy; Waukegan Citizens Advisory Group; North Shore Sanitary District; Illinois Lake Michigan Fisheries Program; and researchers at Loyola University and the University of Iowa.

2.3.1 Summary of Data by TMDL Zone

The project database contains fish tissue, water column, and sediment data. Fish fillet data are summarized in this section because those are the samples used to support the TMDL.

Sampling locations for all water column, fish, and sediment data in the database were paired with impaired waterbody segment(s), with input from IEPA, reflecting which sampling stations were located within the impaired segments. IEPA assessed use support for the nearshore open water segment based on samples collected in the nearshore open water segment. The 51 shoreline segments were similarly assessed based on samples collected in the nearshore open water segments. Because the data collected in the nearshore open water were used to assess the nearshore as well as the 51 shoreline segments, these segments are collectively referred to as being within the "nearshore open water/shoreline" TMDL zone. Samples collected within each of the four impaired harbors (Calumet, Diversey, North Point Marina, and Waukegan North) were assigned to the appropriate harbor. Fish samples collected just outside the nearshore open water segment were also categorized as "nearshore open water/shoreline," due to fish mobility. Samples collected from Lake Michigan well outside the nearshore open water segment were classified as "offshore."

The tables that follow summarize the number of samples available in the project database for the study area. A count of PCB fillet samples, by fish species and TMDL zone, is shown in Table 2-1. Note that 109 of the 164 samples are composites, with the number of fish per composited sample ranging from 2 to 25. Table 2-2. presents a count of water column and sediment PCB samples by TMDL zone. The location of the PCB fish fillet samples is shown in Figure 2-7.

Table 2-1. Count of Fish PCB Fillet Samples by Species and TMDL Zone

Fish Species	TMDL Zone					Grand Total
	Nearshore open water/ shoreline	Calumet Harbor	Diversey Harbor	North Point Marina	Waukegan Harbor	
Alewife	6	-	-	-	-	6
Black bullhead	-	-	-	-	3	3
Bloater chub	7	-	-	-	-	7
Brown trout	1	-	-	-	-	1
Carp	-	-	-	12	40	52
Lake trout	30	-	-	-	-	30
Largemouth bass	-	-	-	3	1	4
Pumpkinseed sunfish	-	-	1	-	2	3
Rainbow smelt	1	-	-	-	-	1
Rainbow trout	2	-	-	-	-	2
Rock bass	-	1	-	4	5	10
Round goby	-	1	-	2	-	3
Smallmouth bass	-	5	-	2	-	7
Sunfish	-	-	-	4	3	7
White sucker	-	-	-	2	4	6
Yellow perch	21	-	-	-	1	22
Grand Total	68	7	1	29	59	164

Table 2-2. Count of PCB Water Column and Sediment Samples by TMDL Zone

Media	TMDL Zone				Grand Total
	Nearshore open water/ shoreline	Calumet Harbor	North Point Marina	Waukegan Harbor	
Water column	All 110 measurements <DL[a]	-	-	-	110
Sediment	8[b]	6[c]	2	4	20

[a]The detection level (DL) for 110 IEPA nearshore water column PCBs ranged from 0.04 to 0.55 ug/L

[b]Collected from Waukegan Approach Channel

[c]These six sediment samples were collected from material on the dredging barge; the exact location is not known.

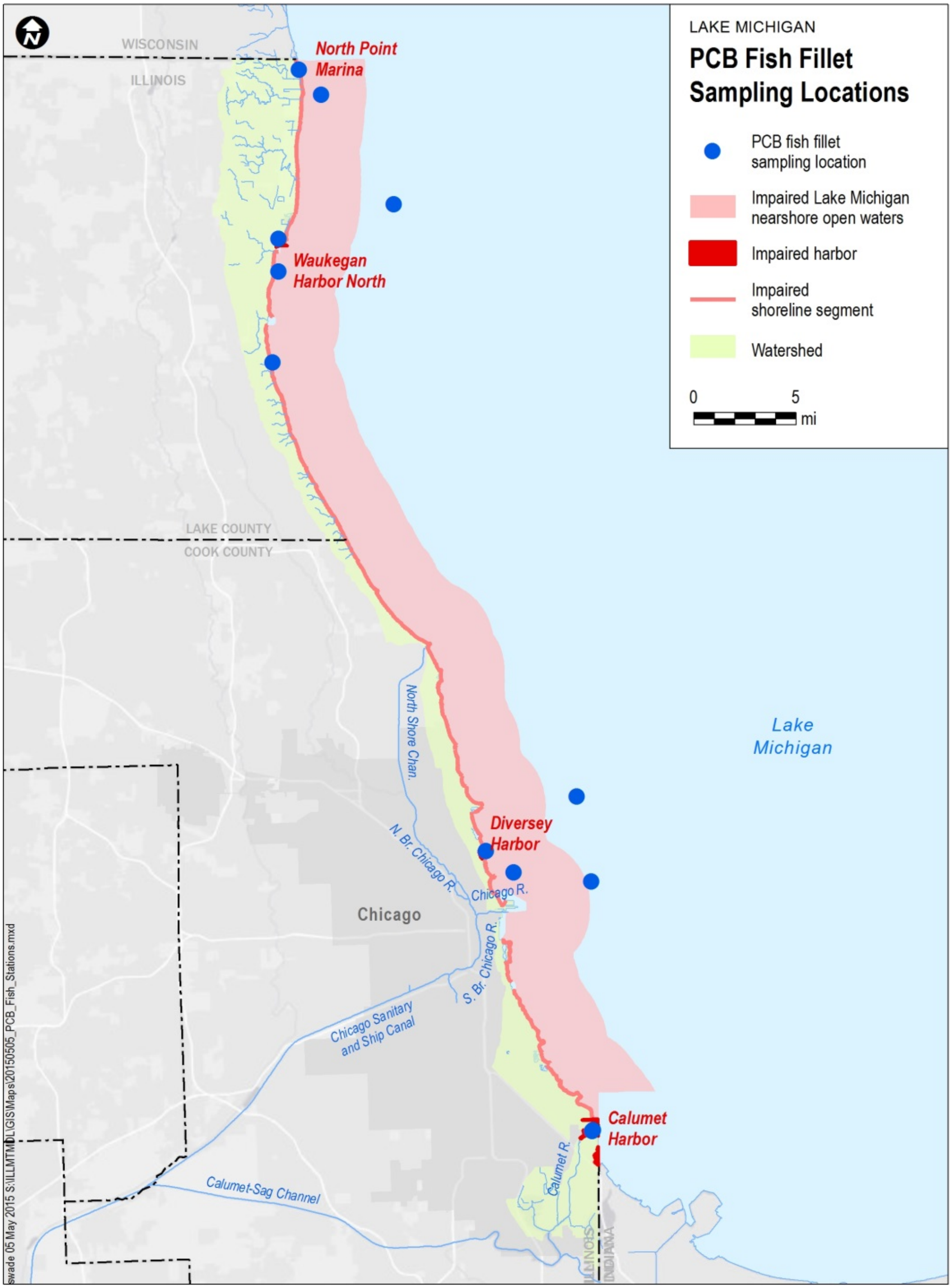


Figure 2-7. Sampling Locations for PCB Fish Fillets

3 Applicable Water Quality Standards and TMDL Targets

This section describes relevant WQS, designated use support, and numeric TMDL targets for PCBs.

3.1 Water Quality Standards

The Clean Water Act, Section 303(c)(2)(A), requires states to designate appropriate water uses for all waterbodies, and adopt WQS for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water. Designated uses describe the various uses of waters that are considered desirable, and identify those waters that should be protected. Some examples of designated uses are primary contact (such as swimming and water skiing), fish consumption, aquatic life, and aesthetic quality. Surface waters in Illinois fall into one of four categories: General Use, Public and Food Processing Water Supplies, Secondary Contact and Indigenous Aquatic Life, and Lake Michigan Basin (IEPA, 2014). Each category has its own set of WQS. The standards for the Lake Michigan Basin are found in the Illinois Administrative Code (35 IAC 302.501-595, Subpart E). Some of the Lake Michigan Basin WQS apply to all waters within the basin, while others apply only to the open waters of the Lake or only to tributary waters of the Lake. WQS for the Lake Michigan Basin protect aquatic life, human health, wildlife, and recreational uses. Waters of the Lake Michigan Basin must be free from any substance or any combination of substances in concentrations toxic or harmful to human health or to animal, plant, or aquatic life (35 IAC 302.540). Lake Michigan Basin waters include all tributaries of Lake Michigan, harbors, and open waters of the Illinois portion of the lake. Numeric water quality criteria are developed to protect the designated uses of surface waters, and the standards for PCBs are described below.

The WQS for PCBs in surface waters of the Lake Michigan basin are 120 pg/L for the protection of wildlife, and 26 pg/L for the protection of human health [35 IAC 302.504(e)]. The PCB standard applies to all waters of the Lake Michigan Basin. These standards were adopted by the State of Illinois as part of the Great Lakes Water Quality Initiative (GLI).

3.2 Designated Use Support

Every two years, the State of Illinois evaluates the extent to which waters of the state are attaining their designated uses. The degree of support of a designated use in a particular area (assessment unit) is determined by an analysis of biological, physiochemical, physical habitat, toxicity, and other data. When sufficient data are available, each applicable designated use in each assessment unit is assessed as *Fully Supporting* (good), *Not Supporting* (fair), or *Not Supporting* (poor). Waters in which at least one applicable use is not fully supported are considered impaired.

Fish consumption use is associated with all waterbodies in the state. The assessment of fish consumption use is based on (1) waterbody-specific fish-tissue data and (2) fish-consumption advisories issued by the multi-agency[2] Illinois FCMP, which consists of staff from the departments of Agriculture, Natural Resources, Public Health, the Illinois Emergency Management Agency, and IEPA. The FCMP uses a risk-based process developed in the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Anderson et al. 1993). The Protocol requires the determination of a Health Protection Value (HPV) for a contaminant, which is then used to calculate the level of contaminant in fish tissue that will be protective of human health at several meal consumption frequencies (ranging from unlimited consumption to "do not eat"). This information is used to calculate the level of the contaminant in fish that will not result in exceeding the HPV at each meal consumption frequency.

For PCBs, the HPV for fish consumption is 0.05 µg/kg/day. Based on this HPV, the lowest fish tissue concentration that results in a fish consumption advisory is 0.06 mg/kg for all species; this is, therefore, the concentration used to assess support of the fish consumption use. It should be noted that this fish tissue assessment concentration was derived independently of numeric water column criteria.

Except in extraordinary circumstances, two or more recent sampling events in a waterbody in two different sampling years finding fish exceeding the fish tissue level of concern are necessary for issuing an advisory (based on data collected since 1985). The issuance of a fish-consumption advisory for a specific waterbody provides the basis for a determination that fish consumption use is impaired, with the contaminant of concern listed as a cause of impairment.

Aquatic life uses are assessed using available data for the most recent three years. For Lake Michigan open waters and harbors, if two or more samples exceed the acute aquatic life criterion, the waters are considered impaired. If more than 10 percent of the samples exceed the chronic aquatic life criterion, the waters are considered impaired.

3.3 Numeric TMDL Targets

TMDL targets are established at a level that attains and maintains the applicable WQS, including designated uses, numeric and narrative criteria, and antidegradation policy [40 CFR §130.7(c)(1)]. TMDL submittals must include a description of any applicable water quality standard, and must also identify numeric water quality targets, which are quantitative values used to measure whether or not applicable WQS are being attained. Depending on the designated use being addressed, a TMDL target may be based on human health, aquatic life, or wildlife criteria (USEPA, 2011). Where possible, the water quality criterion for the pollutant causing impairment is used as the numeric water quality target when developing the TMDL. Because all of the assessment units addressed in this TMDL are impaired for the fish consumption use, the HPV for fish consumption for sensitive populations was used to derive the TMDL target. The TMDL target is the PCB fish tissue concentration of 0.06 mg/kg.

[2] From Illinois Department of Public Health website Factsheet "Fish Advisories in Illinois"

4 Source Assessment

The purpose of a source assessment is to consider all potential sources of the pollutant of concern, in order to quantify source reductions that are needed to attain designated uses. The sources that were investigated and their estimated current load contributions are discussed in this section.

Because this TMDL is based on an approach that groups all segments (discussed in more detail in Section 5), the total load to the study area (rather than to each impaired waterbody segment) is presented. The following source categories were investigated:

- Hydrodynamic transport
- Atmospheric loading
- MS4 stormwater loading
- Flow reversals from the Chicago Area Waterways
- Other point source discharges
- Resuspension and/or pore water diffusion of PCBs from bed sediments

As described below, the most significant sources were found to be hydrodynamic transport of PCBs from the open water of Lake Michigan and atmospheric loading. Resuspension and/or pore water diffusion of PCBs from bed sediments were found to be insignificant contributors. The remaining source categories, while smaller than hydrodynamic transport and atmospheric loading, could only be roughly estimated, because all available data for those sources were below laboratory detection limits.

4.1 Hydrodynamic Transport

The open water of Lake Michigan is a source of PCBs to the project study area. As described below, the predominant flow patterns in Lake Michigan circulate counter-clockwise in the vicinity of the study area (Beletsky and Schwab, 2001; Beletsky et al. 1999). As such, PCB loads to the study area can be estimated using the flow into the study area and Lake Michigan PCB concentrations at the northern end of the study area.

Hydrodynamic transport between Lake Michigan and the nearshore open water segment was estimated for this project using the NOAA Great Lakes Coastal Forecasting System (GLCFS). The GLCFS is a set of models that simulate and predict the two- and three-dimensional structure of currents, temperatures, winds, waves, and ice in the Great Lakes using a 4-km^2 (2 km x 2 km) grid size. The GLCFS uses a modified Princeton Ocean Model, developed by NOAA's Great Lakes Environmental Research Laboratory and The Ohio State University, which is supported by the National Weather Service (NOAA, 2015).

To estimate the gross transfer of PCBs into the study area, results from the GLCFS were used to estimate the annual average flow of Lake Michigan water into the study area. GLCFS modeling results were extracted for the northern edge of the study area, as this is the entry point based on the lake current's predominant flow direction. Figure 4-1 shows the mean circulation adapted from Beletsky and Schwab (2001). The mean current velocity from the north was 3.35 cm/s for 2014. The area of transfer between the open lake and the study area was calculated as 54,000 m^2 by multiplying the average depth of the first two model grid cells from the GLCFS (10 m and 17 m) by the width of each cell (2 km each).

Multiplying the average speed by the area produced an average flow into the study area of 1,810 m^3/s. Results from the USEPA Great Lakes Aquatic Contamination Survey data estimated the open lake PCB concentration in Lake Michigan as approximately 0.140 pg/L in 2004. Venier et al. (2014) reported Lake Michigan PCB concentrations near Chicago of 233 pg/L. Multiplying this range of concentrations by the flow equaled 8-13 kg/yr of PCBs entering the study area due to transport from Lake Michigan. The Lake Michigan Mass Balance Study estimated that by 2014, the average lake-wide PCB concentration could be as low as 80 pg/L if the "continued slow recovery" scenario (representing a lower-bound estimate in the rate of decrease in atmospheric PCB concentrations) is followed, as shown in Figure 4-2. This could reduce the annual PCB load entering the study area from 8-13 kg/yr to 4.6 kg/yr.

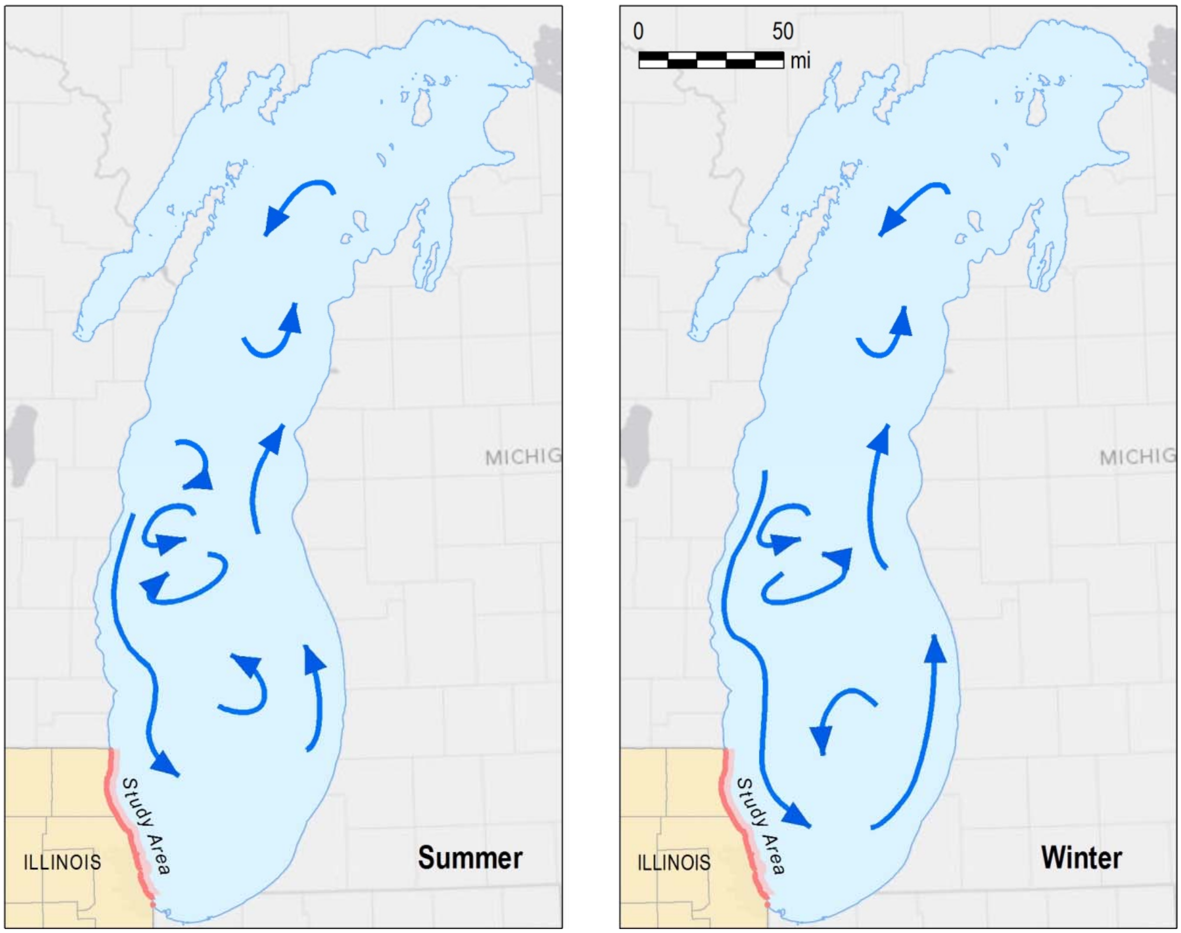


Figure 4-1. Observed Mean Circulation in Lake Michigan (Adapted from Beletsky et al., 1999 cited in Beletsky and Schwab, 2001)

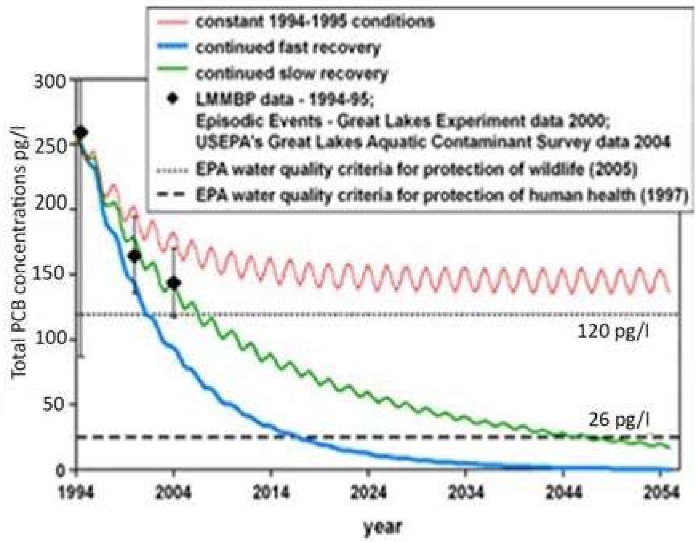


Figure 4-2. Lake Michigan Mass Balance Monitoring Data and Model Results (Source: http://www.epa.gov/med/grosseile_site/LMMBP/pcbs.html)

Search on Lake Michigan Mass Balance Study

4.2 Atmospheric PCB Loading

PCBs can be delivered to the study area from atmospheric sources via three mechanisms: wet deposition, dry deposition, and gas deposition. Wet deposition consists of PCBs contained in precipitation. Dry deposition consists of PCBs attached to airborne particulates that settle onto the lake. Gas deposition occurs as a transfer across the air-water interface when atmospheric gas phase PCB concentrations exceed the equivalent dissolved phase PCB concentrations in the water column. Miller et al. (2001) demonstrated that gas deposition in the Chicago area of Lake Michigan greatly exceeds wet and dry deposition, so the calculations that follow focus solely on gas deposition as the dominant component of atmospheric PCB loading.

The magnitude of gas deposition is determined by two primary factors: the atmospheric gas phase PCB concentration, and the mass transfer coefficients that control the rate at which PCB concentrations pass through the air-water interface.

Section 4.2.1 presents a range of methods for estimating the annual average atmospheric gas phase PCB concentrations over the study area.

Section 4.2.2 presents the mass transfer coefficients that control the rate of PCB passage through the air water interface.

Section 4.2.3 combines this information to estimate the atmospheric loading rate

4.2.1 Atmospheric Gas Phase PCB Concentration

Two primary data sets exist to describe atmospheric gas phase PCB concentrations in the vicinity of the study area:

1. The Integrated Atmospheric Deposition Network, established in 1990 to monitor PCBs in the air around the Great Lakes.
2. The Atmospheric Exchange Over Lakes and Oceans Study, designed to assess atmospheric depositional fluxes of pollutants to large waterbodies, originating from urban coastal areas.

PCB monitoring from both of these studies show that instantaneous PCB concentrations over Lake Michigan near Chicago vary drastically as a function of wind direction and season. Wind direction was important, due to the fact that off-shore winds transported the high atmospheric concentrations of PCBs originating in Chicago over the lake (e.g. Simcik et al., 1997). Atmospheric PCB concentrations were also strongly correlated to air temperature, as warmer temperatures led to increased volatilization of land-based PCBs to the atmosphere. Because of the large day-to-day variation in atmospheric PCB concentrations, estimation of annual average concentrations requires that individual concentration measurements somehow be integrated over a range of environmental conditions. Two methods of averaging have been used: 1) empirical regressions, and 2) direct averaging of multiple individual measurements. As discussed below, both approaches are being used in this TMDL to accomplish different objectives.

Zhang et al. (1999) and Venier and Hites (2010a) used empirical regressions that estimate atmospheric PCB concentration as a function of environmental conditions. Zhang et al. (1999) applied their regression over the range of 1994-1995 environmental conditions to predict an annual average atmospheric PCB concentration of 356 pg/m^3 for the southern quarter of Lake Michigan. The regression of Venier and Hites (2010a), which applies to the entire Great Lakes region, includes independent variables of date and local population.

The alternative to empirical regressions for estimating annual average PCB concentrations is to take an average of multiple discrete measurements that represent a full spectrum of wind and temperature conditions. Simcik et al. (1997) provide such a data set, with 25 nearshore over-lake PCB measurements from 1994 to 1995, covering three seasons and a range of wind directions. The average of these data is 529 pg/m^3, compared to the 356 pg/m^3 reported by Zhang et al. (1999) for the same time period. This difference in results seems reasonable, as:

- The Simcik et al. (1997) data were specific to the Illinois nearshore area (529 pg/m^3).
- The Zhang et al. (1999) calculation represented the average over the southern quarter of Lake Michigan (356 pg/m^3).
- The Chicago area has been identified as a significant source of atmospheric PCBs to Lake Michigan (Sun et al., 2006), such that atmospheric concentrations in the Chicago nearshore area would be greater than the average concentration over the southern quarter of Lake Michigan.

In conclusion, the results from Simcik et al. (1997) are recommended to serve as the basis of the estimate of annual average atmospheric PCB concentrations over the study area, as they provide the only estimate of concentrations based solely on data specific to the study area. The method of Zhang et al. (1999) will be used to specify atmospheric PCB concentrations for purposes of estimating the mass transfer rate, as discussed in the following section.

4.2.2 Mass Transfer Rate at the Air-Water Interface

The magnitude of gas deposition depends not only on the gas phase PCB concentration, but also upon the rate of mass transfer of PCBs through the air-water interface. Zhang et al. (1999) demonstrated that this rate depends upon wind and water temperature, and calculated the spectrum of mass transfer rates that occurred in response to hourly wind speed and water temperatures from buoy data. The results of their analysis showed an annual gross absorptive flux of PCBs of 300 kg/yr in response to an annual average PCB concentration as 356 pg/m^3. Their flux calculation represented the 16,000 km^2 surface area of southern Lake Michigan. Therefore, normalizing their calculation on an areal basis results in an annual mass transfer rate of 300 kg/yr per 356 pg/m^3 per 16,000 km^2 = 5.3×10^{-5} $kg/km^2/yr$ / (pg/m^3). The next section describes the combination of this mass transfer rate with the atmospheric PCB concentration and surface area of the study area waterbodies to calculate a PCB loading rate from atmospheric sources.

4.2.3 Atmospheric Loading Rate

To calculate the atmospheric loading rate, an atmospheric gas phase concentration was selected and merged with information on the mass transfer rate. In section 4.2.1, the method from Simcik et al. (1997) was recommended for estimating the annual average atmospheric PCB concentrations over the study area. As shown in 4.2.1, the results from Zhang et al. (1999) correspond to the entire southern portion of Lake Michigan, while the work of Venier and Hites is more regionally-based, covering the entire Great Lakes. These results were therefore less applicable to this TMDL study.

The data from Simcik et al. (1997) showed an annual average atmospheric PCB concentration over the study area of 529 pg/m^3 for the period of 1994-1995. Atmospheric PCB concentrations throughout the Great Lakes in general, and over the Chicago area in particular, have been observed to decrease over that period.

Sun et al. (2006) calculated a half-life of atmospheric PCB concentration in the Chicago area of 7.7 years, while Venier and Hites (2010b) calculated that atmospheric PCBs around the Great Lakes were decreasing with a half-life of 17 years. The estimated 2015 PCB concentration ranges from 87 to 234 pg/m^3, depending upon which decay rate is assumed.

Combined with the mass transfer rate at the air-water interface defined in Section 4.2.2 and a surface area of 473 km^2 for the study area waterbodies, the range of current atmospheric loading is 2.1 to 5.8 kg/year.

4.3 MS4 Stormwater PCB Loading to Harbors and Nearshore Open Water Segments

In addition to the fact that Lake County, Shields Township, Waukegan Township, Illinois Department of Transportation and the Cook County Highway Department have MS4 permits, 93.5 percent of the study area watershed lies within an MS4 city or village. As a result, close to 100 percent of the study area is within an MS4 area. However, no site-specific data were available to quantify stormwater PCB loads for the study area watershed (MWRDGC, 2015). The magnitude of stormwater PCB loads was therefore estimated as the product of runoff quantity, the study area drainage area, and an assumed stormwater PCB concentration, based on stormwater sampling outside the study area watershed. It was also conservatively assumed that all of the runoff generated within the study area watershed drained to Lake Michigan. The development of these inputs is described below.

Runoff quantity was calculated using the method developed by the Metropolitan Washington Council of Governments (Schueler, 1987) as **R = P * Pj * Rv**

Where:

R = Annual runoff (inches),

P = Annual rainfall (inches), estimated as 36.1 inches, based on the average annual rainfall reported for Chicago Midway Airport 3 SW for the 1929-2013 period (http://www.crh.noaa.gov/lot/?n=111577_Midway)

Pj = Fraction of annual rainfall events that produce runoff (set to the default of 0.9)

Rv = Runoff coefficient. Rv is a function of impervious cover in the study area watershed. Impervious cover was calculated using Geographic Information System (GIS) analysis for each major land use category: commercial (0.71), industrial (0.54), and residential (0.37). The following runoff coefficients resulted from these impervious cover values: commercial (0.69), industrial (0.54), and residential (0.38).

The area of the contributing watershed was calculated as 99.6 square miles, broken down as 3.82 square miles commercial, 4.05 square miles industrial, and 91.73 square miles residential. PCBs in urban stormwater have been studied in various watersheds in the United States, and they are ubiquitous. The PCB concentration was set to 7,270 pg/L based on measurements from the City of Spokane (2014) collected from 2012-2014, which represented "typical" urban stormwater. The selected Spokane PCB concentration for estimating the stormwater PCB load was based on sampling in a watershed that has a land use distribution similar to that of the study area watershed, which is 73 percent residential, 4 percent commercial, and 19 percent open space.

The estimated stormwater PCB load for the study area equaled 1.36 lbs/year (0.62 kg/yr, or 0.0017 kg/day).

4.4 PCB Loading from Flow Reversals from the Chicago Area Waterways

The CAWS is a 76.3-mile branching network of navigable waterways controlled by hydraulic structures. The CAWS flow is composed of treated sewage effluent, CSO, and stormwater runoff, and dominant uses are conveyance of treated municipal wastewater, commercial navigation, and flood control. Flows from the CAWS ultimately drain to the Mississippi River, but on occasion, flows are reversed and flow into Lake Michigan.

There are two types of reversals: gate reversals and lock reversals. Gate reversals occur adjacent to the lock structure and involve small volumes of water. Lock reversals occur when the locks are opened during severe storms. Lock reversals allow a much greater volume of water to flow into Lake Michigan. During particularly large storms, lock reversals allow flow from the CAWS to discharge to Lake Michigan through the control works shown in Figure 2-5 (O'Brien Lock, the Chicago River Lock, and Wilmette Lock).

Limited site-specific data were available to quantify the magnitude of PCB loads from the CAWS flow reversals. The magnitude of loads entering the study area waters from periodic flow reversals of the CAWS was estimated based on measured flow and site-specific concentration data as described below. Because this estimate was uncertain, a second load calculation is provided, using site-specific flow data and PCB measurements from another location.

The volume of flow is reported by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) on their website.

http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting_the_environment/Combined_Sewer_Overflows/pdfs/Reversals.pdf. Until recently, the MWRDGC conducted water quality sampling in the CAWS in the vicinity of the control works during flow reversals, including measurements of PCBs. PCB loads were estimated based on concentration data collected twice at each sampling station during the 2013 flow reversals (Table 4-1), and the average 2010-2014 annual volume (4,021.4 million gallons) of water entering Lake Michigan through the three locks.

Table 4-1.Measured CAWS PCB Concentrations during Times of Flow Reversals

Location	Location of PCB sampling	Total PCB results (4/18/13)
O'Brien Lock	Calumet Harbor, 95th St. Bridge; Calumet Harbor, Ewing Ave. Bridge	All 4 samples < 0.3 ug/L
Chicago River Lock	Chicago River Locks, Inner Harbor Sluice Gate; Chicago River Locks, Sluice Gate, DuSable Harbor	Both samples < 0.3 ug/L
Wilmette Lock	Wilmette Harbor, Wilmette Pump Station	Both samples < 0.3 ug/L

Because all PCB concentration measurements were lower than the levels of detection, loads for this source could not be accurately quantified. However, total PCBs from this source can be estimated to be less than 100.7 lbs/yr (45.68 kg/yr, or 0.125 kg/day), using the detection limit of 0.3 ug/L as the basis for an upper-bound estimate of PCB concentration. It is recognized that the PCB detection limit of 300,000 pg/L could be orders of magnitude higher than actual concentrations, such that this may be an extremely high upper-bound estimate.

To better assess the PCB load and understand the relative source contribution from CAWS flow reversals, in the absence of detectable concentrations of PCBs, it was assumed that CSOs comprise a significant portion of the CAWS flows (note that the actual composition of flows in the CAWS during periods of flow reversals is unknown (MWRDGC, 2015b)). Loads were calculated using the average 2010-2014 annual volume (4,021.4 million gallons) of water entering Lake Michigan through the three locks and observed PCB concentration data in CSOs collected by the City of Spokane (2014) using low detection limits, which provides a more realistic upper-bound PCB concentration.

Using the Spokane observed average PCB concentration of 12,420 pg/L for CSOs results in an upper-bound PCB loading estimate of less than 4.2 lbs/yr (1.9 kg/yr, or 0.005 kg/day). The actual PCB concentration and load is expected to be less than this upper-bound estimate, because the flow reversals contain significant amounts of stormwater, which had a lower PCB concentration in the Spokane study.

4.5 Other Point Source PCB Discharges to the Study Area

Other point source PCB loads (in addition to permitted MS4 loads) were calculated based on permitted flow and measured concentration data, for facilities determined to have the potential to contribute PCB loads to the study area. These facilities were identified based on input and data provided by IEPA.

There are three individual NPDES permits in the watershed which have permit Special Conditions for PCBs. These are Zion Station (IL0002763), Winnetka Power Generation Station (IL0002364), and Midwest Generation LLC Waukegan (IL0002259). All of these permits state "There shall be no discharge of PCBs." One facility (IL0002763, Zion Station) also has permit monitoring requirements for PCBs. All effluent PCB measurements (2009-2015) were less than the 0.001 mg/ L (1,000,000 pg/ L) detection limit. Because all samples were less than the detection limit for one facility, and were not available for the other facilities, point source loads could not be accurately quantified.

4.6 Resuspension and/or Pore Water Diffusion of PCBs from Bed Sediments

No site-specific data were available to define the magnitude of pore water diffusion and/or resuspension of PCBs into the study areas from bed sediments. The magnitude of pore water diffusion from bed sediments was estimated based on a combination of physical-chemical properties taken from the Lake Ontario PCB model (LimnoTech, 2004) with study area-specific measurements of sediment PCB concentrations. The properties taken from the Lake Ontario PCB model were bed porosity by volume (0.92), fraction organic carbon of bed sediment solids (0.02), bed sediment particle density (2.45 g/cm^3), and the organic carbon partition coefficient for PCBs (106.1 m^3/kg).

Results from the Lake Michigan Mass Balance Study (USEPA, 2006) indicate that sediment PCB concentrations over the study domain are on the order of 20 ng/g, resulting in a gross sediment flux of 0.012 kg/year across the entire study area. Lacking site-specific data on the magnitude of sediment resuspension for bed sediment PCBs, it can be reasonably assumed that this process is much smaller than sediment diffusion, given that this is a lake (rather than river) environment and that much of the re-suspended sediment PCB re-deposits shortly after resuspension events.

4.7 Summary

Hydrodynamic transport of PCBs from the main body of Lake Michigan and atmospheric loading are clearly important loading sources (

Table 4-2). No definitive determination could be made for stormwater loading, other point source discharges, or flow reversals from the CAWs, because site-specific PCB concentration data are either below detection limits or not available. While literature-based estimates for these sources indicate that they are likely to be minor contributors to the study area as a whole, they have the potential to be significant contributors to individual harbors.

Table 4-2. PCB Loads to the Study Area

Process	Data Sufficiency[a]	Estimated Magnitude
Hydrodynamic Transport from Main Body of Lake Michigan	Acceptable	4.6 to 13 kg/yr
Atmospheric Loading[3]	Acceptable	2.1 to 5.8 kg/yr
MS4 Stormwater Loading	Limited. Rough estimate made using literature-based concentrations	0.62 kg/yr
Flow Reversals from the CAWs[4]	Limited. Estimate of upper bound; all available data are non-detectable	<<1.9 kg/yr
Other Point Source Discharges[5]	Limited. Estimate of upper bound; all available data are non-detectable.	<< 5 kg/yr
Resuspension and/or Pore Water Diffusion of PCBs from Bed Sediments	Limited. Estimated using site-specific sediment concentrations combined with literature values for diffusion rates.	0.012 kg/year

[a] Site-specific data sufficiency is characterized as limited (indicating the use of literature values and/or measurements less than the detection level) for the majority of the processes of concern, with hydrodynamic transport and atmospheric loading being the only sources quantified with existing data

Figure 4-3 presents a map of PCB sources considered under this TMDL, which have been described in this section, with two exceptions. Neither "atmospheric loading" nor "resuspension and/or pore water diffusion of PCBs from bed sediments" can be easily mapped, so these two sources are excluded from Figure 4-3.

[3] Range based on half life value used as described in Section 4.2.3.
[4] Using observed data from Spokane watershed with similar land use
[5] At detection limit 0.001 mg/L (1,000,000 pg/L)

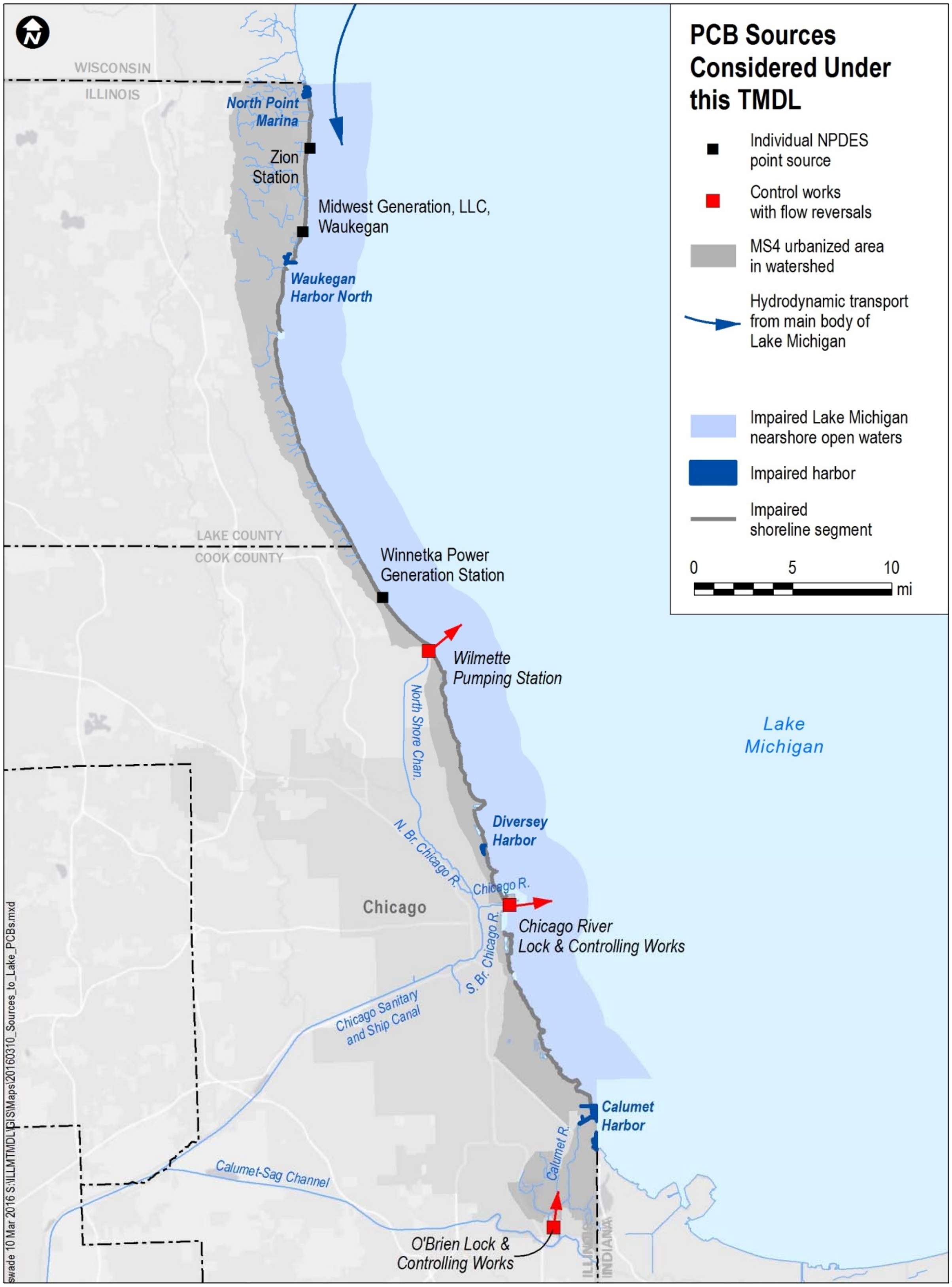


Figure 4-3. PCB Sources Considered Under This TMDL, Excluding Atmospheric Loading and Resuspension and/or Pore Water Diffusion Which Can't Easily be Mapped

5 Modeling Approach

This section describes the modeling approaches for calculating the PCB TMDL. A wide range of existing modeling frameworks could potentially be used to support development of the Illinois Lake Michigan Nearshore PCB TMDL. The TMDL Scoping Report (LimnoTech, 2015) reviewed the range of available frameworks and concluded that a zero-dimensional, steady state proportionality approach was most appropriate for this project, given the amount of data available to support TMDL development. This approach has been referred to as a "Level One" or "direct proportionality approach." Two different types of proportionality approaches were applied in developing the TMDL to determine the percentage of reduction needed to ensure that the resulting TMDL was protective of both the fish tissue and water column targets representing WQS for PCBs. One proportionality approach uses existing fish-tissue levels to estimate required load reductions, while the other approach is based on a gas phase equilibrium equation combined with bioaccumulation factors.

This section describes each approach and how they were applied to define the required reduction percentage that will meet TMDL targets. It is divided into the following sub-sections:

- Fish tissue-based direct proportionality approach
- Gas-exchange model direct proportionality approach
- Required reduction percentage

5.1 Fish Tissue-Based Direct Proportionality Approach

The approach for linking pollutant loads directly to fish tissue concentrations for this TMDL is patterned after the statewide mercury TMDL developed by the Minnesota Pollution Control Agency (MPCA, 2007), and statewide mercury and PCB TMDLs developed by the Michigan Department of Environmental Quality (LimnoTech, 2013; LimnoTech, 2012), which drew from the work of Jackson et al. (2000), a regional mercury TMDL for the Northeast United States (CDEP et al., 2007).

This approach is based on the following assumptions: 1) a reduction in PCB levels in the air will ultimately result in a proportional reduction in the overall rate of PCB deposition; 2) a reduction in PCB deposition will ultimately result in a proportional decrease in PCB loading to waterbodies; and 3) a proportional reduction in PCB loading into waterbodies will ultimately result in a proportional decrease in PCB concentrations in fish.

This can be expressed mathematically as:

$$C_{fish} = A * W_{Atm} \tag{5-1}$$

For purposes of TMDL development, Equation 5-1 can be rearranged to define the PCB loading rate that will attain compliance with fish tissue targets, as well as the percentage of reduction in loading necessary to attain those targets, i.e.

$$W_{Atm,TMDL} = C_{fish,target}/A \tag{5-2}$$

Where:

$W_{Atm,TMDL}$ = Atmospheric PCB loading rate necessary to attain compliance with TMDL
$C_{fish,target}$ = Target PCB concentrations in fish (mg/kg)
A = proportionality constant

The steady state conditions represented in the model correspond to long-term average fish tissue concentrations expected to eventually occur in response to long-term reduction in loading. Therefore, it is not expected that the proportional relationship between atmospheric deposition reductions and fish tissue reductions will be observed immediately. However, it is expected that the proportional response will be seen over the long term, once the systems have achieved a steady state. Even the most complex PCB TMDL models (e.g., DRBC, 2007; ICPRB, 2007) exhibit a linearly proportional response between external load and the resulting environmental concentration when applied to steady-state conditions.

Application of the fish tissue-based approach requires the selection of a target concentration (Section 3.3), an appropriate fish species, and calculation of a reduction percentage, also referred to as a reduction factor (RF).

5.1.1 Selection of a Target Fish Species

Fish tissue PCB concentrations have been sampled in a wide range of species across the study area, and they show varying degrees of bioaccumulation. The use of fish tissue samples from multiple species to form the basis for fish consumption advisories incorporates these varying degrees of bioaccumulation across the study area into the assessment for impairment of the fish consumption designated use.

Fish tissue PCB concentration data for 164 samples across 16 species of fish, spanning the collection period of 2000 to 2012, were used in the evaluation. PCB levels in carp tissue are the highest observed for all species of fish, and carp are also the most widely sampled species (Table 5-1.). Black bullhead have the second highest PCB concentration, but the sample size is not large. Although lake trout have the third highest concentration and are less likely to be influenced by legacy concentrations of PCBs, they are not as widely distributed or sampled as carp.

Table 5-1. Mean Fish Fillet PCB Concentration (mg/kg) across Entire Study Area

Species	Count	Mean	Species	Count	Mean
Carp	52	4.329	**Smallmouth Bass**	7	0.172
Lake Trout	30	0.811	**Pumpkinseed Sunfish**	3	0.183
Black Bullhead	3	1.027	**Alewife**	6	0.187
Rock Bass	10	0.276	**Round Goby**	3	0.137
Sunfish	7	0.189	**Yellow Perch**	22	0.092
Largemouth Bass	4	0.225	**Brown Trout**	1	0.659
Bloater	7	0.270	**Rainbow Trout**	2	0.152
White Sucker	6	0.237	**Rainbow Smelt**	1	0.100

Carp tissue PCB data are not available for every impaired segment. As shown in Table 5-2. , the number of carp tissue samples available ranges from zero (Diversey Harbor, Calumet Harbor and the nearshore open water/shoreline) to 40 (Waukegan Harbor). While the majority of the carp measurements come from Waukegan Harbor, the conclusion that carp are the most contaminated species is not driven solely by results from Waukegan Harbor. PCB concentrations in carp from North Point Marina are similar to, and slightly higher on average than, PCB concentrations in carp from Waukegan Harbor. Because of the high concentration of PCBs in carp tissue, their comparatively large sample number, and their spatial distribution, the TMDL uses the fish tissue concentration in carp to represent baseline concentrations in fish. The reductions in the baseline fish tissue PCB concentrations that are needed to achieve the target PCB fish tissue concentration are used in the TMDL to determine the percentage reductions from PCB sources.

Table 5-2. Number of Carp PCB Fillet Samples and Mean Concentration by TMDL Zone

TMDL Zone	Count	Mean (mg/kg)
Nearshore Open Water/Shoreline	0	-
Calumet Harbor	0	-
North Point Marina	12	4.7
Waukegan Harbor	40	4.2
Diversey Harbor North	0	-

5.1.2 Consideration of Legacy Effects

Using carp in the fish tissue-based, direct proportionality approach selected for this TMDL necessitates careful consideration of the aquatic system's response to historical load reductions. This is due to a combination of two factors.

First, carp are benthic feeders and receive much of their PCB exposure from bottom sediments. Second, pollutant concentrations in bottom sediments respond much more slowly to pollutant load reductions than do pollutant concentrations in the water column. For this reason, the PCB concentrations in carp tissue reflect historical loading levels more than PCB levels in other fish species' tissue, because other fish receive the majority of their PCB exposure from the water column and water column-based food sources.

Carp tissue data available for this TMDL are shown in Figure 5-1. A historical decrease in tissue PCB concentration is apparent, with the fish tissue concentrations observed in 2005 being much lower than those observed in 2000 and 2001.

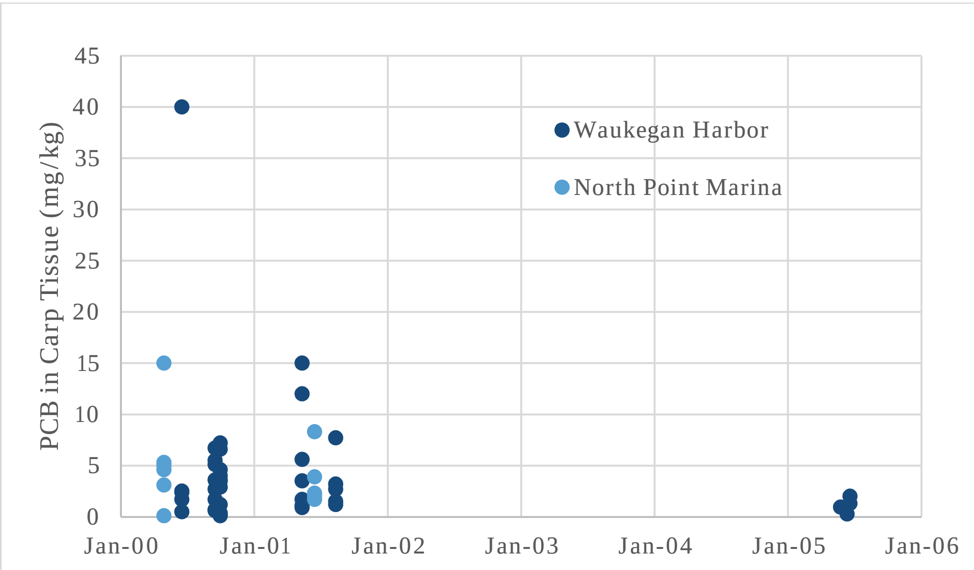


Figure 5-1. Carp Tissue PCB Concentration Data Available for TMDL

The use of carp tissue data in the fish tissue-based direct proportionality approach can lead to the requirement of unrealistically high load reductions, because this approach assumes that current fish tissue concentrations reflect only current loads. This effect can be demonstrated using the data in Figure 5-1. If a consideration of legacy sources was not necessary, the default proportionality approach would use all of the carp tissue concentration data (average = 4.3 mg/kg), which combined with the tissue target of 0.06 mg/kg in Equation 2 results in a required load reduction of 99 percent. If one assumes that the decrease in observed carp tissue concentration over time represents the decreasing importance of legacy sources (for example, reflecting additional clean-up of Waukegan Harbor PCBs in 2012 and 2013), and instead uses only the average of the most recent data for the current baseline (2005 average = 1.13 mg/kg), the required load reduction decreases to 94.7 percent.

The existing carp tissue PCB concentrations are known to reflect some combination of existing sources and legacy sources. Ideally, the TMDL would somehow adjust the existing tissue data to parse out how much of the current tissue contamination comes from existing versus legacy sources. Three specific options were considered:

- Development and application of a Level Three time variable mass balance model
- Empirical extrapolation of existing fish tissue data
- Censoring of existing fish tissue data

Theoretically, the parsing out of historical and current loading effects would require development and application of a time variable mass balance approach to both water column and sediments of the system, as described in the TMDL Scoping Report (LimnoTech, 2015). However, IEPA concluded that the data currently available are insufficient to support the application of a time variable framework.

A second option for accounting for the impact of legacy sources on estimated current PCB tissue contamination would consist of applying a statistical regression through the available fish tissue data, and subsequently using that regression to calculate expected existing concentrations. An exponential decay function was fit to the existing data using Excel, with the resulting regression shown in Figure 5-2. This regression, extrapolated out to 2015 conditions, results in a predicted PCB concentration in carp tissue of 0.2 mg/kg. This concentration is lower than that observed in several other fish species, and it could be used as justification for demonstrating that a TMDL based on protection of a different fish species would still be protective of carp.

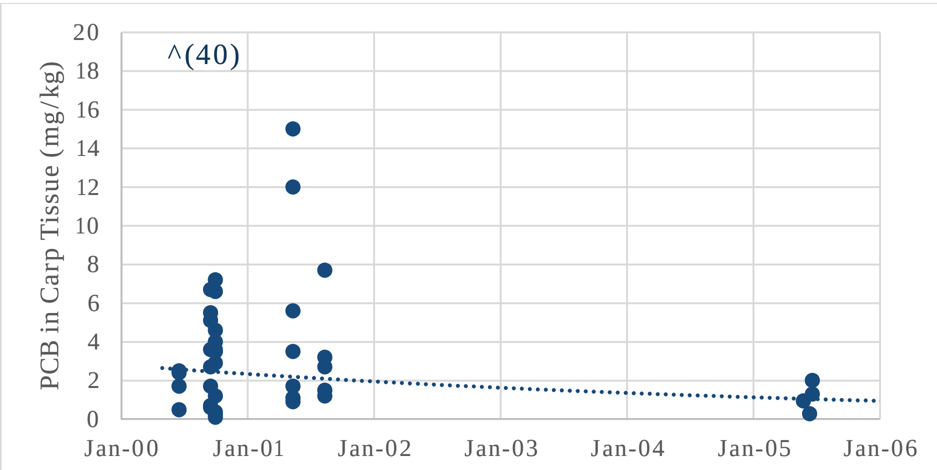


Figure 5-2. Exponential Regression Fit to PCB Concentrations in Carp Tissue

The drawback to this approach is that there is little basis on which to assume that the same rate of decay that occurred between 2000 and 2005 (which could be partially the result of external load reduction during that time, not just sediment decline) would take place between 2005 and 2015. In particular, IEPA dredged PCB-contaminated sediments between 2009 and 2013, as a follow-up to the original removal of contaminated sediments in 1992. These factors result in extremely high uncertainty regarding the projected concentrations.

The third option for adjusting the data to minimize the effect of legacy loading is to use only the most recent (2005) carp data in calculating required load reductions. While it is expected that the 2005 carp tissue data still reflect some degree of legacy effect, the 2005 data alone clearly have less legacy influence than the combined 2000-2005 data set. As Figure 5-2 shows, the PCB concentration in the carp tissue data from 2005 is approximately 30 percent of the average PCB concentration from 2000-2005. Even at these reduced levels, however, carp have the highest concentration levels of all applicable species.

Based on the analysis above, applying the proportionality approach using the entire carp data set would disproportionately reflect legacy sources. Therefore, the approach taken for this TMDL is to use only the most recent (2005) carp data in calculating required load reductions. This will reduce most, but not all, of the legacy effect and result in a load reduction requirement more similar to that necessary to be protective of lake trout, a species with the third-highest mean PCB concentration, which isn't as strongly influenced by legacy sediment sources

5.2 Gas-Exchange Model Direct Proportionality Approach

The second approach that was used in the TMDL to implement the direct proportionality approach applied theoretical and empirically based equations to link atmospheric loading to the resulting PCB concentrations in the water column and fish tissue. This was done to determine if the calculated required load reductions for the water column will meet Illinois WQS and also to provide an alternate application of the direct proportionality approach for determining the load reductions necessary to protect fish tissue concentrations. This approach does not require existing fish tissue concentrations; therefore, it is not influenced by the legacy effect inherent in the existing carp tissue data. The gas-exchange model direct proportionality approach consists of the following steps.

1. Define the atmospheric PCB concentration that will result in compliance with WQS.
2. Define the relationship between steady state sediment PCB and water column concentrations.
3. Use published biota-sediment accumulation factors to define the relationship between steady state sediment PCB and carp tissue PCB concentrations.
4. Use published bioaccumulation factors to define the relationship between steady state water column PCB and lake trout tissue PCB concentrations

The application of each step to the Illinois Lake Michigan (nearshore) PCB TMDL is described below.

5.2.1 Atmospheric PCB Concentration that will Result in Compliance with WQS

Henry's Law, one of the gas laws in chemistry, states that the amount of a gas that dissolves in a liquid is directly proportional to the partial pressure (i.e. gas phase concentration) of that gas in equilibrium with that liquid. In mathematical terms, this can be stated as:

$$p = k_H c \qquad (5\text{-}3)$$

where

p = the partial pressure of the gas above the solution

k_H = a chemical constant termed the Henry's Law constant

c = the concentration of the dissolved gas in solution

Because the TMDL approach being taken represents steady-state conditions, Equation 5-3 can be adapted to define the atmospheric PCB concentration that will result in compliance with WQS. The adaptations are required because:

- Henry's Law applies to a single chemical at a constant temperature, while PCBs represent a mixture of individual chemicals, and the temperature of Lake Michigan varies seasonally.
- Henry's Law predicts only the dissolved phase PCB concentration in water, while total PCB concentrations consist of both dissolved and particulate forms.

The adaptations taken for this TMDL consisted of: 1) using a Henry's Law constant representative of the mixture of PCB congeners present in the Great Lakes (LimnoTech, 2004); 2) using an annual average temperature of 10 ^{0}C taken from USEPA (2006) MICHTOX model results for Lake Michigan; and 3) using fraction dissolved PCB in the water column of 0.67, also taken from the MICHTOX (USEPA, 2006) modeling. These adaptations resulted in a Henry's Law constant of 1.09 x10^{-04} atm*m^3/mol at ambient temperature; when combined with a dissolved PCB fraction of 0.67, this constant results in an atmospheric concentration of 82 pg/m^3 being the equilibrium equivalent of a water column standard of 26 pg/L.

5.2.2 Relationship between Steady State Sediment PCB and Water Column Concentrations

One objective of the gas-exchange model direct proportionality approach is to define atmospheric PCB loads that will result in acceptable carp tissue PCB concentrations, via the application of biota-sediment accumulation factors (BSAFs). BSAFs estimate the relationship between pollutant concentrations in the bottom sediments and the pollutant concentration in the tissue of fish that obtain much of their pollutant exposure from these sediments. Accomplishing this objective requires a method of estimating sediment PCB concentration from atmospheric loading rates. Section 5.2.1 presented the linkage between atmospheric PCB concentrations and water column concentrations; this section defines the necessary linkage between water column concentrations and sediment concentrations.

The ratio between sediment and water column PCB concentrations can be defined as shown in equation 5-4 (Chapra, 1997):

$$C_2/C_1 = (V_sF_{p1} + V_dF_{d1}) / (k_2Z_2 + V_r + V_b + V_dF_{d2}) \tag{5-4}$$

Where:

C_2/C_1 = ratio of sediment PCB concentration to water column PCB concentration
V_s = solids settling velocity (m/day)
F_{p1} = fraction of PCB in particulate form - water column
k_2 = PCB decay rate in sediments (1/day)
Z_2 = sediment layer thickness (m)
V_r = sediment resuspension velocity (m/day)
V_b = sediment burial velocity (m/day)
V_d = diffusion velocity
F_{d1} = fraction of PCB in dissolved form - water column
F_{d2} = fraction of PCB in dissolved form - sediments

Steady state values for all of the above coefficients were estimated for Southern Lake Michigan as part of development of the MICHTOX Lake Michigan Mass Balance Project (USEPA, 2006; Endicott, 2005; and Endicott et al., 2005), and are listed in Table 5-3.

Table 5-3. Coefficients for Equation 5-4

Parameter	Abbreviation	Value	Units
Settling Velocity	V_s	1.5	m/day
Diffusion Velocity	V_d	$3.00\text{x}10^{-3}$	m/day
Resuspension Velocity	V_r	$3.42 \text{ x}10^{-7}$	m/day
Burial Velocity	V_b	$4.66 \text{ x}10^{-6}$	m/day
Sediment Decay Rate	k_2	0.0	1/day
Sediment Layer Thickness	Z_2	0.033	m
Fraction Particulate Water Column	F_{p1}	0.3264708	none
Fraction Dissolved Water Column	F_{d1}	0.6735292	none
Fraction Dissolved Sediment	F_{d2}	$3.84 \text{ x}10^{-5}$	none
Fraction Organic Carbon, Surface	f_{oc1}	0.290	none
Fraction Organic Carbon, Sediment	f_{oc2}	0.052	none
Log Organic Carbon Partition Coefficient	$Log(K_{oc})$	6.32	Log(L/kg)
Sediment Particle Concentration	m_2	240	kg/m^3
Water Column Particle Concentration	m_1	0.8	g/m^3
Sediment Particle Density	p	2.5	g/cc
Porosity	phi	0.904	none
Sediment Partition Coefficient	K_{d2}	0.109	m^3/g
Water Column Partition Coefficient	K_{d1}	0.606	m^3/g

Application of Equation 5-4 results in a steady state sediment/water column PCB ratio of 9.61×10^4. This ratio, when combined with the water column water quality standard for PCBs of 26 pg/L, results in a sediment PCB concentration of 2.50×10^{-3} g/m^3.

5.2.3 Relationship between Steady State Sediment PCB and Fish Tissue PCB Concentrations

The relationship between steady state carp tissue PCB concentrations and sediment PCB concentrations can be defined using a BSAF, which is a parameter describing bioaccumulation of sediment-associated organic compounds or metals into tissues of ecological receptors. BSAFs can be used to calculate tissue concentrations using the following equation (Burkhard, 2009):

$$C_{FISH} = \frac{BSAF.\,C_{SED}.\,F_L}{F_{SOC}} \tag{5-5}$$

Where:

C_{FISH} = the chemical concentration in the organism (µg/kg wet weight)
$BSAF$ = the biota sediment accumulation factor (g organic carbon/g lipid)
F_L = the lipid fraction of the organism (g lipid/g wet weight)
C_{SED} = the chemical concentration in surficial sediment (µg/kg dry weight)
F_{SOC} = the fraction of the sediments as organic carbon (g organic carbon/g dry weight).

USEPA (2015d) maintains a database of approximately 20,000 BSAFs from 20 locations. This database was accessed to find the BSAFs for PCBs in carp. The most relevant values found were from Green Bay of Lake Michigan, where the median BSAF was determined to be 3.3 g organic carbon/g lipid. The PCB database developed for this project was accessed to determine the median lipid content of carp fillets, which was determined to be 8.85 percent.

The above information was entered into Equation 5-5, with the result of a carp tissue PCB concentration of 0.0585 mg/kg being expected in response to a water column PCB concentration equal to the water quality standard of 26 pg/L. This indicates that a TMDL that is protective of the water quality standard would also be protective of carp tissue concentrations. It should be noted, however, that there is very high uncertainty around this estimate for the following reasons:

- Uncertainty analysis of the MICHTOX model indicated that results could vary within a factor of two, and likely by even more than that when applied to harbors.
- The lipid content of individual carp fillets used to calculate the average varied over several orders of magnitude.
- The observed BSAF values were from Green Bay, and not specific to the study area.

5.2.4 Relationship between Steady State Water Column PCB and Lake Trout Tissue PCB Concentrations

The PCB concentrations in fish resulting from the PCB bioaccumulation process can be expressed as follows (USEPA, 1995; CDEP et al., 2007):

$$C_{fish} = BAF * C_{water} \tag{5-6}$$

Where:

C_{fish} = PCB concentrations in fish (mg/kg)
BAF = bioaccumulation factor which is constant (l/kg)
C_{water} = PCB concentrations in water (mg/L)

The revised Trophic Level 4 BAF from the Final Revisions to the GLI PCB human health criteria (Federal Register, 3/12/1997), which was calculated assuming a lipid fraction of 3.10 and a freely dissolved fraction of 0.6642, is 1,086,000. The information above was entered into Equation 5-6, with the result of a lake trout tissue PCB concentration of 0.028 mg/kg being expected in response to a water column PCB concentration equal to the water quality standard of 26 pg/L (2.6×10^{-8} mg/L). This indicates that a TMDL that is protective of the water quality standard for the water column would also be protective of tissue concentrations in lake trout, a species that is largely influenced by exposure to PCBs in the water column.

5.3 Required Reduction Percentage

As the previous sections indicate, the Illinois Lake Michigan (nearshore) PCB TMDL has multiple targets (i.e., water column concentration, tissue concentration in different species of fish) and multiple methods for determining the load reduction necessary to attain compliance with each target. Specifically, the following different applications of the direct proportionality approach were conducted:

1. Fish tissue-based approach to determine load reductions necessary to meet fish tissue targets, based on observed fish tissue data
2. Gas-exchange model direct proportionality approach to determine load reductions necessary to meet the water column water quality standard

3. Gas-exchange model direct proportionality approach to determine load reductions necessary to meet fish tissue targets, based upon relationships observed at other sites

This section calculates the required reduction percentage necessary to attain each target using each calculation method. It also provides a recommendation for which reduction percentage should serve as the basis for the TMDL.

The calculation of the required reduction target requires the specification of a baseline time period, since atmospheric PCB concentrations in the Great Lakes area have been decreasing over time (Venier and Hites, 2010b; Sun et al., 2006) in response to the ban on PCB production enacted in 1979. A baseline year of 2005 was selected for this TMDL for the following reasons:

- The carp tissue data used in the fish tissue-based approach were all collected in 2005.
- The lake trout tissue data used in the fish tissue-based approach were all collected between 2000 and 2009.
- The two scientific papers that document the decline in atmospheric PCB concentrations (Venier and Hites, 2010b; Sun et al., 2006) are based on data sets that end in 2007 and 2003, respectively. Estimating present-day PCB concentrations using these regressions would require a major extrapolation to time periods roughly 10 years beyond the data set used to develop the regression.

5.3.1 Fish Tissue-Based Approach

Equations 5-1 and 5-2 can be rearranged to calculate a required reduction percentage as follows:

$$\%\ Reduction = 100 \times \left(C_{fish,current} - C_{fish,target}\right)/C_{fish,current} \tag{5-7}$$

Where:

$C_{fish,current}$ = current PCB concentrations in fish (mg/kg)

$C_{fish,target}$ = target PCB concentrations in fish (mg/kg)

Equation 5-7 was applied using the average PCB concentration of the 2005 carp data (1.13 mg/kg) in conjunction with the fish tissue target of 0.06 mg/kg to calculate a required load reduction of 94.7 percent. Equation 5-6 was also applied using the average PCB concentration of all lake trout data (0.811 mg/kg) to calculate a required load reduction of 92.6 percent.

5.3.2 Gas-Exchange Model Direct Proportionality Approach

The gas-exchange model direct proportionality approach can be applied to calculate the required reduction in PCB loading necessary to meet the following TMDL targets:

- Water column total PCB concentration
- Carp tissue target
- Lake trout tissue target

The load reduction required to meet the water column total PCB concentration target can be determined by rearranging Equation 5-7 as follows:

$$\%\ Reduction = \left(C_{atm,current} - C_{atm,target}\right)/C_{atm,current} \tag{5-8}$$

Where:

$C_{atm,current}$ = current atmospheric PCB concentrations (pg/m^3)

$C_{atm,target}$ = atmospheric PCB concentrations necessary to comply with water column criterion, as defined by (pg/m^3)

Section 4.4 explained the conclusion that the Simcik et al. (1997) data provided the best estimate of nearshore over-lake PCB concentration measurements and showed an annual average atmospheric concentration of 529 pg/m3 for the period 1994-1995. Combining that value with the half-life of 7.7 years for Chicago-area atmospheric PCB concentrations results in a 2005 concentration of 197 pg/m^3. Application of Equation 5-3 above showed that an atmospheric concentration of 82 pg/m^3 was required to attain an equilibrium equivalent water column standard of 26 pg/L. Combining the current concentration of 197 pg/m^3 and the target concentration of 82 pg/m^3 in Equation 5-8 results in a required reduction percentage of 58 percent.

Application of the BSAF in Section 5.2.3 showed that a water column PCB concentration of 26 pg/L would be expected to result in a carp tissue concentration of 0.0585 mg/kg, which is essentially equal to the fish tissue target of 0.06 mg/kg. For this reason, the 58-percent reduction in atmospheric concentration determined above as necessary to meet the water column target would also be required to meet the carp tissue target.

Application of the Trophic Level 4 bioaccumulation factor in Section 5.2.4 indicates that a water column PCB concentration of 56 pg/L would result in compliance with the tissue target of 0.06 mg/kg. This water column concentration corresponds to an atmospheric PCB concentration of 177 pg/m^3. Combining the current concentration of 197 pg/m^3 and the target concentration of 177 pg/m^3 in Equation 5-8 results in a required reduction percentage of 10 percent.

5.3.3 Recommended Reduction Percentage

Reduction percentages have been calculated to range from 10 to 94.5 percent, corresponding to different targets and different calculation methods. Overall, the fish tissue-based approach results in a greater required reduction percentage (92.6 to 94.7 percent) than the gas-exchange model direct proportionality approach (10 to 58 percent). It is noted that the gas exchange model only considers current atmospheric sources, while the fish tissue approach reflects the influence of historical and non-atmospheric loads. Given that atmospheric sources were shown to be the dominant source of PCBs to the study area, the higher reduction percentage required by the fish tissue approach likely indicates that current carp and lake trout tissue concentrations exhibit a significant legacy effect reflecting historically higher loading rates. Nonetheless, it is recommended that the 94.7 percent reduction resulting from the fish tissue-based approach for carp be used as the basis for the TMDL. There are two primary reasons for this recommendation.

- The uncertainty in these estimates is high for several reasons (e.g., limited number of fish tissue samples available), and use of the upper bound of the range of reduction percentages meets the TMDL requirement of providing a margin of safety (MOS) to account for uncertainty.
- It will take decades for the legacy effect to diminish. While a 58 percent reduction in loading may be all that is required to attain targets, selection of a larger reduction percentage will allow the targets to be attained more quickly. This concept is illustrated in Figure 5-3, which demonstrates the 58 percent reduction eventually reaching the target fish tissue level of 0.06 mg/kg. The 94.7 percent reduction, on the other hand, ultimately attains a target level much less

than the target of 0.06 mg/kg, but attains the target concentration decades sooner than the 58% reduction.

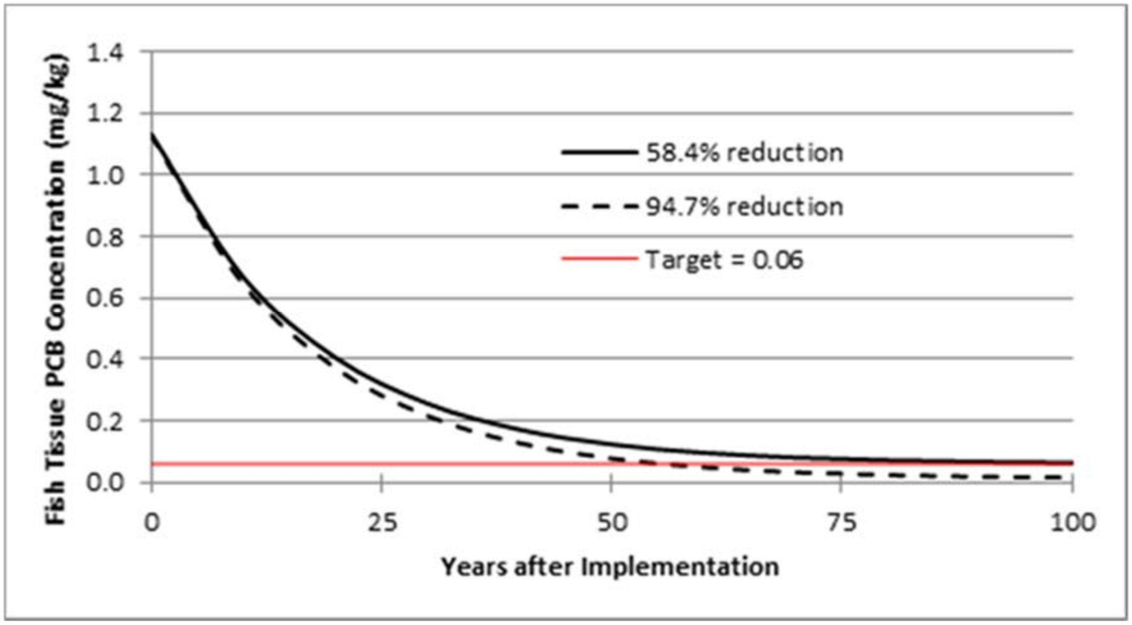


Figure 5-3. Illustration of Fish Tissue PCB Concentration over Time, Under Two Reduction Scenarios

6
TMDL Development

A TMDL calculates the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet the WQS for that particular pollutant, in this case for PCBs. The TMDL allocates the maximum allowable load to point sources (Wasteload Allocation, or WLA), and nonpoint sources (Load Allocation, or LA), which include both anthropogenic and natural background sources of the pollutant. TMDLs must also include a margin of safety (MOS) to account for uncertainty in the relationship between pollutant loading and receiving water quality, and account for seasonal variations.

The TMDL is typically defined by the equation:

$$TMDL = \sum LA + \sum WLA + MOS \qquad (6\text{-}1)$$

Where

TMDL = total maximum daily load (i.e., the loading capacity (LC) of the receiving water)

$\sum$LA = sum of all load allocation for nonpoint sources

$\sum$WLA = sum of all wasteload allocation for point sources

MOS = margin of safety

The process to determine the TMDL includes:

1) Determine the LC of the receiving water(s) (i.e., the maximum pollutant load that the waterbody can assimilate and attain WQS)
2) Allocate this loading capacity among the three categories shown in Equation 6-1

Equation 6-2 is used to calculate the TMDL using the existing combined load of PCBs from point and nonpoint sources, defined as the "baseline load," and the reduction factor

$$TMDL = \text{Baseline Load} * (1\text{-}RF) \qquad (6\text{-}2)$$

Where

TMDL = total maximum daily load (mass/time);

Baseline load = total source load during the baseline year of 2005 (including all air sources and NPDES permitted discharges of PCBs);

RF = reduction factor.

The RF is based on the reductions needed to achieve target fish PCB concentrations (see Equation 5-7 in Section 5.3.1). An annual load is the most appropriate way to calculate this PCB TMDL because the goal is to address long-term PCB bioaccumulation, rather than to track short-term effects. Nonetheless, TMDLs are recommended to be expressed in daily units whenever feasible. Consistent with the Michigan statewide PCB TMDL (LimnoTech, 2012), a maximum allowable daily load can be estimated by examining the intra-annual variability in loading and determining the highest daily load expected to occur within a year that meets the annual average target.

This section presents the calculation of the TMDL, and is divided into the following sections:

- Baseline PCB load

- TMDL loading capacity
- Wasteload allocation
- Load allocation
- Margin of safety
- Critical conditions and seasonal variation

6.1 Baseline PCB Load

The baseline load is the sum of the existing nonpoint and point source loads of PCBs for the baseline year. As discussed in Section 5.3, the year 2005 was selected as a baseline year because it most closely matches the timing of the fish tissue samples used as the basis of the TMDL.

Diffuse, or nonpoint, sources of PCBs to the study area consist primarily of atmospheric exchange, either directly to the study area or indirectly via atmospheric exchange with the main body of Lake Michigan and subsequent transport into the study area.

Table 4-2 indicates that PCB loading to the study area due to hydrodynamic transport from the main body of Lake Michigan ranges from 4.6 to 13 kg of PCB per year, while direct atmospheric exchange to the study area contributes 2.1 to 5.8 kg/yr. These loads are expressed as ranges, accounting for the fact that atmospheric loads are decreasing over time. Normalizing these loads to the baseline year of 2005 results in a hydrodynamic transport load from the main body of Lake Michigan equal to 7.4 kg of PCB per year, and a direct atmospheric load of 4.9 kg/yr. The sum of these numbers, 12.3 kg/yr, represents the nonpoint source load for the baseline year of 2005.

Point sources of PCBs consist of regulated wastewater and stormwater discharges (including permitted MS4 discharges). Stormwater regulated under the NPDES stormwater program (i.e., Phase I and Phase II) is a point source. No detectable PCB concentrations were available for any of the NPDES discharges in the study area, and no data are available for the stormwater discharges. The source assessment conducted in Section 4 indicated that these sources are likely a small contributor to existing PCB loads to the segment (Table 4-2). As such, point sources are not included in the baseline loading allocation. Point sources will receive a WLA, however, to ensure that future loads do not lead to a WQS violation.

The baseline total source load is the sum of the baseline point source load and nonpoint source load. Because the only detectable load of PCBs is from nonpoint sources, the baseline load for 2005 is equal to the nonpoint source load and is 12.3 kg/yr (Table 6-1).

Table 6-1. Baseline PCB Load for 2005

Portion of Baseline PCB Load	Result
Point Source Load	No detectable load *
Nonpoint Source Load	12.3 kg/yr
Total Baseline Load (2005)	12.3 kg/yr

* See discussion above for further explanation

6.2 TMDL Loading Capacity

The baseline load described in Section 6.1 and the reduction factor described in Section 5.3 are used to define the TMDL Loading Capacity by applying the RF to the baseline load, as shown in Equation 6-3.

$$\text{TMDL} = \text{Baseline Load} \times (1-\text{RF})$$

$$0.65 = 12.3 \times (1 - 0.947) \tag{6-3}$$

Inserting the baseline load (12.3 kg/yr) and RF (94.7 percent) into Equation 6-3 yields a TMDL of 0.65 kg/yr. TMDLs are recommended to be expressed in daily units whenever feasible. Consistent with the Michigan Statewide PCB TMDL (LimnoTech, 2012), a daily load can be estimated by examining the intra-annual variability in loading and determining the highest daily load expected to occur within a year that meets the annual average target. As noted previously, the total nonpoint source load consists of two components: an atmospheric PCB load and PCB transport from Lake Michigan. The intra-annual variability in these two source categories was assessed separately. The variability in atmospheric loading was calculated by taking the highest observed single-day atmospheric PCB concentration in Simcik et al. (1997), and dividing that by the annual average concentration to get a ratio for daily maximum to annual average concentration of 2.1, using the equation

Maximum daily atmospheric load =

(Total annual load) x (Ratio of atmospheric: total load) x (Ratio of daily maximum: annual average) (6-4)

Application of Equation 6-4 results in a maximum daily load attributable to direct atmospheric exchange of:

0.65 kg/yr x (4.9/12.3) x 2.1 ÷ 365 days/yr = 0.0015 kg/day

It can be reasonably assumed that Lake Michigan PCB concentrations do not vary substantially over the course of a year, so the daily load for transport from Lake Michigan is calculated as the annual load divided by 365, i.e.:

Maximum daily Lake Michigan transport load =

(Total annual load) x (Ratio of transport: total load) (6-5)

Application of Equation 6-5 results in a maximum daily load attributable to transport from Lake Michigan of:

0.65 kg/yr x (7.4/12.3) ÷ 365 days/yr = 0.0011 kg/day

The resulting maximum daily loading capacity is the sum of those two loads, or 0.0026 kg/day (=0.0015 kg/day+0.0011 kg/day). To be clear, this does not mean that the load can be 0.0026 kg/day every day of the year. This means that, given expected seasonal variability in atmospheric concentrations, if the highest daily load is 0.0026 kg/day, then the annual load will not exceed the target of 0.65 kg/yr. For example, the average daily loading rate from atmospheric sources is 0.00071 kg/day. Seasonal variations in atmospheric concentrations are such that this loading rate can be as high as 0.0015 kg/day on the worst day of the year. These seasonal variations also dictate that atmospheric loading will be much less than the average value of 0.00071 kg/day on other days of the year.

This is the daily allowable load of PCBs that, over time, is expected to result in meeting the fish tissue target for PCBs of 0.06 mg/kg, and attaining WQS.

6.3 Wasteload Allocation

The WLA is defined as the portion of the loading capacity allocated to NPDES-permitted point sources, including MS4 stormwater. Even though point source PCB loads were determined to be small compared to current nonpoint source loads, it is important to ensure that these loads will not cause or contribute to a violation of the WQS after reductions of nonpoint sources occur. The only way to ensure that these sources maintain compliance with WQS is to establish WLAs for these sources that are designed to attain WQS at the point of discharge. This TMDL, therefore, establishes WLAs for MS4s and three individual NPDES-permitted dischargers, to ensure that PCB loadings from these sources attain WQS. Entities in the study area with MS4 permits are listed in Table 6-2, along with three individual NPDES permits for facilities which currently have PCB limits in their permits.

Table 6-2. Study Area Entities with MS4 and Individual NPDES Permits

Type of Permit	Place Name (MS4 permit) or Facility Name (individual permit)	Permit Number
MS4	Beach Park	ILR400164
MS4	Chicago	ILR400173
MS4	Cook County Highway Department	ILR400485
MS4	Evanston	ILR400335
MS4	Glencoe	ILR400198
MS4	Highland Park	ILR400352
MS4	Highwood	ILR400353
MS4	Kenilworth	ILR400214
MS4	Lake Bluff	ILR400366
MS4	Lake County	ILR400517
MS4	Lake Forest	ILR400367
MS4	North Chicago	ILR400402
MS4	Shields Township	ILR400123
MS4	Waukegan	ILR400465
MS4	Waukegan Township	ILR400148
MS4	Wilmette	ILR400473
MS4	Winnetka	ILR400476
MS4	Winthrop Harbor	ILR400477
MS4	Zion	ILR400482
MS4	Illinois Department of Transportation	ILR400493
Individual	Zion Solutions LLC	IL0002763
Individual	Winnetka Power Generation Station	IL0002364
Individual	Midwest Generation LLC Waukegan	IL0002259

The WLA associated with MS4 stormwater discharges is determined by multiplying the magnitude of stormwater flow delivered to the study area from each of these sources (calculated in Section 4.3) by a concentration equal to the water quality standard in order to convert it to a load. This results in a stormwater MS4 WLA of 0.0022 kg/yr (0.000006 kg/day).

The WLA for the three individual permits is zero, consistent with their existing permits that state, "There shall be no discharge of PCBs." The total WLA is calculated as the sum of the MS4 and individual permit WLAs and equals 0.0022 kg/yr (0.000006 kg/day).

6.4 Load Allocation

The LA, presented in Table 6-3, is essentially[6] equal to the loading capacity of 0.0026 kg/day calculated in Section 6.2. As defined in Section 6.2, the LA consists of two components: direct atmospheric exchange of PCBs to the study area and transport of PCBs into the study area from Lake Michigan (which also originate from atmospheric deposition).

Table 6-3. PCBs Load Allocation

Portion of Load Allocation	Result
Direct atmospheric exchange	0.0015 kg/day
Transport from Lake Michigan	0.0011 kg/day

The calculations in Section 5 demonstrated that a 94.7-percent reduction in atmospheric PCB concentration is necessary to attain PCB levels that are protective of designated uses. This TMDL only has regulatory authority over PCBs originating from within the state of Illinois. For that reason, it is necessary to divide existing PCB concentrations into separate components corresponding to: (1) out-of-state sources; and (2) within-state sources. The PCB contribution due to out-of-state sources was defined for this TMDL by the PCB concentration measured in 2005 at the remote Eagle Harbor, Michigan monitoring station of the Integrated Atmospheric Deposition Network, which is 53 pg/m^3 (USEPA, 2015b). It is difficult to predict the origin of atmospheric PCBs from outside the state. Atmospheric mixing processes are very complex and change constantly. Over time, PCBs being deposited on Lake Michigan could come from as far away as China (University of Minnesota and LimnoTech, 2009; MacLeod et al., 2005). The PCB contribution from in-state sources was defined as the difference between the total atmospheric PCB concentration over the nearshore study area (197 pg/m^3) and the concentration attributed to out-of-state sources. In-state sources make up 73 percent of the study area's atmospheric PCB concentration, while out-of-state sources make up the remaining 27 percent.

If the TMDL was designed solely to reduce in-state sources, the necessary reductions from these sources would be calculated using Equation 6-4:

$$\text{\% reduction in in-state deposition} = RF / (1 - \text{\% out-of-state contribution}) \qquad (6\text{-}4)$$

Where

RF = required reduction factor in overall concentration

Given a required reduction factor of 94.7 percent, and an out-of-state contribution of 27 percent, Equation 6-4 indicates that in-state sources would need to be reduced by 130 percent if no reductions are made to out-of-state sources. In-state reductions in PCB atmospheric deposition will not achieve the TMDL target alone. Therefore, this TMDL assumes that reductions from out-of-state sources will be consistent with those required for in-state sources (i.e., a 94.7-percent reduction will be required for both in-state and out-of-state sources). It is important to recognize, however, that even though reductions in in-state PCB concentrations alone will not attain compliance with WQS, reduction in in-

[6] A portion of the load capacity will be allocated to point sources, but this portion is within the round-off error of load allocation

state sources closer to background levels will lead to significant improvement in fish tissue levels. Table 6-4. presents the baseline and target atmospheric PCB load for Illinois in-state sources.

Table 6-4. Summary of Baseline and Target Atmospheric PCB Load from Illinois In-State Sources

Category	Atmospheric PCBs Load
2005 Estimated In-State Atmospheric Load	8.4 kg/yr
Target Reduction Rate in Illinois' Atmospheric Load	94.7%
2005 Target In-State Atmospheric Load[a]	0.45 kg/yr

[a]Calculated as 2005 Estimated Instate Atmospheric Load x (1 - 0.947)

6.5 Margin of Safety

The MOS is a required part of the TMDL to account for technical uncertainties such as model predictions, analysis of technical data, and the relationship between pollutant loading and receiving water quality. When calculating the TMDL, the MOS can be explicit (e.g., stated as an additional percentage of load reduction), implicit (e.g., conservative assumptions in the TMDL calculations or overall approach), or a combination of the two. For this PCB TMDL, the MOS is implicit through the use of carp tissue data as the basis for calculating required reduction percentages. Although the most recent available carp data were selected for use in this TMDL, the data likely reflect legacy PCB loads to some extent, because the average life span of carp is 8 to 15 years, with a maximum of 47 years (Becker, 1983). Calculation of required reduction percentages using alternate methods not influenced by legacy effects results in much lower required reduction percentages. Calculating the TMDL based on this high average PCB tissue concentration incorporates an implicit MOS into the analysis.

6.6 Critical Conditions and Seasonal Variation

TMDLs are required to consider seasonal variations and critical environmental conditions [40 CFR§130.7(c)(1)]. PCB concentrations in the atmosphere and water column can fluctuate seasonally. However, PCBs accumulate in fish tissue more slowly than seasonal fluctuations occur, and the increases do not correspond to seasonal variations. Instead, the PCB concentration in the fish represents an integration of all temporal variation up to the time of sample collection. Variability in fish tissue PCB concentrations are more likely influenced by differences in size, diet, habitat, and other undefined factors that are expected to be greater in sum than seasonal variability (MPCA, 2007).

There are critical conditions in the sense that certain waterbodies and fish species are more likely to bioaccumulate PCBs due to individual water chemistry characteristics and the biochemistry of individual fish species. This aspect of critical conditions has been addressed in this TMDL by using a fish species known to have high bioaccumulation potential. Thus, the critical conditions are assumed to be adequately addressed in the existing analysis.

6.7 TMDL Summary

The components of the PCB TMDL are summarized in Table 6-5.

Table 6-5. Summary of TMDL Components

TMDL Components	Results
Target Level and Reduction Factor	
Target Fish PCB Concentration (Fish Tissue Residue Value)	0.06 mg/kg
Baseline PCB Concentration for Carp	1.13 mg/kg
Reduction Factor	94.7 %
PCB Load for Baseline Year 2005	
Point Source Load	No detectable load
Nonpoint Source Load	12.3 kg/yr
Transport from main body of Lake Michigan	7.4 kg/yr
Direct atmospheric load	4.9 kg/yr
Total Baseline Load	12.3 kg/yr
Final TMDL	
Loading Capacity (LC)	0.0026 kg/day
Necessary Reduction from Atmospheric Sources	94.7%
Margin of Safety (MOS)	Implicit
Wasteload Allocation (WLA)	0.000006 kg/day l
Load Allocation (LA)	0.0026 kg/day
PCB Load Allocation for In-State and Out-of-State Deposition Sources	
In-State Contribution to LA[a]	0.0019 kg/day
Out-of-State Contribution to LA[b]	0.0007 kg/day

Numbers may not sum exactly due to rounding

[a] Calculated as 73% of LA

[b] Calculated as 27% of LA

7
Implementation Plan and Monitoring Recommendations

To achieve the PCB load allocations described in Section 6, PCB loads must be significantly reduced. Atmospheric PCB loads are the most significant source of PCBs to the study area waterbodies (either through direct atmospheric exchange or indirectly through transport from portions of Lake Michigan outside the study area), with point and other nonpoint sources contributing a much smaller proportion. TMDLs that call for reduction in sources for which an NPDES permit is not required should provide a reasonable assurance that the controls will be implemented and maintained. It is important to reduce all possible sources of PCBs. Atmospheric PCBs that are intercepted by impervious area can be removed before they continue to cycle through the natural and engineered systems by adjusting existing controls that remove other stormwater pollutants. Monitoring can identify areas likely to contain sinks or sources of PCBs. Focusing on a preventative, best management approach can provide a reasonable assurance that the controls needed to reduce PCBs and other pollutants will be implemented and maintained.

Monitoring data over the last several decades have shown a steady and steep decline in gas phase atmospheric PCB concentrations in the Great Lakes region (Figure 2-2). This decline can be attributed to the ban on the manufacture and use of PCBs in the United States in the 1970s. PCBs are removed from the environment via several mechanisms: replacement of PCB-containing equipment with non-PCB containing equipment, proper disposal of PCB-containing oils and equipment, and identification and modification of processes that inadvertently create PCBs. The PCB ban and subsequent removal of PCBs from the environment is reflected in the downward trend of atmospheric PCB concentrations. The implementation actions discussed in this section may accelerate this rate of decline, by actively removing historical sources of PCBs that have been previously volatilizing and contributing to elevated atmospheric PCB concentrations.

NPDES-permitted point sources including MS4 stormwater runoff, while not estimated to be the primary source of PCBs to the study area, must also be controlled to ensure that water quality targets are attained. This section provides best management practices (BMPs) for reducing PCBs in runoff, as well as specific language to include in MS4 permits.

This section provides recommendations for actions to reduce PCBs in the environment, and ways to monitor progress. It is divided into the following sections:

- Potential sources to target for PCB control
- BMPs for reducing PCB loads
- Funding opportunities
- Reasonable assurances for achieving the TMDL target
- Monitoring recommendations to track TMDL effectiveness

7.1 Potential Sources to Target for Control

This TMDL calls for control of two broad categories of PCB sources: atmospheric loads and point sources. Atmospheric PCB loads can be reduced through the targeted reduction of PCBs in Illinois, thereby limiting the amount of PCBs that volatilize into the atmosphere. Point source loads, consisting primarily of municipal stormwater, can be controlled either by reducing the amount of PCBs entering the stormwater system and/or treating the stormwater itself. The identification of PCB sources contributing to the atmosphere and stormwater is a difficult but important step. The discussion that follows provides some guidance on identifying potential PCB sources using existing information.

7.1.1 Identification of Potential PCB-Containing Products and Sources

Due to the ban of production of PCBs in 1979, PCBs that remain in the environment today are a result of: 1) cycling of PCBs from historical/legacy uses, and 2) new sources, inadvertently produced as by-products of chemical manufacture. The most common historical uses for PCBs were capacitors (50.3 percent) and transformers (26.7 percent), followed by a variety of other industrial uses such as plasticizers, hydraulic fluids, carbonless copy paper, and heat transfer fluids (USEPA, 1994). Watershed-specific data on legacy sources is unavailable, but more specific data from the U.S. on legacy PCB uses and sources can be found in Appendix C. As mentioned in the source assessment section (Section 4), PCBs from legacy sources volatilize into the atmosphere or are released into stormwater runoff via contaminated sediment. Thus, cleaning up existing sources is important to prevent future release or discharge. A paper published by Shanahan et al. (2015) provides an inventory of PCBs in Chicago. Shanahan et al. (2015) estimate that sewage sludge drying beds have the potential to contribute significantly to annual PCB emissions for the City of Chicago, second behind soils (background), and just ahead of transformers. IEPA will follow up with the researchers and facilities that generate sludge in the watershed to understand this issue.

Despite the ban on the intentional production of PCBs, there is still widespread inadvertent production of PCBs during the manufacture of chemicals. Hu and Hornbuckle (2010) reported that a PCB that was not produced as part of the banned Aroclor mixtures, was reported in air samples collected in Chicago, Philadelphia, the Arctic, and several sites around the Great Lakes. In Chicago, the congener 3,3'-dichlorobiphenyl (PCB11) was found to be the fifth most concentrated congener and ubiquitous throughout the city, exhibiting a seasonal concentration trend suggesting volatilization from outdoor surfaces. Hu and Hornbuckle (2010) detected PCB congeners in pigments commonly used in paint, inks, textiles, paper and other products. The U.S. Toxics Substance Control Act provides exemptions for PCBs as unintentional contaminants in manufacturing processes, allowing for PCB concentrations of up to 50 ppm in certain products.

For a list of those chemical processes that have the potential to generate new PCBs and reported cases of inadvertently produced PCBs, see Appendices D and E, respectively, in Washington Department of Ecology (2014)

7.1.2 Point Sources

NPDES-permitted point sources, including MS4 stormwater runoff, are estimated to be a relatively small source compared to atmospheric loading. However, stormwater can transport PCBs from air deposition, demolition dust and contaminated soil to waters and add to PCBs available to bioaccumulate in the aquatic food chain. Implementing BMPs inMS4 permits in an effort to meet TMDL allocations would break this cycle with the added potential benefit of reducing other pollutants loads and stormwater peak flow velocities and volumes. In order to ensure future MS4 loads meet the TMDL, the MS4 WLA will be addressed in permits issued by IEPA requiring the implementation of BMPs. Provided IEPA receives the NPDES permit renewal application prior to the expiration date of the existing NPDES permit, the WLAs will be incorporated into the permits upon reissuance. Examples of BMPs to implement for reducing PCBs in runoff are provided in Section 7.2 and specific language to include in MS4 permits is provided in Appendix D.

7.2 BMPs for Reducing PCB Loads

This section describes the different types of BMPs that will be used to reduce PCB loads to the nearshore waters of Lake Michigan, and describes their appropriateness based on location/source. These BMPs are expected to reduce PCBs from both nonpoint sources and MS4 stormwater runoff. Table 7-1. provides information on the implementation points, sources, and pathways for the range of BMPs. Table 7-2. summarizes the level of effectiveness achieved in reducing contaminant loads to the storm sewer system for the range of BMPs described below.

7.2.1 Institutional BMPs

Institutional BMPs are focused on information sharing and governmental practices to help businesses and the general public avoid, or clean up and properly dispose of, products containing PCBs. These BMPs require the least amount of infrastructure, engineering work, maintenance, and disturbance of existing land, because their purpose is to avoid the continued use, inadvertent production, or release of PCBs. A past program, the Chicago PCB Clean Sweep Pilot program was designed to educate Chicago-area businesses on the identification and proper management of PCBs and to set up a process under which certain businesses would be able to send certain PCB (and mercury) waste to a participating facility for recycling or disposal at a reduced cost. The Clean Sweep program has been discontinued, but could serve as a model for additional clean-up if communities are interested in pursuing funding to revitalize it. The institutional BMPs listed below will help reduce PCB loads to the atmosphere through cleaning up existing sources and properly disposing of PCB-containing products and waste.

- Conduct public education and outreach campaigns to facilities, local officials, and demolition/construction contractors to spread information about the potential sources of PCBs, what to do with them if discovered, and safer alternatives. Information should be shared with buyers and suppliers of industrial equipment, consumers, and residents who fish for recreation or subsistence, to increase their awareness of fish advisories and the fish species that contain the highest concentrations of PCBs. The effectiveness of an education and outreach campaign may be increased by educating those more likely to come into contact with PCBs.
- Conduct a survey of the state's utilities and other owners of electrical equipment to confirm the presence of PCBs in transformers inventoried in the IEPA database mentioned above (USEPA 2011a). Provide technical assistance where requested for disposal and replacement of the contaminated fluid (Washington State Department of Ecology, 2014).
- Promote wider/higher use of recycling facilities, to reduce the presence of light ballasts, drums, old transformers, capacitors, etc.
- Develop and implement take-back programs: government- or non-profit-run programs to accept PCB-containing waste.

- Prevent more material from being washed down streets, to prevent it from entering storm drains. Conduct targeted street sweeping to modify the areas or frequency covered to target sources of PCBs.
- Clean up illegally dumped waste, such as old drums, electrical equipment, or building demolition material, that may have PCB-contaminated caulk or paint to prevent dust from entering air or water.
- Review local/regional laws regulating waste disposal, and revise as necessary: this could include implementing fines for improperly disposing of PCBs and sharing information on safer alternatives for lighting, paint, caulk, etc.

7.2.2 Contaminated Sites and Soil Remediation BMPs

Shanahan et al. (2015) estimate that soils (background) have annual PCB emissions that are higher than other source sectors in Chicago, but note that these emissions depend on soil PCB concentrations. This category of BMPs involves identifying and cleaning up soil that has been contaminated from past use of PCBs.

It is important to identify and remediate PCB-contaminated soil before it can be mobilized and transported into the storm drain system, especially during wet weather, to avoid further discharge and distribution into Lake Michigan and its tributaries. In addition, remediation of contaminated soil and sites will prevent further contributions to atmospheric concentrations of PCBs. Significantly more equipment use and land disturbance are required for these solutions than the institutional control addressed previously. Examples of contaminated site and soil remediation BMPs include:

- Identification and elimination of storage or use of PCBs: removal of old equipment or drums of PCBs and proper disposal, in addition to soil remediation if PCBs have been spilled.
- Building remodeling or demolition: identification of older building that may contain PCBs and replacement of the fixtures with safer alternatives, or removal of the buildings altogether. Common options include:
    - Removal of caulking installed before 1979 that contains PCBs
    - Identifying and disposing of light ballasts, surfaces painted with PCB-containing paint, etc.

7.2.3 Treatment Control BMPs (MS4 Stormwater BMPs):

Treatment control BMPs are engineered options to be installed or built within the existing storm sewer infrastructure to capture sediment containing PCBs and prevent it from being discharged to Lake Michigan and can help meet the MS4 permit requirements. Since PCBs adsorb to soil/sediment, reducing solids will in turn reduce PCBs. These BMPs can be implemented anywhere, but the limiting factor is access, because they require regular inspection and maintenance and specialized knowledge for installation. These BMPs are effective at treating a range of contaminants and are not limited to controlling PCB loads. They are organized by their placement relative to storm sewer pipes. Appendix D provides a menu of BMPs to facilitate reductions in PCBs from stormwater consistent with the goals of this Lake Michigan Illinois Nearshore TMDL. These BMPs can be applied at three different locations within the stormwater systems:

- Pipe entrance
    - Capture of PCBs before they enter stormwater pipes

    - Includes infiltration trenches, basins, retention and reuse (rain barrels or underground tanks), ponds, detention basins, swales, buffer strips, bioretention
- Installed within MS4 pipes:
    - Includes filters, screens, wet vault[7], hydrodynamic separators
    - Usually have high maintenance requirements and can sometimes back up flow when not maintained properly
- End of pipe
    - Includes sedimentation basins, constructed wetlands, or diversion of flow to treatment at wastewater treatment plants

[7] A wet vault is a permanent pool of water in a vault that rises and falls with storms and has a constricted opening to let runoff out. Its main treatment mechanism is settling of solids that are contaminated.

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Table 7-1. BMP Application for Controlling PCBs in Urban Areas Relative to Sources (Source: San Francisco Estuary Institute (SFEI), 2010)

Best Management Practice (BMP) Category	Implementation Points								Applicable sources and pathways	
	Dispersed								PCBs	
	Private homes	Public lots, schools, hospitals, govt bldgs and research institutions	Private offices and businesses	Other private lots and industrial yards	On the street	Start of pipe	Within pipe	End of pipe	Sources	Pathways
Institutional BMPs										
Education and outreach	√	√	√	√					F,OI,IUP,ID,HW,BDR	
Volunteer cleanup efforts	√	√	√	√	√				F,OI,IUP,ID,HW	
Recycling	√	√	√	√						
Amnesties	√	√	√	√					OI,IUP,HW	
Product Bans/product replacement	√	√	√	√					F,OI,IUP,HW	
Enforcement			√	√					F,OI,IUP,ID,HW,BDR	
Sweeping		√	√	√	√				A,OI,RF,RD,BDR	RI,VT,FT,W
Washing (streets/footpaths)		√	√	√	√				RD,BDR	RI,VT,FT,W
Illicit waste dumping cleanup					√	√	√	√	OI,ID	RI
Stormwater conveyance maintenance				√		√	√	√	A,OI,ID,RF	RI,VT,FT,W
Treatment BMPs										
Infiltration trench		√	√	√		√			A,OI,RF	RI,VT,FT,W
Infiltration basin		√	√	√		√			A,OI,RF	RI,VT,FT,W
Retention and reuse/irrigation	√	√	√			√		√	A,OI,RF	RI,VT,FT,W
Wet Pond		√	√	√		√			A,OI,RF	RI,VT,FT,W
Constructed wetland		√	√	√		√		√	A,OI,RF	RI,VT,FT,W
Extended detention basin		√	√	√		√		√	A,OI,RF	RI,VT,FT,W
Vegetated swale		√	√	√		√			A,OI,RF	RI,VT,FT,W
Vegetated buffer strip		√	√	√		√			A,OI,RF	RI,VT,FT,W
Bioretention (rain garden/green roof)	√	√	√	√		√			A,OI,RF	RI,VT,FT,W
Media filter		√	√	√			√		A,OI,RF	RI,VT,FT,W
Water quality inlet		√	√	√			√		A,OI,RF	RI,VT,FT,W
Wet vault		√	√	√			√		A,OI,RF	RI,VT,FT,W
Hydrodynamic separation		√	√	√			√		A,OI,RF	RI,VT,FT,W
Drain insert		√	√	√			√		A,OI,RF	RI,VT,FT,W
Flow diversion to wastewater treatment								√	All sources	All pathways

True sources: Factories = F, Atmospheric deposition= A
Source areas: Old industrial - OI, PCBs and Hg products still in use = IUP, Illegal disposal - ID, Recycling facilities = RF, Road deposits = RD, Home and work place = HW
Building demolition and remodeling = BDR
Transport pathways: Runoff from impervious surfaces = RL, Vehicle tracking = VT, Foot tracking = FT, Wind = W

Table 7-2. Program Assessment Effectiveness for BMPs (Source: SFEI, 2010)

Best management practice (BMP) category	Most applicable effectiveness assessment outcome levels					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	Documenting activities	Raising awareness	Changing behavior	Reducing loads from sources	Improving runoff quality	Protecting receiving water quality
Institutional BMPs						
Education and outreach	√	√	√			
Volunteer cleanup efforts	√			√		
Recycling	√			√		
Amnesties	√			√		
Product Bans / product replacement	√			√		
Enforcement	√	√	√	√		
Sweeping	√			√		
Washing (streets/footpaths)	√			√		
Illicit waste dumping cleanup	√			√		
Stormwater conveyance maintenance	√			√	√	
Treatment BMPs						
Infiltration trench	√			√	√	
Infiltration basin	√			√	√	
Retention and reuse / irrigation	√			√	√	
Wet Pond	√			√		
Constructed wetland	√			√		
Extended detention basin	√			√		
Vegetated swale	√			√	√	
Vegetated buffer strip	√			√	√	
Bioretention (Rain garden / green roof)	√			√	√	
Media filter	√			√		
Water quality inlet	√			√		
Wet vault	√			√		
Hydrodynamic separation	√			√		
Drain insert	√			√		
Flow diversion to wastewater treatment	√			√	√	√

7.3 Funding Opportunities

The most likely funding sources to implement the BMPs described previously are the Great Lakes Restoration Initiative, GLRI (http://greatlakesrestoration.us/index.html), the Illinois Green Infrastructure Program for Stormwater Management (http://www.epa.illinois.gov/topics/grants-loans/water-financial-assistance/igig/index), and Nonpoint Source Section 319 grants (http://www.epa.illinois.gov/topics/water-quality/watershed-management/nonpoint-sources/index). However, multiple other programs can aid in funding measures to reduce PCBs, as shown in Table 7-3.

Table 7-3. Funding Opportunities for Implementation of BMPs and Other Measures for Reducing PCBs

Funding Opportunity	Description
U.S. Environmental Protection Agency	
Great Lakes Restoration Initiative	Funds various projects, including a program area focused on Areas of Concern like Waukegan Harbor.
Environmental Education Local Grants Program	Support locally-focused environmental education projects that increase public awareness and knowledge about environmental issues and provide the skills that participants in its funded projects need to make informed environmental decisions and take responsible actions toward the environment.
National Institutes of Health	
Assessing and Addressing Community Exposures to Environmental Contaminants	Applicants should investigate the potential health risks of environmental exposures of concern to the community and implement an environmental public health action plan based on research findings
National Oceanic and Atmospheric Administration	
Coastal Services Center Cooperative Agreements	Provides technical assistance and project grants through a range of programs and partnering agreements, all focused on protecting and improving coastal environments.
Illinois Environmental Protection Agency	
Illinois Green Infrastructure Program for Stormwater Management	Grants are available to local units of government and other organizations to implement green infrastructure BMPs to control stormwater runoff for water quality protection in Illinois. Projects must be located within a MS4 or CSO area.
Nonpoint Source Section 319 Grants	Grants are available to local units of government and other organizations to protect water quality in Illinois. Projects must address issues relating to nonpoint source pollution (like stormwater runoff). Funds can be used for the implementation of watershed management plans, which focus on the installation of BMPs.

7.4 Reasonable Assurance

TMDLs that call for reduction in sources for which an NPDES permit is not required should provide a reasonable assurance that the controls will be implemented and maintained. IEPA believes that a refocusing of existing activities such as stormwater management, and identifying and addressing potential PCB hot spots in the study area, will reduce overall PCB loads in the environment. Removing PCBs that cycle between the atmosphere, water, soil, and sediments, will also reduce loadings to impaired waters, and reduce concentrations in fish to meet the targets of this TMDL.

This section provides reasonable assurances that BMPs will be implemented, along with a description of other projects currently underway that will assist in reducing PCB loads to nearshore Lake Michigan waters.

7.4.1 BMP Implementation

IEPA proposes to work in collaboration with others to reduce the number of potential PCB sources to Lake Michigan. These sources and methods to address them, mainly through the implementation of BMPs are listed below, and are adapted from Washington Department of Ecology (2014).

1. In partnership with communities and stakeholders in the study area, assess schools and other public buildings for the presence of PCB-containing building materials. Identify buildings most likely to contain PCBs based on age, type of construction and scope of any past remodeling.

    a. Survey and assess PCB-containing lamp ballasts in schools and other public buildings. Encourage replacement with more energy efficient PCB –free fixtures. Use data from item 1 above to identify those buildings where PCB-containing light ballasts are likely still in use, with schools as a priority. Lamp ballasts with PCBs can then be identified through visual inspection. Combine PCB removal with increasing energy efficiency where possible.
    b. Find avenues to provide information to government building managers about the importance of removing ballasts and programs aimed at replacing fixtures with more energy efficient fixtures. Provide technical and informational reports for proper handling of PCB containing fixtures.

2. Identify, develop and promote BMPs for containment of PCB-containing materials in buildings currently in use and those slated for demolition.

    a. Work with USEPA Region 5, IEPA, local governments, the Waukegan Harbor Advisory or other local citizen organizations in the TMDL study area to identify outreach materials developed to prevent PCB exposure from building materials and prevent their release into the environment.
    b. Identify additional audiences for outreach and avenues for informational material distribution.
    c. Create a connection to USEPA's Green Demolition Initiative by providing added information on potential for PCB-containing materials in demolitions. Circulate through established channels for green demolition materials to appropriate contractors and businesses engaged in demolition activities in Illinois Nearshore Lake Michigan TMDL area.

3. Learn more about what products contain PCBs and promote the use of processes that don't inadvertently generate PCBs. Unpermitted non-point releases, such as from consumer products, are becoming increasingly important to control to reduce overall PCB delivery.
    a. Start with the USEPA report (1982) identifying 70 manufacturing processes likely to inadvertently generate PCBs, and efforts in the Great Lakes to reduce PCBs. Identify existing information about PCBs in pigments and dyes, which are potential sources of PCBs to the environment. Identify potential audiences in the TMDL area for sharing information to develop alternative purchasing options that don't have potential to

release PCBs [Note that a list is being developed by Washington Department of Ecology and Green Chemistry Northwest].
   b. Work with USEPA and other government partners to promote alternatives to supplies that contain PCBs and share with partner green purchasing programs.

4. Survey and identify "retirement" dates of electrical equipment that contains more than 2 ppm PCB. From 1929 to 1979 the production of PCBs in the US was approximately 1.4 billion lbs (600,000 metric tons), with the largest use for electrical equipment (USEPA, 1994). Federal regulations focus on transformers with more than 500 ppm PCBs. Identify funding to collect and properly dispose of this equipment with concentrated PCBs.

5. Use a best management practices approach to reduce PCBs in the study area by effectively managing discharges of PCBs from NPDES permitted stormwater sources, including MS4s. In the Illinois Lake Michigan Nearshore PCB TMDL, The authority to establish BMP conditions in NPDES permits is provided in 40CFR 122.44 (k). IEPA believes that initiating appropriate Minimum Control Measures in their MS4 permits will achieve reductions in PCBs consistent with the Lake Michigan Nearshore PCB TMDL by preventing and removing PCBs that reach impaired waters via stormwater.
   Currently, the MS4 General Permit IL40 requires all regulated construction sites to have a stormwater pollution prevention plan that meets the requirements of the MS4 General Permit ILR400. Part IV of General NPDES Permit No. ILR10, including management practices, controls, and other provisions must be at least as protective as the requirements contained in the Illinois Urban Manual, 2014, or as amended including green infrastructure techniques where appropriate and practicable. In addition, there are requirements for meeting TMDL allocations: "If a TMDL allocation or watershed management plan is approved for any waterbody into which you discharge, you must review your stormwater management program to determine whether the TMDL or watershed management plan includes requirements for control of stormwater discharges. If you are not meeting the TMDL allocations, you must modify your stormwater management program to implement the TMDL or watershed management plan within eighteen months of notification by IEPA of the TMDL or watershed management plan approval".

   a. Within 60 days of TMDL approval, mail the approved TMDL to MS4 communities and permittees along with a menu of best management practices for implementation of the TMDL in MS4 permits to permittees**.** The proposed MS4 BMP Menu is contained in Appendix D.

6. Compile a list of materials to use for conducting a public educational campaign. Identify and utilize avenues in cooperation with stakeholders for distributing to the public. Refer to Appendix E for examples of resource information.

7.4.2 Great Lakes Projects and Activities

There have been many efforts established that continue to achieve progress in ensuring that the quality of the Great Lakes is restored and maintained. In May 2004, a Presidential Executive Order was signed recognizing the Great Lakes as a national treasure, calling for the creation of a "Regional Collaboration of National Significance," and a cabinet-level Federal Great Lakes Interagency Task Force.

The Great Lakes Water Quality Agreement, first signed by the United States and Canada in 1972, was recently updated in 2012 to better identify and manage current water quality threats to the Great Lakes.

This update included 10 priority areas, called “Annexes,” that describe commitments to specific environmental issues. Three Annexes are relevant to this TMDL’s watershed and PCBs:

- Annex 1 Areas of Concern: Restore beneficial uses at AOCs (e.g., Waukegan Harbor) and ensure implementation of Remedial Action Plans.
- Annex 2 Lake Management: Develop a Lakewide Management Plan for Lake Michigan in 2019.
- Annex 3 Chemicals of Mutual Concern: Reduce anthropogenic release of certain chemicals. In February 2014, PCBs were nominated to the list of chemicals of mutual concern. This Annex commits both countries to continued monitoring of PCBs in the Great Lakes and coordinated efforts to reduce release of PCBs.

The Great Lakes Restoration Initiative represents the largest U.S. investment in the Great Lakes in two decades. A task force of 11 Federal agencies developed a plan to put the President’s initiative into action. The GLRI Action Plan II covers fiscal years 2015 through 2019 and addresses four urgent focus areas. One of these focus areas is cleaning up of AOCs, including Waukegan Harbor. PCBs have been a major contaminant of concern in the Waukegan area (Figure 7-1).

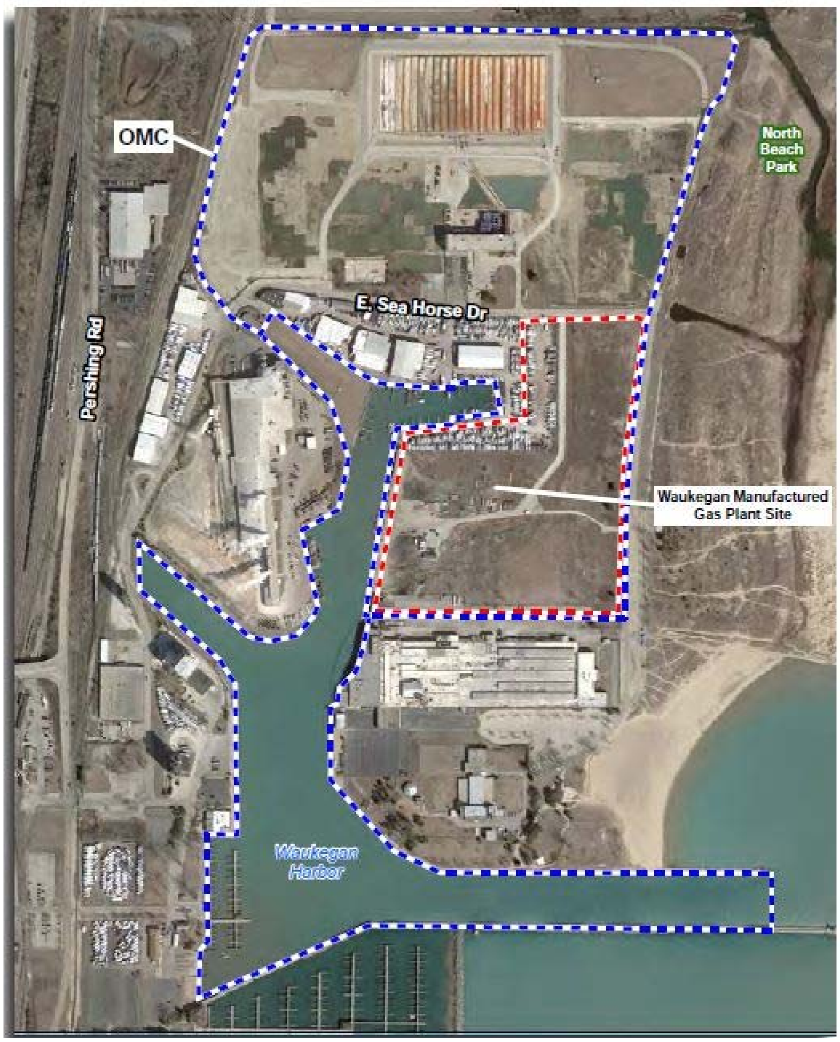

Figure 7-1. Waukegan Harbor AOC (Source: USEPA, 2014)

7.4.3 Waukegan Harbor AOC

The Waukegan Harbor AOC/OMC Superfund site consists of four cleanup units: Waukegan Harbor, the former Waukegan Manufactured Gas and Coke Plant (WCP), PCB-containment cells and OMC Plant 2. A summary of the contamination at the site and the cleanup process to date is described by USEPA (2014):

> The area was contaminated by PCBs "which OMC used in hydraulic fluids at its boat motor manufacturing plant, and trichloroethylene (TCE), a chlorinated solvent that OMC used to degrease newly-made parts. PCBs are found in Waukegan Harbor and on the OMC Plant 2 site. TCE is found in the groundwater under the OMC Plant 2 site. The WCP portion of the site has a different set of contaminants of concern because OMC did no manufacturing there. Contaminants identified at the WCP site included tars, creosote, arsenic, ammonia, and phenol found in soil and/or groundwater.
>
> OMC first cleaned up Waukegan Harbor in 1992 by dredging PCB-contaminated sediment. However, USEPA determined in 2009 that more dredging was needed to remove residual PCB contamination to fully clean the harbor. In July 2013, USEPA completed hydraulic dredging of sediment with residual contamination from the harbor and pumped it to the OMC Plant 2 property for storage in a consolidation facility.
>
> The three PCB containment cells were constructed and filled in 1992. The City of Waukegan, under USEPA oversight, is now in charge of their operation and maintenance. Since 2005, the city has been maintaining the surface covers on the containment cells, conducting routine inspections, and operating the ground-water pumps to remove and then treat water from inside the cells".

The USEPA describes the cleanup of Waukegan Harbor as one of the most significant accomplishments of the Federal Superfund program. The cleanup goal of 50 ppm PCBs in sediment was achieved, followed by lowering the goal to less than 1 ppm. However, until the goal of 1 ppm can be met, the site will remain an AOC (IDNR, 2011). The site's status as both an AOC and Superfund site guarantees regulatory action and funding, thus there is reasonable assurance that work will continue to ensure that PCB concentrations in the harbor will decline to a level that is no longer harmful to the environment.

7.5 Monitoring Recommendations to Track TMDL Effectiveness

Post-TMDL monitoring consists of collecting/compiling and analyzing data to evaluate progress toward attaining the TMDL target. Post-TMDL monitoring can assist in determining whether planned control actions are sufficient, or whether further measures need to be implemented. This section describes recommended PCB monitoring for tracking trends and assessing TMDL effectiveness.

7.5.1 Illinois Monitoring

IEPA monitoring is described in IEPA (2014a). Within the Great Lakes Basin, Illinois monitors fish tissue PCB on an annual basis as part of its FCMP. Results are used to assess the status of existing fish consumption advisories or issue new advisories. Currently, there are advisories for 10 species of fish in Lake Michigan due to elevated PCB concentrations, and four additional species have advisories specific to Waukegan North Harbor. Continued monitoring provides important information for the public from a health perspective. Fish tissue PCB concentrations from the FCMP can be used to assess progress toward the TMDL target. These data should be compiled as they become available and assessed to determine if PCB concentrations are decreasing.

7.5.2 Atmospheric Monitoring

The United States and Canada jointly maintain the Great Lakes IADN Program. PCBs are monitored under this program. Atmospheric PCB monitoring at the Chicago site is relevant to this TMDL, and PCB measurements have been collected at Chicago since 1993. PCBs in air (gas phase only) and precipitation are measured at the Chicago site. Gas phase measurements are made for 24 hours every 12 days, and precipitation samples are collected monthly using an automated sampler. IADN is one of GLNPO's long-term monitoring programs, and is therefore expected to continue indefinitely into the future. PCB concentrations measured at this IADN station can be used to assess atmospheric PCB concentrations over time for the study area and Lake Michigan.

7.6 Schedule

This section presents the general BMP implementation schedule. A detailed schedule for implementing specific BMPs will depend on stakeholder engagement and active participation in the selection of BMPs and development of watershed based plans. IEPA strongly recommends establishing a watershed workgroup to work with the MS4 communities in the selection of BMPs and implementation plans. This is because practical and financial resources need to be considered, budgeted, and grants secured. IEPA will work with watershed workgroups and MS4 communities to provide guidance and to prioritize the recommended strategies to determine the most feasible BMP options and implementation plans. Please refer to the Guidance for Developing Watershed Action Plans in Illinois - May 2007 (CMAP/IEPA): http://www.epa.state.il.us/water/watershed/publications/watershed-guidance.pdf.

Current NPDES permits (Table 7-4) will remain in effect until the permits are re-issued, provided IEPA receives the NPDES permit renewal application prior to the expiration date of the existing NPDES permit. The WLAs will be incorporated into the permits upon reissuance.

The recently re-issued MS4 General Permit became effective on March 1, 2016. The General Permit Part III- Special Condition (C) requires the MS4 Permittee to comply with the WLA when a TMDL is developed for that particular watershed within 18 months following notification by IEPA once the TMDL is approved. The BMPs contained in this section of the TMDL including the "menu of potential BMPs for MS4s" in Appendix D, can be adopted as appropriate, as minimum measures for permits to be consistent with the WLA contained in the TMDL and will be incorporated into the MS4 General Permit by reference.

Table 7-4. Schedule for Implementation

Activity	Schedule
Stakeholder Engagement	
Working with stakeholders and workgroups to engage partners to prioritize recommended strategies	IEPA will reach out to other state agencies to share this TMDL and implementation plan. Additionally, because the majority of the TMDL study area lies within an MS4 service area, stakeholder and watershed work groups are encouraged to work with their respective MS4 Permittees in the prioritization and selection of the BMPs and actively participate in the planning and design of the BMP projects to meet the TMDL requirements as discussed in the next section
Monitoring	
Illinois Fish Contaminant Monitoring Program	Each year, fish samples are collected from four Lake Michigan open water stations and analyzed for PCBs. In addition, every 3-5 years, fish samples are collected from four Lake Michigan harbor stations and analyzed for PCBs. Harbors targeted for sampling include Calumet, Jackson, Waukegan North and North Shore Marina.
Atmospheric Monitoring (IADN) at Chicago	PCB measurements have been collected since 1993, and no end date is planned. Gas phase measurements are made every 12 days. Precipitation samples are collected monthly.
Permitting	
General NPDES Permit (No. ILR40) MS4 Stormwater Expires 02/28/21	Following notification by IEPA of the TMDL approval, the permittee must modify their stormwater management program to implement the TMDL recommendation, if the permittee determines they are not meeting the TMDL allocations within eighteen months of the notification date. Additional details are found in the General NPDES Permit ILR40, Part III Special Conditions C.
Zion Station (IL0002763) Expires 02/28/18	Continue current PCB monitoring requirements and report results on monthly discharge monitoring report forms. Any change in permit requirements will be addressed during the next permit renewal cycle.
Winnetka Power Generation Station (IL0002364) Expires 08/31/18	In future permit renewal cycles, the permit may be revised to require monitoring to verify compliance with water quality standards.
Midwest Generation, LLC Waukegan (IL0002259) Expires 03/31/2020	In future permit renewal cycles, the permit may be revised to require monitoring to verify compliance with water quality standards.
Waukegan Harbor AOC	Ongoing regulatory action and funding until clean-up goals are met.

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Public Participation

Two public meetings were held on January 13, 2016 (6:00 pm) at Waukegan Public Library (Bradbury Room), Waukegan, Illinois, and on January 14, 2016 (10:00 am) at USEPA- Region 5 Office in Chicago, Illinois. The purpose of the meetings was to provide the public with an opportunity to comment on the final draft TMDL reports and to provide additional data that may be included in the TMDL development process.

IEPA announced the public notice by placing a display ad in the newspapers in the watershed (Chicago Tribune and Waukegan Lake County Sun. The public notice gave the date, time, location, and purpose of the meetings. It also provided references to obtain additional information about this specific watershed, the TMDL Program, and other related issues. The public notice was also mailed to NPDES and MS4 Permittees, environmental groups, and other organizations in the watershed by first class mail. The draft TMDL Report was available for review at the Waukegan Public Library Waukegan, Illinois and on the IEPA's website at http://www.epa.illinois.gov/public-notices/index. Twenty two people in Waukegan and six people in Chicago attended the public meetings.

IEPA representatives, USEPA staff member along with the TMDL contractors conducted the public meetings and have answered several questions within the scope of the TMDL projects, and attendees were advised to send written questions/comments to IEPA by the end of the public comment period.

Contact information for IEPA staff and the TMDL consultant were provided to those interested to allow for follow-up questions. All attendees were asked to submit their comments and concerns to IEPA by midnight February 16, 2016.

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Appendix A: Illinois Lake Michigan (nearshore) Toxics TMDL Scoping Report

Illinois Lake Michigan (nearshore) Toxics TMDL Scoping Report

Prepared for:
USEPA
Contract No. EP-C-12-052,
Task Order No. 0003
Public Notice Version
May 8, 2015

Michael Baker INTERNATIONAL

LimnoTech

Water | Scientists
Environment | Engineers

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List of Acronyms

AOC	Area of Concern
BAF	Bioaccumulation Factor
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CAWS	Chicago Area Waterway System
CMAP	Chicago Metropolitan Agency for Planning
CWA	Clean Water Act
FCMP `	Fish Contaminant Monitoring Program
GEM	Gaseous Elemental Mercury
GIS	Geographic Information System
GLCFS	Great Lakes Coastal Forecasting System
GLENDA	Great Lakes Environmental Database
GLI	Great Lakes Water Quality Initiative
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
HPV	Health Protection Value
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
LMMBS	Lake Michigan Mass Balance Study
MGD	Million Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MWRD	Metropolitan Water Reclamation District
NCCA	National Coastal Condition Assessment
NOAA	National Oceanic and Atmospheric Administration
ORD	Office of Research and Development
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
REMSAD	Regional Modeling System for Aerosols and Deposition

SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1 Introduction

Within the Illinois Lake Michigan Basin, the Illinois Environmental Protection Agency (IEPA) has identified a total of 56 nearshore beach/shoreline, harbor and open water segments that are impaired due to concentrations of polychlorinated biphenyls (PCBs) and mercury in fish tissue and the water column (IEPA, 2014). The fish consumption use is impaired for all of these waterbody segments, and one segment (Waukegan Harbor North) is also impaired for aquatic life use. These impaired waters are included on Illinois' Clean Water Act (CWA) Section 303(d) list. This project will develop mercury and PCB Total Maximum Daily Loads (TMDLs) for these impaired waterbodies to quantify pollutant load reductions needed to reduce mercury and PCB levels in fish tissue and the water column so that the waterbodies can meet water quality standards.

This memorandum includes the following information:

- Section 2. A description of the study area and impaired waterbodies
- Section 3. A summary of data sources and review of data for inclusion in the final database
- Section 4. A description of applicable standards and targets
- Section 5. A discussion of the selection of target fish species
- Section 6. An introduction to TMDL development approaches
- Section 7: A discussion of model selection considerations
- Section 8: A discussion of a range of applicable frameworks
- Section 9: A description of conceptual model development and data gap assessment
- Section 10: A discussion of candidate approaches
- Section 11: A recommendation for a preferred approach

This information will ultimately form the basis for development of TMDLs for mercury and PCBs for the impaired waterbodies.

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2
Study Area and Impaired Waterbodies

The project study area is shown in Figure 2-1, and includes one nearshore open water segment, fifty-one beach/shoreline segments and four harbors that are identified by IEPA (IEPA, 2014) as being impaired due to both mercury and polychlorinated biphenyls. All fifty-six impaired waters are located in Lake and Cook Counties, Illinois. The fish consumption use is *Not Supporting* for all segments, and the aquatic life use is also *Not Supporting* for Waukegan Harbor North. Appendix A contains a full listing of the impaired segments and causes[1].

As described later in this document, IEPA assesses use support for both the nearshore open water segment and the shoreline segments based on samples collected in the nearshore open water segment. For discussions regarding sampling data, the nearshore open water segment and all 51 shoreline segments are combined into a single 'TMDL zone' referred to as the "nearshore open water/shoreline" zone. The pairing of the impaired waterbodies and TMDL zones is shown in Appendix A.

[1] As part of the Quality Assurance (QA) of the project database, the GIS shapefiles for the impaired waterbody segments were reviewed (See Appendix B). Based on discussions with IEPA and U.S. Environmental Protection Agency (USEPA), the shapefiles were refined as part of this project, and the resulting waterbody sizes presented in Appendix B differ from those in the 2014 303(d) report. Figure 2-1 and Appendix A waterbody lengths and areas reflect those refinements and are the waterbody sizes that will be used in the TMDL.

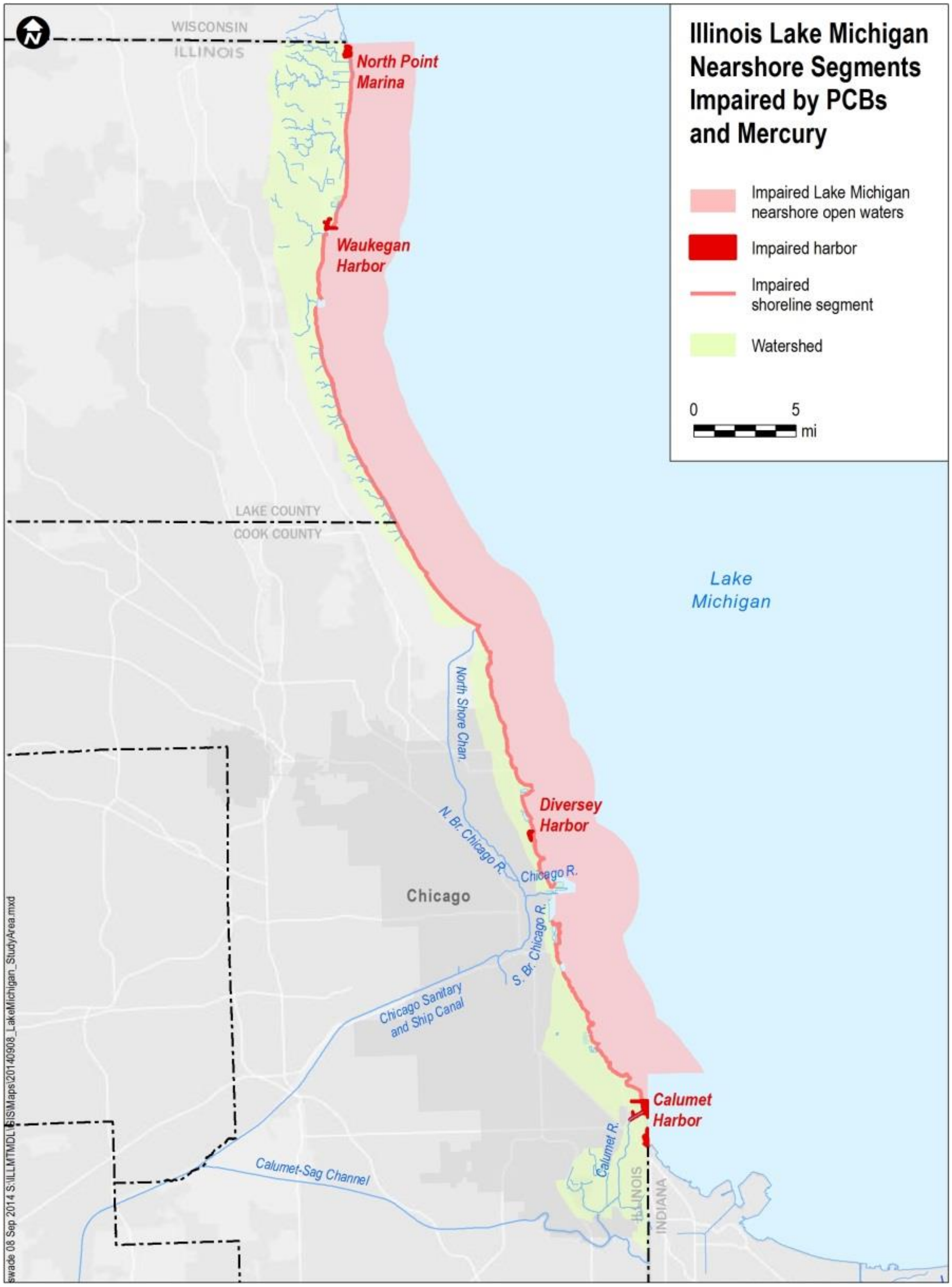

Figure 2-1. Project Study Area and Impaired Segments

2.1 Watershed description

The study area watershed is long and narrow and encompasses roughly 100 square miles within Lake and Cook Counties, Illinois that drain to Lake Michigan. With the exception of the lower Calumet River and occasional flow reversals from the Chicago Area Waterways System (CAWS), the waterbodies within the watershed are generally small streams and ravines that carry intermittent stormwater and surface drainage to Lake Michigan.

Within Lake County, the watershed boundary generally follows the crest of the glacial Highland Park moraine, and extends much farther inland than it does to the south (Illinois Department of Natural Resources [IDNR], 2015). The watershed narrows near the southern end of Lake County and northern end of Cook County, due to diversion of flows into the CAWS. As discussed below, the CAWS is excluded from the study area watershed because it flows away from Lake Michigan, except during extreme wet weather conditions. At the southern end of the study area, the watershed again extends inland further to the O'Brien Lock and Dam and includes those waterbodies such as Lake Calumet, that have a hydrologic connection to Lake Michigan.

The study area watershed is highly developed and land use is roughly distributed as: residential (73%), industrial (4%), commercial (4%) and open space (19%). The watershed includes portions of the following municipalities: Wilmette, Winnetka, Kenilworth, Winthrop Harbor, Chicago, Burnham, Highland Park, Lake Bluff, Beach Park, Highwood, Waukegan, North Chicago, Zion, Evanston, Glencoe and Lake Forest. All but one of the municipalities (Burnham) listed above have Municipal Separate Storm Sewer System (MS4) permits that discharge to Lake Michigan, and together with the MS4 permits for the Cook County Highway Department, Lake County, Shields Township and Waukegan Township, cover roughly 100% of this drainage. Although there are a number of permitted point sources located in the watershed, only one was identified that has the potential to discharge PCBs to the impaired waters (Figure 2-2).

The CAWS is comprised of man-made and natural waterways, which provide navigation, receive water reclamation plant effluents, combined sewer overflows and stormwater runoff and convey flows from the Chicago Metropolitan Area to the Des Plaines River watershed and away from the study area waterbodies. This system is heavily altered from its natural state, including diversion of the Chicago River (in 1900), and the Little and Grand Calumet River (in 1922) away from Lake Michigan. There are three locations where the flows from the CAWS can reverse and discharge to Lake Michigan: the Wilmette Pumping Station, the Chicago River Lock and Controlling Works and O'Brien Lock and Controlling Works, on the Calumet River (Figure 2-2).

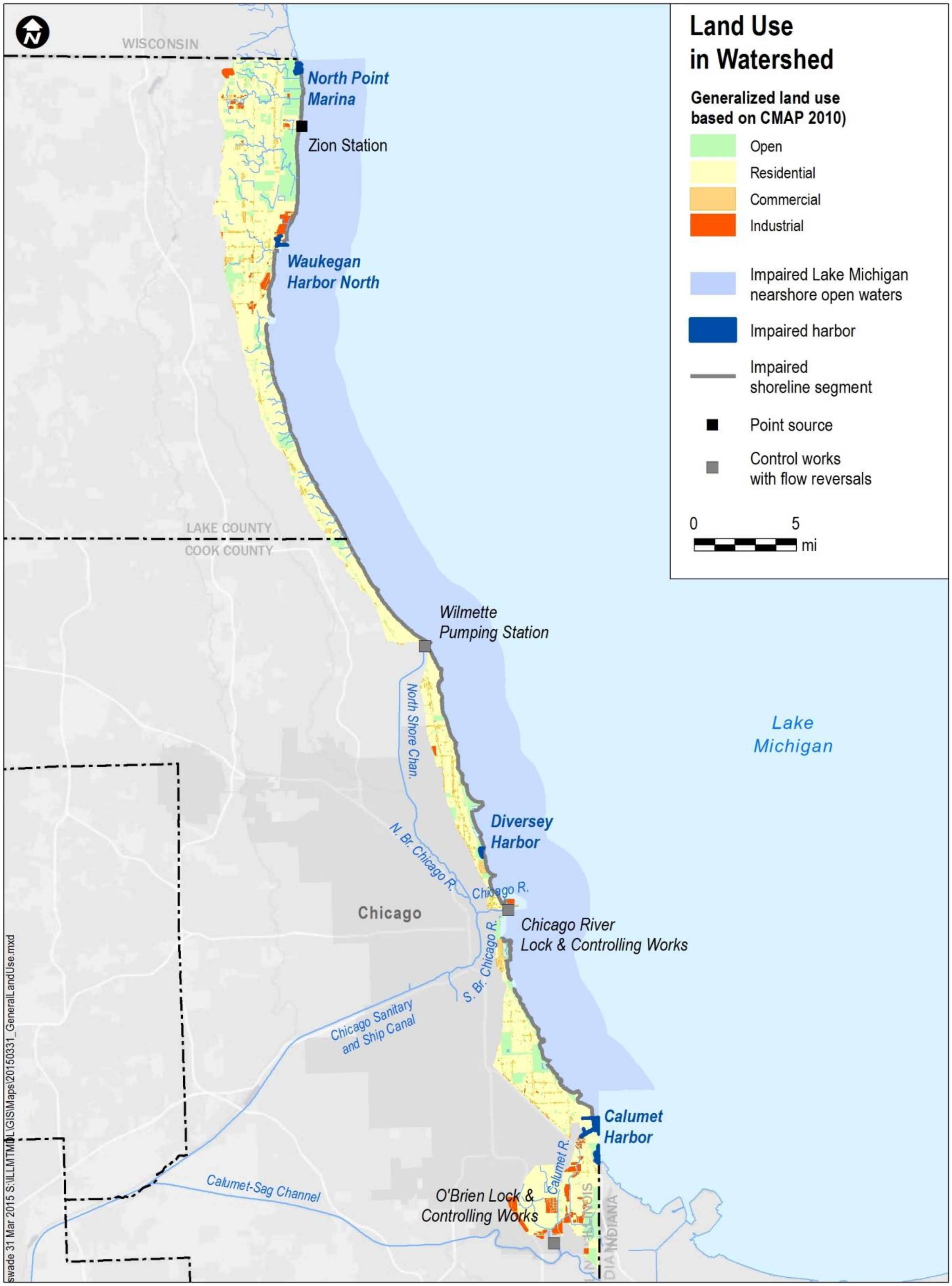

Figure 2-2. Study Area Land Use

2.2 Impaired waterbody description

There are a total of fifty-six segments impaired due to PCBs and mercury. The impaired nearshore open water segment is 180 square miles in size, extending 5 km into Lake Michigan from the Illinois Lake Michigan shoreline, with Lake Michigan serving as its eastern boundary. Additionally, there are fifty-one shoreline (beach) segments identified as impaired due to mercury and PCBs. The term shoreline segment is used in this document because not all of the segments have beaches. The total length of these shoreline segments is approximately 63.5 miles, with segment lengths ranging from 0.07 to 5.5 miles. Finally, interspersed with the shoreline segments, are four harbors that are impaired due to mercury and PCBs. These are shown in Figure 2-3 and are described briefly below. The four harbors are: Waukegan Harbor North (~0.07 square miles), North Point Marina (~0.12 square miles), Diversey Harbor (~0.05 square miles) and Calumet Harbor (~2.4 square miles).

Waukegan Harbor is a Federally-authorized navigation project located in Waukegan, Illinois and is used for both industrial and recreational activities. The United States Army Corps of Engineers (USACE) has been involved with dredging operations at this harbor since 1889. With the exception of some intermittent harbor deepening projects, the vast majority of dredging operations have focused on maintaining navigable conditions, primarily within the Approach Channel (Department of the Army Chicago District Corps of Engineers, 2013), which is beyond the extent of the impaired area shown in Figure 2-3. In 1975, PCBs were discovered in Waukegan Harbor sediments. The site was added to the National Priorities List in the early 1980s and in 1981, the US and Canadian governments identified Waukegan Harbor as an Area of Concern (AOC). In 1992 and 1993, roughly one million pounds of PCBs were removed during remediation activities at the Outboard Marine Corporation site and Waukegan Harbor, including the removal of 32,000 cubic yards of contaminated sediments from the Waukegan Harbor AOC. In 2012 and 2013, 124,000 cubic yards of contaminated sediment were removed from Waukegan Harbor (USEPA, 2015).

North Point Marina is located in Winthrop Harbor, Illinois and is the largest marina on the Great Lakes (IDNR, 2015a). **Diversey Harbor** is located in Lincoln Park, within Lake Shore Drive. Due to bridge restrictions, Diversey Harbor can only accommodate power boaters (Chicago Harbors, 2015). **Calumet Harbor** is located on the southwest shore of Lake Michigan in Chicago, Cook County, Illinois and the approach channel and outer harbor are located Lake County, Indiana. Calumet Harbor is a deep draft commercial harbor that is protected by 12,153 linear feet of steel sheetpile and timber crib breakwater structures (United States Army Corps of Engineers Detroit District, 2015). This is the largest of the four impaired harbors located within the study area.

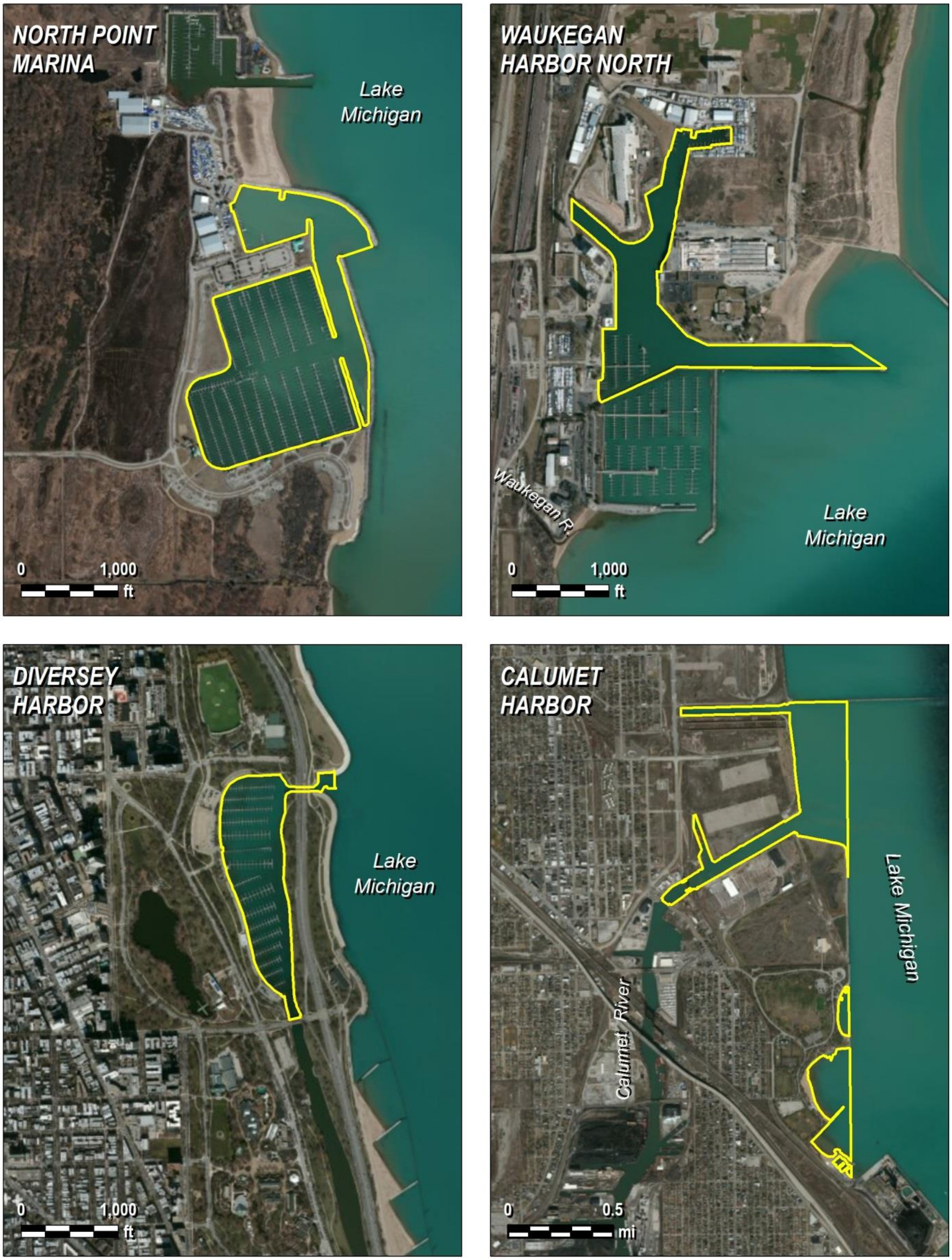

Figure 2-3. Impaired Harbor Segments

3 Sources of Technical Data and Data Inventory

Technical data were inventoried, obtained and reviewed in order to develop a database to support waterbody characterization, confirmation of waterbody listing, and TMDL development. This section describes the sources that were researched to develop the project database, and summarizes the data available to support subsequent analyses.

3.1 Researched data sources

All potentially useful sources of data were identified based on project team knowledge, including much input from IEPA and USEPA staff, internet queries, and communication with agencies and Great Lakes researchers familiar with the project study area. In addition, the project team led a webcast on September 17, 2014 to present the objectives of the study to a much broader audience and to solicit input on additional studies or datasets that may be relevant for this project. The project team followed up on all leads identified as a result of the webcast.

Agencies contacted for data included: USEPA Great Lakes National Program Office (GLNPO), USEPA Office of Research and Development (ORD) Grosse Isle, MI, USEPA Superfund Division, USEPA Water Division, Illinois EPA Toxicity Assessment, Illinois EPA Bureau of Water, Illinois EPA Fish Contaminant Monitoring Program, Illinois Department of Natural Resources, Wisconsin Water Science Center of the US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Environment Canada, Area of Concern project managers, USACE, US Navy, Waukegan Citizens Advisory Group, North Shore Sanitary District, Illinois Lake Michigan Fisheries Program, and researchers at Loyola University and the University of Iowa.

3.2 Data review

Identified datasets were reviewed first to ensure they were relevant to the project, and second to ensure they met the quality objectives and criteria outlined in the project Quality Assurance Project Plan (QAPP).

To ensure the data compilation was focused on data relevant to this project, the following data conditions were established:

- Media: Fish tissue, water column and sediment samples
- Location: Data were collected within the impaired waterbody segments. Water column data collected within the Southern Lake Michigan open waters were also compiled.
- Vintage: Data were collected after 1999

Consistent with the project QAPP, the following criteria were applied when reviewing the available data: data are from a known and reliable source; data are of known quality; and data are appropriate for the intended use.

3.2.1 Data are from a known and reliable source

Data included in the project database were obtained from reliable state, federal and peer-reviewed sources. The sources of the data retained for the project database include those from IEPA (fish and water column data), USEPA (fish and water column data) and USGS (water column and sediment data).

3.2.2 Data are of known quality

Data were evaluated for adequacy in terms of the applicable common data quality indicators, such as precision, accuracy, representativeness, comparability, completeness and sensitivity, depending on what data were available in the compiled datasets. Data obtained from government databases and peer-reviewed publications were assessed to determine if known quality requirements were applied during the sampling and analysis of data. These data and all other data were reviewed for usability, general quality and consistency with other available data sources using the following data evaluation criteria:

- The data were generated under an approved QAPP or other sampling document;
- The data include quality assurance statements, descriptions, qualifiers and/or associated QC data that allows evaluation for precision, bias, representativeness, completeness, comparability and/or sensitivity, as appropriate;
- The data come from peer-reviewed publications;
- The data quality is limited or unknown, but come from a reliable source.

Fish data were available from IEPA's fish contaminant database (12 sample locations), USEPA's Great Lakes Environmental Database (USEPA GLENDA, 1 station), and USEPA's National Coastal Condition Assessment (USEPA-NCCA, 4 stations). These data came from reliable sources but information about data quality had to be researched more thoroughly through agency contacts. For example:

- Units were not specified in the database for the mercury, PCB and lipid content measurements obtained from IEPA. This was resolved through communication with Dr. Tom Hornshaw (IEPA fish contaminant monitoring program), who confirmed that the units for mercury and PCBs in fish were mg/kg wet weight. Additionally, it was determined that fish lipid content from 2000-2001 was entered both in percent format (i.e., 40%) and decimal format (i.e., 0.40). Dr. Hornshaw reported that lipid content for "bass, walleye, and yellow perch and other panfish species [is] almost always in the range of 0.3-1.5%, catfish [is] in the range of 1-4%, and carp [is] in the range of 2-6%" (personal communication). Using this as guidance, fish lipid result values from 2000-2001 were converted from decimal to percent when it seemed reasonable.
- Fish data obtained from USEPA-NCCA have not been published but were collected using rigorous QA/QC protocols. The USEPA-NCCA QAPP was provided for this project (National Coastal Condition Assessment, Quality Assurance Project Plan, USEPA, July 2010).

Water column data were available from IEPA (21 stations), the 2010-2014 Great Lakes Restoration Initiative (GLRI) Mercury Cycling and Bioaccumulation in the Great Lakes study headed by David Krabbenhoft of USGS (2 stations), and 2010 sampling work from Environment Canada (1 station). The IEPA mercury data (only available through 2002), were excluded due to high detection limits that resulted in all samples being non-detect, IEPA has suspended water column mercury sampling across all Surface Water programs due to collection methodology; the proper collection requires at least two staff performing "clean hands/dirty hands" technique. The PCB and mercury data from Environment Canada were excluded because they were available as a lake-wide average only.

The IEPA PCB data and 2010-2014 GLRI data were retained in the project database. These data also came from reliable sources but information about data quality had to be researched more thoroughly through agency contacts. The recently collected GLRI water column mercury data were collected outside the TMDL study area, but were retained in the database because they may be valuable for later stages of the project. These data have not been published yet, but were collected and analyzed using rigorous QA/QC protocols (personal communication with David Krabbenhoft, Wisconsin Water Science Center – USGS). The collection and analysis of low-level mercury samples used ultra trace level clean collection and analytical methods. The water collection device consists of a 12 position sampling rosette with

Teflon- coated 8L Niskin bottles that was purchased especially for Great Lakes work.[2] The USGS Standard Operating Procedure (SOP) for ultra-trace level mercury analysis is available at http://wi.water.usgs.gov/mercury-lab/index.html. The IEPA PCB water column data were also retained in the database, but were flagged as follows:

- IEPA PCB data from pre-2003 did not have units, so the units were assumed to be "ug/L" which was consistent with the PCB units used in later sampling efforts.
- IEPA PCB data pre-2010 did not have a specified sampling depth. In these cases, the sampling depth was assumed to be 0.9144 m (3 ft.) which was based on the known depth of the pump used to collect samples aboard the research vessel.

Sediment data contained within the project database are from the 2010-2014 GLRI Mercury- Cycling and Bioaccumulation in the Great Lakes study headed by Dave Krabbenhoft, Wisconsin Water Science Center – USGS. These data were collected near the TMDL study area, and are paired with water column data described above. Additional potential sources of sediment data were identified (e.g., USEPA GLENDA, USEPA STORET (STOrage and RETrieval), MercNet (mercury monitoring network), NOAA, Environment Canada, University of Minnesota Calumet Harbor Sediment Study, USACE, and USGS) but will not be investigated in detail unless and until a need for additional sediment data is determined.

An additional 162 document files were received from USACE for Waukegan Harbor and Calumet Harbor, after the database was finalized. These documents were reviewed and files containing water column or sediment PCB and mercury data were identified and summarized for consideration in TMDL development. The files did not include any fish sampling data.

3.2.3 Data are appropriate for intended use

Datasets included in the project database were documented based on their usability. From the QAPP, usability is defined as:

- The data satisfy the project objectives;
- The data satisfy the evaluation and modeling requirements;
- The data exhibit appropriate characteristics (e.g., quality, quantity, temporal, spatial); and
- The data were generated using appropriate methods.

Judgments on the usability of the data were checked when feasible by comparing the data trends and by comparing data with other comparable datasets. However, the number of available data sources was limited, especially for water column data. The available mercury water column data are consistent with overall declining mercury concentrations that have been observed throughout the Great Lakes region (personal communication with David Krabbenhoft, Wisconsin Water Science Center – USGS). The average PCB fish concentration data obtained from IEPA and USEPA GLENDA databases are consistent for coho salmon, which is the only species represented in the USEPA GLENDA database. Mercury data are not available for coho salmon in the IEPA database for comparison to the USEPA GLENDA data.

3.3 Database development

Table 3- 1 summarizes the data included in the project database. All data entered manually or electronically were confirmed by checking the source data. Limitations in the datasets will be

[2] USGS sampling protocols are explained in the following references: Low-Level Collection Techniques and Species- Specific Analytical Methods for Mercury in Water, Sediment, and Biota (Mark L. Olson and John F. DeWild, 1999); and Mercury sources, distribution, and bioavailability in the North Pacific Ocean: Insights from data and models (Sunderland, Krabbenhoft, Moreau, Strode and Landing, May 2009).

acknowledged and included in discussions of their use. Data qualification codes and/or descriptions are in the final database so as to readily describe any data limitations, and will be described in communications about the data and work results and/or in the final report, as applicable. Qualified datasets are being examined on a case by case basis to determine if they should be used. The decision to include qualified data will depend on a sensitivity analysis of the effect of uncertainty in the data on the result outcome.

Table 3-1. Summary of Data Included in Project Database by Source, Sample Media and Parameter

SOURCE FOR FINAL DATABASE	WATER COLUMN DATA			FISH DATA[a]			SEDIMENT DATA[2]		REMARKS
	Mercury	PCB	General Water Quality	Mercury	PCB	Lipids	Mercury	PCB	
IEPA				✓	✓	✓			All water column PCB data were non-detect; Fish mercury data are from 6 stations; Fish PCB and lipids data are from 12 stations
USEPA Great Lakes Environmental Database (GLENDA)				✓	✓	✓			Data collected from 1 station
USEPA National Coastal Condition Assessment (NCCA)				✓	✓	✓			Data collected from 4 stations
USGS 2010-2014 Great Lakes Restoration Initiative (GLRI) Hg Cycling	✓		✓				✓		All data collected on 9/24/13 from 2 stations located offshore

[a] 127 IEPA fish PCB samples collected at Station Q-02 were initially excluded from the database on recommendation from IEPA, because they were collected from 'multiple harbors' and the exact sample location was unknown. Seven composite coho salmon samples collected by USEPA at Station P233-Cook County Illinois were excluded for the same reason. Because the Level One approach currently being considered for TMDL development does not require the exact harbor location be known for these data (i.e., it is sufficient to know the samples were collected from within the project study area), these data were subsequently analyzed to determine if they would add value to the TMDL. They do not, because the species in these harbor datasets have much lower concentrations of PCBs than the target species recommended in Section 5.2. These data have been added to the project database, but are not used in analyses described in this scoping report and are not expected to be used for TMDL development.

Subsequent to finalizing the project database, additional USACE harbor assessment datafiles were provided in pdf format for Calumet and Waukegan Harbors. Relevant data will be added to the project database, if needed, to support TMDL development.

3.3.1 Summary of data by TMDL Zone

Sampling locations for all water column, fish, and sediment data in the database were paired with impaired segment(s), with input from IEPA, reflecting which sampling stations are located within the impaired segments. Per IEPA, the nearshore open water segment is assessed based on samples collected in the nearshore open water segment. The 51 shoreline segments are similarly assessed based on samples collected in the nearshore open water segment. Because the data collected in the nearshore open water are used to assess the nearshore as well as the 51 shoreline segments, these segments are collectively referred to as being within the 'nearshore open water/shoreline' TMDL Zone. Samples collected within each of the four impaired harbors (Calumet, Diversey, North Point Marina and Waukegan North) were assigned to the respective harbor. Based on input from Dr. David Bunnell, a USGS research fisheries biologist, and concurrence by IEPA, fish samples collected just outside the nearshore open water segment were also categorized as "nearshore open water/shoreline" due to fish mobility. Samples collected from Lake Michigan well outside the nearshore open water segment were classified as "offshore." Additional designations were included in the database for Wolf Lake (located in the Calumet Harbor watershed, upstream of Calumet Harbor), and Jackson Harbor. Data collected from Wolf Lake were excluded from the Calumet Harbor assessment because the fish collected from Wolf Lake are not likely to reflect conditions in Calumet Harbor. Jackson Harbor was excluded because it is not included on the 303(d) list as impaired by PCBs or mercury.

To summarize, sampling data are classified into TMDL Zones to reflect which sampling locations are reflective of the impaired waterbody segments. The TMDL Zones are: nearshore open water/shoreline, Calumet Harbor, Diversey Harbor, North Point Marina, Waukegan Harbor North and offshore. The impaired segments associated with the TMDL zones are shown in Table 3-2 and the number of sampling locations associated with each TMDL zone is also reported. Appendix C presents a count of fillet samples by TMDL zone, which are the fish data used in the subsequent data analysis. Table 3-3 provides a summary of fish and water column samples by TMDL zone.

Table 3-2. TMDL Zones and Impaired Segments

TMDL Zone	Associated Impaired Segment(s)	Number of Sampling Locations in Project Database			
		Fish[a]		Water column	
		Mercury	PCB	Mercury	PCB
Nearshore open water/shoreline	1 nearshore open water segment 51 shoreline segments	4	4	0	21 (all ND)
Calumet Harbor	Calumet Harbor	2	2	0	0
Diversey Harbor	Diversey Harbor	0	1	0	0
North Point Marina	North Point Marina	1	1	0	0
Waukegan Harbor North	Waukegan Harbor North	1	1	0	0
Offshore	Lake Michigan open waters outside of and distant from the study area	0	0	2	0

[a]Fish sampling locations include whole and fillet fish samples

Table 3-3. Count of Fish and Water Column Samples by TMDL Zone

TMDL Zone	Mercury (fish)	PCB (fish)[a]	Mercury (water)	PCB (water)
Nearshore open water/shorelinea	7f,w	76f,w	0	110 (all non-detect)b
Calumet Harbor	6f	7f	0	0
Diversey Harbor	0	1f	0	0
North Point Marina	14f	29f	0	0
Waukegan Harbor North	13f,w	72f,w	0	0
Offshore			6	

[a]Samples collected in the nearshore open water segment are described as “Nearshore open water/shoreline” because data collected in the nearshore open water segment are also used to assess use support for the 51 shoreline segments.

[b] Detection levels range from 0.04 ug/L to 0.55 ug/L, with sample distribution as follows: 70 samples at 0.04 ug/L; 39 samples at 0.1 ug/L; and 1 sample at 0.55 ug/L.

[f]Includes fillet samples.

[w]Includes whole fish samples

4
TMDL Targets

This section describes relevant water quality standards, designated use support and numeric TMDL targets for PCBs and mercury.

4.1 Water quality standards

The Clean Water Act Section 303(c)(2)(A) requires states to designate appropriate water uses for all waterbodies, and adopt, water quality standards for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water. Designated uses describe the various uses of waters that are considered desirable, and identify those waters that should be protected. Surface waters in Illinois fall into one of four categories: General Use, Public and Food Processing Water Supplies, Chicago Area Waterways, and Lake Michigan Basin. Each category has its own set of water quality standards. The standards for the Lake Michigan Basin are found at 35 IAC 302.501-595 (Subpart E). Some of the Lake Michigan Basin water quality standards apply to all waters within the basin while others apply only to the open waters of the Lake or only to tributary waters of the Lake. Water quality standards for the Lake Michigan Basin protect aquatic life, human health, wildlife and recreational uses. Waters of the Lake Michigan Basin must be free from any substance or any combination of substances in concentrations toxic or harmful to human health, or to animal, plant or aquatic life (35 IAC 302.540). Lake Michigan Basin waters include all tributaries of Lake Michigan, harbors and open waters of the Illinois portion of the lake. Numeric water quality criteria are developed to protect the designated uses of surface waters, and are described for PCBs and mercury, below.

4.1.1 PCBs

Water quality standards for PCBs in surface waters of the Lake Michigan basin are 120 pg/L for the protection of wildlife, and 26 pg/L for the protection of human health [35 IAC 302.504(e)]. The PCB standard applies to all waters of the Lake Michigan Basin. These standards were adopted as part of the Great Lakes Water Quality Initiative (GLI). These criteria are interpreted as the arithmetic average of at least four consecutive samples collected over a period of at least four days.

4.1.2 Mercury

Water quality standards for mercury in surface waters of the Lake Michigan basin are 0.0013 µg/L (or 1.3 ng/L) for the protection of wildlife, 0.0031 µg/L (or 3.1 ng/L) for the protection of human health, and 1,700 ng/L (1.7) µg/L and 910 ng/L (0.91 µg/L) for the protection of aquatic life from adverse effects due to acute and chronic toxicity, respectively [35 IAC 302.504(e)]. These standards also originated with the GLI and apply to all waters of the Lake Michigan Basin. The acute standard must not be exceeded at any time and the chronic human health and wildlife standards must not be exceeded by the arithmetic average of at least four consecutive samples.

4.2 Designated use support

Every two years, the State of Illinois evaluates the extent to which waters of the state are attaining their designated uses. The degree of support of a designated use in a particular area (assessment unit) is determined by an analysis of various types of information, including biological, physicochemical, physical habitat, and toxicity data. When sufficient data are available, each applicable designated use in each assessment unit is assessed as *Fully Supporting* (good), *Not Supporting* (fair), or *Not Supporting* (poor). Waters in which at least one applicable use is not fully supported are considered impaired.

Fish consumption use is associated with all waterbodies in the state. The assessment of fish consumption use is based on (1) waterbody-specific fish-tissue data and also on (2) fish-consumption advisories issued by the Illinois Fish Contaminant Monitoring Program (FCMP). The FCMP uses a risk-based process developed in the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Anderson et al. 1993). The Protocol requires the determination of a Health Protection Value (HPV) for a contaminant, which is then used to calculate the level of contaminant in fish tissue that will be protective of human health at several meal consumption frequencies (ranging from unlimited consumption to "do not eat"). The level of contaminant in fish is then calculated that will not result in exceeding the HPV at each meal consumption frequency.

4.2.1 PCBs

For PCBs, the Health Protection Value (HPV) for fish consumption is 0.05 µg/kg/day. Based on this HPV, the lowest fish tissue concentration that results in a fish consumption advisory is 0.06 mg/kg; this is, therefore, the concentration used to assess support of the fish consumption use. There is no relationship between the fish tissue assessment concentration and numeric water column criteria.

Except in extraordinary circumstances, two or more recent sampling events in a waterbody in two different sampling years finding fish exceeding the fish tissue level of concern are necessary for issuing an advisory (based on data collected since 1985). The issuance of a fish-consumption advisory for a specific waterbody provides the basis for a determination that fish consumption use is impaired, with the contaminant of concern listed as a cause of impairment.

Aquatic life uses are assessed using the most recent three years of available data. For Lake Michigan open waters and harbors, if two or more samples exceed the acute aquatic life criterion, the waters are considered impaired. If more than 10% of the samples exceed the chronic aquatic life criterion, the waters are considered impaired.

4.2.2 Mercury

For mercury, the Health Protection Value (HPV) for fish consumption for sensitive populations is 0.10 µg/kg/day. Based on this HPV, the most stringent fish tissue concentration that would result in a fish consumption advisory is 0.06 mg/kg; this is, therefore, the concentration used to assess support of the fish consumption use. The 0.06 mg/kg fish tissue concentration is used by the Fish Contaminant Monitoring Program as the starting point for issuing a 1 meal/week advisory is a risk-based advisory concentration developed from an extensive database of studies of the health effects of methyl mercury. This concentration was derived by the Great Lakes Fish Advisory Task Force and accepted by the Great Lakes states for use in their sport fish advisory programs. There is no relationship between the fish tissue assessment concentrations and numeric water column criteria.

While there is a statewide fish consumption advisory for mercury because of widespread contamination above criteria levels throughout the state, not all waterbodies have been sampled, and not all samples exceeded criteria levels. For mercury, fish consumption use is assessed as *Not Supporting* only for those specific waters where at least one fish-tissue sample is available and where at least one fish species exceeds the 0.06 mg/kg criterion for mercury. Also, because the statewide advisory is for predator species, fish consumption use is only assessed as *Fully Supporting* in those waters where predator fish-tissue data from the most recent two years do not show mercury contamination above criteria levels. Waters where sufficient fish-tissue data are unavailable are considered Not Assessed.

Aquatic life uses are assessed using the most recent three years of available data. For Lake Michigan open waters and harbors, if two or more samples exceed the acute aquatic life criterion, the waters are considered impaired. If more than 10% of the samples exceed the chronic aquatic life criterion, the waters are considered impaired.

4.3 Numeric TMDL Targets

TMDL targets are established at a level that attains and maintains the applicable WQS, including designated uses, numeric and narrative criteria, and antidegradation policy [40 CFR §130.7(c)(1)]. TMDL submittals must include a description of any applicable water quality standard, and must also identify numeric water quality targets, which are quantitative values used to measure whether or not applicable WQS are being attained. Depending on the designated use being addressed, a TMDL target may be based on human health, aquatic life, or wildlife criteria (U.S. EPA, 2008a). Where possible, the water quality criterion for the pollutant causing impairment is used as the numeric water quality target when developing the TMDL. Because all of the assessment units addressed in this TMDL are impaired for the fish consumption use, the Health Protection Value (HPV) for fish consumption for sensitive populations was used to derive the TMDL target of 0.06 mg/kg for PCB and 0.06 mg/kg for mercury. This TMDL will also need to demonstrate that compliance with the fish tissue TMDL target will also meet the water quality targets including the human health and wildlife criteria described above (for all waters) and additionally for Waukegan Harbor, the aquatic life criteria. This will be accomplished via the application of published bioaccumulation factors (BAFs) for the Great Lakes, which provide a translator between pollutant concentration in water column and resulting fish tissue contamination (USEPA, 1995). TMDL loads will be set to ensure compliance with the lower of the two concentrations (water column or fish tissue) used to protect the designated use.

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5
Target Fish Selection

Fish tissue PCB and mercury concentrations have been sampled in a wide range of species across the study area, and show varying degrees of bioaccumulation. The use of fish tissue samples from multiple species to form the basis for compliance with the fish consumption advisories incorporates these varying degrees of bioaccumulation across the study area into the assessment for impairment of the fish consumption designated use. However, one fish species must be selected to establish how much pollutant loads must be reduced to meet the fish tissue target value and obtain the designated use. The species selected to represent the achievement of the target fish tissue concentration level in most (but not all) fish should be protective of concentrations in other fish species, such that load reductions set to attain the target level in the selected species will result in fish tissue concentrations at or below the target level in other species. The fish species used for comparison with the TMDL fish tissue target concentration would ideally possess the following characteristics:

- They should possess concentrations near the upper bound of the range of all species, such that TMDL reductions designed to achieve attainment in the target species will be protective of other species.
- They should be consumable by humans and therefore appropriate to represent the linkage between the fish tissue concentration that is the basis for the fish consumption advisory that is the assessment measure for the standard.
- They should allow for the application of a TMDL approach that considers geographic, chemical, loading and temporal variability.
- They should be sampled abundantly enough to allow calculation of a reduction factor that is not overly influenced by potential sampling variability.

5.1 Data review

5.1.1 PCBs

LimnoTech reviewed the fish tissue data (i.e., IEPA's fish contaminant database, USEPA's Great Lakes Environmental Database, and USEPA's National Coastal Condition Assessment) to make an assessment of which fish species would be suitable to serve as a TMDL target for PCBs. Only data from the edible portion monitoring were considered since these are the data that support the fish consumption designated use assessment. Table 5-1 summarizes the available data across the entire study area. The highest observed fish tissue concentrations are observed both in North Point Marina and Waukegan Harbor. The data present both mean and 90th percentile tissue concentrations, as other fish tissue-based PCB TMDL have been based on protection of an upper-bound percentile of the range of population data. Results for the 90th percentile values should be evaluated only in a qualitative manner, however, because:

1. The large majority of fish data represent the composite of multiple fish; with up to 25 fish composited per analysis.
2. Results for the majority of fish species were based on fewer than ten measurements, making the estimate of the 90th percentile value highly uncertain.

Table 5-1. Mean and 90th Percentile Fish Fillet PCB Concentration (mg/kg) across Entire Study Area

Species	Count	Mean	90th percentile*
Carp	52	4.329	7.6500
Lake trout	30	0.811	2.0200
Black bullhead	3	1.027	1.3600
Rock Bass	10	0.276	0.7660
Sunfish	7	0.189	0.4180
Largemouth Bass	4	0.225	0.3960
Bloater	7	0.270	0.3660
White sucker	6	0.237	0.3550
Smallmouth bass	7	0.172	0.2620
Pumpkinseed sunfish	3	0.183	0.2400
Alewife	6	0.187	0.2300
Round goby	3	0.137	0.1580
Yellow perch	22	0.092	0.1000
Brown Trout	1	0.659	Can't Calculate
Rainbow trout	2	0.152	Can't Calculate
Rainbow smelt	1	0.100	Can't Calculate

90th percentile concentration calculated when there are at least three samples

PCB tissue levels in carp (Trophic Level 3) are the highest observed for all species of fish, and carp are also the most widely sampled species. Despite being the most widely sampled species, carp tissue PCB data are not available for every impaired segment. As shown in Table 5-2, the number of carp tissue samples available ranges from zero (Diversey Harbor, Calumet Harbor and the nearshore open water/shoreline) to 40 (Waukegan Harbor). While the majority of the carp measurements come from Waukegan Harbor, the conclusion that carp are the most contaminated species is not driven solely by results from Waukegan Harbor. PCB concentrations in carp from North Point Marina are similar to, and slightly higher on average than, PCB concentrations in carp from Waukegan Harbor.

Table 5-2. Number of Carp PCB Fillet Samples Available by TMDL Zone

TMDL Zone	Count
Nearshore open water/shoreline	0
Calumet Harbor	0
North Point Marina	12
Waukegan Harbor	40
Diversey Harbor North	0

As will be discussed subsequently in the Assessment section, the fact that carp obtain much of their PCB body burden from contaminated sediments causes some limitation in their suitability to serve as target species due to the fact that sediment concentrations may be more reflective of legacy pollutant sources than active sources. For that reason, the fish tissue database was further examined to identify additional candidates to serve as target species for PCBs. As seen in Table 5-1, lake trout (Trophic Level 4), black bullhead (Trophic Level 3), and rock bass (Trophic Level 3) have some of the highest PCB concentrations among all sport fish. Lake trout had the second highest 90th percentile concentration, but were not sampled from any of the harbors. All lake trout samples came from nearshore open water/shoreline zone. The third and fourth highest 90th percentile concentrations were found for black bullhead followed by rock bass. Black bullhead were only sampled a total of three times at one location in one TMDL Zone (Waukegan Harbor). Rock bass are among the most sampled species. A review of the distribution of sampling locations (Table 5-3) by TMDL zone shows that all of the rock bass samples came from harbors. If TMDLs are developed separately for harbors and the nearshore zone, rock bass will be a suitable candidate to represent harbors. Rock bass will not be a suitable target species for to represent the open water/shoreline zone, as there are no rock bass samples for this portion of the study area.

Table 5-3. Number of Rock Bass PCB Fillet Samples Available by TMDL Zone

TMDL Zone[a]	Count
Nearshore open water/shoreline	0
Calumet Harbor	1
North Point Marina	4
Waukegan Harbor North	5
Diversey Harbor	0

The database was further reviewed to find a potential target species to represent the nearshore open water/shoreline TMDL zone. Lake trout were determined to be the best candidate, because: 1) they possess high tissue levels, 2) they are a sport fish that serve as the subject of fish consumption advisories, and 3) they are the most widely sampled species in the nearshore open water/shoreline zone, with all 30 lake trout PCB fillet samples coming from this zone (Appendix C).

5.1.2 Mercury

LimnoTech reviewed the fish tissue data to make an assessment of which fish species would be suitable to serve as a TMDL target for mercury. Similar to PCBs, only data from the edible portion monitoring were considered. For the same reasons described above for PCBs, results for the 90th percentile values should be evaluated only in a qualitative manner. Table 5-4 summarizes the available data across the entire study area.

Table 5-4. Mean and 90th Percentile Fish Fillet Mercury Concentration (mg/kg) across Entire Study Area

Species	Count	Mean	90th percentile
Largemouth Bass	3	0.2800	0.4120
Smallmouth bass	7	0.1096	0.1660
Rock Bass	9	0.1023	0.1580
White sucker	4	0.0528	0.0666
sunfish	5	0.0328	0.0510
Black bullhead	2	0.0550	Can't Calculate
Rainbow trout	2	0.0638	Can't Calculate
Brown Trout	1	0.1030	Can't Calculate

90th percentile concentration calculated when there are at least three samples

Mercury tissue levels in largemouth bass are the highest observed for all species of fish, although only three tissue concentration samples exist. As shown in Table 5-5, all three largemouth bass tissue samples were collected in North Point Marina.

Table 5-5. Number of Largemouth Bass Mercury Fillet Samples Available by TMDL Zone

TMDL Zone	Count
Nearshore open water/shoreline	0
Calumet Harbor	0
North Point Marina	3
Waukegan Harbor North	0
Diversey Harbor	0

As shown in Table 5-5, no largemouth bass samples are present from the nearshore open water/shoreline zone. Review of the database indicates that that there are no more than two samples available for any species describing mercury concentration in the nearshore zone.

5.2 Recommendations

5.2.1 PCBs

The current fish tissue dataset is not capable of providing a single target species that can support segment-specific TMDL reduction calculations for PCBs, due to the lack of samples completely covering TMDL zones. Carp are the most highly contaminated and widely sampled species, but there are no carp data for Diversey Harbor, Calumet Harbor or the nearshore open water/shoreline zone. Rock bass and lake trout are also candidate target species, although no harbor data exist for lake trout, and no data exist for rock bass in Diversey Harbor or the nearshore open water/shoreline, and only a single rock bass data point exists for Calumet Harbor.

The use of carp as a target species poses some issues in terms of TMDL development. Carp, being benthic feeders, obtain much of their PCBs from bottom sediments. Sediment PCB concentrations respond much more slowly to changes in loading than do water column concentrations. The Level One TMDL approach described below is based upon the assumption that fish tissue PCB levels are dictated by the current PCB loading rate to the system. Observed carp PCB data reflect some degree of historical loading rates and do not accurately reflect current loading. As a result, TMDL reductions required by the Level One approach for carp may be greater than what are necessary to ultimately achieve fish tissue targets, by ignoring the fact that fish tissue levels reflect historical loading rates.

Considering the above factors, the following recommendations are made in terms of target fish species selection for the PCB TMDL:

- Carp should be used as one of the target species for the PCB TMDL. To the extent that the available data allow, the TMDL approach should differentiate the percentage of current carp body burden that is attributable to current PCB sources versus that attributable to legacy PCB sources. This will be accomplished by comparing estimated historical water column PCB loading rates to current loading rates, and considering the response time of surficial sediments to changes in water column loading rates.
- TMDL calculations should also consider rock bass and lake trout, to verify that reductions in current sources necessary to protect carp are also protective of these species. Lake trout are migratory open water species, such that their use as a target species will require consideration of the amount of exposure they receive in nearshore areas versus what they receive from their time in the main body of the lake.
- TMDL calculations will require the pooling of fish data across sites to account for the absence/limited number of fish samples in certain TMDL zones. One potential grouping scheme would be to pool all fish data from harbors, and all fish data from nearshore open water/shoreline areas.

5.2.2 Mercury

The current fish tissue dataset is not capable of providing a target species that can support segment-specific TMDL reduction calculations for mercury, due to the lack of samples completely covering TMDL zones. Largemouth bass are the most highly contaminated species, but only three tissue samples exist, all from North Point Marina. Should the desire exist to base the TMDL on more than three tissue samples, tissue data from largemouth bass could be pooled with tissue data from smallmouth bass to generate a larger data set. Smallmouth bass are from the same genus (Micropterus) as largemouth bass, and have the second-highest concentration of all fish sampled. Seven tissue samples exist for smallmouth bass, taken from Calumet Harbor and North Point Marina.

Considering the above factors, the following recommendations are made in terms of target fish species selection for the PCB TMDL:

- Largemouth bass should be used as the target species for the mercury TMDL, possibly supplemented with data from smallmouth bass.
- TMDL calculations will require the extrapolation of fish data across sites to account for the absence/limited number of fish samples in certain TMDL zones, given the lack of data from several harbors and the nearshore open water/shoreline zone.

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6
TMDL Development Approaches

TMDLs are required to define the maximum pollutant loading rate that will result in compliance with water quality standards. Development of TMDLs therefore requires the use of a mechanism to translate a pollutant loading rate into units that can be compared to the water quality standard, e.g. water column or fish tissue concentration. This translation is typically done with some type of mathematical modeling framework, either empirical (i.e. based on observed data correlations) or mechanistic (i.e. based on a description of the specific mechanisms that affect pollutant concentrations.)

A wide range of modeling frameworks exist that could potentially be used to support development of the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs. This section summarizes the range of potential approaches for developing PCB and mercury TMDLs for Illinois nearshore waters, and is intended to assist USEPA and IEPA to evaluate the best option(s) for completing these TMDLs. It is divided into subsections describing:

- Model selection considerations
- Range of applicable frameworks
- Conceptual model and data gap assessment
- Candidate approaches
- Recommendation for preferred approach

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7
Modeling Selection Considerations

Available model frameworks for conducting PCB and mercury TMDLs vary in terms of:

- Temporal Scale
- Spatial Scale
- Loading Sources Considered
- Pollutant Forms
- Environmental Compartments Considered
- Fate and Transport Processes Considered
- Assessment of Bioaccumulation

Each of these factors impacts the data needed to support the model development and application. It is important to assure that adequate data are available to support the selected model framework, as a model is only as good as the data available to support it. The relevant aspects of each of these factors relative to PCB and mercury TMDLs are described below.

7.1 Temporal Scale

Temporal scale relates to a model's ability to describe how concentrations change over time. Temporal scale can be divided into two broad categories: 1) steady state, and 2) time-variable. Steady state models predict the concentration that will (eventually) occur in response to constant loading and constant environmental conditions. They are not capable of predicting the response time of concentrations to changes in loading rates. Time-variable models predict how concentrations change in response to changes in loading and/or environmental conditions. Gradations of temporal resolution exist within the category of time-variable models, as some models are designed to predict changes on an hour by hour basis while other models may predict with much coarser temporal resolution such as year to year.

The primary consideration of temporal scale for TMDLs is whether the TMDLs need to define the response time between load reduction and attainment of water quality standards. This is relevant for these TMDLs because PCBs and mercury do not degrade rapidly and therefore have longer response times than most other pollutants. Secondary considerations for requiring a time-variable model include the desire to simulate inputs that fluctuate widely over time, and/or water quality standards that are expressed in terms of allowable percent of time that standards may be exceeded. Time-variable models will be able to address these considerations, while steady state models will not. Time-variable models are generally more complex and have greater data needs than steady state models. The ability of a model to make predictions at a fine scale temporal resolution is - may not be appropriate for PCB and mercury TMDLs that consider the relationship between pollutant sources and the measured contaminant concentration in fish tissue. The impairment of the designated use for the waterbodies in this TMDL are due to fish consumption advisories which are determined by excessive contaminant concentration in fish tissue. Tissue levels in target fish species respond slowly to changes in pollutant concentrations, so that simulating short-term changes in pollutant concentration in the waterbodies are of less importance than the bioaccumulation of the contaminants in the tissue of predatory fish over years. A temporal resolution of years will adequately capture the resulting concentration in fish tissue which is the focus of the addressing the impairment.

7.2 Spatial Scale

Spatial scale relates to a model's ability to describe how concentrations vary over space within the model domain. Spatial scale can be divided into broad categories corresponding to the number of different spatial dimensions considered by a model. Zero-dimensional models do not consider how changes vary within the model domain, and treat the entire system as a single well-mixed entity. One dimensional models predict changes over a single spatial dimension (e.g., longitudinally). Two dimensional models predict changes over two spatial dimensions (e.g., longitudinally and laterally, or longitudinally and vertically). Three dimensional models predict changes over all spatial dimensions - longitudinally, laterally, and vertically. Gradations of spatial resolution also exist, as different model frameworks can describe changes on a meter-by-meter or mile-by-mile basis. Again, increasing spatial resolution/dimensionality increases a model's complexity and the data needs for the model development and application.

The primary consideration of spatial scale for PCB and mercury TMDLs is that the model needs to have sufficient spatial resolution to capture gradients in pollutant concentrations that are important with respect to the management decisions being made. For example, if the management objective is to have separate TMDLs for harbors and nearshore shoreline and open water areas, the model must contain sufficient spatial resolution to differentiate the load-response relationship between these areas. Similarly, if the requirement is for water quality standards to be met at "any place, any time" (as opposed to being averaged over an entire segment), the model must have sufficient spatial resolution to capture the variability in concentrations within a given segment. It should be noted that increases in spatial scale require a large increase in the amount of data required to support model application.

7.3 Loading Sources Considered

A specific TMDL model framework can also vary in terms of the range of loading sources that it considers. Potentially important loading sources of PCBs and mercury to the Illinois nearshore waters of Lake Michigan include:

- Atmospheric load, either via direct deposition or (for PCBs) gas-phase exchange
- Transport of pollutants originating in the main Lake Michigan basin into the nearshore and harbors
- Stormwater loading from the contributing watershed
- Flow reversals from the Chicago Area Waterways (CAWS)
- Direct point sources other than stormwater
- Legacy sediment contamination

To the extent that any of these loading sources contribute a significant amount of pollutant to any of the impaired waterbodies of concern, they will need to be considered in the TMDL model. Conversely, if it can be demonstrated using site-specific data or the scientific literature that any of these loading sources do not contribute a significant amount of pollutant to any of the waterbodies of concern, they can be excluded from the TMDL analysis. Other TMDLs (e.g. Connecticut Department of Environmental Protection et al., 2007; MPCA, 2007) have used a cut-off of 1-2% of the total in terms of defining what constitutes a "significant" load. Based on this precedent, the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs will define any loading source estimated to be greater than 1% of the total load to be defined as significant.

7.4 Pollutant Forms

PCBs and mercury can exist in different forms in the environment. PCBs are comprised of 209 different congener forms, and can exist either in a dissolved state or adsorbed onto particulate matter. Mercury can exist in a range of inorganic forms which can be dissolved or adsorbed onto particulate matter, as well as in organic forms of methyl-mercury. Some model frameworks are capable of simulating individual forms of pollutants, while others consider all pollutant forms lumped together as total pollutant.

There are two potential reasons for selecting a model framework capable of simulating multiple pollutant forms. The first is in cases where the fate and transport of the pollutant strongly depends on the form that the pollutant is in, and future management controls will significantly alter the distribution between pollutant forms. For example, only sorbed forms of a pollutant settle from the water column and only certain dissolved forms of a pollutant can exchange with the gas phase in the atmosphere. The second is cases where the water quality endpoint strongly depends on the pollutant form, and future management controls will significantly alter the distribution between forms. For example, only the methylated form of mercury is bioaccumulated through the food chain to fish.

7.5 Environmental Compartments Considered

Mathematical models for PCB and mercury TMDLs can explicitly simulate pollutant concentrations in up to three different environmental compartments: water column, bed sediments, and biota (see Figures 9-2 and 9-3 below for examples). The most rigorous models simulate the processes that affect pollutant concentrations in each compartment. It is not necessary, however, to explicitly simulate all compartments in order to estimate load reductions necessary to meet target pollutant levels in biota. For example, some modeling approaches allow the pollutant concentrations of PCBs and mercury in biota to be estimated directly from the predicted water column concentrations through the use of bioaccumulation factors.

7.6 Fate and Transport Processes Considered

Fate and transport describes those processes related to transformation and/or movement of chemicals once discharged into the environment. These processes are potentially important to simulate because they control the rate at which pollutant loading sources are diluted. The processes include hydrodynamic transport (i.e. movement by water), settling of particulate-bound pollutants from the water column to bed sediments, volatilization of pollutants from the water column to atmosphere, and resuspension or diffusion of pollutants from bed sediments to the water column. Even though fate and transport processes both affect the pollutant load-response relationship, it not necessarily required to explicitly simulate them in a TMDL. If controls required by the TMDL do not affect the relative impact of fate and transport processes, the TMDL can be based upon the assumption of proportional relationship between pollutant loading rate and resulting concentration.

7.7 Assessment of Bioaccumulation

The final consideration in model selection pertains to a description of how fish tissue obtains chemicals from the receiving water, lower levels of the food chain and/or bed sediments. The simplest bioaccumulation models assume a directly proportional relationship between pollutant loading rate and fish tissue concentrations. Intermediate level models predict pollutant concentrations in the water column and sediment, and use bioaccumulation factors that are derived from observed measurements to predict fish tissue concentrations. The most complex models explicitly simulate how pollutants are transferred through the food web, including the rate at which they are absorbed (and released) by fish as part of their diet.

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8
Range of Applicable Frameworks

With at least two options available for each of the seven categories of factors described above, there are theoretically hundreds of potential permutations of model frameworks that could be developed. In reality, there are much fewer realistic options, as selection of one factor often dictates the nature of selection of other factors (e.g. selection of a "proportional relationship" in place of explicit modeling of fate and transport processes requires selection of a steady state temporal approach). This section presents three candidate frameworks, divided into categories corresponding to different levels of TMDL approaches described in the USEPA (2011) PCB TMDL Handbook (which are equally relevant for mercury TMDL development as well.)

8.1 Level One: Simple Proportionality Approaches

Level One modeling approaches for TMDLs described in USEPA (2011) include assuming a directly proportional relationship between PCB loadings and environmental concentrations, and/or back-calculating the loading capacity from the fish tissue targets and fish tissue data.

The Level One approach corresponds to the model selection factors described above as:

- Steady state: Level One approaches are unable to describe how pollutant concentrations will change over time in response to source reductions.
- Zero dimensional: Level One approaches are unable to describe how pollutant concentrations will vary spatially within a study area, beyond assuming that the existing spatial distribution of pollutants remains identical in response to load reductions (i.e. concentrations in all locations are reduced proportionally).
- Loading sources: Level One approaches generally assume the existence of a single loading source. They can be applied to multiple loading sources for cases where it can be assumed that the load-response relationship for each source is identical (e.g. a one pound per day reduction in loading results in the exact same system response regardless of which source is reduced).
- Pollutant forms: Level One approaches are designed to only address total pollutant concentrations.
- Environmental compartments considered: Level One approaches can consider all environmental compartments: water column, sediments, and biota.
- Fate and transport processes considered: Level One approaches do not explicitly describe fate and transport processes. These processes are generally implicitly considered, by assuming that whatever fate and transport processes control the existing load-response relationship will remain unchanged in response to future load reductions.
- Bioaccumulation: Bioaccumulation is implicitly predicted, via the assumption of a proportional relationship between load and fish tissue concentration.

Level One approaches were recently used in the Michigan Statewide PCB TMDL (LimnoTech, 2012) and Michigan Statewide Mercury TMDL (LimnoTech, 2013), and have previously been used in the Minnesota statewide mercury TMDL (MPCA, 2007). This approach is largely empirical and requires a minimal amount of data, limited to measurements of pollutant load and system response (e.g. fish tissue pollutant concentration).

8.2 Level Two: Steady State Mass Balance Approaches

Level Two approaches for TMDL development described in USEPA (2011) PCB TMDL Handbook consist of simpler mass balance models. The Level Two approach corresponds to the model selection factors described above as:

- Steady state: Level Two approaches are unable to describe how pollutant concentrations will change over time in response to source reductions.
- Multi-dimensional: Level Two approaches are capable of simulating multiple spatial dimensions, but are generally applied in zero or one dimension due to the fact that two- and three-dimensional steady state descriptions of transport processes are rarely available. As a rule, if sufficient resources are available to develop a two- or three-dimensional hydrodynamic model, sufficient resources are also available to support a Level Three modeling approach.
- Loading sources: Level Two approaches are capable of simulating multiple loading sources. The primary constraint of these approaches with loading sources is that they are not suited for assessing the response of the system to sources that change over time, due to its steady state nature.
- Pollutant forms: Level Two approaches can simulate a range of pollutant forms.
- Environmental compartments considered: Level Two approaches explicitly simulate concentrations in the water column and sediments.
- Fate and transport processes considered: Level Two approaches can simulate a wide range of fate and transport processes, with primary constraints being that the processes can be assumed to be relatively constant over time, given the steady state nature of the framework.
- Bioaccumulation: Level Two approaches rely on an assumed relationship between concentrations in these compartments and biota to predict fish tissue concentrations.

A Level Two approach was used in the Shenandoah River PCB TMDL (USEPA and VADEQ, 2001).

8.3 Level Three: Time-variable Model of Pollutant Forms in Water Column and Sediments

The most rigorous model framework suitable for the PCB and mercury TMDLs is a time-variable, spatially detailed model of pollutant forms in water column and sediments.

- Time-variable: Level Three approaches are capable of describing how pollutant concentrations will change over time in response to source reductions. Level Three approaches can also be used to provide steady state results, by holding loads and environmental conditions constant and simulating a sufficiently long period of time such that environmental concentrations eventually remain constant. While this type of approach provides identical results as a steady state framework, it provides the additional benefit of defining how much time will be required for steady state conditions to occur.
- Multi-dimensional: Level Three approaches are capable of simulating multiple spatial dimensions, at fine levels of spatial detail.
- Loading sources: Level Three approaches are capable of simulating the entire range of loading sources, including those that change over time.
- Pollutant forms: Level Three approaches can simulate a range of pollutant forms.
- Environmental compartments considered: Level Three approaches are capable of explicitly simulating concentrations in the water column, sediments, and biota.

- Fate and transport processes considered: Level Three approaches can simulate the entire range of fate and transport processes.
- Bioaccumulation: Level Three approaches are capable of explicitly simulating bioaccumulation throughout the food web. Similar to Level Two approaches, they often rely on an assumed relationship between concentrations in the water column/sediments and biota to predict fish tissue concentrations.

The primary limitation of Level Three approaches is that they require significantly more resources (i.e. data, time, and staff) than Level One or Level Two approaches. Level Three approaches have been used in the Delaware River Estuary PCB TMDLs (DRBC, 2003), the Tidal Portions of the Potomac and Anacostia Rivers TMDLs (ICPRB, 2007), the Lake Ontario PCB TMDL, and the Savannah River mercury TMDL (USEPA, 2001).

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9 Conceptual Model and Data Gap Assessment

DePinto et al (2004) summarize the basic principles for TMDL model selection and conclude that there is no one best model for all TMDLs; model selection should be driven by an explicit consideration of management objectives, site-specific characteristics, and resource/data constraints. Consideration of site-specific characteristics requires defining the constituents and processes of concern for the site of interest. This is done by: 1) Defining all of the potential processes composing the site-specific linkages between causes and effects, either in the form of a simple list or a more formal box and arrow process diagram; 2) Estimating the magnitude of each of the component processes using available data, and 3) Eliminating those processes that play an insignificant role in the site-specific cause-effect linkage.

Development of this conceptual model is also useful for identifying data gaps. The process of estimating the magnitude of each of the component processes in the conceptual model requires the same type of information necessary to support development of the TMDL model itself. Any gaps in available data that are identified during the development of the conceptual model will also be data gaps for the development of the TMDL itself.

This section describes the conceptual model development and data gap assessment for PCBs and mercury. It begins with a conceptual model of all potentially relevant processes applicable to both pollutants, then presents separate refined conceptual models and data gap assessments for PCBs and mercury.

9.1 Conceptual Model of All Potentially Relevant Processes

A conceptual model of all potentially relevant processes applicable to PCBs and mercury is shown in the form of box and arrow diagrams in Figures 9-1, 9-2 and 9-3. Figure 9-1 depicts processes related to hydrodynamic transport and spatial resolution. Figure 9-2 depicts all other loading, fate and transport processes potentially applicable to water column and bed sediment pollutant concentrations in a given spatial segment. Figure 9-3 depicts bioaccumulation pathways between pollutants in the water column/sediment and various locations in the food web.

Figure 9-1 represents a separate model segment for each impaired waterbody, which is the minimum spatial resolution capable of providing TMDLs unique to each impaired segment. Note that options exist to lump multiple impaired segments together for TMDL purposes, or to further divide individual impaired segments into smaller sub-segments. Key transport processes that would need to be defined at this level of resolution include:

- Hydrodynamic transport between each harbor and its adjacent shoreline segment.
- Hydrodynamic transport between Calumet Harbor and the main body of Lake Michigan
- Hydrodynamic transport between each adjacent shoreline segment
- Hydrodynamic transport between each shoreline segment and the adjacent nearshore open water segment
- Hydrodynamic transport between the nearshore open water segment and Lake Michigan
- Hydrodynamic transport between each adjacent nearshore open water segment, if multiple nearshore open water segments are used in the model

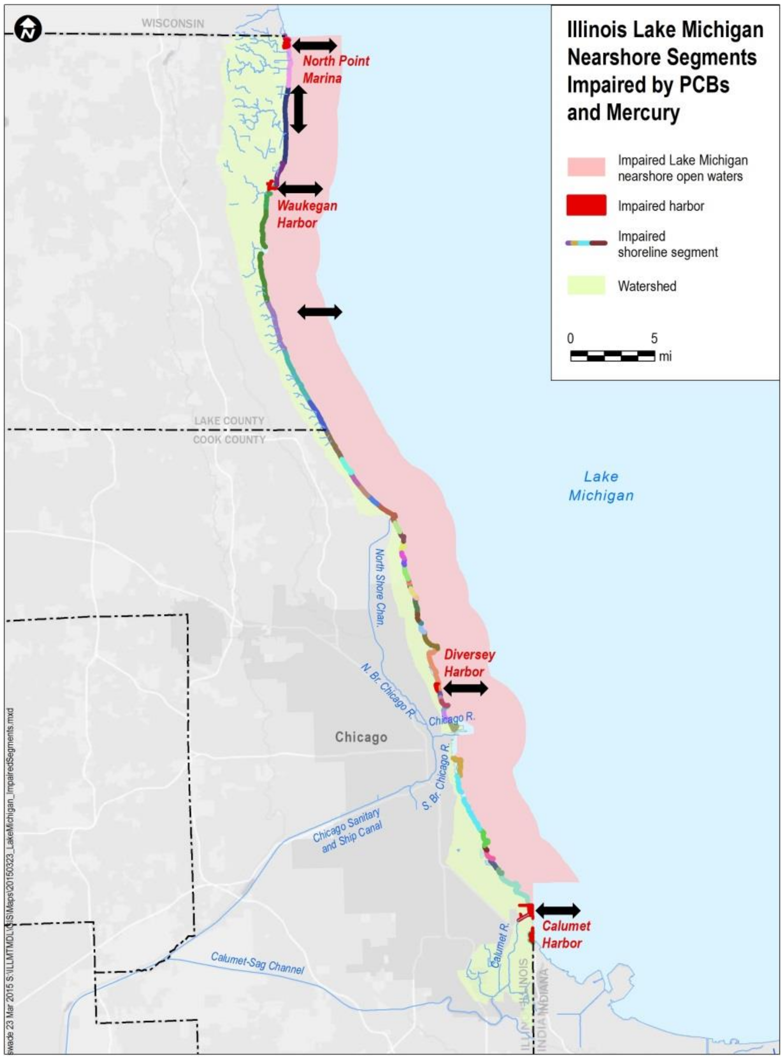

Figure 9-1. Conceptual Model with Arrows Depicting All Potentially Relevant Processes Related to Hydrodynamic Transport and Spatial Resolution.

Figure 9-2 depicts all other loading, fate and transport processes potentially applicable to a given spatial segment, in addition to transport of pollutants from Lake Michigan into the study area. With respect to external loads, potential loading sources of PCBs and mercury consist of:

- Atmospheric loading, including wet deposition, dry deposition, and gas-phase exchange
- Stormwater loading to harbors and shoreline segments
- Flow reversals from the Chicago Area Waterways
- Point source discharges to harbors and shoreline segments
- Resuspension and/or pore water diffusion from contaminated sediments

The remaining potentially applicable fate and transport processes consist of:

- Phase partitioning between the adsorbed and dissolved forms of pollutant in the water column
- Phase partitioning between the adsorbed and dissolved forms of pollutant in bed sediments
- Settling of the adsorbed pollutant
- Volatilization of the dissolved form of the pollutant
- Pollutant decay processes (e.g. biodegradation)

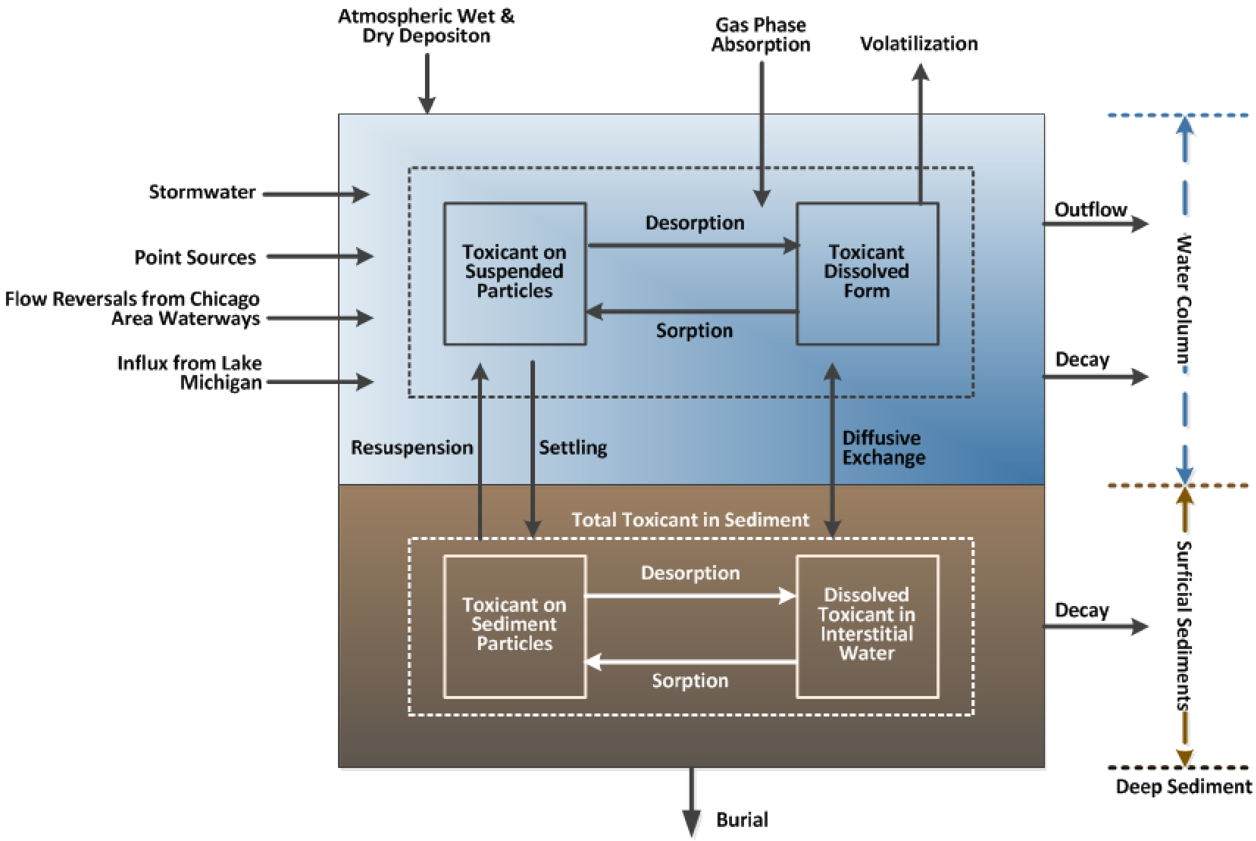

Figure 9-2. Conceptual Model of Relevant Loading, Fate and Transport Processes for PCBs and Mercury (adapted from LimnoTech, 2004)

Figure 9-3 depicts the transfer of chemicals through the food web and the relevant uptake and loss mechanisms in fish. Food web icons represent the order of different trophic levels, and arrows represent the interactions of each trophic level with lower trophic levels and surrounding medium. The base of the food chain can either be based on bed bottom sediment (i.e., benthic invertebrates) or water column (i.e., phytoplankton). A food web bioaccumulation model can either be a stand-alone model, which requires inputs for exposure concentrations in water and sediment, or it can be linked to the results of a water quality model through the use of empirical bioaccumulation factors. Modeling bioaccumulation in fish found in the Illinois nearshore Lake Michigan area is complex, due to the presence of migratory fish species (e.g., lake trout) that spend only a portion of their life cycle in the study area and the remainder in the main body of Lake Michigan.

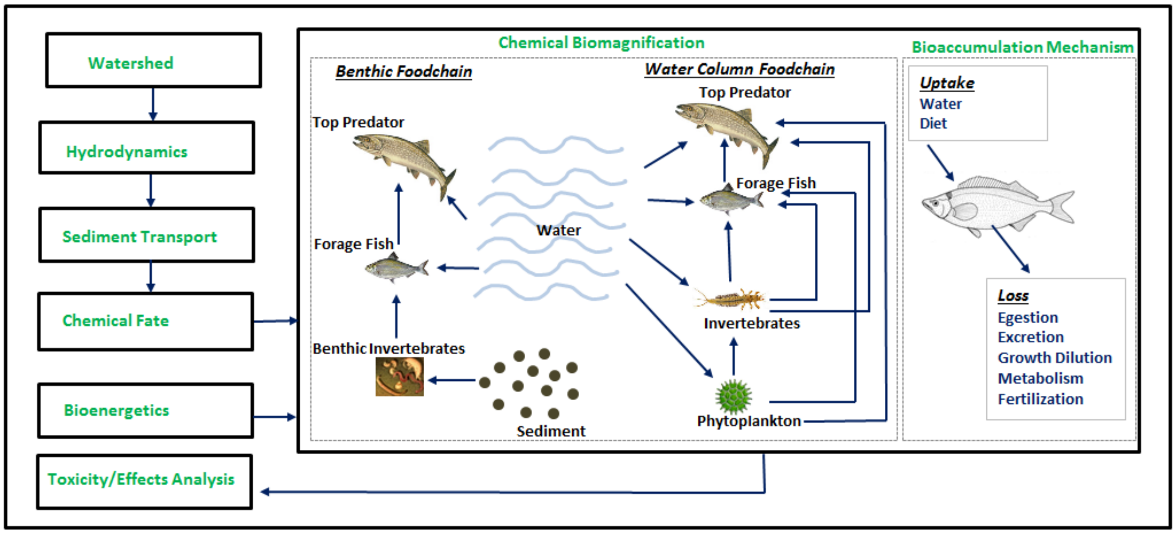

Figure 9-3. Conceptual Model of Aquatic Food Web Bioaccumulation (from EPRI, 2013)

9.2 Refined Conceptual Model and Data Gap Assessment for Hydrodynamic Transport

Development of a refined conceptual model consists of estimating the magnitude of each of the component processes in the full conceptual model, and eliminating those processes that play an insignificant role in the site-specific cause-effect linkage. The process of estimating the magnitude of each of the component processes also identifies potential data gaps for the development of the TMDL.

The NOAA Great Lakes Coastal Forecasting System (GLCFS) is the one tool capable of describing the transport of pollutants in the study area. The GLCFS is a set of models that simulate and predict the 2-D and 3-D structure of currents, temperatures, winds, waves, ice in the Great Lakes. The GLCFS uses a modified Princeton Ocean Model, developed by NOAA's Great Lakes Environmental Research Laboratory and Ohio State University, and is supported by the National Weather Service (NOAA, 2015). The model is sufficient to provide an estimate of the hydrodynamic transport between the nearshore open water segment and Lake Michigan; however, because of its 4 km^2 (2 km x 2 km) grid size, it lacks the spatial resolution necessary to predict hydrodynamic exchange between adjacent shoreline segments or hydrodynamic exchange between harbors and their adjacent nearshore open water segments. For example, the average surface area of the impaired harbors is 0.37 km^2, which is much smaller than a single grid cell in the model.

Given this limitation of spatial detail on hydrodynamic transport, any TMDL developed based on available information will require a lumping of all segments for assessment purposes (or development of a hydrodynamic model capable of describing the exchange between harbors and their adjacent nearshore open water segments). For this reason, the refinement of conceptual models in the subsequent section will focus more on the relative importance of various components to the system as a whole, as opposed to evaluating processes on a segment-by-segment basis.

Results from the GLCFS can be used to estimate the gross transfer of PCBs and mercury into the study area. This is first accomplished by estimating the annual average flow of Lake Michigan water into the study area. Results were extracted for the GLCFS model located on the northern edge of the study area as the predominant lake current is in this direction (Beletsky and Schwab, 2001; Beletsky et al. 1999). Figure 9-4 shows the mean circulation adapted from Beletsky and Schwab (2001). The mean current speed from the north was 3.35 cm/s for 2014. The area of conveyance for this velocity is 54,000 m^2, which was calculated by multiplying the average depth of the first two model grid cells from the GLCFS (10 m and 17 m) by the width of each cell (2 km each). Multiplying the average speed by the area equals an average flow into the study area of 1,810 m^3/s. Results from the USEPA Great Lakes Aquatic Contamination Survey data estimate the open lake PCB concentration in Lake Michigan of approximately 0.14 ng/L in 2004. Venier et al. (2014) report Lake Michigan PCB concentrations near Chicago of 0.233 ng/L. Multiplying these concentrations by the flow equals 8-13 kg/yr of PCB's entering the system. The Lake Michigan Mass Balance Study estimated that by 2014, the average lake-wide PCB concentration could be as low as 0.08 ng/L if the "continued slow recovery" scenario is followed as shown in Figure 9-5. This could reduce the annual PCB load entering the study area from 8-13 kg/yr to 4.5 kg/yr. Mercury concentrations from Lake Michigan (USGS, undated) measured near the study area averaged 0.18 ng/L, which would equal approximately 10 kg/yr of mercury transported into the study area using the flow information from above. Hydrodynamic transport out of the study area for PCBs and mercury should be of similar magnitude as transport into the study area.

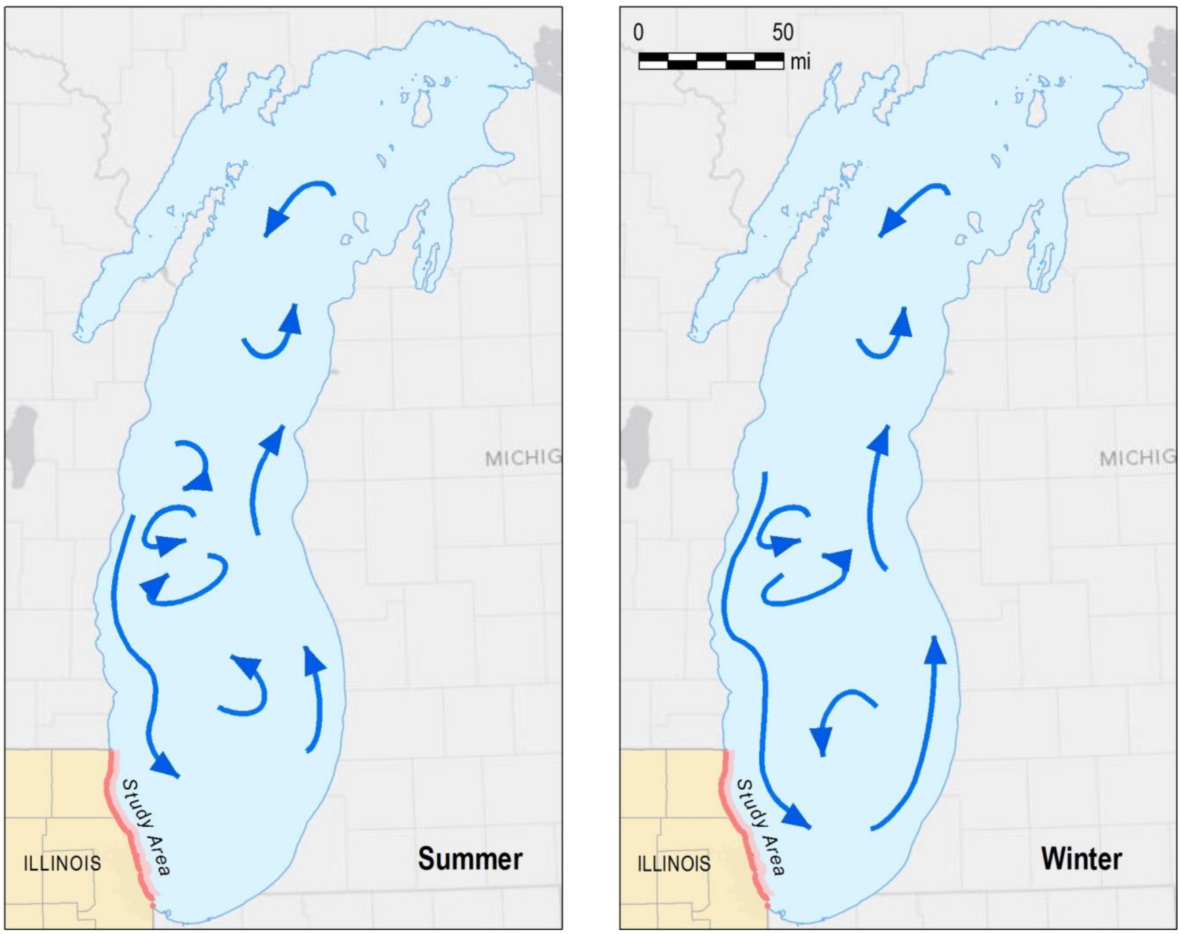

Figure 9-4. Observed Mean Circulation in Lake Michigan (Adapted from Beletsky et al., 1999 cited in Beletsky and Schwab, 2001).

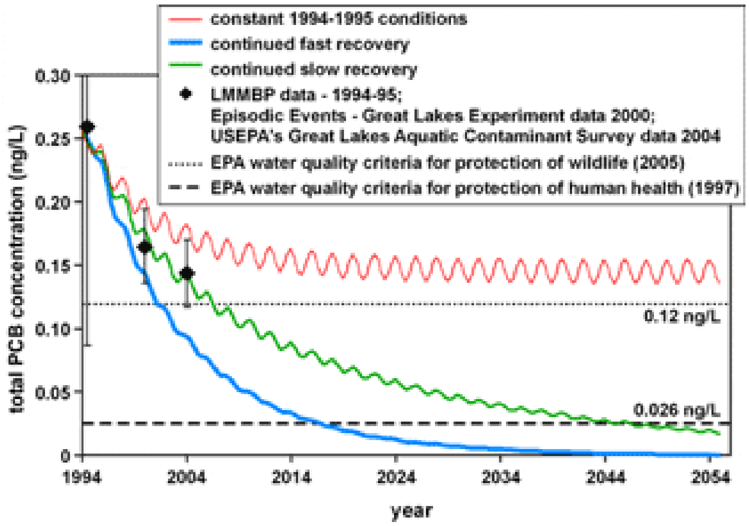

Figure 9-5. Lake Michigan Mass Balance Monitoring Data and Model Results
http://www.epa.gov/med/grosseile_site/LMMBP/pcbs.html

9.3 Refined Conceptual Model and Data Gap Assessment for PCBs

This section identifies the magnitude of all other potentially applicable loading, fate and transport processes for PCBs beyond hydrodynamic transport. Those sources are:

- Atmospheric loading to the harbors and nearshore open water segments, including wet deposition, dry deposition, and gas-phase exchange
- MS4 stormwater loading to harbors and nearshore open water segments
- Flow reversals from the Chicago Area Waterways
- Point source discharges to the study area
- Resuspension and/or pore water diffusion from contaminated bed sediments
- Phase partitioning between adsorbed and dissolved form of the pollutant in the water column and bed sediments
- Settling of the particle-bound pollutant
- Volatilization of the dissolved form of the pollutant
- Pollutant decay processes
- Bioaccumulation

A data gap assessment and refined conceptual model for PCBs are presented at the end of this section.

9.3.1 Atmospheric PCB Loading

Potentially important atmospheric loading sources include wet deposition, dry deposition, and gas-phase exchange. The magnitude of these processes is estimated as follows. Wet deposition calculations were based on annual average rainfall, observed average PCB concentration in rainfall, and the surface area of the study domain. Average PCB concentrations in rainwater ranged from 4.1 ng/L to 189 ng/L during four events in 1994 and 1995 near Chicago with an average of 54 ng/L (Offenberg and Baker, 1997). With an average rainfall of 36.1 inches (0.94 m) per year and a surface area of the nearshore waters of 473 km^2 (surface area of the impaired nearshore open water segment and four impaired harbors, based on a GIS analysis) the mass of PCB deposited by rainfall is 23.4 kg/yr.

Franz et al (1998) estimated PCB dry deposition near Chicago to range from 0.02 to 2.1 ug/m²/d. Assuming an approximate rate of 0.1ug/m²/d the annual dry deposition across the study area could approach 17 kg/yr.

Gross PCB gas phase absorption from the atmosphere to the water column was estimated by downscaling estimates from the Lake Michigan Mass Balance Study (LMMBS) (USEPA, 2004). The LMMBS estimated a lake-wide absorption of 1507 kg for 1994 and 1995 (753.5 kg/yr). The nearshore open water segment of the Illinois waters of Lake Michigan and four impaired harbors comprise approximately 0.82% of the total surface area of Lake Michigan (473km²/58,000km²). So the downscaled absorption of PCBs in the study area would be approximately 6.1 kg/yr. However it has been documented that gas phase concentrations of PCBs in southwest Lake Michigan are up to four times higher than the average Lake Michigan concentration (USEPA 2004), therefore atmospheric absorption would be about four times higher as well because Henry's Law states that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. This would increase the estimate of gas phase absorption to 24.6 kg/yr for the study area. The total atmospheric load is determined as the sum of wet deposition (23.4 kg/yr), dry deposition (17 kg/yr), and gas phase absorption (24.6 kg/yr), and is equal to 65 kg/yr.

9.3.2 MS4 Stormwater PCB Loading to Harbors and Nearshore Open Water Segments

93.5% of the study area watershed lies within an MS4 city or village, and in addition, the County of Lake, Shields Township, Waukegan Township, and the Cook County Highway Department have MS4 permits. As a result, close to 100% of the study area is within an MS4 area. No site-specific data were available to quantify stormwater PCB loads for the study area watershed (MWRDGC, 2015). Another nearby state, Michigan, also reported that they do not collect, or have plans to collect stormwater PCB data (MDEQ, 2015). The magnitude of stormwater PCB loads was therefore estimated as the product of runoff quantity, the study area drainage area, and an assumed stormwater PCB concentration. The development of these inputs is described below.

Runoff quantity was calculated using the method developed by the Metropolitan Washington Council of Governments (Schueler, 1987) as: **R = P * Pj * Rv**

Where:

R = Annual runoff (inches),

P = Annual rainfall (inches) estimated as 36.1 inches, based on the average annual rainfall reported for Chicago Midway Airport 3 SW for the 1929-2013 period (http://www.crh.noaa.gov/lot/?n=111577_Midway)

Pj = Fraction of annual rainfall events that produce runoff (set to the default of 0.9)

Rv = Runoff coefficient. Rv is a function of impervious cover in the study area watershed, and was calculated using GIS analysis to determine impervious cover for commercial (0.71), industrial (0.54) and residential (0.37) land uses. The resulting runoff coefficients were: commercial (0.69), industrial (0.54) and residential (0.38).

The area of the contributing watershed was calculated as 99.6 square miles, broken down as: 3.82 square miles (commercial), 4.05 square miles (industrial) and 91.73 square miles (residential). The PCB concentration was based on measurements from the City of Spokane (2014) representing 'typical' urban stormwater, and was set to 7.27 ng/L. The estimated stormwater PCB load equals 1.36 lbs/year (0.62 kg/yr).

9.3.3 PCB Loading from Flow Reversals from the Chicago Area Waterways

Limited site-specific data were available to quantify the magnitude of bypass PCB loads from the Chicago Area Waterways. The magnitude of loads entering the study area waters from periodic flow reversals of the Chicago Area Waterways is estimated based on measured flow and concentration data. Flow reversals from the Chicago Area Waterways to Lake Michigan occur periodically through O'Brien Lock, the Chicago River Lock, and Wilmette Lock. The volume of flow is reported by the Metropolitan Water Reclamation District (MWRD) on their website for 1985 through 2014. http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting_the_environment/Combined_Sewer_Overflows/pdfs/Reversals.pdf

Until recently, MWRD conducted sampling during flow reversals, including measurements of PCBs. PCB loads were estimated based on concentration data collected twice at each sampling station during the 2013 flow reversals (Table 9-1), and the average 2010-2014 annual volume (4,021.4 million gallons) of water entering Lake Michigan through the three locks.

Table 9-1. Measured CAWS PCB Concentrations during Times of Flow Reversals

Location	Location of PCB sampling	Total PCB results (4/18/13)
O'Brien Lock	Calumet Harbor, 95th St. Bridge: Calumet Harbor, Ewing Ave. Bridge	All 4 samples < 0.3 ug/L
Chicago River Lock	Chicago River Locks, Inner Harbor Sluice Gate; Chicago River Locks, Sluice Gate, DuSable Harbor	Both samples < 0.3 ug/L
Wilmette Lock	Wilmette Harbor, Wilmette Pump Station	Both samples < 0.3 ug/L

Because all PCB concentration measurements are less than detection, loads for this source cannot be accurately quantified. However, total PCBs from this source can be estimated to be less than 100.7 lbs/yr (45.68 kg/yr), using the detection limit as the basis for an upper-bound estimate of PCB concentration. It is recognized that the PCB detection limit of 0.3 ug/L could be orders of magnitude higher than actual concentrations, such that this may be a high upper bound estimate. For the purposes of estimating a potential pollutant load in the absence of data, PCB loads from the CAWS were calculated using data from another urban area which had lower detection limits. Observed PCB concentration data in combined sewer overflows collected by the City of Spokane (2014) using low detection limits provide a more realistic upper bound PCB concentration. Using their observed average PCB concentration of 0.01242 ug/L results in an upper-bound PCB loading estimate of less than 4.2 lbs/yr (1.9 kg/yr). Note that CSO measurements of PCBs are not available for the study area (MWRDGC, 2015a).

9.3.4 Other Point Source PCB Discharges to the Study Area

Other point source PCB loads were calculated based on permitted flow and measured concentration data, for facilities determined to have the potential to contribute PCB loads to the study area. These facilities were identified based on input and data provided by Illinois EPA.

One facility (IL0002763, Zion Station) was determined to have the potential to contribute PCB loads to the study area waterbodies, based on permit monitoring requirements. All 23 effluent PCB measurements (2009-2014) were less than the 0.001 mg/L detection limit. Because all samples are less than the detection limit, point source loads cannot be accurately quantified. However, based on the average measured flow (3.6 MGD) and a concentration of 0.001 mg/L (set at the detection limit), the load is estimated to be less than 11 lbs/yr (5 kg/yr).

9.3.5 Resuspension and/or Pore Water Diffusion of PCBs from Contaminated Bed Sediments

No site-specific data are available defining the magnitude of pore water diffusion and/or resuspension from bed sediments. The magnitude of pore water diffusion from bed sediments is estimated based on a combination of physical-chemical properties taken from the Lake Ontario PCB model (LimnoTech, 2004), combined with site-specific sediment PCB concentrations. The properties taken from the Lake Ontario PCB model were bed porosity by volume (0.92), fraction organic carbon of bed sediment solids (0.02), bed sediment particle density (2.45 g/cm^3), and organic carbon partition coefficient for PCBs (106.1 m^3/kg).

Results from the Lake Michigan Mass Balance Study (USEPA, 2006) indicate that sediment PCB concentrations over the study domain are on the order of 20 ng/g, resulting in a gross sediment flux of 0.012 kg/year across the entire study area. Lacking site-specific data on the magnitude of sediment resuspension bed sediment PCBs, it can be reasonably assumed that this process is much smaller than sediment diffusion, given that this is a lake (rather than river) environment and that much of the sediment PCB re-deposits shortly after resuspension events.

9.3.6 Phase Partitioning Between the Adsorbed and Dissolved Form of PCB in the Water Column and Bed Sediments

While this process does not directly cause transfer of PCBs into or out of the system (and therefore is not represented with a magnitude in Table 9-2), it can be important in determining the magnitude of other phase-dependent processes such as settling and volatilization. No site-specific data are available defining the phase partitioning between adsorbed and dissolved form of PCBs, either in the water column or bed sediments. However, the degree of partitioning between dissolved and adsorbed forms and be roughly estimated from existing total suspended solids and particulate organic carbon data.

9.3.7 Settling of Particle-Bound PCB

No site-specific data are available defining the settling of particle-bound PCBs from the water column to bed sediments. Screening-level estimates of the magnitude of this process, suitable for determining its potential significance for inclusion can be obtained using inputs from the Lake Ontario PCB model (LimnoTech, 2004). Assuming a suspended solids settling velocity of 1.37 m/day as used for Lake Ontario, gross settling loss of PCBs in nearshore Lake Michigan is estimated at 4.2 kg/yr.

9.3.8 Volatilization of Dissolved Form PCB

No site-specific data are available defining the volatilization of PCBs from the water column to the atmosphere, although screening-level estimates of the magnitude of this process can be obtained using inputs from the Lake Ontario PCB model (LimnoTech, 2004). Volatilization losses of PCB from nearshore Lake Michigan is estimated at 8.4 kg/yr.

9.3.9 PCB Decay Processes

No site-specific data are available defining the PCB decay processes. PCBs are known to decay very slowly in the water column, with the only potentially significant loss component being biodegradation in bed sediments (due to very long sediment resident times).

9.3.10 Bioaccumulation

Section 5.1.1 of this report reviewed the available fish tissue PCB data. This review showed that carp were the most widely sampled fish species, with a total of 52 measurements available from Waukegan Harbor and North Point Marina. . Lake trout were the next most widely sampled species, with 30 measurements available from the nearshore open water/shoreline zone. Only two other fish species have ten measurements or more: rock bass and yellow perch.

9.3.11 Data Gap Assessment for PCBs

Table 9-2 summarizes the result of the data gap assessment for PCBs. Site-specific data sufficiency is characterized as poor (indicating the use of literature values and/or measurements less than the detection level) for the majority of the processes of concern, with hydrodynamic transport and atmospheric loading being the only sources that can be acceptably defined with existing data. Fewer than ten fish tissue samples are available on a study area-wide basis, making characterization of 90th percentile values difficult. Insufficient data are available to characterize fish tissue concentrations specific to each impaired segment.

Table 9-2. Summary of Data Gap Assessment for PCBs.

Process	Data Sufficiency	Estimated Magnitude
Hydrodynamic transport from main body of Lake Michigan	Acceptable	4.5 to 13 kg/yr
Hydrodynamic transport to main body of Lake Michigan	Acceptable	4.5 to 13 kg/yr
Atmospheric Loading	Acceptable	65 kg/yr
MS4 Stormwater Loading	Poor. Rough estimate made using literature-based concentrations	0.62 kg/yr
Flow Reversals from the Chicago Area Waterways	Poor. Estimate of upper bound; all available data are non-detect	<1.9 kg/yr
Other Point Source Discharges	Poor. Estimate of upper bound; all available data are non-detect	< 5 kg/yr
Diffusion and/or Resuspension from Bed Sediments	Poor. Rough estimate made using literature-based values	0.012 kg/yr
Phase Partitioning Between Adsorbed and Dissolved Form	Moderate. Can be estimated from available data.	n/a
Settling	Poor. Rough estimate made using literature-based values.	4.2 kg/yr
Volatilization	Moderate. Reasonable estimate made using literature-based values.	8.2 kg/yr
Decay Processes	Poor, but process believed to be small.	n/a
Bioaccumulation	Moderate. Tissue PCB data are available for most impaired segments, but are generally insufficient to calculate 90th percentiles on a segment-specific basis.	n/a

9.3.12 Refined Conceptual Model for PCBs

The results in Table 9-2 also allow an assessment of which fate and transport processes are potentially significant enough to merit inclusion in the TMDL model framework. Hydrodynamic transport of PCBs from the main body of Lake Michigan and atmospheric loading are clearly important loading sources. A definitive determination cannot be made for stormwater loading, other point source discharges, or flow reversals from the Chicago Area Waterways, because site-specific PCB concentration data is either below detection limits or not available. While literature-based estimates for these sources indicate that they are likely a minor contributor to the study area as a whole, the potential exists for them to be significant contributors to individual harbors. Hydrodynamic transport, settling and volatilization appear to be important loss processes.

9.4 Refined Conceptual Model and Data Gap Assessment for Mercury

This section identifies the magnitude of all other potentially applicable loading, fate and transport processes for mercury beyond hydrodynamic transport. Those sources are:

- Atmospheric loading to the harbors and the nearshore open water segment, including wet deposition, dry deposition
- MS4 stormwater loading to harbors and nearshore open water segments
- Flow reversals from the Chicago Area Waterways
- Point source discharges to the study area
- Resuspension and/or pore water diffusion from contaminated bed sediments
- Phase partitioning between adsorbed and dissolved form of pollutant in the water column and bed sediments
- Settling of the particle-bound pollutant
- Volatilization of the dissolved form of the pollutant
- Pollutant decay processes (e.g. photolysis)

A data gap assessment and refined conceptual model for mercury are presented at the end of this section.

9.4.1 Atmospheric Mercury Loading

An initial estimate of the total atmospheric mercury deposition across the nearshore open waters and harbors of the study area was obtained from USEPA's Regional Modeling System for Aerosols and Deposition (REMSAD; USEPA, 2008). REMSAD results were provided previously for use in the Statewide Michigan Mercury TMDL by USEPA (USEPA, 2012), and were used to make an initial estimate of atmospheric mercury deposition for this project. REMSAD is a "three-dimensional grid model designed to calculate the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations" (USEPA, 2008). REMSAD simulates both wet and dry deposition of mercury. Wet deposition occurs as a result of precipitation scavenging, in which mercury is removed from the air by attaching to water vapors or rain/snow. Dry deposition occurs when gas phase and particulate-bound mercury are deposited on terrestrial and aquatic surfaces. Atmospheric mercury loading to terrestrial and aquatic water surface occur via wet and dry deposition. Unlike PCBs, the atmospheric loading via air-water exchange is not significant for mercury. The Particle and Precursor Tagging Methodology feature of REMSAD allows the user to tag or track emissions from selected sources or groups of sources, and quantify their contribution to mercury deposition throughout the modeling domain and simulation period.

The REMSAD model was applied at a national scale. The year 2001 was chosen as the annual simulation year because REMSAD model inputs (emissions and meteorology) were primarily derived from the 2001 Clean Air Interstate Rule (CAIR) database, which USEPA used in the evaluation of the CAIR and the Clean Air Mercury Rule (CAMR).

The mass of mercury deposited on the nearshore open waters and harbors was calculated based on the total surface area of these waterbodies (473 square kilometers) and the model-predicted areal mercury deposition rate (ranges from 27.6 to 54.3 grams/square kilometer/yr). The annual mercury load deposited on the nearshore open water segment and four harbors is estimated to be between 28.7 and 56.7 lbs/yr (13 – 25.7 kg/yr).

9.4.2 MS4 Stormwater Mercury Loading to Harbors and Nearshore Open Water Segments

93.5% of the study area watershed lies within an MS4 city or village, and in addition, the County of Lake, Shields Township, Waukegan Township, and the Cook County Highway Department have MS4 permits. As a result, close to 100% of the study area is within an MS4 area. No site-specific data were available to quantify stormwater mercury loads for the study area watershed. The magnitude of stormwater mercury loads was therefore estimated as the product of runoff, the study area drainage area, and an assumed mercury concentration. The development of these inputs is described below.

Runoff quantity was calculated using the method developed by the Metropolitan Washington Council of Governments (Schueler, 1987) as: **R = P * Pj * Rv**

Where:

R = Annual runoff (inches),

P = Annual rainfall (inches) estimated as 36.1 inches, based on the average annual rainfall reported for Chicago Midway Airport 3 SW for the 1929-2013 period (http://www.crh.noaa.gov/lot/?n=111577_Midway)

Pj = Fraction of annual rainfall events that produce runoff (set to the default of 0.9)

Rv = Runoff coefficient. Rv is a function of impervious cover in the study area watershed, and was calculated using GIS analysis to determine impervious cover for commercial (0.71), industrial (0.54) and residential (0.37) land uses. The resulting runoff coefficients were: commercial (0.69), industrial (0.54) and residential (0.38).

The area of the contributing watershed was calculated as 99.6 square miles, broken down as: 3.82 square miles (commercial), 4.05 square miles (industrial) and 91.73 square miles (residential).

The mercury concentration was based on stormwater measurements from the USGS for the Columbia River Basin, Washington and Oregon (2009-2010) (Morace, 2012). The value used for load calculation was based on the average of reported values for total mercury, which equals 37.17 ng/L. The estimated stormwater mercury load equals 6.96 lbs/year (3.16 kg/yr).

9.4.3 Mercury Loading from Flow Reversals from the Chicago Area Waterways

The magnitude of loads from the Chicago Area Waterways is estimated based on flow and concentration measurements. Flow reversals from the Chicago Area Waterways to Lake Michigan occur periodically through O'Brien Lock, the Chicago River Lock, and Wilmette Lock. The volume of flow is reported by MWRD on their website for 1985 through 2014.
http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting_the_environment/Combined_Sewer_Overflows/pdfs/Reversals.pdf

Until recently, MWRD conducted sampling during flow reversals, including measurements of mercury. Mercury loads to the study area from flow reversals were calculated based on mercury concentration data collected at approximately 30 minute intervals during the 2013 flow reversals at each of these three locations (Table 9-3), and the average 2010-2014 annual volume (4,021.4 million gallons).

Table 9-3. Measured CAWS Mercury Concentrations during Times of Flow Reversals

Location	Location of mercury sampling	Mercury results (4/18/13)
O'Brien Lock	Calumet Harbor, 95th St. Bridge: Calumet Harbor, Ewing Ave. Bridge	All 68 samples < 0.2 ug/L
Chicago River Lock	Chicago River Locks, Inner Harbor Sluice Gate; Chicago River Locks, Sluice Gate, DuSable Harbor	All 28 samples < 0.2 ug/L
Wilmette Lock	Wilmette Harbor, Wilmette Pump Station	All 12 samples < 0.2 ug/L

Because all concentration measurements are less than detection, loads from this source cannot be accurately characterized. However, mercury loads from this source can be estimated to be less than 67 lbs/yr (30.4 kg/yr), using the detection limit as the basis for an upper-bound estimate of mercury concentration. Similar to PCBs, the availability of mercury measurements for CSOs was investigated. CSO measurements for CSOs in the study area are not available (MWRDGC, 2015a).

9.4.4 Other Point Source Mercury Discharges to the Study Area

Point source mercury loads were calculated based on permitted flow and measured concentration data, for facilities determined to have the potential to contribute mercury loads to the study area. These facilities were identified based on input and data provided by Illinois EPA. There are no facilities with mercury permit limits or mercury effluent monitoring requirements within the study area. Therefore, the mercury load from permitted point source dischargers was assumed to equal zero.

9.4.5 Pore Water Diffusion and/or Resuspension of Mercury from Contaminated Bed Sediments

No site-specific data are available defining the magnitude of pore water diffusion and/or resuspension from bed sediments. Pore water diffusion of mercury is typically an insignificant component of the total mercury budget to the lake, and can be assumed unimportant for the Illinois Lake Michigan nearshore area. Based on a mercury mass balance for Lake Michigan, Zhang et al. (2014) reported that the mass flux of mercury settling from water column is roughly four-times greater compared to mercury resuspension from sediments. Therefore, similar to PCBs, it can also be reasonably assumed that resuspension flux of mercury is relatively small, given that this is a lake (rather than river) environment and that much of the sediment-bound mercury re-deposits shortly after resuspension events.

9.4.6 Phase Partitioning Between Adsorbed and Dissolved Form of Mercury in the Water Column and Bed Sediments

While this process does not directly cause transfer of mercury into or out of the system, it is important in determine the magnitude of other phase-dependent processes such as settling and volatilization. No site-specific data are available defining the phase partitioning between adsorbed and dissolved form of mercury, either in the water column or bed sediments. However, the degree of partitioning between dissolved and adsorbed forms and be roughly estimated from existing total suspended solids and particulate organic carbon data.

9.4.7 Settling of Particle-Bound Mercury

No site-specific data are available defining the settling of particle-bound mercury from the water column to bed sediments. Screening-level estimates of the magnitude of this process can be obtained using inputs from the Lake Ontario PCB model (LimnoTech, 2004). Assuming a suspended solids settling velocity of

1.37 m/day as used for Lake Ontario, the gross settling loss of mercury in nearshore Lake Michigan is estimated at 15.6 kg/yr.

9.4.8 Volatilization of Mercury

Volatilization is an important loss pathway for mercury from aquatic systems (Denkenberger et al., 2012). The water-air exchange of mercury is driven by reduction of dissolved mercury species in the water column to gaseous elemental mercury (GEM) and its subsequent loss to the atmosphere. Denkenberger et al. (2012) reported an annual average volatilization rate of 0.75 ng/m^2/hr for Lake Michigan. Applying this value to the study area, the mercury volatilization loss is estimated at 3.1 kg/yr.

9.4.9 Mercury Biological Decay Processes

Mercury being an elemental compound, can undergo redox or sorption reactions to change speciation, but it does not undergo biological decay. This process can also be assumed to be zero.

9.4.10 Bioaccumulation

Section 5.1.2 of this report reviewed the available fish tissue mercury data. This review showed that largemouth bass was the species with the highest concentration, but that only a total of three measurements were available, all from North Point Marina. Smallmouth bass were the next most contaminated species, with seven measurements available from Waukegan Harbor and North Point Marina.

9.4.11 Data Gap Assessment for Mercury

Table 9-4 summarizes the result of the data gap assessment for mercury. Site-specific data sufficiency is characterized as poor (indicating the use of literature values and/or measurements less than the detection level) for the majority of the processes of concern, with hydrodynamic transport and atmospheric loading being the only sources that can be acceptably defined with existing data. Sufficient fish tissue data are available to estimate 90th percentile values for two species on a study area-wide basis. Insufficient data are available to characterize fish tissue concentrations specific to each impaired segment.

Table 9-4. Summary of Data Gap Assessment for Mercury.

Process	Data Sufficiency	Estimated Magnitude
Hydrodynamic transport from main body of Lake Michigan	Acceptable	10 kg/yr
Hydrodynamic transport from main body of Lake Michigan	Acceptable	10 kg/yr
Atmospheric Loading	Acceptable	13 – 25.7 kg/yr
MS4 Stormwater Loading	Poor. Rough estimate made using literature-based values	3.16 kg/yr
Flow Reversals from the Chicago Area Waterways	Poor. Estimate of upper bound; available data are all below detection.	<30.4 kg/yr
Other Point Source Discharges	Acceptable. No known point sources.	0
Diffusion and/or Resuspension from Bed Sediments	Acceptable. Process can be considered insignificant.	n/a
Phase Partitioning Between Adsorbed and Dissolved Form	Moderate. Can be estimated from available data.	n/a
Settling	Poor. Rough estimate made using literature-based values.	15.6 kg/yr
Volatilization	Poor. Rough estimate made using literature-based values.	3.1 kg/yr
Decay Processes	Acceptable. Process can be considered insignificant.	0
Bioaccumulation	Moderate. Tissue mercury data are available for most impaired segments, but are generally insufficient to calculate 90th percentiles on a segment-specific basis.	n/a

9.4.12 Refined Conceptual Model for Mercury

The results in Table 9-4 also allow an assessment of which fate and transport processes are potentially significant enough to merit inclusion in the TMDL model framework. Hydrodynamic transport of mercury from the main body of Lake Michigan and atmospheric loading are clearly important loading sources. A definitive determination cannot be made for stormwater loading, other point source discharges, or flow reversals from the Chicago Area Waterways, because site-specific mercury concentration data is either below detection limits or not available. While literature-based estimates for these sources indicate that they are likely a minor contributor to the study area as a whole, the potential exists for them to be significant contributors to individual harbors. Hydrodynamic transport and settling appear to be important loss processes.

10
Candidate Approaches

Three different candidate approaches are provided for the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs, based upon the refined conceptual models and data gap assessments described above. Three different approaches are provided, corresponding to:

- Level One: Proportionality Approach
- Level Two: Steady State Mass Balance Approach
- Level Three: Time-Variable Approach

10.1 Level One: Proportionality Approach

The simplest option for the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs corresponds to the Level One Proportionality Approach. This approach is based on the assumption that fish tissue pollutant concentrations are directly proportional to the pollutant load delivered to the waterbody of interest, i.e.

$$\text{Fish Tissue Pollutant Concentration} = a \times \text{Pollutant Load} \qquad (1)$$

where a = proportionality constant

With this approach, Equation 1 can be rearranged to calculate the proportionality constant based on current fish tissue concentration and pollutant load:

$$a = \text{Current Fish Tissue Pollutant Concentration} \div \text{Current Pollutant Load} \qquad (2)$$

This proportionality constant can either be a single coefficient based on average values of terms on right hand side, or it can be calculated as the slope of a straight line formed by fitting to multiple values (i.e., different loads and associated fish tissue concentrations).

The proportionality constant can then be used to determine the maximum amount of pollutant load that will meet desired fish tissue concentrations:

$$\text{Maximum Allowable Pollutant Load} = \text{Target Fish Tissue Pollutant Concentration} \div a \qquad (3)$$

This proportionality approach requires the following assumptions:

- All loading sources to the system have the same relative effect on fish tissue concentrations, i.e. the proportionality constant calculated in Equation 2 is equally applicable to all pollutant loading sources. Because this approach does not consider spatial variability, it also assumes that a given load has the same effect on fish tissue regardless of location in the study area.
- The system is currently at steady state, i.e. current fish tissue pollutant concentrations are caused solely by the current pollutant load.

These assumptions, combined with the data gaps defined above, pose some potential limitations with respect to the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs. First, this approach cannot currently be used to define the amount of pollutant loading to individual harbors that will exactly result in compliance with fish targets in those harbors. This is because insufficient information is available to accurately define the existing pollutant load to harbors, as well as to define the amount of dilution that pollutant loads to harbors receive as a result of exchange with Lake Michigan. Second, this approach poses problems for the use of carp as a target fish species for PCBs. This is because carp obtain much of their PCB contamination from bed sediments, and bed sediments are less amenable to the assumption that the system is currently at steady state with respect to loading than is the water column.

The violation of these key assumptions does not necessarily prohibit the use of the Level One Proportionality Approach for the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs, as modifications can be made to this approach to minimize the issues caused by the violation of the key assumptions. The first necessary modification is to require that both the mercury and PCB TMDLs limit direct loading to harbors to concentrations that would be protective of fish tissue concentrations. This modification would ensure that the TMDL was protective of harbors, even though the amount of dilution that harbors receive is unknown. The second required modification is that the level of PCB load reduction necessary to attain compliance in Lake Michigan would need to be based on a species other than carp. The loading target would need to be based on a species, such as lake trout, where it could be reasonably assumed that tissue concentrations current are caused primarily by the current pollutant load as opposed to legacy sediment concentrations. Separate calculations would need to be provided as part of the TMDL demonstrating that PCB loads that are protective of lake trout would ultimately be protective of carp as well.

Consideration of seasonal variation, margin of safety (MOS) and daily loads would be addressed in a manner similar to the statewide Michigan PCB and mercury TMDLs (LimnoTech, 2012 and LimnoTech, 2013). TMDLs are required to consider seasonal variations and critical environmental conditions [40 CFR§130.7(c)(1)]. Atmospheric PCB concentrations are known to vary seasonally due to changes in air temperature. Seasonal variation will be considered in the PCB TMDLs through the use of expected daily maximum concentration associated with expected daily maximum temperature. Mercury concentrations in the atmosphere and water column can fluctuate seasonally. However, accumulation of mercury in fish tissue over time masks any seasonal variations. Due to the extremely slow response time of water and fish concentrations to changes in atmospheric loads, essentially no seasonal variation occurs in fish mercury concentrations due to seasonal variations in atmospheric concentrations. The mercury concentration in the fish represents an integration of all temporal variation up to the time of sample collection. Variability among fish because of differences in size, diet, habitat, and other undefined factors are expected to be greater in sum than seasonal variability (MPCA, 2007).

The MOS is a required part of the TMDL to account for any uncertainty in the relationship between pollutant loading and receiving water quality (40 CFR, Part 130.7(c)(1)). The MOS can be either explicit (e.g., stated as an additional percentage load reduction) or implicit (i.e., conservative assumptions in the TMDL calculations or overall approach) in the calculations of the TMDL, or a combination of the two. An implicit MOS is planned for these TMDLs, supported by the use of the following conservative assumptions that will be used to calculate the TMDL:

- Fish tissue reduction targets will be based on fish species showing the highest pollutant concentration. A TMDL that obtains compliance for these species will ensure compliance for all other fish species.
- The 90th percentile fish tissue concentration will be used as a basis for these TMDLs.

Calculating the TMDL based on these relatively high tissue concentrations will incorporates a MOS into determining the percent reduction required of fish tissue to meet the target goal.

USEPA encourages that TMDLs be expressed on a daily basis, so these annual average concentrations will also be expressed as daily maximum values in this TMDL. An annual load is the most technically appropriate way to express these TMDLs because the goal is to address long term bioaccumulation, rather than track short term effects. Consistent with the Northeast U.S. and Minnesota mercury TMDLs, a daily load will be estimated for these TMDLs by dividing the annual load by 365 (MPCA, 2007, NEIWPCC, 2007).

10.2 Level Two: Steady State Mass Balance Approach

Level Two provides an intermediate complexity option towards development of the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs, and consists of a steady state mass balance approach. The mass balance equation for any given segment can be written as:

$$V_i d[C_i]/dt = W_i + Q_{in,i}[C_{in,i}] - Q_{out,i}[C_i] - V_i k_i [C_i] \tag{4}$$

where V_i = volume of segment i (L^3)

$[C_i]$	=	pollutant concentration in segment i (M/L^3)
W_i	=	pollutant load to segment i (M/T)
$Q_{in,I}$	=	flow into segment i from adjacent "upstream" segment ($M/L^3/T$)
$[C_{in,i}]$	=	pollutant concentration in adjacent "upstream" segment (M/L^3)
$Q_{out,i}$	=	flow out of segment i ($M/L^3/T$)
$[k_i]$	=	pollutant loss rate coefficient in segment i (1/T)

A separate mass balance equation could be written for the pollutant concentrations in bed sediments, if predictions of bed sediment concentrations are of interest. Because Level 2 represents a steady state condition, Equation 4 can be rearranged to solve for the steady state pollutant concentration (i.e. $d[C^i]/dt = 0$) that is expected to occur in response to steady loads and steady environmental conditions:

$$[C_i] = (W_i + Q_{in,i}[C_{in,i}] - V_i k_i [C_i]) / Q_{out,i} \tag{5}$$

Pollutant concentrations estimated using Equation 5 could then be linked to a steady state bioaccumulation model that computes fish tissue concentration as a function of direct uptake from the water plus bioaccumulation via the food chain.

This approach improves upon the capabilities of the Level One approach, by not requiring the assumption that all loading sources to the system have the same relative effect on fish tissue concentrations. It therefore provides the capability of generating unique results for each impaired segment, and would allow the loading capacity of individual harbors to be assessed separately from the loading capacity of the lumped nearshore harbor/shoreline/open water system. Consideration of seasonal variation, margin of safety (MOS) and daily loads would be addressed in the same manner as described above for the Level One approach.

The disadvantage to the Level Two approach is that site-specific data do not exist to define the values of many of the required inputs to Equations 4 and 5. For example, the Great Lakes Coastal Forecasting System has the capability of defining hydrodynamic exchange between the nearshore open water segments and shoreline segments, but it does not have the spatial resolution to define hydrodynamic exchange between harbors and the nearshore open water segment. Similarly, insufficient data are available to rigorously define the pollutant loss rate coefficient by segment.

The lack of data to rigorously define many Level Two model inputs does not necessarily prohibit the use of this approach for the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs, as sufficient information exists to allow the missing input values to be roughly estimated. For example, the Great Lakes Coastal Forecasting System predicts time-variable changes in water surface elevation near the entrances to the harbors of interest. The water level information could be used to estimate the amount of hydraulic exchange between each harbor and the nearshore waters. Existing pollutant fate and transport models developed for the Great Lakes would provide rough estimates of the pollutant loss rate coefficient. While these missing inputs could only be roughly estimated, model sensitivity analyses could be conducted to determine the extent to which uncertainty in these inputs affects TMDL model results.

10.3 Level Three: Time-Variable Approach

The Level Three approach provides the greatest level of temporal detail, spatial detail, and process complexity. The mass balance equation for any given water column segment is similar to Equation 4, differing in the partitioning of total pollutant concentration in dissolved and particle-bound phases and the explicit consideration of interaction with the bed sediments. In addition, a mass balance equation is also solved for the bed sediments

$$V_i d[C_i]/dt = W_i + Q_{in,i}[C_{in,i}] - Q_{out,i}[C_i] - V_i kd_i[Cd_i] - V_i kp_i[Cp_i] + v_{rs,i}/A_i[CS_i] \quad (6)$$

$$VSid[CSi]/dt = VSikpi[Cpi] - vrs,i/Ai[CSi] - vb,i/Ai[CSi] \quad (7)$$

where Vi = volume of segment i (L^3)

[Ci]	=	total pollutant concentration in segment i (M/L^3)
Wi	=	total pollutant load to segment i (M/T)
$Q_{in,i}$	=	flow into segment i from adjacent “upstream” segment ($M/L^3/T$)
$[C_{in,i}]$	=	total pollutant concentration in adjacent “upstream” segment (M/L^3)
$Q_{out,I}$	=	flow out of segment i ($M/L^3/T$)
$[kd_i]$	=	pollutant loss rate coefficient for dissolved phase pollutant in segment i (1/T)
$[kp_i]$	=	pollutant loss rate coefficient for particle-bound pollutant in segment i (1/T)
$v_{rs,i}$	=	flux velocity of pollutants out of bed sediments in segment i (M/T)
A_i	=	Surface area of sediment-water interface in segment i (L^2)
$[VS_i]$	=	volume of active bed sediment layer in segment i (L^3)
$[CS_i]$	=	pollutant concentration of bed sediments in segment i (M/L^3)
$V_{b,i}$	=	burial velocity of pollutants in bed sediments of segment i (M/T)

Results from Equations 6 and 7 can be used to define fish tissue concentrations either via linkage to a food web bioaccumulation model through the use of empirical bioaccumulation factors.

The primary difference between Level Three and the other candidate approaches is that the Level Three approach is capable of simulating how pollutant concentrations change over time. This allows accurate consideration of time-variable loading sources, as well as consideration of the response time that the system will require to attain water quality standards after the TMDL is implemented. This capability is especially useful in terms of assessing existing carp tissue contamination data, as carp contamination may be driven by exposure to legacy sediment contamination which is not readily considered by steady state approaches.

Seasonal variation and expression of the TMDL as daily loads would be explicitly considered in the Level Three approach, as it would simulate the day-to-day variability in pollutant loads and receiving water concentrations. The margin of safety would be handled in the same implicit manner as for Levels One and Two, through the use of conservative assumptions.

The overwhelming limitation of the Level Three approach is the absence of data available to support its application. Level Three models require not only information for each of the inputs to Equations 6 and 7, but they also require an understanding of how each of these inputs has varied over time. This information is not available for the Illinois Lake Michigan Nearshore area, for either mercury or PCBs.

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Recommendation for Preferred Approach

None of the candidate model frameworks are ideally suited for the Illinois Lake Michigan Nearshore PCB and Mercury TMDLs. Selection of the Level One approach brings an *a priori* requirement that all loads to impaired harbors must be demonstrated to be insignificant, or be restricted to concentrations that will comply with water quality standards. Selection of the Level Two approach will require several model input parameters to be roughly estimated. Both the Level One and Level Two approaches are incapable of directly addressing the potential that carp tissue PCB concentration are influenced by legacy contamination. The Level Three approach, while theoretically free of the limitations of the Level One and Level Two approaches, requires significantly more data than are currently available.

Of the above limitations, only the severe lack of data to support a Level Three approach can be considered insurmountable. Indirect methods can be used in the Level One and Level Two approaches to assess whether a given TMDL will be protective of carp tissue PCB levels. Values for missing Level Two inputs can be estimated, and the uncertainty associated with these inputs can be evaluated.

Selection between the Level One and Level Two approaches requires a policy decision. If it is acceptable to require *a priori* that all loads to impaired harbors must be at concentrations that will comply with water quality standards, the Level One approach is capable of defining the necessary reduction in local and regional atmospheric sources necessary to attain fish tissue targets. If regulatory flexibility is desired to allow sources to impaired harbors to be at concentrations above water quality standards (and therefore make use of the assimilative capacity of the harbors), the Level Two approach is recommended. Based upon consultation with Illinois EPA and USEPA, the Level One approach is recommended.

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Appendix A: 303(d) List of Impaired Segments and Causes

Table A-1. Impaired segments in the project study area

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment	Cause(s)
Nearshore open water/shoreline	Lake Michigan Shoreline	North Point Beach	IL_QH-01	0.42	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park North	IL_QH-03	2.72	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan North Beach	IL_QH-04	1.51	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan South Beach	IL_QH-05	1.55	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park South	IL_QH-09	4.67	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Bluff Beach	IL_QI-06	5.5	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Forest Beach	IL_QI-10	3.79	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Rosewood Beach	IL_QJ	2.19	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Park Ave. Beach	IL_QJ-05	4.08	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Glencoe Beach	IL_QK-04	2.15	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Tower Beach	IL_QK-06	1.17	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Lloyd Beach	IL_QK-07	0.32	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Maple Beach	IL_QK-08	0.57	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Elder Beach	IL_QK-09	0.92	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Kenilworth Beach	IL_QL-03	0.76	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Gilson Beach	IL_QL-06	2	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Greenwood Beach	IL_QM-03	0.38	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Lee Beach	IL_QM-04	0.43	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Lighthouse Beach	IL_QM-05	0.64	Miles	Fish consumption	Mercury, PCBs

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment	Cause(s)
Nearshore open water/shoreline	Lake Michigan Shoreline	Northwestern University Beach	IL_QM-06	0.73	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Clark Beach	IL_QM-07	0.94	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	South Boulevard Beach	IL_QM-08	0.98	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Touhy (Leone) Beach	IL_QN-01	0.41	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Loyola (Greenleaf) Beach	IL_QN-02	0.29	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Hollywood/ Ostermann Beach	IL_QN-03	0.27	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Foster Beach	IL_QN-04	0.65	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Montrose Beach	IL_QN-05	1.45	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Juneway Terrace	IL_QN-06	0.07	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Rogers Beach	IL_QN-07	0.16	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Howard Beach	IL_QN-08	0.16	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Jarvis Beach	IL_QN-09	0.26	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Pratt Beach	IL_QN-10	0.19	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	North Shore/Columbia	IL_QN-11	0.16	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Albion Beach	IL_QN-12	0.53	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Thorndale Beach	IL_QN-13	0.69	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	North Ave. Beach	IL_QO-01	0.55	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Fullerton Beach	IL_QO-02	3.07	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Webster Beach	IL_QO-03	0.29	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Armitage Beach	IL_QO-04	0.27	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Schiller Beach	IL_QO-05	0.57	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Oak St. Beach	IL_QP-02	0.64	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Ohio St. Beach	IL_QP-03	0.93	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	12th St. Beach	IL_QQ-01	1.93	Miles	Fish consumption	Mercury, PCBs

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment	Cause(s)
Nearshore open water/shoreline	Lake Michigan Shoreline	31st St. Beach	IL_QQ-02	3.32	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	49th St. Beach	IL_QR-01	1.43	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Jackson Park/63rd Beach	IL_QS-02	0.73	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Rainbow	IL_QS-03	3.34	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	57th St. Beach	IL_QS-04	0.33	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	67th St. Beach	IL_QS-05	0.71	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	South Shore Beach	IL_QS-06	0.43	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Shoreline	Calumet Beach	IL_QT-03	1.29	Miles	Fish consumption	Mercury, PCBs
Nearshore open water/shoreline	Lake Michigan Open Water	Open waters Lake Michigan Nearshore	IL_QLM-01	180	Square miles	Fish consumption	Mercury, PCBs
North Point Marina Harbor	North Point Marina Harbor	North Point Marina Harbor	IL_QH	0.121	Square miles	Fish consumption	Mercury, PCBs
Waukegan Harbor	Waukegan Harbor	Waukegan Harbor North	IL_QZO	0.0652	Square miles	Fish consumption, Aquatic life	Mercury, PCBs
Calumet Harbor	Calumet Harbor	Calumet Harbor	IL_3S	2.4	Square miles	Fish consumption	Mercury, PCBs
Diversey Harbor	Diversey Harbor	Diversey Harbor	IL_QZI	0.0456 3	Square miles	Fish consumption	Mercury, PCBs

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Appendix B: GIS Data Compilation and QA Review

GIS data layers were compiled in an ArcGIS file geodatabase. All data in the geodatabase have a consistent projection/coordinate system and horizontal units:

Illinois State Plane Coordinate System (SPCS)
East Zone (FIPS Zone 1201)
NAD 1983
U.S. survey feet

Spatial data layers are grouped within feature datasets: Hydrography, Political, Sources, and Stations (Table B-1). Source information will be used to support development of the TMDL approach and the TMDLs.

Table B-1. Data types and sources

Data type	Spatial data layer	Source
Hydrography	Lake Michigan shoreline segments	Illinois EPA
	Lake Michigan open water segment	Illinois EPA
	Lake Michigan harbors	Illinois EPA
	Streams and lakes	National Hydrography Dataset (NHD)
	Hydrologic units (watersheds)	Watershed Boundary Dataset (WBD)
	Control structures on Chicago Area Waterway System	Metropolitan Water Reclamation District of Greater Chicago
Political	City boundaries	U.S. Census Bureau
	County and state boundaries	U.S. Census Bureau
	County and state boundaries	National Map (U.S. Geological Survey)
Sources	Permitted dischargers	Illinois EPA
	Regulated facilities	U.S. EPA
Stations	Sampling station location	U.S. EPA, Illinois EPA, USGS

For all acquired spatial data, location accuracy was assessed using GIS. If discrepancies were found, further checks or data revisions were pursued. For example, Illinois EPA provided a draft version of the Lake Michigan 5-km open waters segment. Its total area did not match an IEPA documented area, so further checks were made. The shoreline side of the segment was found to not match the IEPA-assessed shoreline segments. As a result, LimnoTech established a standard shoreline shared by the open water and shoreline segments, eliminated harbors that were not open waters, and constructed a GIS data layer for a consistent 5-km buffer truncated at established state boundaries.

Similarly, coordinates of sample stations were first checked to see if they placed a station at the place in its description. If not, LimnoTech used the description and other available information to determine an approximate location for the station. Then locations were compared to the study area boundary (defined by the impaired segments and the contributing watershed), including the open waters buffer and the Lake Michigan watershed on the land side in Illinois, which includes small tributaries directly to Lake Michigan.

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Appendix C: Count of Fish Fillet Samples by TMDL Zone

Table C-1 presents a count of fish mercury fillet samples by species and TMDL zone. Table C-2 presents the same information for PCB fillet samples.

Table C-1. Count of fish mercury fillet samples by species and TMDL zone

Fish Species	TMDL Zone				Grand Total
	Nearshore open water/ shoreline	Calumet Harbor	North Point Marina	Waukegan Harbor	
Black bullhead				2	2
Brown trout	1				1
Largemouth bass			3		3
Rainbow trout	2				2
Rock bass		1	4	4	9
Smallmouth bass		5	2		7
Sunfish			3	2	5
White sucker			2	2	4
Grand Total	**3**	**6**	**14**	**10**	**33**

Table C-2. Count of fish PCB fillet samples by fish species and TMDL zone.

Fish Species	TMDL Zone					Grand Total
	Nearshore open water/ shoreline	Calumet Harbor	Diversey Harbor	North Point Marina	Waukegan Harbor	
Alewife	6					6
Black bullhead					3	3
Bloater chub	7					7
Brown trout	1					1
Carp				12	40	52
Lake trout	30					30
Largemouth bass				3	1	4
Pumpkinseed sunfish			1		2	3
Rainbow smelt	1					1
Rainbow trout	2					2
Rock bass		1		4	5	10
Round goby		1		2		3
Smallmouth bass		5		2		7
Sunfish				4	3	7
White sucker				2	4	6
Yellow perch	21				1	22
Grand Total	**68**	**7**	**1**	**29**	**59**	**164**

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Appendix B:
303(d) List of Segments Impaired due to PCBs that are Addressed by this TMDL

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	North Point Beach	IL_QH-01	0.42	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park North	IL_QH-03	2.72	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan North Beach	IL_QH-04	1.51	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Waukegan South Beach	IL_QH-05	1.55	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	IL Beach State Park South	IL_QH-09	4.67	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Bluff Beach	IL_QI-06	5.5	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lake Forest Beach	IL_QI-10	3.79	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rosewood Beach	IL_QJ	2.19	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Park Ave. Beach	IL_QJ-05	4.08	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Glencoe Beach	IL_QK-04	2.15	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Tower Beach	IL_QK-06	1.17	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lloyd Beach	IL_QK-07	0.32	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Maple Beach	IL_QK-08	0.57	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Elder Beach	IL_QK-09	0.92	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Kenilworth Beach	IL_QL-03	0.76	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Gilson Beach	IL_QL-06	2	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Greenwood Beach	IL_QM-03	0.38	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lee Beach	IL_QM-04	0.43	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Lighthouse Beach	IL_QM-05	0.64	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Northwestern University Beach	IL_QM-06	0.73	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Clark Beach	IL_QM-07	0.94	Miles	Fish consumption

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	South Boulevard Beach	IL_QM-08	0.98	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Touhy (Leone) Beach	IL_QN-01	0.41	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Loyola (Greenleaf) Beach	IL_QN-02	0.29	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Hollywood/ Ostermann Beach	IL_QN-03	0.27	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Foster Beach	IL_QN-04	0.65	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Montrose Beach	IL_QN-05	1.45	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Juneway Terrace	IL_QN-06	0.07	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rogers Beach	IL_QN-07	0.16	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Howard Beach	IL_QN-08	0.16	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Jarvis Beach	IL_QN-09	0.26	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Pratt Beach	IL_QN-10	0.19	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	North Shore/Columbia	IL_QN-11	0.16	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Albion Beach	IL_QN-12	0.53	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Thorndale Beach	IL_QN-13	0.69	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	North Ave. Beach	IL_QO-01	0.55	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Fullerton Beach	IL_QO-02	3.07	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Webster Beach	IL_QO-03	0.29	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Armitage Beach	IL_QO-04	0.27	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Schiller Beach	IL_QO-05	0.57	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Oak St. Beach	IL_QP-02	0.64	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Ohio St. Beach	IL_QP-03	0.93	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	12th St. Beach	IL_QQ-01	1.93	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	31st St. Beach	IL_QQ-02	3.32	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	49th St. Beach	IL_QR-01	1.43	Miles	Fish consumption

TMDL Zone	HUC 10	Waterbody Name	Segment ID	Size	Size Units	Designated Use Impairment
Nearshore open water/shoreline	Lake Michigan Shoreline	Jackson Park/63rd Beach	IL_QS-02	0.73	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Rainbow	IL_QS-03	3.34	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	57th St. Beach	IL_QS-04	0.33	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	67th St. Beach	IL_QS-05	0.71	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	South Shore Beach	IL_QS-06	0.43	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Shoreline	Calumet Beach	IL_QT-03	1.29	Miles	Fish consumption
Nearshore open water/shoreline	Lake Michigan Open Water	Open waters Lake Michigan Nearshore	IL_QLM-01	180	Square miles	Fish consumption
North Point Marina Harbor	North Point Marina Harbor	North Point Marina Harbor	IL_QH	0.121	Square miles	Fish consumption
Waukegan Harbor	Waukegan Harbor	Waukegan Harbor North	IL_QZO	0.0652	Square miles	Fish consumption, Aquatic life
Calumet Harbor	Calumet Harbor	Calumet Harbor	IL_3S	2.4	Square miles	Fish consumption
Diversey Harbor	Diversey Harbor	Diversey Harbor	IL_QZI	0.0456 3	Square miles	Fish consumption

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Appendix C: Historic PCB Uses and Sources

USEPA (1994) compiled historic uses of PCBs in the U.S. (Table B-1) and examples of how these products were used in industrial processes (Table B-2). Specific Aroclor mixtures were created and targeted to specific applications (Table B-3). This information is useful in source identification since Aroclors in sediment/soil, fish and water samples can be distinguished in laboratory analysis and matched with those industries/uses present in the watershed. In addition to Aroclors, there are dozens of other trade names that have been used to refer to PCBs and PCB mixtures. Appendix B of Washington Department of Ecology (2014) has a full list. USEPA has a database of transformers reported to be still in use and that contain PCBs. There were 134 registered transformers that remained in the watershed as of 2011, containing 182,064 kg of PCBs (Table B-4; USEPA, 2011a).

Table C-1. Historic Uses of PCBs in the U.S., 1929-1975 Source: USEPA 1994

PCB Use	Pounds (millions)	Percentage of Total
Capacitors	630	50.3%
Transformers	335	26.7%
Plasticizer Uses	115	9.2%
Hydraulics and Lubricants	80	6.4%
Carbonless Copy Paper	45	3.6%
Heat Transfer Fluids	20	1.6%
Petroleum Additives	1	0.1%
Miscellaneous Industrial Uses	27	2.2%
Totals	1,253	100%

Table C-2. Examples of Legacy Uses of PCBs in Industrial Processes Source: USEPA 1994

Class	US Consumption	Examples
Closed: PCB-containing fluid is encased in equipment	75%	Industrial scale transformers, capacitors, voltage regulators
		Fluorescent light ballasts
		Consumer electrical items (fridges, televisions, washing machines)
		Manufacturing machinery (capacitors, transformers, associated switchgear)
Partially closed: PCB-containing fluid potentially has exposure to the outside	10%	Hydraulic fluids
		Heat exchange fluids
		Gas pipelines
Open: PCBs exist in materials that are exposed all the time	15%	Plasticizer in paints, resins, synthetic rubber, surface coatings, wax
		Sealants, waterproofing compound, glues and adhesives
		Caulking compounds
		Pesticide extenders
		Pigments and dyes
		Carbonless copy paper
		Microscope immersion oil
		Sound proofing materials
		Window glazing

Table C-3. End Uses for Specific Aroclor Mixtures Source: ATSDR, 2000

End use	Aroclor								
	1016	1221	1232	1242	1248	1254	1260	1262	1268
Capacitors	•	•				•			
Transformers				•		•	•		
Heat transfer				•					
Hydraulics/lubricants									
Hydraulic fluids			•	•	•	•	•		
Vacuum pumps					•	•			
Gas-transmission turbines		•		•					
Plasticizers:									
Rubbers		•	•	•	•	•			•
Synthetic resins					•	•	•	•	•
Carbonless paper				•					
Miscellaneous:									
Adhesives		•	•	•	•	•			
Wax extenders				•		•			•
Dedusting agents						•	•		
Inks						•			
Cutting oils						•			
Pesticide extenders						•			
Sealants and caulking compounds						•			

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Table C-4. Registered transformers that remained in the watershed as of 2011 Source: USEPA, 2011a

RECORD ID	COMPANY	CONT_NAME	CONT_PHONE	ASSIGNED TRANS LOCATION ID	TRANSFORMER BOX NUMBER	SITE	TRANS_STR	TRANS_CITY	TRANS_STATE	TRANS_ZIP	NO_TRANSFORMERS	WT_KG	NAME_OFF	TITLE_OFF	DATE_SIGNED
55	Acme Steel Company	David Holmberg	708-841-8383 ext. 2438	1772	2	Chicago Coke Plant	11236 South Torrence Avenu	Chicago	IL	60617	2	3362	David Holmberg	Manager, Environmental Services	3-Dec-98
56	Acme Steel Company	David Holmberg	708-841-8383 ext. 2438	1773	3	Chicago Furnace Plant	10730 South Burley Avenue	Chicago	IL	60617	3	4182	David Holmberg	Manager, Environmental Services	3-Dec-98
779	Chicago Specialities, Inc.	Cindy Ferguson	773-660-4016	1778	1	Blank	735 East 115th Street	Chicago	IL	60628	2	2931	Robert Fournier	Plant Manager	17-Dec-98
873	ComEd	David Rubner	312-394-4455	1775	2	ComEd Substation Calumet Peaking Unit	3200 East 100th Street	Chicago	IL	60623	17	1455	Brian M McCann	Land Quality Supervisor	1-Dec-98
877	ComEd	David Rubner	312-394-4455	2756	15	ComEd Substation SS-674/ Irving Park	4664 West Irving Park	Chicago	IL	Blank	2	402	Brian McConn	Land Quality Supervisor	1-Dec-98
878	ComEd	David Rubner	312-394-4455	2757	14	ComEd Substation SS-679/Besley Court	1814 North Elston	Chicago	IL	Blank	1	2409	Brian McConn	Land Quality Supervisor	1-Dec-98
879	ComEd	David Rubner	312-394-4455	2758	13	ComEd Substation SS-68/Ardmore	1128 West Ardmore	Chicago	IL	Blank	1	207	Brian McConn	Land Quality Supervisor	1-Dec-98
880	ComEd	David Rubner	312-394-4455	2759	18	ComEd Substation SS-687/Nagel	5837 North Nagel	Chicago	IL	Blank	2	468	Brian McConn	Land Quality Supervisor	1-Dec-98
881	ComEd	David Rubner	312-394-4455	2760	7	ComEd Substation SS-767/Division	1510 Division Street	Chicago	IL	Blank	16	42249	Brian McConn	Land Quality Supervisor	1-Dec-98
882	ComEd	David Rubner	312-394-4455	2761	9	ComEd Substation SS-781/56th St	5549 South Lowe	Chicago	IL	Blank	1	4702	Brian McConn	Land Quality Supervisor	1-Dec-98
883	ComEd	David Rubner	312-394-4455	2762	17	ComEd Substation SS-793/ Laramie	909 North Laramie	Chicago	IL	Blank	2	409	Brian McConn	Land Quality Supervisor	1-Dec-98
884	ComEd	David Rubner	312-394-4455	2763	20	ComEd Substation SS-851/Washtenaw	4722 South Washtenaw	Chicago	IL	Blank	1	584	Brian McConn	Land Quality Supervisor	1-Dec-98
885	ComEd	David Rubner	312-394-4455	2764	19	ComEd Substation SS-875/Throop	6909 South Throop	Chicago	IL	Blank	4	808	Brian McConn	Land Quality Supervisor	1-Dec-98
886	ComEd	David Rubner	312-394-4455	2765	10	ComEd Substation SS-884/ Prairie	4716 South Prairie	Chicago	IL	Blank	1	2673	Brian McConn	Land Quality Supervisor	1-Dec-98
887	ComEd	David Rubner	312-394-4455	2766	11	ComEd Substation SS-896/111th St	2501 West 111th Street	Chicago	IL	Blank	2	1089	Brian McConn	Land Quality Supervisor	1-Dec-98
888	ComEd	David Rubner	312-394-4455	2767	12	ComEd Substation TSS-137/Washington Park	6220 South Prairie Street	Chicago	IL	Blank	1	986	Brian McConn	Land Quality Supervisor	1-Dec-98
889	ComEd	David Rubner	312-394-4455	2768	8	ComEd Substation TSS-31/Galewood	2350 North Narragansett	Chicago	IL	Blank	1	4422	Brian McConn	Land Quality Supervisor	1-Dec-98
890	ComEd	David Rubner	312-394-4455	2769	16	ComEd Substation TSS-35/Lakeview	1141 West Diversey	Chicago	IL	Blank	1	188	Brian McConn	Land Quality Supervisor	1-Dec-98
891	ComEd	David Rubner	312-394-4455	2770	21	ComEd Substation TSS-41/Roseland	10801 South Michagan	Chicago	IL	Blank	3	613	Brian McConn	Land Quality Supervisor	1-Dec-98
896	ComEd	David Rubner	312-394-4455	1753	29	Zion Generating Station	101 Shiloh Boulevard	Zion	IL	60099	23	39715	Brian McConn	Land Quality Supervisor	1-Dec-98
1274	Ford Motor Company	Carla Ward	773-646-7472	1779	1	Chicago Assembly Plant	12600 South Torrence Avenu	Chicago	IL	60633	13	24949	R. Griffin Jr.	Plant Manager	7-Dec-98
1481	Holnam Inc.	Joseph P. Lynch	708-458-3458	3364	1	Under Silo's	8001 West 59th Street	Chicago	IL	Blank	1	4264	Joseph Lynch	Manager of Chicago Terminals	15-Dec-98
2069	North Shore Sanitary District	David C. Miller	847-623-6060	2740	1	Clavey Road Substation	Clavey Road	Highland	IL	Blank	5	7112.76	David C. Miller, ARM	Human Resource Manager	4-Oct-99
2070	North Shore Sanitary District	David C. Miller	847-623-6060	2793	3	Waukegan Substation	Dahringer Road	Waukeg	IL	Blank	4	2575.32	David C. Miller, ARM	Human Resource Manager	4-Oct-99
2212	OMC Waukegan	Michael W. Rehor	847-689-7046	1750	1	Blank	90 Sea Horse Drive	Waukeg	IL	60085	23	28589	Terry D. Schneider	Blank	14-Dec-00
4614	ComEd	Linda Alms	630-576-6731	3652	1	Blank	1100 East 55th Street (ESS-Z-	Chicago	IL	Blank	1	720	Ron Bradley	Director EED ESIH	3-Feb-05
5775	Exelon Corporation - ComEd	Lorinda Alms	630-576-6731	3687	2	Blank	100 N. Western Avenue	Chicago	IL	Blank	1		Neena Hemmady	Supervisor EED Environmental Services-West	6-Jan-06
TOTALS FOR WATERSHED											**134**	**182064.1**			

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Appendix D: Menu of BMPs for MS4s and MS4 Communities

In the Illinois Lake Michigan Nearshore PCB TMDL, IEPA is proposing a best management practices approach to controlling and reducing discharges of PCBs. USEPA has proposed this approach to effectively reduce discharges of PCBs from permitted sources, including MS4s. The authority to establish BMP conditions in NPDES permits is provided in 40CFR 122.44 (k).

IEPA proposes the following example language which can be incorporated into MS4 permits, as adapted from Appendix C 3.1 Specific Recommendations for Areas of Permitted MS4s Contributing to Surface Water Discharges to the Spokane River or Little Spokane River.

MS4-1. Evaluate levels of PCBs in stormwater in areas of the MS4 to identify areas more likely to contribute PCBs to surface waters based on any available information.

MS4-2. Evaluate levels of PCBs in solids, at a quantitation level for total PCBs appropriate for identifying these areas using an USEPA-approved test method.

MS4-3. Prioritize BMPs that are related to reducing or eliminating PCBs in stormwater in areas of the MS4 more likely to contribute PCBs to surface waters, based on any available information, including but not limited to the following:

- Previous and ongoing PCB monitoring.
    - Includes monitoring for PCBs in sediment traps, catch basins, and in stormwater suspended particulate matter (SSPM) at frequencies and locations adequate to assess and identify sources of PCBs to municipal stormwater.
- Nearby toxics cleanup sites with PCBs as a known contaminant.
- Business inspections and compliance records.

MS4-4. Remove accumulated solids from drain lines (including inlets, catch basins, sumps, conveyance lines, and oil/water separators) in priority areas of the MS4 at least once during the permit cycle.

MS4-5. Work with partners to remove of any identified legacy PCB sources within the MS4 (e.g., PCB-containing sealant) as soon as practicable.

MS4-6. Purchase preferred products with the lowest practicable PCB concentrations for products likely to contain inadvertently generated PCBs that are likely to contact municipal stormwater, including but not limited to the following:

- Hydroseed
- Dust suppressants
- Traffic marking paint
- Deicer

MS4-7. Collaborative efforts are encouraged to comply with PCB source control requirements to achieve reductions sought in the TMDL

MS4-8. The permits should include the following requirements for new development and redevelopment disturbing one acre or more:
- o Site design to minimize impervious areas, preserve vegetation, and preserve natural drainage systems.
- o On-site stormwater management.

CCMS4-1. The permits should require the following, for construction projects requiring a building permit from the permittee that do **not** require an NPDES permit for construction stormwater:
- o During demolition of any structure with at least 10,000 square feet of floor space and built before January 1, 1980, the permittee should require the building permit applicant to implement BMPs to achieve the following:
  - ▪ Prevent removed PCB-containing building materials, including paint, caulk, and pre-1980 fluorescent lighting fixtures,[8] from contacting municipal stormwater or otherwise reaching waters of the United States; and
  - ▪ Ensure that disposal of such materials is performed in compliance with applicable state, federal, and local laws.

CCMS4-2. The permits should address possible contributions of PCBs to the MS4 from businesses within the areas served by the MS4 as follows:
- o The permits should require the establishment and maintenance of a database of inspections and status of compliance with applicable State and federal laws and local ordinance related to PCBs in stormwater, for businesses within the area served by the MS4.
- o Based on the information in the database and other available information, the permits should require the permittees to identify businesses that are likely to contribute PCBs to the MS4 and to follow up with such businesses and appropriate regulatory agencies to develop and implement BMPs to reduce contributions of PCBs to the MS4 from such businesses.

[8] http://www.epa.gov/solidwaste/hazard/tsd/pcbs/pubs/ballasts.htm

Appendix E: Information Resources for Education and Outreach

Recommendations for Distributing Information

(Adapted from the Waukegan Community Information Plan, USEPA, May 5, 2015, available at: https://www3.epa.gov/region5/cleanup/waukegan/pdfs/waukegan-cip-5-7-15.pdf)

One of IEPA's goals is to make sure that information about the TMDL and the BMPs recommended gets out to all community members including different ethnic and age groups. IEPA strongly recommends for community members and organizations to promote a watershed workgroup or work closely with their respective municipalities to implement the BMPs outlined in Appendix D.

Listed below are some of the organizations and places that were suggested (from Waukegan Community Information Plan) and a similar approach is recommended for other communities in the watershed.

Lilac Cottage in Bowen Park

Lake County Forest Preserves

Leave No Child Inside meetings

Park Place

Schools

Churches

Online calendar of events

Quarterly magazine

Scoop the Loop

Dandelion Wine Fine Arts Festival

Art Walks

Monarch Festival

Waukegan Sports Park

WaukeganMainStreet.org

Black Chamber of Commerce of Lake County

Minister's Alliance

Polar Bear Plunge

4th of July parade

Tour of homes

Library calendar of events

Belvidere Mall

Illinois Refugee Rights (ISIRR.org)

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Appendix F: Public Notice and Responsiveness Summary

NOTICE OF PUBLIC MEETING

Lake Michigan (nearshore) Watershed

(Cook and Lake Counties)

The Illinois Environmental Protection Agency (IEPA) Bureau of Water will hold two public meetings on

Wednesday, May 27, 2015 (2:30 pm)

Waukegan Public Library Bradbury Room 128 North County Street Waukegan, Illinois

AND

Thursday, May 28, 2015 (10:00 am)

U.S. EPA Region 5 Office 77 West Jackson Blvd. Chicago, Illinois

The material covered in both of these meetings will be identical. The purpose of these meetings is to provide an opportunity for the public to receive information and comment on the draft Total Maximum Daily Load (TMDL) concerning impairments to 51 beach or shoreline segments, four harbors and one Lake Michigan nearshore open water segment within the watershed. The causes of impairment for these segments of the watershed are mercury and polychlorinated biphenyls (PCBs).

A Scoping Report has been completed and will be presented at the public meetings. The Scoping Report describes the study area and impaired nearshore Lake Michigan waters, describes the specification of a TMDL target, and discusses and recommends an approach for defining the relationship between the pollutant load and concentration. Subsequent work will include modeling to define the pollutant load that will result in attainment of the TMDL targets for mercury and PCBs.

The IEPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act. A TMDL is the sum of the allowable amounts of a single pollutant (phosphorus, metals, etc.) that a waterbody can receive from all contributing sources and still meet water quality standards or designated uses.

Stakeholders and participants will also be asked to provide comments on the Scoping Report. An additional public meeting will be held in the future to obtain input on the draft TMDLs for mercury and PCBs.

The Scoping Report for the Illinois nearshore Lake Michigan Mercury and PCB TMDLs will be available on-line at www.epa.state.il.us/public-notices. A hard copy of the draft report will be available for viewing at the Waukegan Public Library during business hours. Questions about the TMDL should be directed to the project manager, Collin Stedman by phone at 217-782-3362 or email Collin.Stedman@illinois.gov or contact Abel Haile (see contact information below).

Closure of the Meeting Record

The meeting record will close as of midnight, June 25, 2015. Written comments need not be notarized but must be postmarked before midnight and mailed to:

Abel Haile, Supervisor
Watershed Management Planning Unit, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P. O. Box 19276
Springfield, IL 62794-9276
Phone 217-782-3362

TDD (Hearing impaired) 217-782-9143
E-mail: Abel.Haile@illinois.gov
Fax: 217-785-1225

NOTICE OF PUBLIC MEETING

Lake Michigan (nearshore) Watershed

(Cook and Lake Counties)

The Illinois Environmental Protection Agency (IEPA) Bureau of Water will hold two public meetings on

Wednesday, January 13, 2016 (6:00 pm)

Waukegan Public Library
Bradbury Room
128 North County Street
Waukegan, Illinois

AND

Thursday, January 14, 2016 (10:00 am)

U.S. EPA Region 5 Office
77 West Jackson Blvd.
Room 325
Chicago, Illinois

The material covered in both of these meetings will be identical. The purpose of these meetings is to provide an opportunity for the public to receive information and comment on the draft Total Maximum Daily Load (TMDL) concerning impairments to 51 beach or shoreline segments, four harbors and one Lake Michigan nearshore open water segment within the watershed. The causes of impairment for these segments of the watershed are mercury and polychlorinated biphenyls (PCBs).

A Draft TMDL Report has been completed and will be presented at the public meetings. The Draft TMDL Report describes the study area and impaired nearshore Lake Michigan waters, describes the specification of a TMDL target, and discusses and recommends an approach for defining the relationship between the pollutant load and concentration.

The IEPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act. A TMDL is the sum of the allowable amounts of a single pollutant (phosphorus, metals, etc.) that a waterbody can receive from all contributing sources and still meet water quality standards or designated uses.

Stakeholders and participants will also be asked to provide comments on the Draft TMDL Report. An additional public meeting will be held in the future to obtain input on the draft TMDLs for mercury and PCBs.

The Draft TMDL Report for the Illinois nearshore Lake Michigan Mercury and PCB TMDLs will be available on-line at www.epa.state.il.us/public-notices. A hard copy of the draft report will be available for viewing at the Waukegan Public Library during business hours. Questions about the TMDL should be directed to the project manager, Collin Stedman by phone at 217-782-3362 or email Collin.Stedman@illinois.gov or contact Abel Haile (see contact information below).

Closure of the Meeting Record

The meeting record will close as of midnight, February 16, 2016. Written comments need not be notarized but must be postmarked before midnight and mailed to:

Abel Haile,
Manager, Planning (TMDL) Unit,
Watershed Management, Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.0. Box 19276
Springfield, IL 62794-9276
Phone 217-782-3362

TDD (Hearing impaired) 217-782-9143
E-mail: Abel.Haile@illinois.gov
Fax: 217-785-1225

Responsiveness Summary

This responsiveness summary responds to substantive questions and comments on the Illinois Lake Michigan mercury and PCBs final draft Total Maximum Daily Load (TMDL) received during the public comment period from January 15 through February 16, 2016 (determined by postmark). The summary includes questions and comments from the January 13, 2016 and January 14, 2016 public meetings as discussed below.

What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Illinois Lake Michigan (nearshore) mercury and PCB TMDL reports contain a plan detailing the actions necessary to reduce pollutant loads to the impaired water bodies and ensure compliance with applicable water quality standards. IEPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations thereunder.

Background Information

Illinois Environmental Protection Agency (IEPA) has identified 56 nearshore beach/shoreline, harbor and open water segments that are impaired due to concentrations of mercury and PCBs in fish tissue and the water column (IEPA, 2014). All of these waterbody segments are impaired for fish consumption use, and one segment (Waukegan Harbor North) is also impaired for aquatic life use. These impaired waters are included on the 2014 Draft Illinois Integrated Water Quality Report and Clean Water Act (CWA) Section 303(d) list (IEPA, 2014).

The CWA and USEPA regulations require that states develop TMDLs for waters that are placed on the CWA Section 303(d) list. IEPA is currently developing TMDLs for pollutants that have numeric water quality standards. Therefore, a TMDL was developed for mercury and PCBs for the watershed targeted for TMDL development within the Illinois Lake Michigan Watershed. IEPA coordinated with USEPA Region 5 and their TMDL contractors Michael Baker International/LimnoTech, Inc. to develop the TMDLs.

Public Meetings

Two public meetings were held on January 13, 2016 (6:00 pm) at Waukegan Public Library (Bradbury Room), Waukegan, Illinois, and on January 14, 2016 (10:00 am) at USEPA- Region 5 Office in Chicago, Illinois. The purpose of the meetings was to provide the public with an opportunity to comment on the final draft TMDL reports and to provide additional data that may be included in the TMDL development process. IEPA announced the public notice by placing a display ad in the newspapers in the watershed (Chicago Tribune and Waukegan Lake County Sun), and the draft TMDL reports were also public noticed on the Agency's Public Notice List webpage. The public notice gave the date, time, location, and purpose of the meetings. It also provided references to obtain additional information about this specific watershed, the TMDL Program, and other related issues. The public notice was also mailed to NPDES & MS4 Permittees, environmental groups, and other organizations in the watershed by first class mail. The draft TMDL Report was available for review at the Waukegan Public Library Waukegan, Illinois and on IEPA's website at http://www.epa.illinois.gov/public-notices/index. Twenty two people in Waukegan and six people in Chicago attended the public meetings.

Agency Responses to Questions, Concerns and Comments

1. The Draft TMDL Report explains that fish tissue concentrations were used to indicate mercury levels because the safe aquatic concentrations of mercury are at or below detectable levels. Fish tissue is not the only known method for concentrating mercury, and more direct methods for monitoring mercury, such as activated carbon, should be widely adopted, both for ambient monitoring, and for sampling of water exposed to coal and its combustion products.

   Response:

   IEPA will take this into consideration when developing future Water Quality Monitoring Plans.

2. The draft TMDL does not sufficiently address the largest source of mercury to nearshore Lake Michigan. It is critical that the IEPA fully address the mercury emissions from coal-fired power plants, especially NRG/Midwest Generation, LLC in Waukegan that is a significant contributor to the mercury pollution in Lake Michigan. While the Waukegan coal plant has installed activated carbon injection to reduce the amount of mercury it emits into the air, the mercury emissions are still significant and must be further addressed. According to USEPA's Toxics Release Inventory Program the plant emits 61 lbs of mercury annually. Since these emissions continue to contribute to the mercury impairment of Lake Michigan the plant should be required to make additional reductions through enhanced usage of the existing controls, and additional upgrades, such as a baghouse that can capture mercury and small particulates, should be installed.

Response:

The Waukegan Power Plant units owned by NRG Energy and operated by Midwest Generation currently comply with the federal Mercury and Air Toxics Standard (MATS) which requires the maximum degree of reduction in mercury emissions that, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, is achievable. These standards are commonly referred to as "Maximum Achievable Control Technology" or "MACT" standards.

Further, the facility is currently required to significantly reduce mercury emissions in accordance with 35 Ill. Adm. Code Part 225 which alone require an approximate reduction in mercury emissions of 90%. Both units are in compliance with all regulations and permit requirements regarding mercury emissions.

Each unit at the Waukegan facility is equipped with a mercury control system consisting of activated carbon injection specifically designed for the control of mercury followed by an electrostatic precipitator to remove mercury and other particulates from the atmosphere. Both units have also recently installed dry sorbent injection systems which will further assist in mercury control.

3. There should be interdepartmental cooperation between the Air Quality and Water Quality departments within the IEPA, particularly for a site area (Waukegan) containing multiple on-going Super Fund cleanups and nine brownfields with a waterfront coal burning plant operating without a legitimate operating license since 1995.

   Response:

   IEPA's Environmental Programs (Bureaus of Air, Land, & Water) work together to address multi-media environmental issues, and in this case the Bureaus have worked together to gather information that was necessary for the draft mercury and PCBs TMDL development process.

   The Waukegan Power Plant owned by NRG Energy and operated by Midwest Generation is and has been operating under valid and legally effective State permits (both operating and construction). These permits were issued under Illinois' SIP authority in 35 IAC Part 201.

   The application for such permit was submitted in 1995 and a Clean Air Act Permit Program (CAAPP) permit was issued in September 2005. However, the permit has not become effective due to an appeal filed before the Illinois Pollution Control Board who stayed the entire permit pending a settlement resolution.

   The current status of this CAAPP permit is in the settlement stage of resolution. IEPA has developed a permit to resolve the appealed conditions in the permit and has sent that draft permit to public notice for comment. IEPA is now finalizing responses to those

comments and appropriate permit revisions as a result of those comments to submit to USEPA for their statutory right of review which is 45 days.

The NPDES Permit for the facility was reissued on March 25, 2015.

4. IEPA should develop a similar set of milestones and a longer-term goal for reductions from each source category to meet the TMDL targets. Minnesota's implementation plan includes a set of milestones spanning from 2009 to 2028 to ensure that their 2025 goal is met. For example, MPCA estimated that the annual mercury emission from coal-fired electric generation was 1,716 lbs/yr in 2005. They set a 2018 milestone of 294 lbs/yr and a 2025 goal of 235 lbs/yr. Their reduction strategy is to reduce emissions by 70-90% at all units greater than 5 lbs/yr by 2025 (mostly sooner) to achieve a 1,481 lbs/yr or 86% source reduction. The IEPA should develop a similar set of milestones and a longer-term goal for reductions from each source category to meet the TMDL targets.

   Response:

   In 2006 and 2007 Illinois both promulgated the Illinois mercury rule and reached multi-pollutant reduction agreements with coal-fired owners and operators that resulted in substantial improvement to Illinois and regional air quality by dramatically reducing mercury, SO_2, and NOx emissions. The rule and agreed to measures were a critical milestone in reducing air pollution and one of the most important environmental and public health advances in Illinois history. At the time, they represented the largest reductions in air emissions ever agreed to by individual companies under any context, whether through an enforcement action or regulation.

   The Illinois mercury rule is designed to achieve a high level of mercury control based on IEPA's finding that there exists mercury control technology that is both technically feasible and economically reasonable. Under the rule, mercury emission reductions began in 2009 and were required to be reduced by approximately 90% statewide by 2015. Mercury emissions from coal-fired power plants in Illinois were estimated at 7,700 lbs/yr in 2006 and are currently estimated to be less than 600 lbs/yr when also taking into account the retirement of 18 coal-fired units in Illinois since 2007. Additionally, mercury emissions will fall considerably further due to the expected retirement or conversion to natural gas of seven more units by the end of 2016, several of which are in the Great Lakes Basin area.

5. The coal ash ponds at the Waukegan plant are directly adjacent to Lake Michigan and are also exposed to weathering, and precipitation. The leachate is minimally treated, sampled, and reported prior to discharge into Lake Michigan. Monitoring of this leachate, exposed to a known source of mercury, should be made continuous and evaluated regularly. Additional test wells should be used to assure that mercury and other toxics are not carried toward the Lake by groundwater flow.

   Response:

Groundwater monitoring data for mercury has been collected at NRG/Midwest Generation, LLC (Waukegan Power Plant) since November, 2010. Groundwater is currently monitored on a quarterly basis from seven on-site monitoring wells. All of the monitoring results for mercury have been non-detection, with a reporting limit of 0.0002 mg/L.

6. Take well samples around the plants and factories regularly, and make the companies accountable. Include a Monitoring Plan to conduct additional monitoring from wastewater and industrial sources. Track and maintain data where all the waste streams go (gas, liquid and solid waste) and make the data available to the public. Inform the citizens what they are breathing and drinking.

   Response:

   The municipal and industrial wastewater treatment facilities in the watershed including the Midwest Generation, LLC (Waukegan Power Plant) are required to monitor the effluent discharge for parameters that are in their respective NPDES permits and submit monthly discharge monitoring reports (DMRs). The DMR reports are available at: http://dataservices.epa.illinois.gov/dmrdata/dmrsearch.aspx.

   In addition, IEPA's website http://www.epa.illinois.gov/citizens/index provides information regarding air quality, drinking water quality, and land pollution control programs.

   Although the mercury Annual Emission Reports (AERs) are currently not available on any website they are readily available through the Freedom of Information Act (FOIA) process.

7. The coal pile at the Waukegan coal fired power plant is directly adjacent to Lake Michigan; coal in train cars is abraded and is also exposed to weathering and runoff release. The leachate from this pile should be collected, concentrated and measured prior to discharge into the Lake Michigan watershed. To reduce the exposure to rain and the airborne release of mercury from coal, it should be covered. In addition, additional test wells should be drilled, and dye tests used to determine whether past runoff from this source is being conveyed into the nearshore zone by groundwater flow.

Response:

The coal pile runoff is collected and treated prior to discharge in compliance with the NPDES permit. The coal pile is sprayed with water to control fugitive dust in compliance with air permit requirements. Sample results from groundwater monitoring from the coal pile area demonstrate no impact to groundwater associated with mercury. These groundwater monitoring results are submitted on a quarterly basis to IEPA, Division of Public Water Supplies.

8. Fixed equipment at the Waukegan Power Plant should be covered, and mercury in water exposed to the mobile equipment should be collected, concentrated and measured prior to discharge into the watershed.

Response:

According to NRG/Midwest Generation, LLC (Waukegan power Plant), the fixed conveyors are covered, stacker operations are monitored and optimized, and transfer points are under negative pressure to minimize fugitive dust during unloading and transport operations. Water coming into contact with transfer equipment is collected, treated, sampled and discharged in compliance with the NPDES permit for the facility.

9. The coal ash ponds at the Waukegan plant are open to precipitation, and the leachate is minimally treated prior to discharge into Lake Michigan. This leachate is then minimally sampled and reported. Monitoring of this leachate, exposed to a known source of mercury, should be made continuous and evaluated by a concentrating method as described above. Although they are lined, these coal ash ponds are next to the plant, and only 300 yards from Lake Michigan, and arsenic has been measured in test wells around them. They should be additionally tested for mercury using concentrating methods, and as requested above, additional test wells should be used to assure that mercury and other toxics are not carried toward the Lake by groundwater flow. To further reduce these risks we strongly encourage the IEPA to require that the plant handle its coal ash waste dry to prevent the leaching of contaminants into groundwater and Lake Michigan. As long as they contain mercury, the ash ponds should be covered to reduce the amount of leachate and the exposure of the nearshore zone to mercury that evaporates from the ponds.

Response:

The coal ash pond water from the lined impoundments is treated, sampled and discharged in accordance with the NPDES permit, and there is no indication of leachate discharge from the lined ash ponds. Sample results from groundwater monitoring from areas between the ash ponds and the Lake demonstrate no detection of mercury. Please also refer to response # 5.

10. While the Waukegan coal plant has installed activated carbon injection to reduce the amount of mercury it emits into the air, the mercury emissions are still significant and must be further addressed. According to the USEPA's Toxics Release Inventory Program the plant emits 61 lbs of mercury annually. Since these emissions continue to contribute to the mercury impairment of Lake Michigan the plant should be required to make additional reductions through enhanced usage of the existing controls, and additional upgrades, such as a baghouse that can capture mercury and small particulates, should be installed. If this is truly out of the jurisdiction of the IEPA's Bureau of Water should direct this critical action to the appropriate body such as the Bureau of Air.

    Response:

    The Bureau of Water has consulted with the Bureau of Air, and the air mercury emissions from NRG/Midwest Generation, LLC (Waukegan-Power Plant) are in compliance with both state and federal laws and regulations.

11. We are concerned that the toxic waste generated by the Waukegan coal plant's dry sorbent injection system, and coal ash the plant has created in the past, and continues to create, contains mercury and might be exposed to weathering in the Lake Michigan watershed. Mercury leaches readily from Portland cement containing coal ash, unless it is specially treated in advance. Coal ash disposal sites in the Lake Michigan watershed should be tested to see whether the stabilizing matrix used presently and in the past immobilizes mercury at the low levels that have polluted the Lake. Mercury that might evaporate from the RCRA sites that received these wastes and reenter the watershed should also be restricted. In addition, CERLCA sites throughout the watershed of this nearshore TMDL should be monitored.

    Response:

    Coal ash disposal sites are beyond the scope of this TMDL report. The NRG/Midwest Generation, LLC (Waukegan-Power Plant) manages coal ash in accordance with Federal and Illinois State requirements and does not own or operate any coal ash disposal sites in the Lake Michigan watershed.

12. The report should consider whether the Waukegan plant or plants near Racine are discharging mercury to Lake Michigan through stormwater runoff or through groundwater that is connected to the lake.

    Response:

    The Illinois Lake Michigan mercury and PCBs draft TMDL Watershed projects only address areas within the watershed and facilities outside the study area will be covered in future TMDL projects. The stormwater runoff at the Waukegan plant is collected in the station's collection system and treated using sedimentation and oil removal prior to discharge. Refer to comment # 5 for ground water monitoring results.

13. Do all potential sources of PCB and mercury loads to Lake Michigan have limits or monitoring requirements in their permits?

    Response:

    The wastewater treatment facilities in the Illinois Lake Michigan TMDL Watershed (refer to Table 6-2 in the TMDL reports) are not allowed to discharge PCBs as stated in their individual NPDES permits. The wastewater treatment facilities that have the potential to discharge mercury to Lake Michigan and its tributaries may have effluent limits or monitoring requirements in their respective NPDES permits. The General MS4 stormwater permit holders do not have limits or monitoring requirements at this time. However, the General Permit Part III- Special Condition (C) requires the MS4 Permittee to comply with the WLA when a TMDL is developed for that particular watershed within 18 months following notification by IEPA once the TMDL is approved.

    There are two coal combustion residual (CCR) surface impoundments in the study area. CCRs are covered by a final USEPA Rule effective October 19, 2015. Among other requirements, the Rule requires operators of CCR units to maintain a publicly available website of compliance information for example, annual groundwater monitoring results, corrective action reports, fugitive dust control plans and closure completion notifications.

14. According to the mercury draft TMDL report (refer to Section 7.5.2) the closest atmospheric mercury monitoring station is in the Indiana Dunes National Lakeshore. Monitoring for PCBs is conducted at the Chicago site (IIT Chicago) of the Integrated Atmospheric Deposition Network (IADN). The IEPA should work with USEPA to establish mercury monitoring at this site or another site within the study area watershed.

    Response:

    IEPA recognizes the value of mercury monitoring for the Great Lakes Basin area. The Lake Michigan Air Directors Consortium (LADCO), of which Illinois is a primary member, currently leads regional efforts on mercury monitoring.

15. Excessive ingress and impingement (I&I) of fish on the intake structures of the Waukegan coal plant generates a large discharge of fish tissue into the local aquatic food chain. The warmed discharge water is known to both attract fish into the nearshore zone and degrade their health. The elevated presence of mercury from the power plant, combined with these factors promotes more rapid uptake of mercury into the tissues of live fish that forage in the nearshore zone. This TMDL should call for reduced I&I both to reduce fish mortality and mercury uptake in the nearshore zone.

Response:

The question is beyond the scope of the TMDL report. The IEPA will look into your comment, however, the NRG/Midwest Generation, LLC (Waukegan power Plant) currently is meeting the requirements of its NPDES permit.

16. IEPA should request that LimnoTech perform plume modeling and develop a proper LA for the Waukegan plant and other prominent sources of mercury air emissions in the region.

Response:

Plume modeling is beyond the scope of this study. Mercury emissions from the coal fired power plant operated by NRG/Midwest Generation LLC are included in the REMSAD modeling that was used to calculate baseline mercury deposition loads to the study area. Reductions therefore consider contributions from that facility. REMSAD also considered mercury emissions from sources within the state of Illinois, regional sources including all other US states, Canada and Mexico, and global emissions. The proportionality approach selected for this project involves calculation of a reduction percentage that applies equally to all sources.

17. Review the Mercury Minimization Plan developed by Clean Water Services for the Tualatin River watershed in Oregon. Their plan includes educational outreach to reduce improper release of mercury to the environment.

Response:

IEPA has reviewed the Mercury Minimization Plan and a similar approach has already been included in the TMDL report.

18. Use monitoring data from the North Shore Sanitary District and emissions data from the Waukegan Generating Facility to estimate mercury loading.

Response:

The current NPDES Permit No. IL0030244 for North Shore Water Reclamation District - Waukegan Water Reclamation Facility does not have mercury limits or monitoring requirements. However, the draft NPDES permit for this facility does contain mercury limits for a discharge to Waukegan North Ditch (Outfall BO2), which is a tributary to Lake Michigan and the TMDL report was revised to include a wasteload allocation to be consistent with the TMDL study and the draft NPDES permit.

Mercury emissions from the coal fired power plant operated by NRG/Midwest Generation LLC (Waukegan power Plant) are included in the REMSAD simulations. Please also refer to response # 16.

19. Section 7.5 of the draft TMDL reports, titled "Monitoring Recommendations to Track TMDL Effectiveness," describes existing monitoring efforts but fails to recommend additional monitoring needed to accurately track TMDL effectiveness. For example, the Fish Contaminant Monitoring Program (FCMP) is given as the source of data on mercury and PCB levels in fish tissue. Given the limited amount of fish tissue data used to develop the TMDL targets, it appears that existing monitoring is insufficient and should be increased or expanded. Fish tissue sampling should be conducted more than once a year and should include a greater number and distribution of samples to accurately represent mercury and PCB contamination in all fish species and locations.

    Response:

    IEPA will continue to work with Illinois Department of Natural Resources (IDNR) to conduct more fish monitoring when additional resources become available.

20. The reports should include methods to address the main transport pathways for mercury and PCB loads to Lake Michigan, including runoff from impervious surfaces.

    Response:

    Section 7 describes best management practices for reducing mercury and PCBs load to Lake Michigan. This includes controls to reduce runoff from impervious surfaces.

21. IEPA should request consultation with USGS, the leading authority regarding environmental mercury.

    Response:

    Thank you for the suggestions. IEPA will contact USGS to follow up on the recent mercury study in the watershed.

22. IEPA should include maps showing the location of key point sources and nonpoint source areas.

    Response:

    A new map has been added to the report, which shows sources considered under each TMDL focusing on those that could easily be mapped.

23. In light of the finding that air deposition from sludge piles is a significant source of PCBs; the IEPA should investigate strategies to control air movement of PCBs from sludge piles.

    Response:

    As IEPA recently learned that a paper published by Shanahan et al. (2015) provides an inventory of PCBs in the watershed and estimates sewage sludge drying beds have the potential to contribute significantly to annual PCB emissions, IEPA will follow up with the

researchers and facilities that generate sludge in the watershed to understand and develop implementation plans to address the issue.

24. IEPA should calculate more specific reduction targets for each source category or facility and should outline the corresponding reduction strategies in an implementation strategy.

    Response:

    A wide range of modeling frameworks exist that could potentially be used to support the Illinois Lake Michigan nearshore mercury and PCB TMDLs. The TMDL Scoping Report (LimnoTech, 2015) reviewed the range of available frameworks and concluded that a zero-dimensional, steady state proportionality approach was most appropriate for this project (for both the mercury and PCB TMDLs), given the amount of data available to support TMDL development. This approach involves calculation of a reduction percentage that applies equally to all sources.

    IEPA will reach out to watershed workgroups and other state agencies and share the TMDL and implementation plan. Interested stakeholders are encouraged to work closely with MS4 Permittees in their respective municipalities in developing BMP implementation strategies.

25. The reports should establish a process to ensure that all permits for new construction contain requirements to capture mercury and PCBs at the pipe entrance before they enter stormwater pipes using methods such as those included in the report (infiltration trenches, basins, retention and reuse, ponds, detention basins, swales, buffer strips, bioretention). The reports should also identify the MS4 pipes and end of pipes regulated by NPDES permits and establish a process for requiring treatment BMPs to control mercury and PCB loads leaving these pipes, such as those listed in the reports (filters, screens, wet vault, and hydrodynamic separators for MS4 pipes; sedimentation basins or constructed wetlands for end of pipe). New stormwater discharges should not be permitted under the MS4 General Permit until this permit is updated to require the BMPs needed to reach the TMDL targets. IEPA should require permits for new construction contain BMPs to capture mercury and PCBs at the pipe entrance before they enter stormwater pipes.

    Response:

    The MS4 General Permit IL40, Part IV- Section B(4) (a)(iv) - requires all regulated construction sites to have a stormwater pollution prevention plan that meets the requirements of Part IV of General NPDES Permit No. ILR10, including management practices, controls, and other provisions at least as protective as the requirements contained in the <u>Illinois Urban Manual, 2014</u>, or as amended including green infrastructure techniques where appropriate and practicable.

26. In order to meet water quality standards and attain all designated uses of the lake, the IEPA must develop a strong implementation plan to meet target reductions in mercury loads identified in the draft TMDL report. The implementation plans must include assurances that the most effective BMPs will be adopted and financed in order to make progress towards the needed reductions.

    Response:

    The draft TMDL reports include implementation and monitoring recommendations (refer to Section 7 in the report) and provides a reasonable assurance that the best management practices (BMPs) and controls outlined in the report will be implemented. IEPA can work with watershed workgroups and other organizations in the watershed to identify appropriate combinations of BMPs for both point and nonpoint sources to implement needed reductions in the study area to meet the TMDL target endpoint.

27. In order to ensure that the suggested BMPs are implemented, the IEPA should establish at least a general timeline that can be adapted as appropriate. This timeline should include a summary of the permit cycles for point sources and MS4s that identifies when BMP requirements will be incorporated. The reports should also include a description of the timeline and structure for the public engagement process to prioritize the recommended strategies to determine the most feasible options.

    Response:

    A schedule for implementation has been added to Section 7 of the PCB and mercury TMDL reports, which includes expiration dates for current individual NPDES permits and the MS4 Stormwater General Permit.

    The TMDL has identified that the existing wastewater treatment plants (WWTPs) are in compliance with their respective NPDES Permit effluent limits or monitoring requirements and must continue to be in compliance to be consistent with the TMDL target endpoint to meet water quality standards. The TMDL will be incorporated by reference into the MS4 General Permit No. ILR40 that became effective on March 1, 2016. The MS4 Permittees must comply with the TMDL recommendation within eighteen months following notification by IEPA upon approval of the final TMDL report by USEPA.

28. Require permits for new construction contain BMPs to capture mercury and PCBs at the pipe entrance before enter stormwater pipes. Identify the MS4 pipes and end of pipes regulated by NPDES permits and establish a process for requiring treatment BMPs to control mercury and PCB loads leaving these pipes. New stormwater discharges should not be permitted under the MS4 General Permit until this permit is updated to require the BMPs needed to reach the TMDL targets.

Response:

According to the MS4 General Permit IL40 – Part IV (B)(3)(b) – MS4 permittees are required to develop a storm sewer system map, showing the location of all outfalls and locations of all waters that receive discharges from those outfalls. In addition, the MS4 permit holders must comply with the requirements of the MS4 General Permit IL40 – Part IV (B)(4)-Construction Site Storm Water Runoff Control.

29. Illinois should specifically focus its Nonpoint Source Section 319 grants on implementing technologies that will directly lead to reductions in atmospheric deposition of mercury. Illinois should develop grants that encourage coal-fired power plants to phase out subbituminous coal and to clean bituminous coal to reduce its mercury content

Response:

IEPA administers the 319 cost share funding program for watershed based plans with the goal of improving water quality impacted by nonpoint source pollution. Grants are available to local units of government and other organizations to protect water quality in Illinois. Projects must address water quality issues relating directly to nonpoint source pollution. Funds can be used for the implementation of watershed based plans, including the development of information/ education programs and for the installation of best management practices (BMPs). Natural Resources Conservation Service (NRCS) and Soil Water Conservation District (SWCD) have Farm Bill funds and other grant possibilities including urban watershed projects that are addressing water quality issues in Illinois.

30. Form a Steering Committee consisting of concerned citizens, businesses, and government to have discussions and solutions to tackle environmental and progress issues. The IEPA should also follow Minnesota's process for stakeholder engagement in the oversight of the TMDL implementation. These stakeholders developed recommendations for source-specific reduction targets, strategies to meet the targets, and interim and final time frames for achieving reductions.

Response:

Thank you for the suggestions. IEPA's 319 cost-share funding program is available for developing best management practices (BMPs) that may be able to address nonpoint sources of mercury and PCBs impairments discussed in the report. Please refer to the link for the Guidance for Developing Watershed Action Plans in Illinois - May 2007 (Chicago Metropolitan Agency for Planning (CMAP)/Illinois EPA: http://www.epa.state.il.us/water/watershed/publications/watershed-guidance.pdf.

31. IEPA successfully implemented past programs such as the Cook County PCB and Mercury Clean Sweep Program. Intensive implementation of similar programs, programs to increase building and equipment recycling, and projects to clean up brownfields will be necessary to achieve the standards.

    Response:

    A past program, the Chicago Clean Sweep Pilot program was designed to educate Chicago-area businesses on the identification and proper management of mercury (and PCBs) and to set up a process under which certain businesses would be able to send certain mercury waste to a participating facility for recycling or disposal at a reduced cost. The Clean Sweep program has been discontinued, but could serve as a model for additional clean-ups if communities are interested in pursuing funding to revitalize it.

32. IEPA should do more community outreach for public meetings on the TMDL Draft Report, and its staff should be more responsive to community questions and public comments. The hearing should be given more widespread notification to local public. Were Waukegan City Officials and Lake County Board Members contacted directly inviting their attendance? We did not find the presenters to be particularly responsive to community questions and public comments

    Response:

    The public notice for the meeting was announced on IEPA's website and in a press release (Chicago Tribune and Waukegan Lake County Sun) to reach the general public in the watershed; environmental groups; municipal and county governments, and NPDES and MS4 permit holders were also notified by first class mail. The announcements provided details of meeting time and location and information on how to access the TMDL documents for review. Individuals who have participated in the earlier Scoping Report or previously expressed interest in the TMDL development process received an e-mail announcing the public notice. The draft TMDLs were available at IEPA website: [http://www.epa.illinois.gov/Assets/iepa/public-notices/2015/lake-michigan-nearshore/public-notice.pdf.](http://www.epa.illinois.gov/Assets/iepa/public-notices/2015/lake-michigan-nearshore/public-notice.pdf) The public notice provides an opportunity for the public to read the TMDL and provide comments on the TMDL. The purpose of the public meeting is to provide an overview of the TMDL and to answer as many questions as possible at the meeting. As discussed at the meetings, the process also allows for IEPA to research any remaining unanswered questions and respond to them through this responsiveness summary. IEPA representatives, USEPA staff member along with the TMDL contractors conducted the public meetings and have answered several questions within the scope of the TMDL projects, and attendees were advised to send written questions/comments to IEPA by the end of the public comment period.