The GLMRIS Report

Appendix B - Affected Environment

USACE
01/06/2014

CONTENTS

CONTENTS (CONT.)

CONTENTS (CONT.)

FIGURES

TABLES

TABLES (CONT.)

LIST OF CAWS SPECIES

B.1 AFFECTED RESOURCES BASELINE AND FUTURE-WITHOUT-PROJECT CONDITIONS

B.1.1 Introduction

B.1.1.1 Appendix Purpose and Structure

The purpose of this Appendix, Affected Environment, is to summarize current conditions of the Chicago Area Waterway System (CAWS) and future-without-project (FWOP) conditions for several targeted resources. Chapter 1 provides a general overview of the Great Lakes and Mississippi River basins' natural and human resources and also includes baseline assessments for the same resources. Chapter 2 summarizes specific assessment procedures for selected resources pertinent to the Great Lakes and Mississippi River Interbasin Study (GLMRIS). Chapter 2 also includes information on how other agencies or entities would influence FWOP conditions for several specific areas related to GLMRIS, including management of aquatic nuisance species (ANS), regulations, and waterway operations. Information may be incorporated by reference to support future-with or alternative plan discussions.

B.1.1.2 Study Area Boundaries

Located entirely within the United States, the GLMRIS study area includes the Great Lakes and Mississippi River basins. The U.S. Army Corps of Engineers (USACE) has defined a Detailed Study Area to include the geographic regions where the largest economic, environmental, and social effects are anticipated resulting from plans implemented by GLMRIS. The Detailed Study Area is located along the Great Lakes and Mississippi River basin divide. This study area includes portions of 17 U.S. states and borders two Canadian provinces within the Great Lakes, the Upper Mississippi River, and the Ohio River watersheds. The third and more closely focused study area is the CAWS, which is the most likely zone for recommended plans to be physically located.

B.1.1.3 Great Lakes Basin Natural History Overview

The Great Lakes watershed presently covers an area of approximately 295,75 mi^2 (765,990 km^2), spanning across eight U.S. states and two Canadian provinces. Collectively, these lakes hold the largest collection of unfrozen freshwater in the world and an abundance of natural resources used by millions of people each year. Formation and evolution of the lakes is an ongoing process that began more than 1 million years ago and can be attributed to both natural and anthropogenic forces, including periods of glaciations, erosion and depositional processes, changing climate patterns, and human development.

Today, the Great Lakes make up the second largest body of freshwater in the world, spanning across two countries with varying topography, geology, and climates with an expansive range of ecological habitats. The basin has been categorized into 20 ecoregions, with half belonging to Canada and half to the United States. Researchers have cataloged numerous distinct coastal habitat types, including wetlands, lake plain prairies, sand, cobble and bedrock beaches, sand dunes, sand barrens, alvars, and islands. Moving away from the lake, many inshore habitats have also been identified, including inshore wetlands, various savanna and prairie communities, and numerous varieties of hardwood and coniferous forests.

With such a diverse assembly of habitats across the basin, the Great Lakes were, and to a good extent are today, home to immensely diverse faunal communities. The natural fish assemblage of the Great Lakes originates from three sources, including Arctic relicts from the northwest, warm water species infiltrating from the Mississippi and Ohio Rivers, and marine species from the Atlantic Ocean. These source populations gained access to the basin through natural connections developed during glacial retreat periods and wetter climatic periods. In addition, man-made connections of canals and other waterways allowed additional species to colonize when European settlers began to manipulate geomorphic features and hydrology in the Great Lakes Basin for the purpose of agriculture and commerce. These native fishes to the Great Lakes have since been adversely affected in both species richness and population abundance. The loss in species richness, abundance, and genetic diversity of the Great Lakes fish assemblage has been attributed to habitat loss and fragmentation, pollution, and commercial fishing practices that once outpaced natural reproduction (Smiley 1882). Once ecosystems become impaired, invasive species, which are typically pioneers species, have the ability to colonize and fill empty niches left by those reduced or impaired native species. Current estimates indicate that approximately 161 native fish species (Hubbs and Lagler 2004) and 25 non-native species (EPA 2011) reside within the basin. Amphibians and reptile populations are generally represented by salamanders, frogs, turtles, and snakes but do include a number of toads and reptiles (Edsall 1998). The Great Lakes also provide invaluable habitat for both migratory and resident bird species. Migratory flyways lace the basin along its shorelines and across island chains providing stopover points for long journeys from north to south. Recently, wetland loss and degradation have led to the declines of many bird species that utilize this habitat for nesting and foraging (EPA-b 2005). In addition, more than 130 rare, threatened, or endangered species reside within the Great Lakes Basin (USACE 2005). These species have been listed mainly because of habitat degradation and loss through human development and pollution.

B.1.1.4 Upper Mississippi River Basin Natural History Overview

The Mississippi River is the second longest river in United States with the third largest drainage in the world. Its basin covers 40% of the country and includes all or part of 31 states. The Upper Mississippi River Basin extends from the river's headwaters at Lake Itasca, Minnesota, to its confluence with the Ohio River near Cairo, Illinois; the Lower Mississippi River Basin extends from its confluence with the Ohio River to the river's mouth in Louisiana.

Similar to regions around the world, the Upper Mississippi River Basin has undergone a transition from undisturbed to human-dominated landscapes. At present, the human population density in the Upper Mississippi River Basin is approximately 45 people/km^2. There are 18 metropolitan areas within the Upper Mississippi River Basin having populations greater than 100,000 people. Three of these metropolitan areas—Minneapolis-St. Paul, Minnesota; Quad Cities, Iowa and Illinois; and St. Louis, Missouri—occur adjacent to the Upper Mississippi River proper. Despite increased urbanization, only 5% of the basin has been converted to urban areas. Predominant land uses in the basin are agriculture, mining, and forested land. The river itself is a commercial waterway and a water source for inhabitants within the Upper Mississippi River corridor.

The Upper Mississippi River is a biologically important resource for a variety of wildlife. The Upper Mississippi River has a rich diversity of aquatic life, supporting nearly 200 native, regularly occurring fishes, as well as an abundance of freshwater mussels, crayfish, and aquatic invertebrate species. The north–south orientation of the river provides a globally important flyway for nearly 60% of all North American bird species, while also harboring diverse amphibian, reptile, and mammal faunas. According to Theiling et al. (2000), the Upper Mississippi River supports no less than 286 state-listed or candidate species, and 36 federally listed or candidate species of threatened or endangered plants and animals endemic to the basin. Past and current adverse pressure on the biodiversity of the Upper Mississippi River is primarily related to the development of the basin for agriculture, navigation, and industry. The drastically altered landscape and channelization of the Upper Mississippi River, has led to the disruption of the physical and ecological processes of the river system, and subsequently a downward trend in fauna abundance and diversity.

B.1.1.5 Chicago Area Waterways Study Area

The CAWS consists of approximately 128 mi of waterway in the Chicago Metropolitan area used for conveyance of stormwater runoff and municipal wastewater, commercial navigation, and flood risk management. Many of the waterways are man-made canals and channels, while others are natural streams, many of which have been dredged, realigned, widened, and straightened. Poor water quality and the absence of natural processes and physical habitat have resulted in limited aquatic biota. Homogenous, silty sediments that restrict macroinvertebrate and fish populations are deposited throughout much of the CAWS due to the unnatural streamflow dynamics (MWRDGC 2008).

The CAWS contains five aquatic pathways between the Great Lakes and Mississippi River basins: (1) Wilmette Pumping Station (WPS), (2) Chicago River Controlling Works (CRCW), (3) Calumet Harbor, (4) Indiana Harbor and Canal, and (5) Burns Small Boat Harbor (BSBH). As shown in Figure B.1, each of these pathways has a single connection point to the Great Lakes Basin. All five pathways share a common connection point with the Mississippi River Basin at the Brandon Road Lock and Dam. The pathways are composed of a combination of 12 waterways: (1) North Shore Channel (NSC), (2) North Branch Chicago River (NBCR), (3) North Branch Canal (NBC), (4) South Branch Chicago River (SBCR), (5) Chicago River, (6) Chicago Sanitary & Ship Canal (CSSC), (7) Little Calumet River (LCR), (8) Calumet-Sag Channel (CSC), (9) Calumet River, (10) West Branch of the Grand Calumet River (GCR), (11) Indiana Harbor & Canal (IHC), and (12) Burns Ditch. Table B.1 identifies which waterways compose the five aquatic pathways in the CAWS.

B.1.1.5.1 Control and Management of Flow in the CAWS

The operation of the CAWS is managed by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) but is subject to regulation under U.S. Supreme Court Decrees and Title 33 of the *Code of Federal Regulations* (CFR), Sections 207.420 and 207.425. The CFR provides for the maintenance of navigable depths to support commercial navigation and to prevent unintentional reversal into Lake Michigan. The U.S. Supreme Court Decrees govern the quantity of water from Lake Michigan that is diverted out of the Great Lakes Basin into the Mississippi River Basin by the State of Illinois. Within Illinois, this quantity is subject to regulation by the Illinois Department of Natural Resources (Illinois DNR), Division of Water Resources (DWR).

The Illinois DNR issues allocation orders for annual average quantities of diversion which are allocated to municipalities for domestic consumption. The MWRDGC has an order allowing it to divert Lake Michigan water into the CAWS to improve water quality. This diversion is called “discretionary diversion,” and it is seasonal and is scheduled such that most flow is during the warm weather months of June through October. Because of more sensitive water quality conditions, some flow is scheduled throughout the year for the NSC. For example, discretionary diversion flows are provided in Table B.2 for calendar year 2006. Currently and through 2014, the MWRDGC’s allocation is for an annual average of 270 cubic feet per second (cfs). In 2015, it is scheduled to be reduced to an annual average of 101 cfs (MWRDGC 2008).

An additional annual average of 35 cfs is allocated to the MWRDGC for navigation makeup. This is necessary to restore the CAWS to the required water level for navigation following a system drawdown for wet weather operations. There are two other diversion categories which do not have a specific allocation but for which the Illinois DNR maintains a reserve quantity. An approximate annual average of 100 cfs is the reserve needed for operation of the locks at the CRCW and Thomas J. O’Brien Lock and Dam for passage of navigation traffic. Another approximate annual average of 50 cfs is reserved for leakage through the walls and structures separating Lake Michigan from the Chicago River.

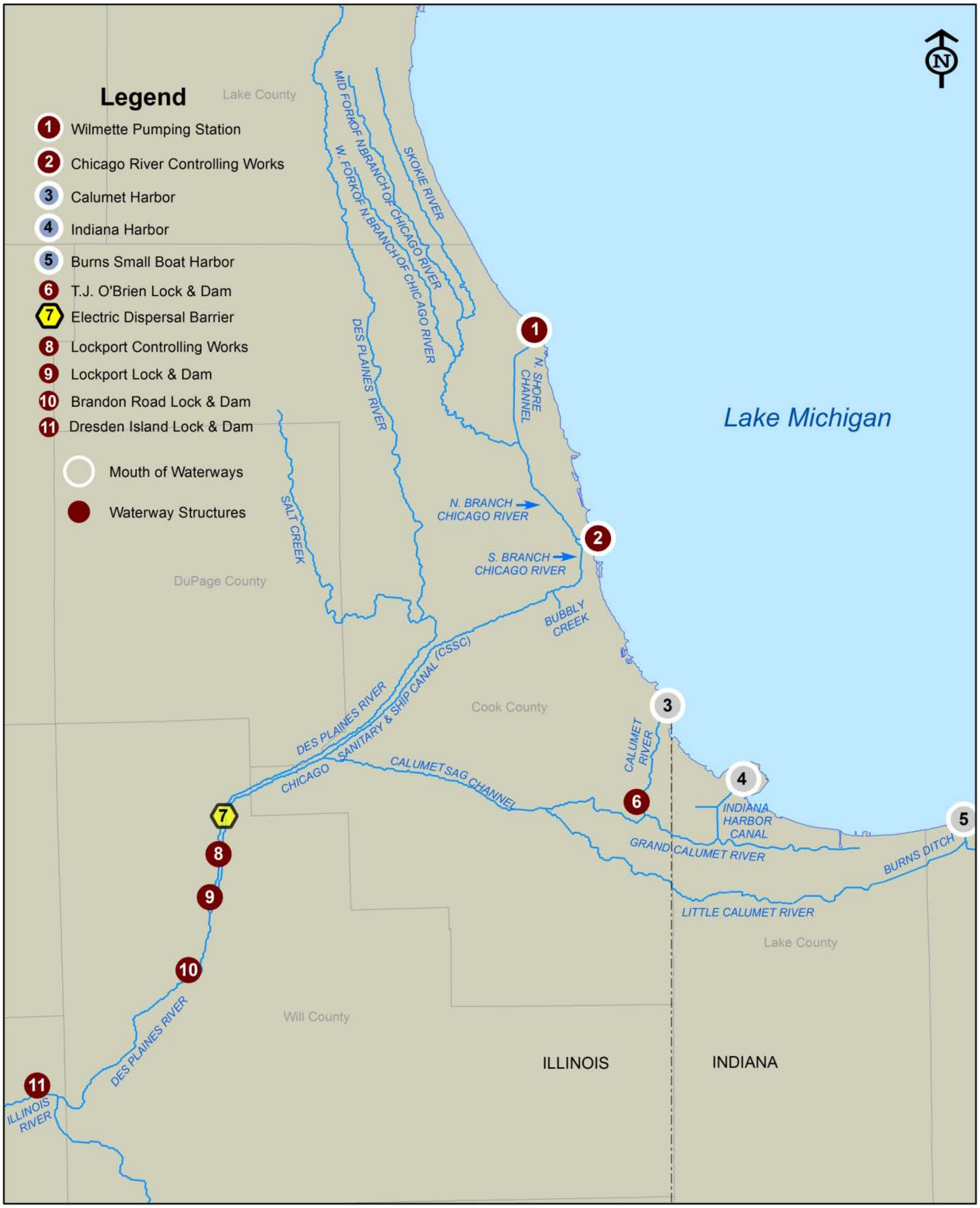


FIGURE B.1 Aquatic Pathways and Control Structures Map

TABLE B.1 Pathway and Waterway Matrix

Pathway	NSC	NBCR	N BC	SBCR	Chicago River	CSSC	LCR	CSC	Calumet River	West Branch GCR	IHC	Burns Ditch
	Waterway											
Wilmette	X	X	X	X		X						
CRCW				X	X	X						
Calumet Harbor						X		X	X	X		
Indiana Harbor						X		X		X	X	
BSBH						X	X	X				X

TABLE B.2 Discretionary Diversion for Calendar Year 2006[a]

Inflow Facility	Average Annual (cfs)	Monthly Minimum (cfs)	Monthly Maximum (cfs)
WPS	40.4	0	129
CRCW	127.5	0	428
O'Brien Lock and Dam	83.5	0	303

[a] Source: MWRDGC (2008).

The waterway control structures along the CAWS are used to control the flow of water in the system. During dry weather (normal condition), outflow from the CAWS is controlled through the turbines at Lockport Powerhouse to maintain river levels at the CRCW and O'Brien Lock and Dam. During wet weather conditions, the waterway system is drawn down by allowing more water to leave at Lockport prior to and/or during major rainfall events. System drawdown increases the capacity of the waterway for stormwater runoff. Flow capacity at Lockport is increased and the sluice gates at the CRCW, O'Brien Lock and Dam, and WPS reverse floodwaters to Lake Michigan as needed. The lock gates at the CRCW and O'Brien Lock and Dam can be opened to further help relieve floodwaters in the system.

Each of the waterways within the CAWS is discussed in detail in the following sections. Additional detail on CAWS operations is provided in Section 1.25, Hydrology and Hydraulics.

B.1.1.5.2 Descriptions of Waterways

Waterway	North Shore Channel
Length (mi)	7.7
Width (ft)	90
Depth (ft)	5 - 10

Control Structure	Wilmette PS
Avg. Annual (cfs)	40.4
Monthly Min (cfs)	0
Monthly Max (cfs)	129

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

North Shore Channel. The northernmost segment of the CAWS is the NSC, which extends from Lake Michigan at Wilmette Harbor in Wilmette, to the confluence with the North Branch Chicago River near Foster Avenue in Chicago. The NSC was designed to increase flow for dilution and flushing of wastewater in the NBCR by connecting the channel to Lake Michigan. Pumps at the WPS convey water from Lake Michigan into the channel which flows south toward the North Branch Chicago River (LimnoTech 2010).

Land use along the NSC is generally urban commercial and residential. Instream aquatic habitat is often present along the partly shaded banks in the form of aquatic plants, tree roots, and brush debris jams. The

MWRDGC's North Side Water Reclamation Plant (WRP), located in Skokie, discharges treated wastewater into the NSC. The North Side WRP has a design capacity of 333 million gallons per day (MGD) (MWRDGC 2008), and effluent from the plant makes up the majority of the average flow in the channel.

In the northernmost reaches of the NSC, near Central Avenue, a variety of sediment types are present and the depth of fines is generally 1 ft or less. Upstream of the North Side WRP at Oakton Avenue, silt makes up the majority of sediment composition, with deeper depth of fines than the upstream reaches (2–4 ft). In the reach directly downstream of the North Side WRP, near Touhy Avenue, a majority of the sediment is composed of sand, with the depth of fines ranging from under 1 ft up to 5 ft. Near Foster Avenue, approaching the confluence with the NBCR, sediment is mixed and depth of fines is less than 1 ft (MWRDGC 2008). Surficial sediments studied by the Illinois Environmental Protection Agency (IEPA) in 2001 were found to contain lead, mercury, and other metals at concentrations toxic to benthic organisms (CDM 2004).

Control Structure – Wilmette Pumping Station. The WPS controls the flow of water between Lake Michigan and the NSC and does not allow navigation between Lake Michigan and NSC, as shown in Figure B.2. Lake water is brought into the channel for augmenting low flows for water quality maintenance. The WPS is currently undergoing a major rehabilitation. The construction is expected to be completed in 2014. At that time, the WPS will include one 150-cfs variable speed pump which will be the primary diversion pump; the rebuilt 250-cfs pump will be used as a backup. In addition, three sluice gates will replace the existing 32-ft × 15-ft gate for backflow operation (MWRDGC 2010).

North Branch Chicago River. From the junction of the Chicago River and the South Branch upstream to Belmont Avenue, the river follows its original course, as shown in Figure B-3. The North Branch is a natural portion of the CAWS that was historically straightened, widened, and dredged to accommodate increased volume of diluted wastewater from the man-made NSC. In several reaches, vertical dock walls have been constructed. North of Belmont Avenue, the channel has been straightened with steep, earthen side slopes.

Waterway	North Branch Chicago River
Length (mi)	5.1
Width (ft)	150 - 300
Depth (ft)	5 - 15

Water Reclamation Plant	North Side
Avg. Annual Flow (MGD)	244
Design Avg. Flow (MGD)	333
Design Max Flow (MGD)	450

Pump Station	North Branch PS
Capacity (cfs)	1,500

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

Today, the northern portion of the North Branch by Wilson Avenue has mostly urban, residential land use and contains in-stream habitat with logs, boulders, and an under-cut bank. In these upstream reaches, sediment, usually less than 1 ft, is composed mostly of cobble and sand. Farther downstream, near Diversey Avenue, land use changes to mostly commercial/industrial. There is decreased canopy cover and limited instream habitat near the banks. The sediment, ranging from 1 to 3 ft, consists mostly of silt with scoured concrete in some areas. As the North Branch approaches downtown Chicago, physical habitat is further degraded. Near Grand Avenue, land use is primarily industrial/commercial, with periodic vertical sheet pile walls and concrete "banks." There is a lack of instream habitat and little canopy cover. Sediment is composed primarily of silt with depth of fines ranging from 1 ft to greater than 5 ft (MWRDGC 2008). Surficial sediments in the North Branch are impacted by toxic concentrations of metals, polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) (CDM 2004). *E. Coli* concentrations detected by the MWRDGC indicate that water quality in the Upper North Branch is impacted by the non-disinfected wastewater effluent from the North Side WRP. The 2012 Illinois 303(d) list also indicates that water quality in the North Branch is also

FIGURE B.2 North Shore Channel Map

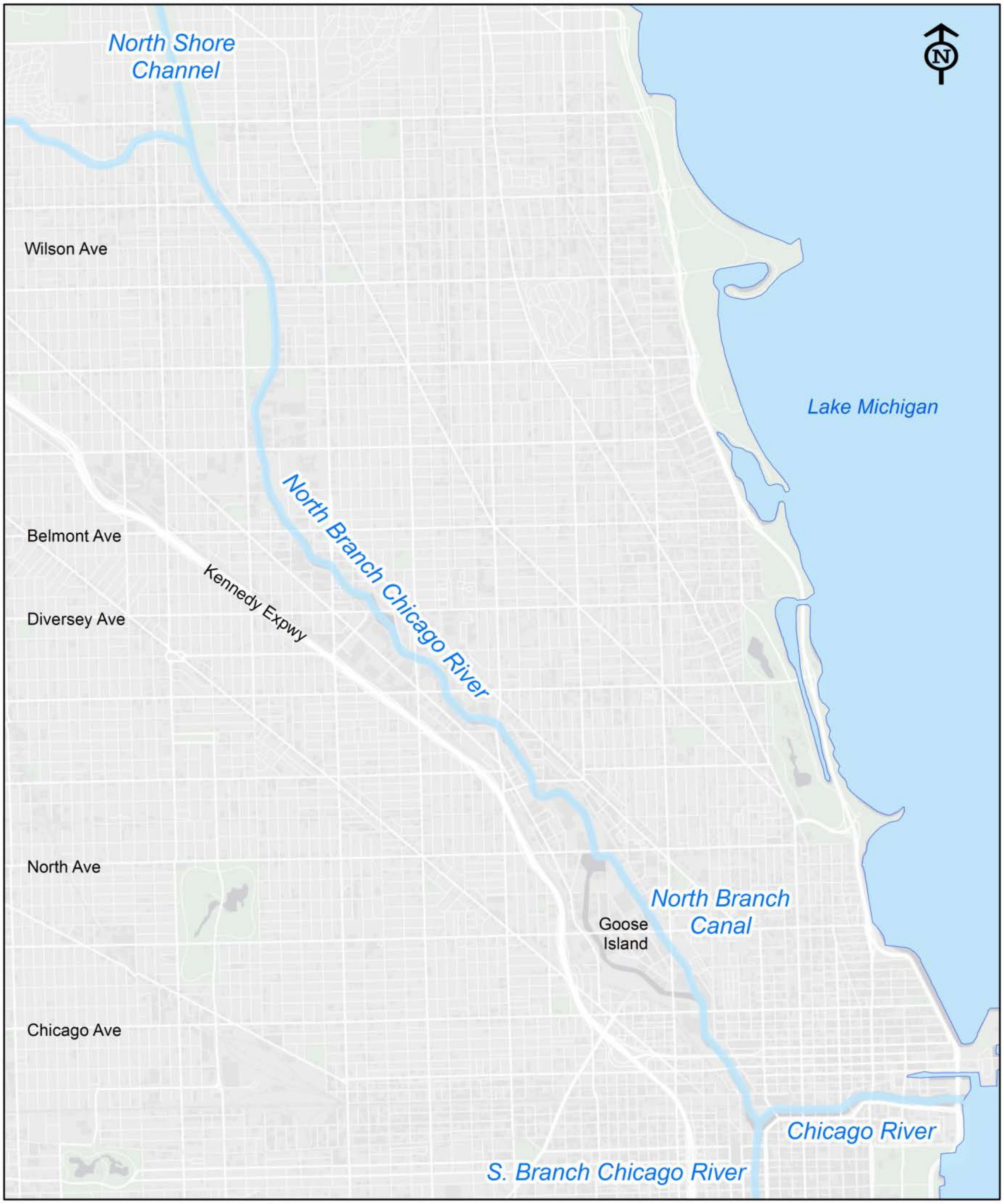


FIGURE B.3 North Branch Chicago River and North Branch Canal Map

impaired by low dissolved oxygen (DO) and by elevated concentrations of mercury, PCBs, iron, oil and grease, and phosphorus (IEPA 2012).

North Branch Canal. The NBC was constructed in 1857 to bypass a major bend in the NBCR in order to reduce travel time up the river. It forms the east side of Goose Island which has been isolated between North Avenue and Chicago Avenue (LimnoTech 2010). (See Figure B-3).

Waterway	North Branch Canal
Length (mi)	0.9
Width (ft)	80 - 120
Depth (ft)	4 - 8

(LimnoTech 2010)

South Branch Chicago River. The SBCR has vertical dock walls throughout most of its length and has several bends, generally following its original course. There is very little instream habitat or canopy cover along the South Branch, and urban industrial and commercial land uses predominate. Near Madison Street in downtown Chicago, the sediment is almost entirely made up of silt, with about 1 ft depth of fines. Downstream at Loomis Street, the side channels are mostly scoured bedrock with 3 to 5 ft of silt and sludge deposits in the center (MWRDGC 2008). Sediment data collected by multiple agencies in recent years indicate that surficial sediments in the South Branch are impacted by toxic concentrations of metals, PAHs, and PCBs (CDM 2004). The 2012 Illinois 303(d) list indicates that water quality in the North Branch is also impaired by elevated concentrations of PCBs (IEPA 2012).

Waterway	South Branch Chicago River
Length (mi)	4.5
Width (ft)	200 - 250
Depth (ft)	15 - 20

(LimnoTech 2010)

South Fork South Branch Chicago River. The South Fork South Branch of the Chicago River, also known as “Bubbly Creek,” is a tributary to the Chicago River system. This segment is composed of a majority of steep earthen or riprap banks, with vertical sheet pile walls along several reaches. Decomposition of organic matter in the sediment results in bubbling gases escaping to the surface. Stagnant flow conditions are common in Bubbly Creek unless there is discharge from the Racine Avenue Pumping Station (RAPS). RAPS, with a design discharge capacity of 6,000 cfs, is capable of pumping millions of gallons a day of combined sewage-stormwater to the CAWS (MWRDGC 2008).

Waterway	South Fork South Branch Chicago River
Length (mi)	1.3
Width (ft)	100-200
Depth (ft)	15-20

Pump Station	Racine Avenue PS
Capacity (cfs)	6,000

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

Urban industrial and commercial land uses are most common, although residential areas have been recently established along the northern reach of Bubbly Creek. A 2008 survey identified logs and brush debris jams instream cover along much of the creek. The sediment, which has a depth of 5 ft, is characterized mostly by sludge and silt deposits (MWRDGC 2008).

A 2005 sediment investigation by the USACE detected PAHs, PCBs, oil and grease, metals, and other semi-volatile organic compounds (SVOCs). Consistent with the USACE’s findings, data collected by the MWRDGC in 2006 revealed the presence of 24 organic pollutants in Bubbly Creek sediments, many at elevated concentrations (MWRDGC 2006). The 2012 Illinois 303(d) list indicates that water quality in Bubbly Creek is also impaired by low DO concentrations, high pH, and elevated phosphorus concentrations (IEPA 2012).

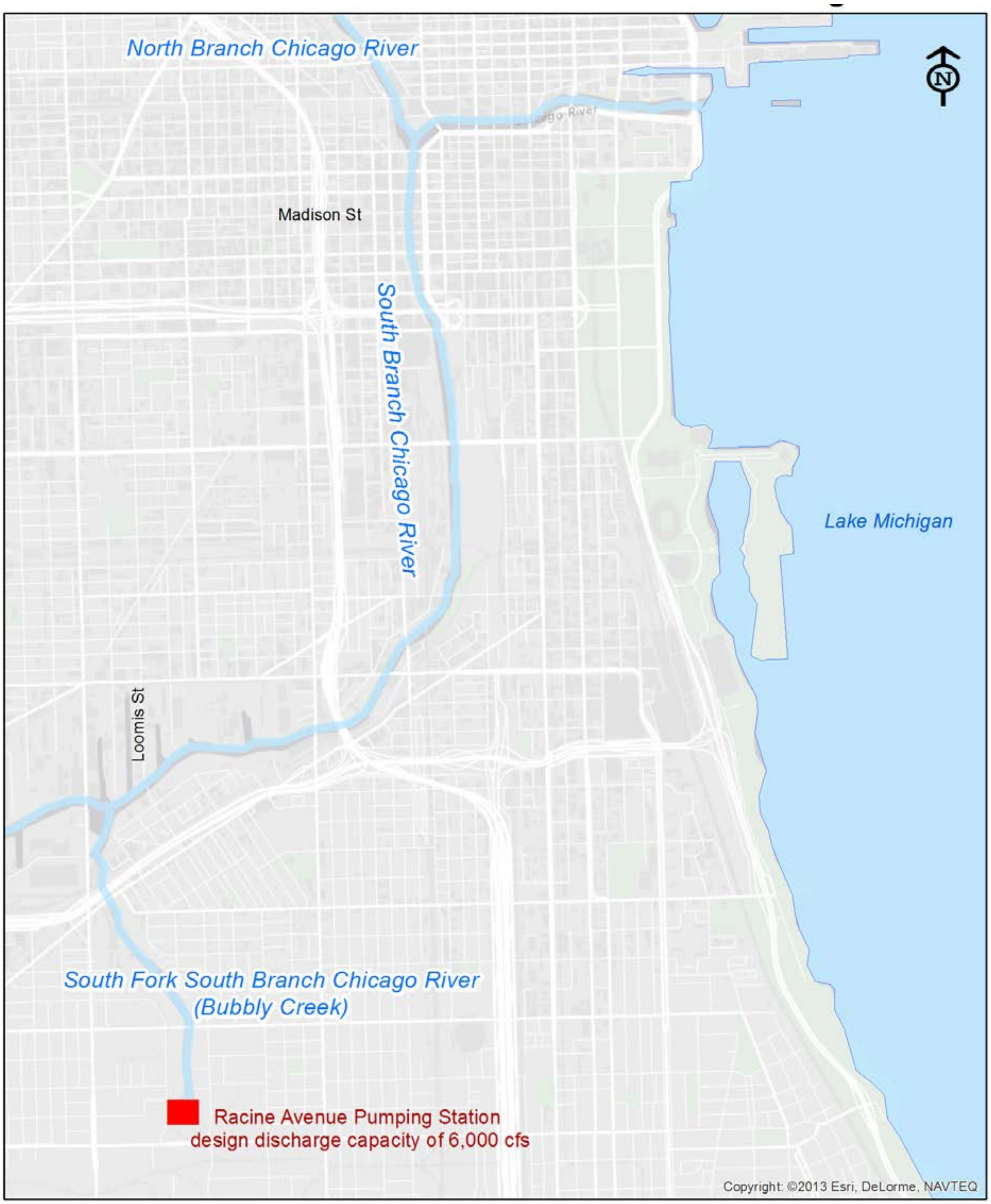


FIGURE B.4 South Branch Chicago River and South Fork South Branch Chicago River Map

Chicago River. The Chicago River has vertical side walls throughout its length, and its alignment is generally straight, with three bends near Michigan Avenue and State and Orleans Streets. It historically flowed into Lake Michigan but was reversed by the construction of the CSSC. Its entire length was also dredged, widened, and straightened.

Waterway	Chicago River
Length (mi)	1.5
Width (ft)	200-400
Depth (ft)	20-26

Control Structure	Chicago River Controlling Works
Avg. Annual (cfs)	127.5
Monthly Min (cfs)	0
Monthly Max (cfs)	428

Control Structure	Chicago Lock
Lock Width (ft)	80
Lock Length (ft)	600
Sluice Gate Width (ft)	10
Sluice Gate Height (ft)	10
Nominal Lift (ft)	4

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

Currently, the Chicago River contains physical limitations to aquatic habitat, as it flows right through downtown Chicago and contains steep vertical sheet pile walls. There are no shallow areas, and there is very little canopy cover. Fine-grained, silty sediments predominate. Because of the temperature and salinity differential between the warmer, more saline water from the NBCR and the colder, less saline water of Lake Michigan, density currents are sometimes established in the Chicago River. These density currents can result in simultaneous bi-directional flow in the Chicago River. In addition, the gradient of the bed is very small, making it difficult to push the water out of the Chicago River (MWRDGC 2008).

Control Structure – Chicago River Controlling Works. The CRCW controls the flow of water between Lake Michigan and the Chicago River, as shown in Figure B.5. It consists of walls separating the river and the lake, a navigation lock, two sets of sluice gates (with four gates each), and a pumping station. The sluice gates allow discretionary flow from Lake Michigan to the Chicago River ,when the lake level is higher than the Chicago River, and flood relief when backflow is required. The pumping station has three pumps of 30 cfs each. The pumps can only discharge from the river to the lake to return excess leakage and lockage water to the lake. The pumps have not yet been used for this purpose.

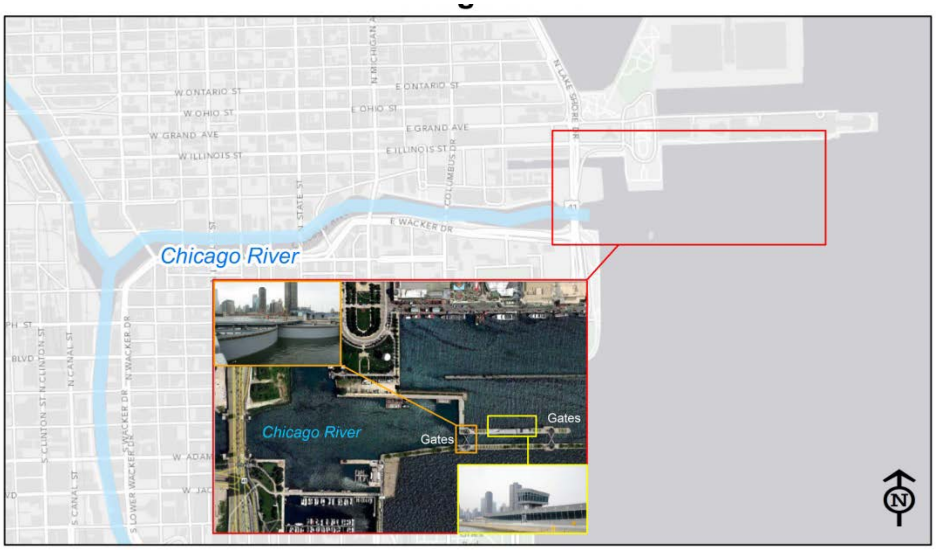


FIGURE B.5 Chicago River Map

Chicago Sanitary & Ship Canal. The CSSC is a man-made channel that was constructed in 1900 to supplement and ultimately replace the Illinois and Michigan Canal as a conduit to the Mississippi River system. Its construction facilitated the reversal of the Chicago River. Industrial and commercial land use dominates the riparian zone along most of the CSSC. There is little to no canopy cover and instream habitat for aquatic life is limited. Silt and sludge makes up a majority of the sediment at Damen Avenue, with depth of fines ranging from 1 to 9 ft. At Cicero Avenue, deposited sediments are 1 to 4 ft deep and are composed of mostly silt and sludge. Sediment, composed of mostly silt, was slightly more variable at Harlem Avenue, but there was also sand, gravel, cobble, and boulders near the bridge. The bedrock was exposed due to scouring near Route 83 and Stephen Street, with some scattered silt deposits. Areas of scouring, as well as pockets of deep silty sediments also occur near Lockport, although habitat improves slightly near the sunken barges on the west bank. Aquatic vegetation and snags are present in this shallow area with deep sand and silt deposits (MWRDGC 2008). Water and sediment quality is impaired throughout. The 2012 Illinois 303(d) list indicates that upstream of the Cal-Sag junction, the CSSC does not support its aquatic life and fish consumption uses because of elevated levels of ammonia, phosphorus, mercury, and PCBs, and low DO concentrations (IEPA 2012). Sediment samples collected near Lockport in 2006 contained elevated levels of cyanide and phenols. Sediment samples collected near Lockport in 2006 contained elevated levels of cyanide and phenols. Ten-day *Chironomus tentans* toxicity testing on sediments collected at Lockport indicated poor habitat quality for benthic organisms (MWRDGC 2006).

Control Structure – Lockport Lock and Dam. The Lockport Lock and Dam consist of one lock chamber, a dam and powerhouse, and an abandoned lock. The MWRDGC uses the dam to control the outflow of the CSSC and limit the diversion of water from Lake Michigan into the Des Plaines River. The Lockport Powerhouse was built in 1900 and consists of two units of turbines and generators, nine pit gates, and a lock. During normal operation, one turbine usually runs to pass dry weather flow downstream and maintain a water depth adequate for navigation from the lakefront to Lockport. The nominal lift between the Lockport Pool and the Brandon Road Pool equals approximately 39 ft as shown in Figure B.6.

Waterway	Chicago Sanitary & Ship Canal
Length (mi)	31.1
Width (ft)	160-300
Depth (ft)	20-27

Control Structure	Lockport Controlling Works
Sluice Gate Width (ft)	20
Sluice Gate Height (ft)	30

Control Structure	Lockport Lock & Powerhouse
Lock Width (ft)	110
Lock Length (ft)	600
Sluice Gate Width (ft)	9
Sluice Gate Height (ft)	14
Nominal Lift (ft)	39

Control Structure	Brandon Lock
Lock Width (ft)	110
Lock Length (ft)	600
Sluice Gate Width (ft)	9
Sluice Gate Height (ft)	14
Nominal Lift (ft)	34

Water Reclamation Plant	Stickney
Avg. Annual Flow (MGD)	729
Design Avg. Flow (MGD)	1200
Design Max Flow (MGD)	1440

Water Reclamation Plant	Lemont
Avg. Annual Flow (MGD)	2.31
Design Avg. Flow (MGD)	2.3
Design Max Flow (MGD)	4.0

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

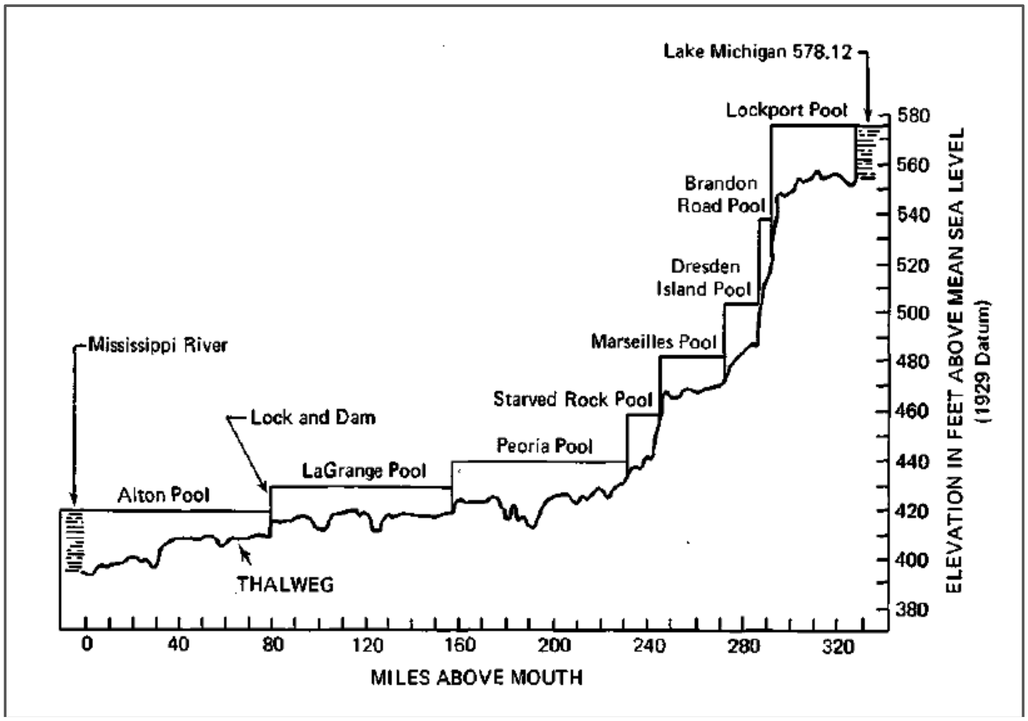


FIGURE B.6 Illinois Waterway Profile (Source: Butts, Schnepper, and Singh 1983)

Control Structure – Lockport Controlling Works. The Lockport Controlling Works is located 2 mi upstream of the Lockport Powerhouse and connects the CSSC to the Des Plaines River as shown in Figure B.7. The Lockport Controlling Works' primary purpose is to control flooding by allowing overflow relief for the CSSC into the Des Plaines River; its secondary purpose is to maintain CSSC's elevations for navigation. In addition, activities at the controlling works are also coordinated with downstream powerhouse activities to maximize electricity production. The Lockport Controlling Works consists of seven operational vertical lift sluice gates, 20 ft high by 30 ft wide, which the MWRDGC opens 6 to 10 times per year.

Control Structure – Brandon Lock. Located downstream of the CSSC on the Des Plaines River, the Brandon Road Lock and Dam contains one lock chamber and a dam. This dam contains 8 operational headgates and 21 tainter gates. The nominal lift between the Brandon Road Pool and the Dresden Island Pool equals approximately 34 ft, as shown in Figure B.6.

Water Reclamation Plants – Stickney and Lemont. The Stickney WRP, which consists of a west side and southwest portion, is the largest wastewater treatment facility in the world. The plant has a design capacity of 1,200 MGD. The Lemont WRP is the smallest of the seven wastewater treatment facilities within the MWRDGC jurisdiction, with an average flow of 2.3 MGD.

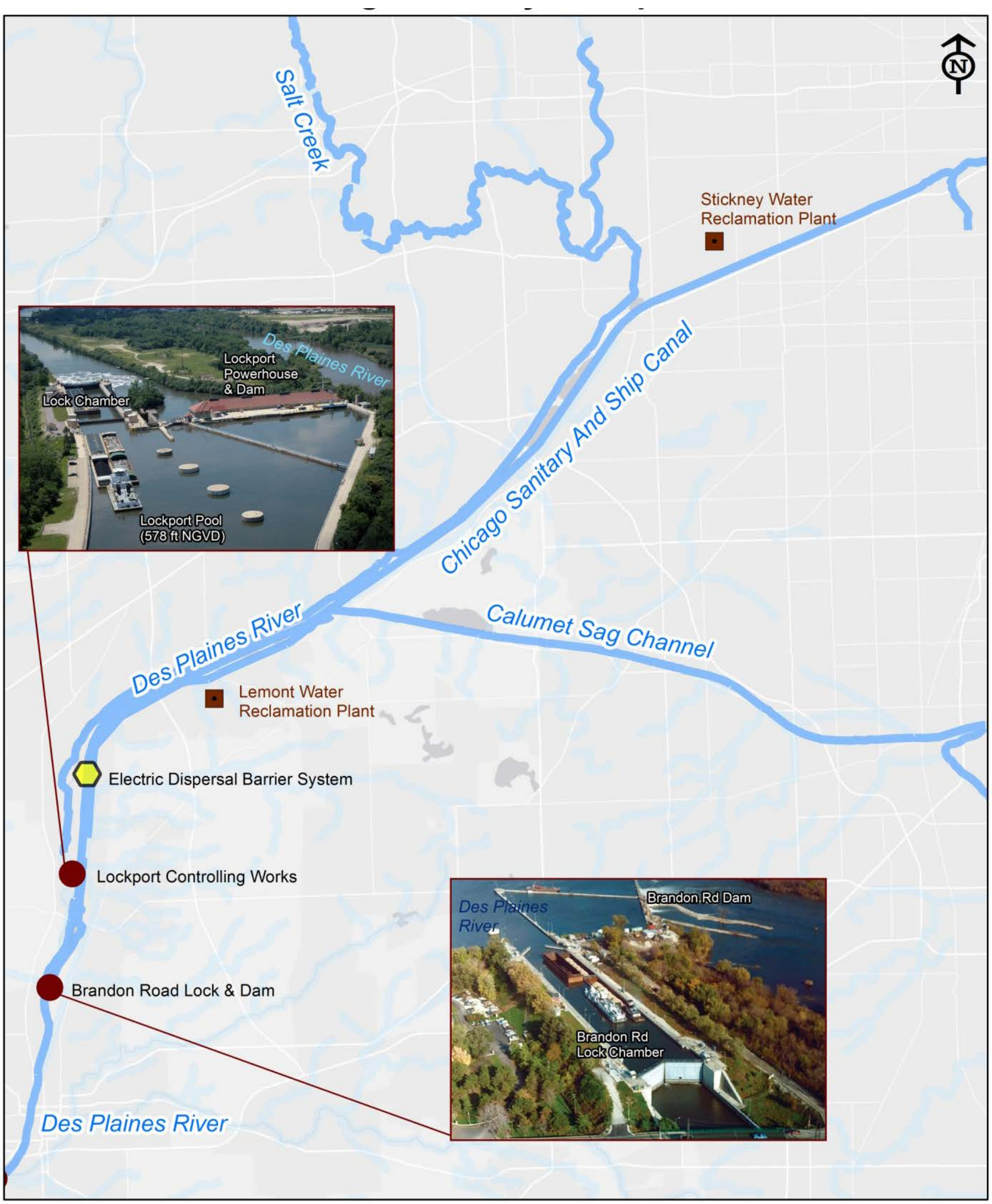


FIGURE B.7 Chicago Sanitary and Ship Canal Map

Calumet River. The Calumet River extends upstream of the GCR, through the O'Brien Lock and Dam and ends at Calumet Harbor in Lake Michigan (Figure B.8). The river is approximately 8 mi long and 450 ft wide on average. The Calumet River was built to carry pollution away from Lake Michigan via the CSC, the LCR, and the GCR. Numerous domestic and hazardous waste landfills surround the Calumet River. The channel banks consist of sheet-pile, concrete walls, and rip-rap. Very little riparian vegetation exists along the Calumet River, except in the vicinity of the landfills (CDM 2004). The Calumet River has been dredged for many years in support of nearby industries, and the USACE has performed extensive sediment sampling in Calumet River and Harbor. Calumet River sediment contains high concentrations of arsenic, chromium, copper, cyanide, lead, manganese, zinc, and oil and grease in samples collected as recently as 2009. Water quality in the Calumet River is not supportive of its designated Aquatic Life, Fish Consumption, and Primary Contact Recreation uses due to elevated concentrations of mercury, PCBs, silver, phosphorus, and fecal coliform (IEPA 2012).

Waterway	Calumet River
Length (mi)	8
Width (ft)	450
Depth (ft)	27

Control Structure	O'Brien Lock & Dam
Avg. Annual (cfs)	83.5
Monthly Min (cfs)	0
Monthly Max (cfs)	303
Lock Width (ft)	110
Lock Length (ft)	1000
Nominal Lift (ft)	4

Pump Station	95th Street PS
Capacity (cfs)	855

Pump Station	122nd Street PS
Capacity (cfs)	375

(CDM 2004)

Control Structure – T.J. O'Brien Lock and Controlling Works. The T.J. O'Brien Lock is located on the Calumet River about 0.5 mi upstream of the confluence with the GCR, and controls flow between the CAWS and Lake Michigan. Like the CRCW and the WPS, the O'Brien Lock and Dam serves as a controlling point to maintain desired water levels in the CAWS, facilitate navigation, and prevent flooding.

Grand Calumet River. The GCR consists of two branches that meet at the southern end of the IHC, shown in Figure B.9 (CDM 2004). The East Branch of the GCR originates at the Grand Calumet Lagoons just east of the U.S. Steel Gary Works facility and flows west for approximately 10 mi to meet the IHC. The West Branch of the GCR, located between the IHC and the Calumet River, usually flows both east and west, with a watershed divide located in the vicinity of Indianapolis Boulevard, depending on the water level in Lake Michigan. The IHC flows north for approximately 3 mi before turning northeast and flowing for an additional 2 mi into Lake Michigan (USACE 2004).

Waterway	Grand Calumet River
Length (mi)	11.2
Width (ft)	30 – 130 ft
Depth (ft)	2

Wastewater Treatment	Hammond
Permitted Flow (MGD)	37.8

Wastewater Treatment	East Chicago
Permitted Flow (MGD)	15

Wastewater Treatment	Gary
Design Avg. Flow (MGD)	60

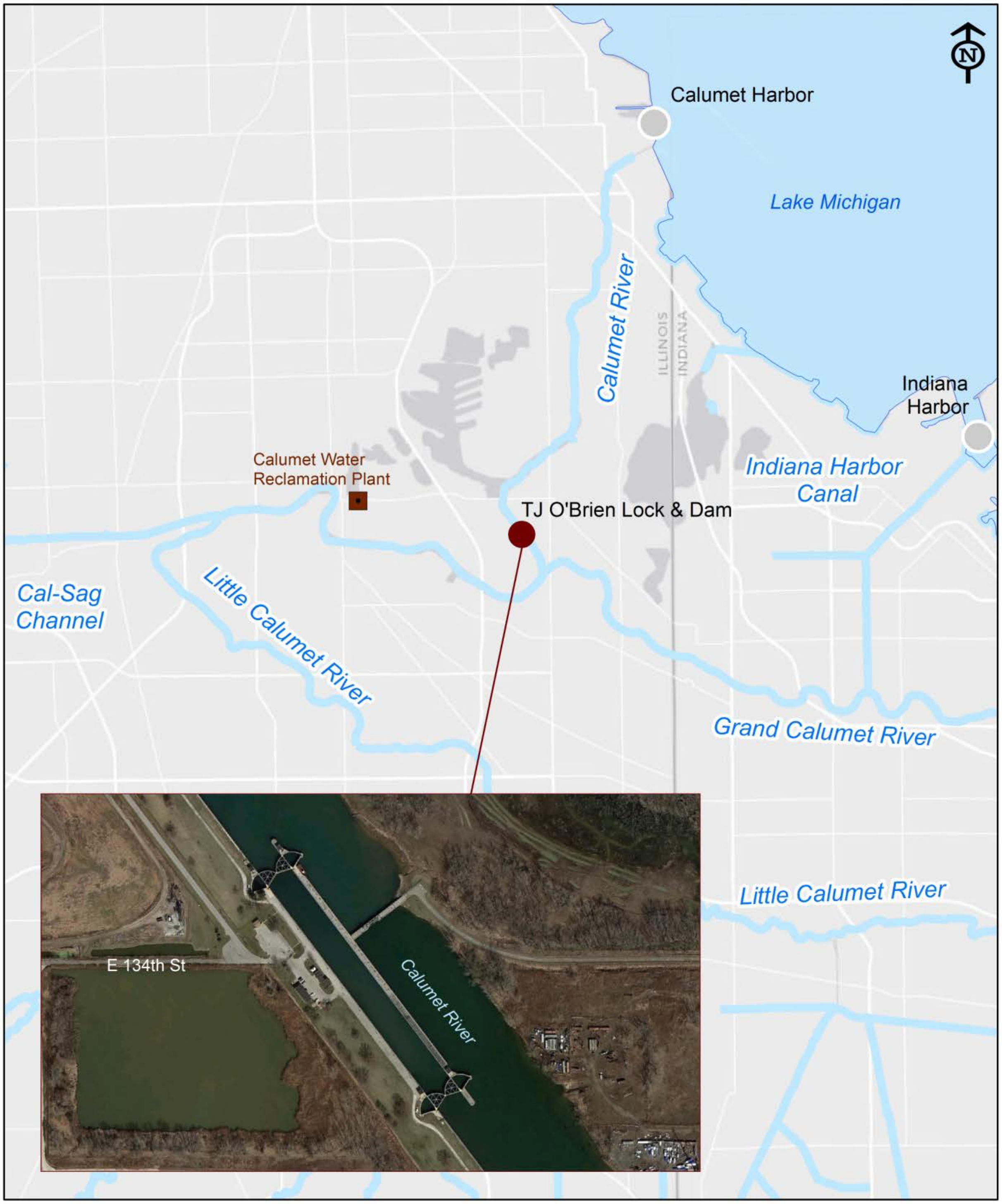


FIGURE B.8 Calumet River Map

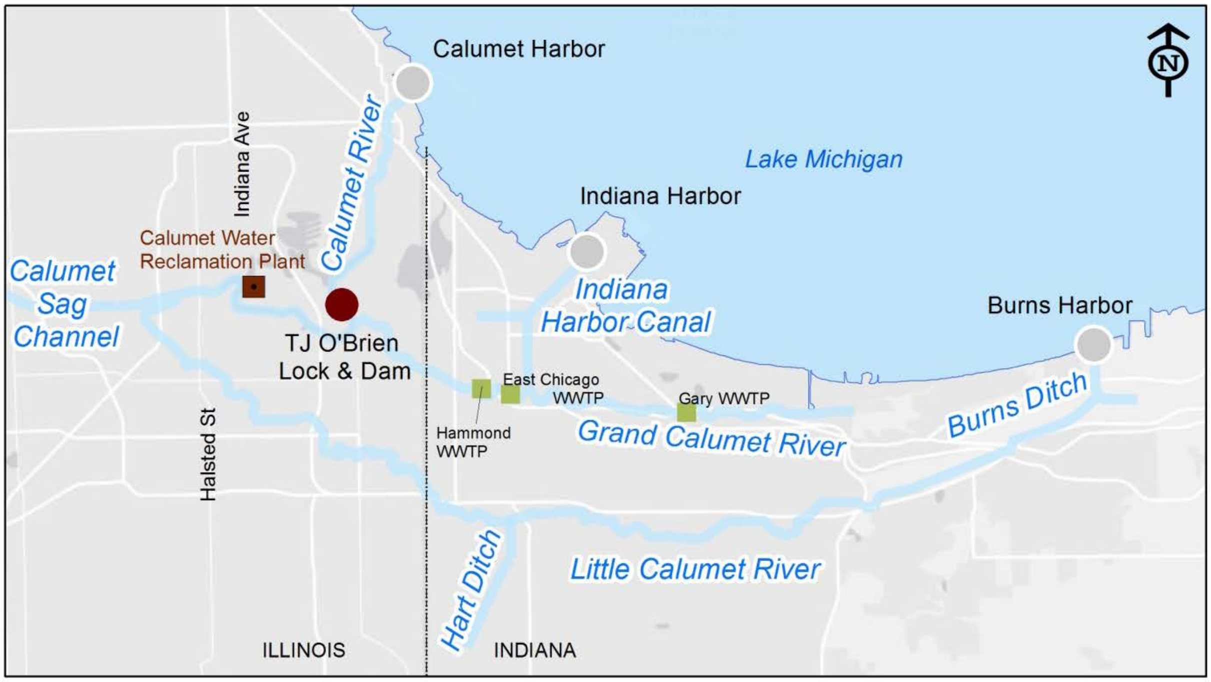


FIGURE B.9 Calumet River System Map

The GCR has riparian vegetation along its banks, which provides habitat for many species of birds and mammals (CDM 2004). The Grand Calumet River is one of 43 Areas of Concern (AOCs) on the Great Lakes identified by the U.S. Environmental Protection Agency (EPA) and is the only AOC impaired for all 14 beneficial uses. The legacy pollutants found in the bottom sediments are the greatest contributor to this waterway's impairment. Dredging and capping projects conducted by U.S. Steel Gary Works and the EPA, together with navigational dredging of the IHC conducted by the USACE, are expected to improve sediment and water quality in this AOC.

Little Calumet River. Originally a reach of the Grand Calumet River in Illinois, the LCR was widened, straightened, and deepened to accept diverted flows from the Grand Calumet River. The flow of the LCR was reversed westward into the CSC (LimnoTech 2010). The LCR has a drainage divide occurring east of Hart Ditch. This divide is the point where in dry weather, all water west of it flows toward Illinois and all water east of it flows toward Lake Michigan, via Burns Ditch. During wet weather events, the water on the east side of the divide will flow west toward Illinois.

Waterway	Little Calumet River
Length (mi)	6.9
Width (ft)	250-350
Depth (ft)	12

Water Reclamation Plant	Calumet
Avg. Annual Flow (MGD)	283
Design Avg. Flow (MGD)	354
Design Max Flow (MGD)	430

Pump Station	125th St. to LCR
Capacity (cfs)	1,140

(LimnoTech 2010) and 2006 data (MWRDGC 2008)

The LCR has few vertical dock walls, and most of the banks are earthen side slopes. Instream habitat for aquatic life is available along the LCR in the form of boulders, logs, brush debris jams, overhanging terrestrial vegetation, and aquatic vegetation. Riparian land use along the LCR upstream of the Calumet WRP outfall, near Indiana Avenue, is generally urban industrial and commercial. The sediments are up to 7 ft deep in this reach and are mostly characterized by sludge and silt deposits; however, there are also gravel substrates in the center of the river. Downstream of the WRP, at Halsted Street, land use varies from urban commercial to forest and wetland. Sediments up to 3 ft deep are relatively heterogeneous, although the substrate is sometimes scoured in the center, exposing bedrock (MWRDGC 2008). Notable levels of trace metals were detected in sediment samples collected by the MWRDGC in 2007. Water quality in the Little Calumet is not supportive of the designated Indigenous Aquatic Life and Fish Consumption uses due to elevated concentrations of mercury, PCBs, aldrin, iron, phosphorus, and silver, and low DO concentrations (IEPA 2012).

Water Reclamation Plant - Calumet. The Calumet WRP provides both primary and secondary treatment, which removes more than 90% of contaminants. The Calumet Tunnel, which is part of the Tunnel and Reservoir Plan (TARP), helps control pollution and eliminates 85% of the combined sewer over-flows.

Waterway	Calumet-Sag Channel
Length (mi)	16.2
Width (ft)	225
Depth (ft)	10

(LimnoTech 2010)

Calumet-Sag Channel. A man-made channel to reverse the flow of the Calumet River away from Lake Michigan, the CSC is generally a trapezoidal shape, but in some sections, the north bank is a vertical wall (see Figure B.10). Once completed, the CSC connected the LCR to the CSSC and was later widened to improve navigation (LimnoTech 2010). The alignment is generally straight. The channel was excavated through limestone and bedrock, and current conditions constitute mostly silt and sludge deposited on a hard, consolidated substrate. A 2008 survey identified aquatic habitat such as log jams and boulders on the bank, and no aquatic vegetation other than attached green algae. In its mid-section, sediment, which ranges from 3 to 9 ft at Cicero Avenue, is mostly composed of sludge and silt. There is an open canopy with logs and boulders on the side bank.

Upstream of Southwest Highway, land use is generally urban/industrial; however, near its western terminus, shortly upstream of the confluence with the CSSC, land is leased to and managed by the Forest Preserve District of Cook County. At Route 83, sediment up to 7 ft deep is mostly composed of silt and sludge. In this reach, some parts of the south bank have boulders and small rock ledges, while the north bank is vertical limestone wall.   Sediment characterizations performed in the CSC by the MWRDGC, the EPA, and USACE in 2001, 2003, 2008, and 2009, detected volatile organic compounds (VOCs) and SVOCs, as well as pesticides and metals exceeding the IEPA's Tiered Approach to Corrective Action Objectives (TACO) criteria. Water quality in the CSC is not supportive of the designated Indigenous Aquatic Life and Fish Consumption uses due to elevated concentrations of mercury, PCBs, iron, phosphorus, and total suspended solids (TSS), as well as low DO concentrations (IEPA 2012).

B.1.1.5.3 Water Quality Structures on CAWS

Sidestream Elevated Pool Aeration (SEPA) stations implemented by the MWRDGC were designed to add oxygen to water through the use of turbulent cascades, or waterfalls. Flow is pumped from the river and then released down steps above the pool. The discharged water is aerated by the creation of turbulent flow, with an attendant increase in the DO in the CAWS within the vicinity of the SEPA station. There are currently five major SEPA stations along the Calumet River and the CSC, as shown in Figure B.11. The aeration process improves water quality, encourages fish populations, and reduces unpleasant odors. Underwater aeration stations at Devon Avenue and Webster Avenue also improve water quality in the NSC and the NBCR.

FIGURE B.10 Calumet-Sag Channel Map

B.1.1.5.4 Combined Sewer Overflows

Combined Sewer Overflows (CSOs) occur during intense rain events when Chicago's combined sewers cannot accommodate the additional stormwater flow, and untreated sewage-storm runoff is discharged to local waterways. Two hundred forty seven (247) permitted CSO outfalls on the CAWS produce hundreds of discharge events each year. More than 600 CSO outfalls exist throughout the entire combined sewer area, which spans Chicago and 51 other municipalities. The approximate extent of the CSOs is shown in Figure B.11. MWRDGC pumping stations convey wastewater to the WRPs and help dewater the sewer system during storm events to prevent basement flooding. However, when the downstream pipes reach capacity, these pumping stations also release large volumes of combined sewage-stormwater to the CAWS. In cases of especially severe storms, the CRCW and the T.J. O'Brien Lock and Dam are opened to allow water from the CAWS to flow out to Lake Michigan. The TARP was adopted in 1972 in order to minimize the impacts of CSOs on the CAWS and Lake Michigan. Completed in 2006, TARP Phase I delivered significant water quality benefits to the CAWS through the construction of 109 mi of large-diameter stormwater tunnels. Completion of the Phase II reservoirs will provide an additional 17.5 billion gallons of storage and further reduce water quality impacts caused by untreated stormwater-sewage releases to the waterways.

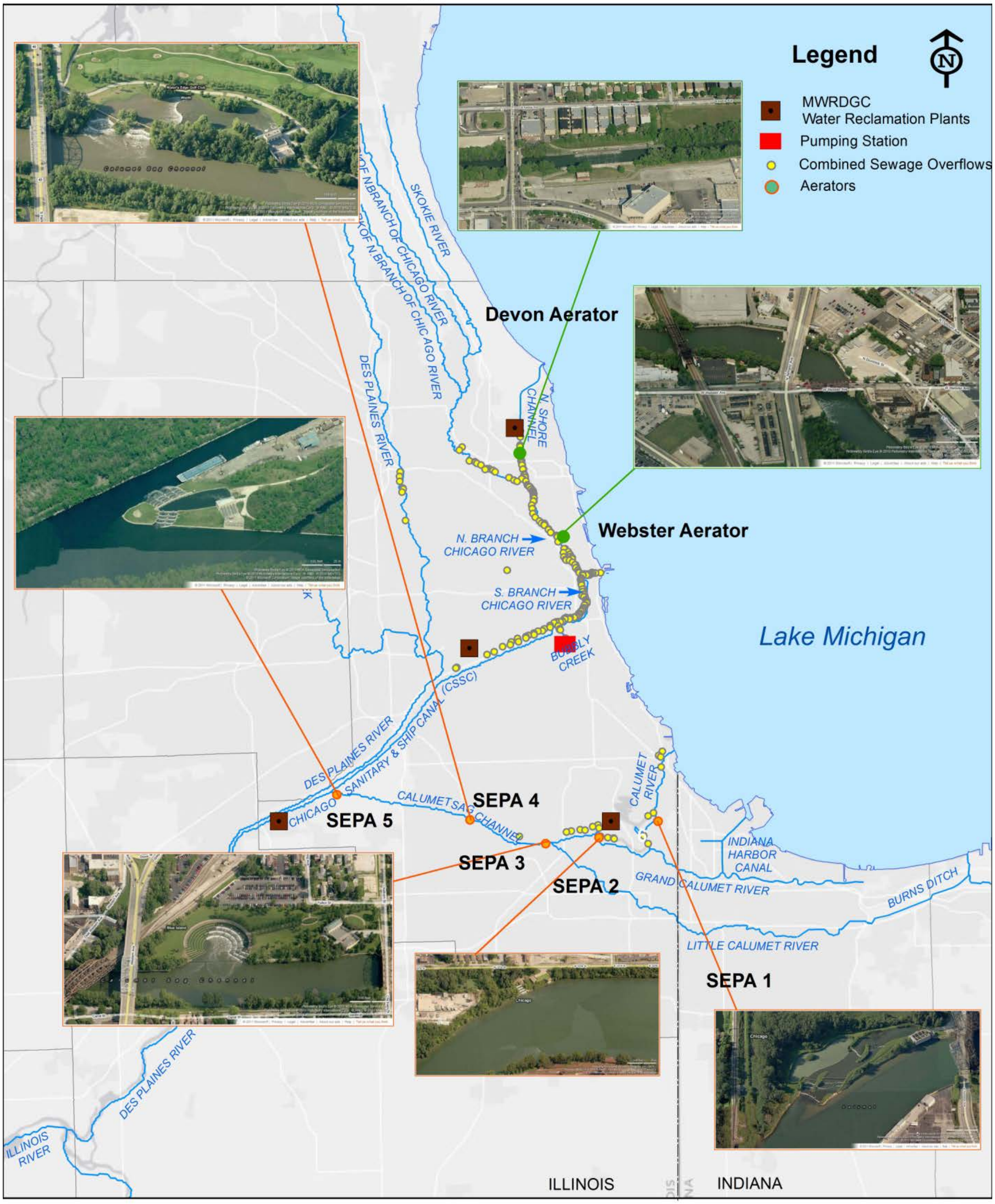


FIGURE B.11 Water Quality Structures on the CAWS

B.1.2 Physical Resources

B.1.2.1 Air Quality

Air quality in the vicinity of the CAWS is highly affected by local industries, power generating stations, and vehicle traffic. As a result, the area air quality has been designated as nonattainment for several criteria pollutants. A criteria pollutant is a pollutant for which National Ambient Air Quality Standards (NAAQS) have been established under the Clean Air Act (CAA). A nonattainment designation is based on the exceedances or violations of the air quality standard. In areas that have been redesignated as attainment from a previous nonattainment status, a maintenance period is established for 10 years after redesignation. The maintenance plan establishes measures to control emissions to ensure the air quality standard is maintained into the future. Counties in the project area are currently in nonattainment or maintenance for a number of criteria air pollutants, and because of the industrial nature of the area, it is expected that these designations will continue into the future study period. These designations are described below and summarized in Table B.3.

The Chicago-Gary-Lake County, Illinois-Indiana Nonattainment Areas for the 8-hour ozone and fine particulate matter ($PM_{2.5}$) NAAQS include the counties of Cook, Lake, DuPage, McHenry, Kane, Will, Grundy (Aux Sable and Goose Lake Townships only), and Kendall (Oswego Township only) in Illinois, as well as Lake and Porter Counties in Indiana.. Monitoring data for Indiana's Lake and Porter Counties demonstrated attainment of the 8-hour ozone standard from 2006–2008, and in 2010, the counties were redesignated as attainment (U.S. National Archives and Records Administration 2010). However, in 2012, the Indiana counties exceeded the standards and were redesignated again as nonattainment for ozone. The Indiana counties were redesignated as attainment of the $PM_{2.5}$ standard in 2012, and a maintenance period was established through 2022.

Lake County, Indiana, was previously designated as primary nonattainment of the 3-hour sulfur dioxide (SO_2) NAAQS. Monitoring data demonstrated that the 3-hour standard for SO_2 was met from 2002–2004. This area was then redesignated as attainment for 3-hour SO_2 in 2005, and a maintenance period was established through 2015. The EPA strengthened the primary air quality standard for SO_2 in 2010 and plans to issue the nonattainment area designations for the new SO_2 standard by June 3, 2013. Once the area designations take effect, state and local governments will have 18 months to develop implementation plans outlining how areas will attain and maintain the standards. Following the revision of NAAQS for SO_2 in 2010, the IEPA recommended a nonattainment designation for the 1-hour SO_2 standard for Lemont Township in Cook County, and Lockport and DuPage Townships in Will County, where air monitoring data have shown exceedances of the new standard. Several local emissions sources, including Oxbow Midwest Calcining, CITGO Petroleum, and Midwest Generation–Will County, are major contributors to this nonattainment. The IEPA recommended that the remainder of the Chicago area be designated as unclassifiable, based on insufficient data. On the Indiana side, the Indiana Department of Environmental Management (IDEM) submitted preliminary recommendations for 1-hour SO_2 designations to the EPA in May 2011 (updated in April 2012), and recommended that counties in Northwest Indiana were unclassifiable at this time, based on insufficient data. Monitoring data in the vicinity of the project area have not shown any exceedances of the 1-hour SO_2 standard. The EPA has not yet approved recommendations from either of the state agencies.

TABLE B.3 National Ambient Air Quality Standards Designations within the Study Area

Pollutant	State	County	Status
Annual $PM_{2.5}$ 1997 NAAQS	IL	Cook	Requested attainment redesignation in 2011
		Lake	
		DuPage	
		McHenry	
		Kane	
		Will	
		Grundy (Aux Sable, Goose Lake Twps)	
		Kendall (Oswego Twp)	
	IN	Lake	Redesignated attainment 2012; maintenance through 2022
		Porter	
8-hr ozone 2008 NAAQS 1-hour SO_2	IL	Cook	Requested attainment redesignation in 2011
		Lake	
		DuPage	
		McHenry	
		Kane	
		Will	
		Grundy (Aux Sable, Goose Lake Twps)	
		Kendall (Oswego Twp)	
	IN	Lake	Redesignated marginal nonattainment 2012
	IL	Porter	
		Cook (Lemont Twp)	Recommended nonattainment 2011
3-hour SO_2	IL IN	Will (Lockport, DuPage Twps)	Recommended unclassifiable 2011
		Remainder Chicago Area	
		Northwest Indiana	Recommended unclassifiable 2011
	IN	Lake	Redesignated attainment 2005; maintenance through 2015
Lead	IL	Cook (Chicago)	

Sources: IEPA (2011) and IDEM (2012b)

Finally, a 2.8-mi^2 area in Chicago, Illinois, is designated for nonattainment of the NAAQS for lead. The IEPA is currently drafting a new lead emissions standard that will impact the singular source responsible for the nonattainment. There are no nonattainment areas within the GLMRIS study area for the 1-hour carbon monoxide, 8-hour carbon monoxide, nitrogen dioxide, or 24-hour $PM_{2.5}$ NAAQS.

B.1.2.2 Water Quality

B.1.2.2.1 Water Quality Standards

The Clean Water Act (CWA), enacted in 1972 to restore and maintain the integrity of the nation's waterways, requires states to adopt Water Quality Standards (WQS) for waters of the United States within their jurisdictions. Section 303(c) of the CWA requires that state agencies designate uses for each water body and define the criteria necessary to protect those uses. WQS are narrative or numeric criteria that define the maximum contamination a water body can receive and still support its designated uses. In addition, WQS must include antidegradation policies that protect existing uses of waters and can allow increased pollution only when "necessary to accommodate important economic or social development."

Section 101 (a)(2) of the CWA states the national goal of achieving "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water" wherever attainable. States may demonstrate to the EPA that Section 101(a)(2) uses are not attainable on a water body, and the EPA may approve new and/or revised WQS for those waters. When states adopt WQS that do not include Section 101(a)(2) uses for a particular water body segment, they are required to re-examine the water body segment every 3 years to determine whether any new information has become available. Water quality must meet all applicable federal and federally approved criteria, as well as any other more stringent requirements described in state implementation procedures.

Designated uses for Illinois waters include Aquatic Life, Fish Consumption, Public and Food Processing Water Supplies, Primary Contact, Secondary Contact, Indigenous Aquatic Life, and Aesthetic Quality. Since 1972, most segments of the CAWS have been designated for Secondary Contact use, which includes fishing, boating, and other activities where water contact is minimal or incidental but excludes swimming and other Primary Contact activities. The Secondary Contact designation was re-evaluated and upheld in 1985, and was reevaluated again from 2002–2011. On the basis of information generated through a Use Attainability Analysis conducted by the IEPA, it was determined that recreation in and on the water is attainable for many segments of the CAWS. In 2012, the EPA approved new and revised use designations that better protect recreation on the CAWS. "Primary Contact Recreation" use designations are now in effect for 8 of 17 CAWS segments, consistent with Section 101(a)(2) recreational goal uses. The recreational use designations in effect for the other 9 segments provide for less than Section 101(a)(2) goals. The applicable federal aquatic life use designations currently in effect for 3 of the 17 CAWS and Lower Des Plaines River (LDPR) segments provide for protection and propagation of fish, consistent with Section 101 (a)(2) aquatic life goal uses. The federally applicable Indigenous Aquatic Life use designations currently in effect for the 14 other segments provide for less than Section 101(a)(2) aquatic life goal uses. Table B.2 summarizes the WQS currently in effect for the CAWS and LDPR.

Tributaries to the CAWS and LDPR, including the upstream reaches of the NBCR, the Little and Grand Calumet Rivers, and the Upper Des Plaines River, are designated for the protection of Section 101 (a)(2) goals for aquatic life and recreation in both Illinois and Indiana. Further, Indiana has developed more stringent antidegradation requirements for waters of "outstanding" quality, which include Indiana's portion of the open waters of Lake Michigan, as well as waters in the Indiana Dunes National Lakeshore and Cedar Creek in Allen and DeKalb Counties in the Indiana portion of the Great Lakes watershed. Lake Michigan Basin waters, which include all tributaries of Lake Michigan, and harbors and open waters of the Illinois portion of the lake, must meet the Lake Michigan Basin WQS defined in Title 35 of the *Illinois Administrative Code*. Lake Michigan WQS are the most restrictive and support all six designated uses.

B.1.2.2.2 Impaired Waters

Section 303(d) of the CWA requires states, territories, and authorized tribes to submit a list of impaired and threatened water bodies to the EPA. "Impaired" waters are defined as those not meeting WQS, and "threatened" waters are those not expected to meet WQS by the next listing cycle. The IEPA has identified that many segments of the CAWS and LDPR are not supporting their designated uses, as shown in Table B.4. High counts of fecal coliform indicator bacteria impair many of the waterways for recreational use, and chemical constituents such as phosphorus, mercury, PCBs, and DO impair many of the waterways for aquatic life. To develop the Section 303(d) list, the IEPA Ambient Water Quality Monitoring (AWQM) program monitors 213 locations throughout Illinois, two located on the CAWS.

The IEPA AWQM collects samples every 6 weeks and analyzes for 55 parameters. The MWRDGC also operates an AWQM program, with 20 locations on the CAWS. The MWRDGC's water quality monitoring is performed annually at some locations and once every 4 years at others. Standard chemical parameters, biological conditions, physical habitat, and sediment quality are analyzed, and DO and temperature are measured hourly at 30 locations on the CAWS. In recent years, MWRDGC data have indicated violations of the following water quality parameters: DO, pH, chloride (Cl), TDS, and fecal coliform in the Chicago River system; violations of the DO, Cl, sulfate, total dissolved solids (TDS), fecal coliform, iron and un-ionized ammonia in the Calumet River system; and DO, pH, Cl, TDS, fecal coliform, soluble copper, and hexavalent chromium in the Des Plaines River system.

In 2012, the IEPA Lake Michigan Monitoring Program (LMMP) assessed all 196 mi^2 of Lake Michigan open waters and found them to be Fully Supporting for the following uses: Aquatic Life, Aesthetic Quality, Primary Contact, Secondary Contact, and Public and Food Processing Water Supplies. However, Fish Consumption use in the Illinois portion of Lake Michigan was assessed as Not Supporting (Poor) due to contamination from PCBs and mercury. In addition, all Lake Michigan beaches in Illinois were assessed as Not Supporting (Poor) for Primary Contact use due to contamination from *Escherichia coli* bacteria (IEPA 2012).

For each waterway on the Section 303(d) list, states must establish a total maximum daily load (TMDL) for each contaminant, and limit discharges to the impaired water body. A TMDL calculates the maximum amount of a pollutant that a water body can receive and still meet WQS. TMDLs identify pollutant sources and allocate pollutant loads to point and nonpoint sources. The EPA has approved TMDLs for impairments within the CAWS and its tributaries, including the following: Spring Brook TMDL, completed in 2004 to address low DO and high biochemical oxygen demand (BOD); West and East Branch of the Du Page River TMDLs, completed in 2004 to address Cl and conductivity related impairments; Addison Creek TMDL, completed in 2004 to address nutrients; and Saganashkee Slough and Tampier Lake, completed in 2010 to address low DO and total phosphorus. The IEPA is currently developing TMDLs to address bacteria impairments along the Lake Michigan shoreline and various impairments in the NBCR and its tributaries, including Cl, DO, bacteria, temperature, and total phosphorus. TMDLs are also being developed for CAWS tributaries, including the Upper Des Plaines River (Higgins Creek), and Lower DuPage River and Salt Creek in the Bums Harbor, Indiana, area.

B.1.2.2.3 Point Sources

The major inputs to the CAWS include WRP effluent, water diverted from Lake Michigan, tributary flow, CSOs, and nonpoint runoff. Approximately 70% of flow in the CAWS is generated from the WRPs. Four of the MWRDGC's seven WRPs discharge to the CAWS: North Side, Stickney, Calumet, and Lemont. These plants treat average annual volumes of 239 MGD, 269 MGD, 717 MGD, and 2 MGD, respectively. The current National Pollutant Discharge Elimination System (NPDES) permits in effect (2002) for the North Side, Calumet, and Stickney plants do not require disinfection of bacteria, nor phosphorus removal. The MWRDGC's annual water quality reports evaluate the impact of the plant effluent on ambient water quality by comparing the monitoring station data just upstream and downstream of each plant outfall. These comparisons indicate that in 2010, the Calumet plant made a statistically significant impact on ambient water quality for 14 of 67 parameters assayed. Effluent from the North Side plant significantly impacted water quality for 19 of 67 parameters, and the Stickney plant significantly impacted ambient water quality for 8 of 62 parameters assayed. Table B.5 illustrates that WRP effluent has a notable impact on some water quality parameters, particularly fecal coliform and nitrate/nitrite.

TABLE B.4 Water Impairments from 2012 Illinois 303(d) List

Waterway	Non-Supporting Designated Use	Impairment(s)
Primary Contact Recreation Use, Indigenous Aquatic Life Use		
Lower North Shore Channel from the North Side Water Reclamation Plant (WRP) to confluence with the North Branch of the Chicago River (NBCR)	Fish Consumption	Mercury, polychlorinated biphenyls (PCBs)
NBCR from its confluence with the North Shore Channel (NSC) to its confluence with the South Branch of the Chicago River (SBCR) and Chicago River	Fish Consumption	Mercury, PCBs
	Aquatic Life	Iron, oil and grease, oxygen, dissolved, phosphorus (Total)
SBCR	Fish Consumption	PCBs
Little Calumet River from its confluence with the Calumet River and Grand Calumet River to its confluence with Calumet-Sag Channel (CSC)	Fish Consumption	Mercury, PCBs
	Indigenous Aquatic Life	Aldrin, dissolved oxygen (DO), iron, phosphorus (total), silver
CSC	Fish Consumption	Mercury, PCBs
	Indigenous Aquatic Life	DO, iron, phosphorus (total), total suspended solids (TSS)
Primary Contact Recreation Use, General Use		
Chicago River	Aquatic Life	Phosphorus (total), silver
	Fish Consumption	Mercury, PCBs
	Primary Contact Recreation	Fecal coliform
Incidental Contact Recreation Use, Indigenous Aquatic Life Use		
South Fork of the SBCR (Bubbly Creek)	Indigenous Aquatic Life	DO, pH, phosphorus (total)
Chicago Sanitary and Ship Canal (CSSC) from its confluence with the SBCR to its confluence with the CSC	Fish Consumption	Mercury, PCBs
	Indigenous Aquatic Life	Ammonia, DO, phosphorus (total)
Lake Calumet	Fish Consumption	PCBs
Lake Calumet Connecting Channel	Fish Consumption	PCBs
Grand Calumet River (GCR)	Indigenous Aquatic Life	Ammonia, aquatic algae, arsenic, barium, cadmium, chromium (total), copper, DDT, DO, iron, lead, nickel, PCBs, sedimentation/siltation, silver, phosphorus (total), zinc
Lower Des Plaines River (LDPR) from the Brandon Road Lock and Dam to Interstate 55 bridge	Fish Consumption	Mercury, PCBs
Calumet River from the T.J. O'Brien Lock and Dam to its confluence with the GCR and Little Calumet River (LCR).	Aquatic Life	pH, phosphorus (total), silver
	Fish Consumption	Mercury, PCBs
	Primary Contact Recreation	Fecal coliform
General Use		
Upper North Shore Channel from the Wilmette Pumping Station to North Side WRP	Aquatic Life	DO, nickel, phosphorus (total), zinc
	Fish Consumption	Mercury, PCBs
	Primary Contact Recreation	Fecal coliform
Calumet River from Lake Michigan to the T.J. O'Brien Lock and Dam	Aquatic Life	pH, phosphorus (total), silver
	Fish Consumption	Mercury, PCBs
	Primary Contact Recreation	Fecal coliform
Secondary Contact Recreation Use, Indigenous Aquatic Life Use		
CSSC from its confluence with the CSC to its confluence with the Des Plaines River	Indigenous Aquatic Life	DO, iron, oil and grease, phosphorus (total)
	Fish Consumption	PCBs
LDPR from its confluence with the CSSC to the Brandon Road Lock and Dam	Aquatic Life	Aldrin, arsenic, Cl, DO, methoxychlor, pH, phosphorus (total)
	Fish Consumption	Mercury, PCBs

CSOs occur during intense rain events when Chicago's combined sewers cannot accommodate the additional stormwater flow, and untreated sewage-storm runoff is discharged to local waterways. Two hundred forty seven (247) active CSO outfalls on the CAWS produce hundreds of discharge events each year. Three hundred ninety seven (397) active CSO outfalls exist throughout the CAWS and its tributaries (MWRDGC 2012b). MWRDGC pumping stations convey wastewater to the WRPs and help dewater the sewer system during storm events to prevent basement flooding. However, when the downstream pipes reach capacity, these pumping stations also release large volumes of combined sewage-stormwater to the CAWS. Table B.6 shows the volume of untreated discharges from the pumping stations each year. Studies show that CSOs to the CAWS can impact several water quality parameters (including DO, 5-day carbonaceous BOD, and ammonium as nitrogen) for up to 2 weeks following a storm event (Alp and Melching 2009). In cases of especially severe storms, the CRCW and the T.J. O'Brien Lock and Dam are opened to allow water from the CAWS to flow out to Lake Michigan. These backflows to Lake Michigan degrade water quality and ecosystem health, which impacts the accessibility of beaches to the public and potentially the raw water supply for the greater Chicago area.

TABLE B.5 Water Quality Impacts of WRP Effluent

		North Side		Stickney		Calumet	
		U[a]	D	U	D	U	D
Dissolved oxygen	mg/L	8.4	7.1	6.0	7.6	**8.7**	**6.9**
Chloride	mg/L	**30**	**155**	161	188	104	159
Ammonium nitrogen	mg/L	**0.13**	**0.83**	0.56	0.52	0.20	0.37
Total Kjeldahl Nitrogen (TKN[b])	mg/L	**<0.43**	**2.06**	1.40	1.50	**0.64**	**1.30**
NO_2+NO_3	mg/L	**0.31**	**6.53**	**5.10**	**8.10**	**1.10**	**5.40**
TS	mg/L	**255**	**534**	546	621	420	586
TDS	mg/L	**248**	**527**	533	614	407	579
Sulfate	mg/L	**25**	**42**	**43**	**61**	61	75
Phosphorus, Total	mg/L	**<0.136**	**1.15**	0.68	0.79	**0.37**	**2.01**
Fecal coliform	#/100mL	**54**	**5393**	**137**	**1391**	**74**	**1926**

[a] U = upstream, D = downstream. Numbers shown in bold face are statistically different upstream and downstream of the plant. (MWRDGC Report 11-59)
[b] TKN = Total Kjeldahl Nitrogen.

TABLE B.6 Untreated Pump Station Discharges to CAWS (million gallons)

Pump Station	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
North Branch	2,730	1,565	1,674	1,180	614	1,238	1,427	3,520	3,262	1,689	2,161
Racine	8,041	3,965	3,903	3,669	1,475	5,212	5,314	10,968	9,933	7,191	10,178
125th St.	914	371	522	471	344	496	676	1,731	1,241	971	660
95th St.	222	121	183	0	0	0	0	137	0	68	0

The TARP was adopted in 1972 in order to protect Lake Michigan and the Chicago waterways from raw sewage pollution. TARP Phase I constructed 109 mi of large-diameter rock tunnels, which provided 2.3 billion gallons of stormwater storage. Phase I was completed in 2006 and has dramatically reduced the number of days per year that combined sewage-stormwater is released to the waterways. The Majewski Reservoir, also known as Chicago Underflow Plan (CUP) O'Hare Reservoir, was completed in 1998 and provides 350 million gallons of stormwater storage. Construction of the CUP-Thornton and CUP-McCook reservoirs will provide a total system storage volume of 17.5 billion gallons once completed. Completion of TARP Phase I delivered significant water quality benefits to the CAWS. Completion of the Phase II reservoirs will further reduce water quality degradation by preventing releases of untreated stormwater-sewage to the waterways.

Cooling water intake structures (CWISs) impact water bodies in two ways: from the water withdrawal and from the thermal impact of the water discharge. CWIS can have a significant impact upon the biological community of a water body. Impingement and entrainment mortality measure the impacts from withdrawal of organisms from the water body that either become trapped on screens or are carried through the cooling facility and discharged. Impingement usually affects larval, juvenile, and adult life stages, while entrainment impacts egg and larval stages. NPDES permits for facilities that operate CWIS require the Best Technology Available (BTA) to minimize adverse environmental impacts.

Most facilities within the study area are operated as once-through cooling systems that withdraw substantial volumes of water and discharge significant heat loads that can raise temperatures considerably. Illinois WQS require that for Secondary Use waters, discharge temperatures shall not exceed 93°F more than 5% of the time, or 100°F at any time. For General Use waters, the temperature standard is much more stringent. Among other requirements, the maximum temperature rise may not exceed a maximum limit of 93°F at any time or increase more than 5°F above natural temperatures. During hot summers, however, ambient water temperatures and energy demand both increase, creating hotter plant effluent. In 2012, the IEPA granted more variances or variance extensions from the temperature standard than ever before. Particularly in August, the CAWS received hundreds of millions of gallons of water per day at temperatures approaching 100°F (Meyer and Wernau 2012). Thermal discharges put aquatic organisms at risk, as most can only survive within a narrow temperature range. Elevated temperatures also typically decrease DO concentrations, which can also harm aquatic animals. Higher water temperatures can also impact the food web and shift community composition and migration.

B.1.2.2.4 Nonpoint Sources

Unlike pollution from discrete pipes and other channels, nonpoint source (NPS) pollution comes from many diffuse sources as rainfall and snowmelt move over and through the ground, picking up pollutants and transporting them to waterways. NPS pollution in the CAWS study area consists of salt from road de-icing operations; oil, grease and other chemicals from urban runoff and energy production; atmospheric deposition; sediment from construction sites and eroding streambanks; and excess fertilizers and herbicides from agricultural and residential areas.

Water quality data collected by the MWRDGC from 2001–2008 indicate extremely high levels of Cl in many segments of the CAWS, particularly in winter months due to road salting and stormwater discharges. The Chicago area applies more than 270,000 tons of road salt during an average winter (Kelly et al. 2009). At the Albany Avenue monitoring point on the NBCR, CL concentrations regularly increase to 400–500 mg/L or higher in the winter months, with the maximum recorded concentration at approximately 1,100 mg/L. Elevated Cl concentrations have also been observed in the Little Calumet and Grand Calumet Rivers, the CSSC, and the Illinois River well downstream of the Chicago area. In 1986, the EPA published National Recommended Water Quality Standards for Cl to protect aquatic life. For freshwater, the Criteria Maximum Concentration (acute standard) was set at 860 mg/L while the Criterion

Continuous Concentration (chronic standard) was set at 230 mg/L. The Illinois Cl standard for General and Secondary Use waters is 500 mg/L, and the Illinois Lake Michigan standard is just 12 mg/L, though Cl concentrations measured at the drinking water intakes regularly exceed this level, typically ranging from 11 to 17 mg/L. Detrimental effects from road salt to water chemistry and aquatic life have been documented since the 1960s. Even low aqueous concentrations of Cl can affect the growth of different algal species, alter the food web, and shift community structures. Affected biota include trees, grasses, fish, amphibians, and aquatic invertebrates (Kelly et al. 2009). In lakes, elevated salt concentrations can also lead to stratification and prevent spring turnover and the distribution of oxygen and nutrients to the benthos (Corsi et al. 2010).

Section 319 of the CWA, established in 1987, provides federal grants to state agencies for the development of NPS management program plans. IEPA and IDEM staff work with state and local agencies, non-profit entities, and third parties to develop and implement projects that address nonpoint sources of pollution through educational and training programs, watershed-based planning, and implementation of best management practices to protect water quality. Dozens of these projects are underway within the GLMRIS study area and are described in the EPA Grants Reporting and Tracking System (GRTS) and the IEPA Section 319 Biannual Reports.

B.1.2.3 Sediment Quality

CAWS sediment quality has been degraded by historical industrial activities and unregulated discharges to the waterways prior to the CWA. The USACE has conducted sediment investigations in the CAWS and its tributaries, including the Calumet Harbor and River, GCR, IHC, Burns Waterway Harbor, BSBH, and Burns Ditch. The NSC, the Chicago River System, CSSC, CSC, and LCR have not been dredged for navigation or environmental restoration in recent years, and, therefore, the USACE has not conducted sampling. The MWRDGC collected and analyzed surficial sediment grab samples from the Calumet and Chicago River systems during 2002, 2003, 2005, 2006, and 2007. The samples were analyzed for 8 general chemistry constituents, 11 trace metals, 111 organic priority pollutants, total organic carbon (TOC), simultaneously extracted metals/acid volatile sulfide (SEM/AVS), particle size, and toxicity (MWRDGC 2006, 2008a, 2008b, 2011). EPA-Great Lakes National Program Office (GLNPO) performed sediment sampling on the Chicago River in 2000 and 2002. Six surficial grab samples and 12 sediment cores were collected from 12 locations and were analyzed for oil and grease, dioxins and furans, heavy metals, PCBs, PAHs, volatile organics, pesticides, TOC, SEM/AVS, and toxicity (Collier and Cieniawski 2003). This collection of existing sediment data does not include all reaches of the waterways, and parameters of analysis and collection methods vary among sampling events. In general, CAWS sediments are contaminated throughout with persistent organic pollutants such as PAHs and PCBs, heavy metals, dioxins and furans, and oil and grease. Overall, the surficial sediments are less contaminated than the deeper sediments throughout the system.

B.1.2.3.1 Chicago River

The 2000–2002 EPA-GLNPO study found that sediments in the main stem of the Chicago River are significantly less contaminated than the north and south branches. Elevated levels of PAHs were found throughout the Chicago River, but particularly in the South Branch (as high as 716 ppm). Samples collected in the North Branch indicated lower PAH concentrations but higher PCB concentrations (up to 76 ppm). Sediments with PCB concentrations greater than 50 ppm are regulated under the Toxic Substances Control Act (TSCA) and are classified as hazardous waste under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Elevated levels of heavy metals, PCBs, and oil and grease were also found throughout the Chicago River branches (Collier and Cieniawski 2003). In 2006, the MWRDGC sediment sampling also revealed high concentrations of phosphorus, phenols, and total cyanide in the South Branch.

B.1.2.3.2 South Fork South Branch of the Chicago River

This channel served as an open sewer for the Union Stock Yards for many years, starting in 1865. To this day, methane and hydrogen sulfide gas continue to rise to the surface from the decomposing meatpacking waste below, earning the waterway its nickname, "Bubbly Creek." Sediment quality in this dead-end channel is also affected by frequent CSOs from the Racine Avenue Pump Station (RAPS). Sediment sampling performed by the MWRDGC in 2006 revealed the presence of 24 organic pollutants, many at elevated concentrations. Consistent with the MWRDGC's findings, a 2005 sediment investigation by the USACE identified PAHs, PCBs, oil and grease, metals, and other SVOCs as contaminants of concern (CDM 2005). A Feasibility Study is underway to evaluate opportunities to restore the physical habitat characteristics of the South Fork South Branch of the Chicago River under the USACE Ecosystem Restoration mission.

B.1.2.3.3 Chicago Sanitary and Shipping Canal (CSSC)

Within the CSSC, sediment quality generally improves, and the amount of fines decreases as you move farther downstream. The CSSC south of the confluence with the CSC generally has very little sediment accumulation, and the channel bottom consists of bedrock. Sediment samples collected near Lockport in 2006 contained elevated levels of cyanide and phenols. Ten-day *Chironomus tentans* toxicity testing on sediments collected at Lockport indicated poor habitat quality for benthic organisms (MWRDGC 2006).

B.1.2.3.4 Calumet River

The USACE dredges the Calumet River and Harbor regularly for navigational maintenance and has collected a great deal of sediment data since 1984. A Tier 1 Sediment Evaluation for material dredged from the Calumet Harbor and River completed in November 2010 showed that there has not been a substantial improvement in river sediment quality over time. Calumet River sediment contains high concentrations of arsenic, chromium, copper, cyanide, lead, manganese, zinc, and oil and grease in samples collected as recently as 2009. The sediment within the Calumet Harbor area contains lower contaminant concentrations than the material in the Calumet River. Dredged material from the river and harbor are placed in the Chicago Confined Disposal Facility (CDF), located in Calumet Harbor adjacent to the port's Iroquois Landing Facility. It is possible that the harbor sediment could be suitable for unconfined upland use, but a Tier 2 Sediment Evaluation will be needed to determine the material's suitability. The hydrology of the Calumet Harbor and River area is complex due to the development and modification of the waterway. The Calumet River periodically discharges to Lake Michigan, which is of concern because of the elevated contaminant levels in the river sediment. Variation in the flow and flow direction and its influence on sediment deposition is the subject of a study currently underway at the USACE Engineer Research and Development Center (ERDC).

B.1.2.3.5 Grand Calumet River

The Grand Calumet River is one of 43 AOCs on the Great Lakes identified by the EPA and is the only AOC impaired for all 14 beneficial uses. The legacy pollutants found in the bottom sediments are the greatest contributor to this waterway's impairment. The GCR and IHC contain 5 to 10 million yd^3 of contaminated sediment up to 20 ft deep. Contaminants include PCBs, PAHs, and heavy metals, such as mercury, cadmium, chromium, and lead. Additional problems include high fecal coliform bacteria levels, BOD and suspended solids, and oil and grease. Implementation of a multi-stage Remedial Action Plan has been underway since the early 1990s. U.S. Steel Gary Works dredged 5 mi on the East Branch, and the EPA has recently completed remediation of a heavily polluted 1-mi stretch of sediments on the West Branch in Hammond, Indiana. Phase II of the EPA Great Lakes Legacy Act restoration effort will dredge and cap 235,000 yd^3 of polluted sediment on the East Branch near Roxanna Marsh. The IHC has not been dredged since 1972 because of contaminated sediments and lack of an acceptable disposal location. Construction of a confined disposal facility was recently completed in East Chicago, Indiana, and navigational dredging was begun in 2012. Sediment quality in this waterway will significantly improve because of the ongoing dredging activities, but the scope of the dredging project will not include complete environmental remediation of sediments.

B.1.2.3.6 Little Calumet River

The MWRDGC collected sediment grab samples at two monitoring stations on the LCR in 2007, one near Halsted Street and the other near Indiana Avenue. Notable levels of trace metals were detected, up to 3,178 mg/kg of manganese at the Halsted Street location. Sediment samples from the Indiana Avenue location exhibited a high SEM/AVS ratio (1.9), indicating greater bioavailability of metals, and therefore a greater risk of toxicity to organisms.

B.1.2.3.7 Cal-Sag Channel

Sediment characterizations have been performed in the CSC by the MWRDGC, EPA, and USACE in 2001, 2003, 2008, and 2009. In the 2009 sampling, VOCs and SVOCs were detected in 6 and 9 samples, respectively. Pesticide concentrations exceeded the TACO criteria at one location, and PCB congener Aroclor-1242 was detected in seven samples. While all the metals analyzed were found in each sediment sample, lead was the only metal detected in excess of the TACO residential cleanup criteria.

B.1.2.4 Land Use

Many of the drainage areas of the CAWS, such as the upper CSSC, Chicago River, and Calumet River, are fully built out with little change in the land use over the last few decades (Figure B.12). Areas where some change might be expected are in the two major tributaries of the CAWS, such as in the North Branch of the Chicago River Basin or the Little Calumet River Basin. Based on National Land Cover Data (NLCD) datasets, small relative changes in land use occurred between 1992 and 2001, and leveling off of land use or basically no change occurred between 2001 and 2006 (Appendix E Hydrologic and Hydraulic Analyses). This would indicate that the overall land use trend of the CAWS watershed appears to be stabilizing with little relative change expected in the near future, based on extrapolation of the latest observed data.

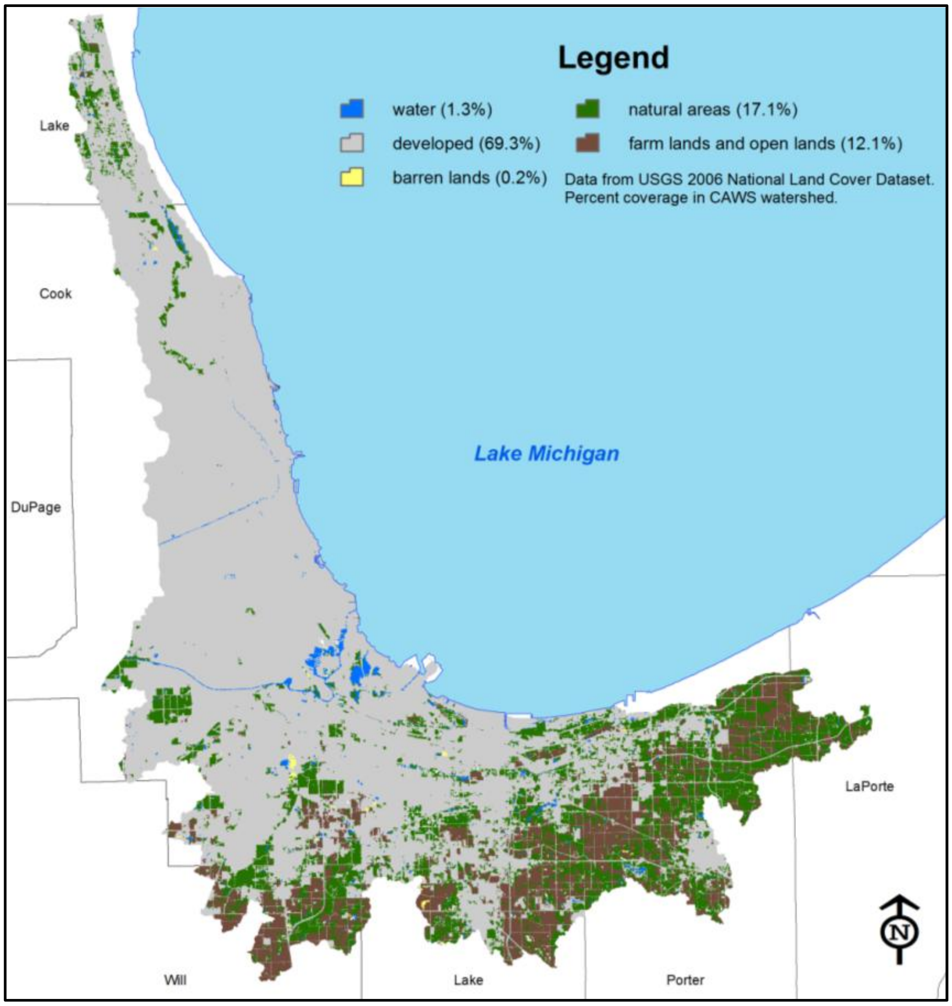
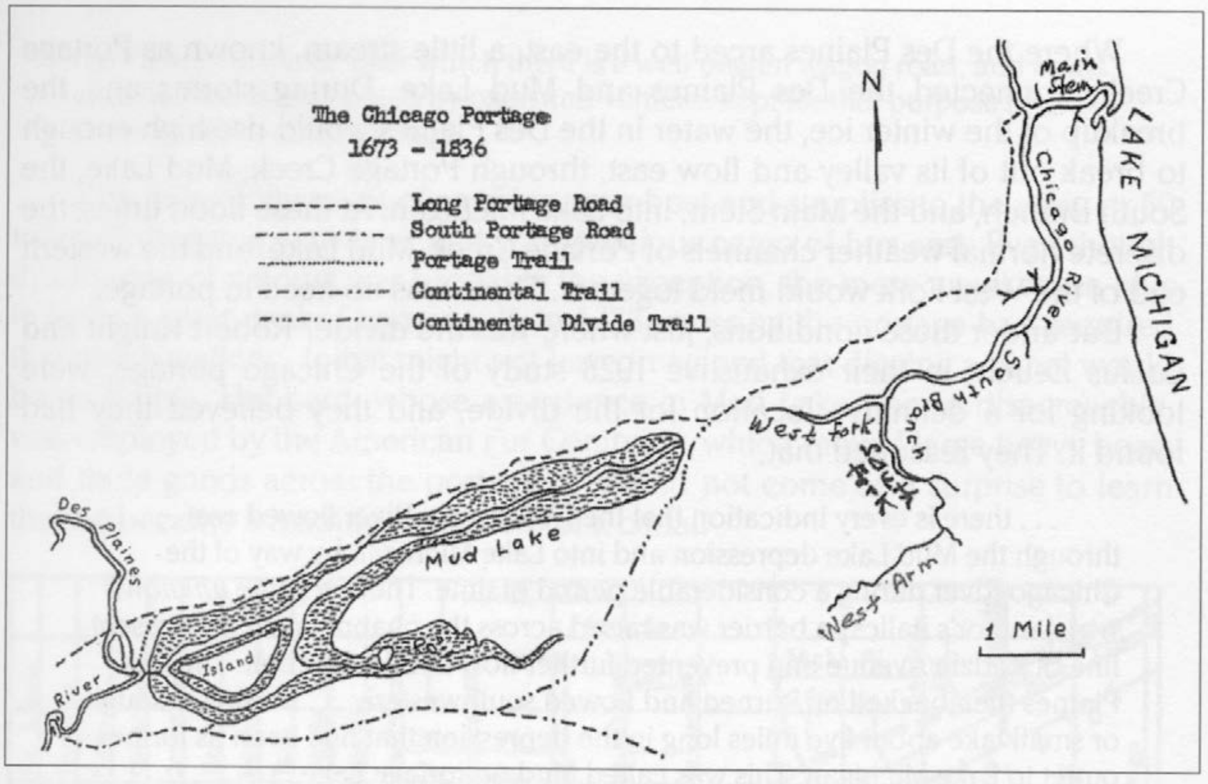


FIGURE B.12 Land Use for the CAWS Study Area

B.1.2.5 Hydrology and Hydraulics

Natural fluvial geomorphology and processes within the CAWS are significantly altered from natural condition due to years of anthropogenic activity. The majority of the CAWS is composed of man-made canals, with sporadic remnant fragments of natural stream and slough that flow into the navigable waterway. Prior to anthropogenic intervention, the Chicago and Calumet Rivers were composed of large wetland complexes that sluggishly flowed east into Lake Michigan. The Des Plaines River naturally flowed west into the Mississippi River drainage. During periods of wet weather, the Des Plaines River would change its course and flow into the Chicago and Calumet Rivers. Wet weather periods would also cause the Chicago and Calumet Rivers to inundate flat areas extensively enough to create a surface water connection with the Des Plaines River. This occurred at two critical locations, Mud Lake (Figure B.13) and Saganashkee Slough. Depending on the location and quantity of rainfall, these geomorphic features would overflow into each other; the West Fork of the SBCR near Kedzie Avenue and the LCR near Blue Island. This interbasin flow provided a temporary connection between the respective drainage basins.



Courtesy of Philip E. Vierling.

FIGURE B.13 Depiction of Pre-Sanitary and Ship Canal Basin Separation

The continual or persistent connection between the Great Lakes Basin and the Illinois River was established in 1848 with the completion of the Illinois and Michigan (I&M) Canal (Figure B.14). The dimensions of the original I&M Canal were 60 ft wide at the surface, 36 ft wide at the base, and 6 ft deep. In the spring of 1849, the LCR was connected to the I&M Canal via the 40 ft wide and 4 ft deep Calumet Feeder Canal, which had been constructed through the Saganashkee Slough. The I&M Canal was replaced by the much larger CSSC, started in 1892, that connected Lake Michigan with the Illinois Waterway. The permanent connection between the Lake Michigan and the Mississippi drainage was finalized with the completion of the CSSC in 1900. On the Calumet River, the Corps of Engineers removed sandbars and built piers at the mouth during 1870–1882; between 1888–1896, the river between Lake Michigan and Lake Calumet was straightened; between 1899 and 1916, the Calumet River was dredged to a depth of 16 ft; between 1911 and 1922, the Calumet Feeder Canal was obliterated by the construction of the CSC, which was incised through a vast and unique dolomite prairie, formerly the Saganashkee marshland. With the completion of joining the CSC with the Calumet River, the Calumet region’s drainage was chiefly reversed; and in 1965, the Calumet River was completely reversed by the construction of the T.J. O’Brien Lock and Dam near the original confluence with Lake Michigan.

Natural elevations of the river are altered by the construction of navigational locks to control the flow and depth of the CAWS. Under normal conditions, water levels in most part of the system are like a flat pool.

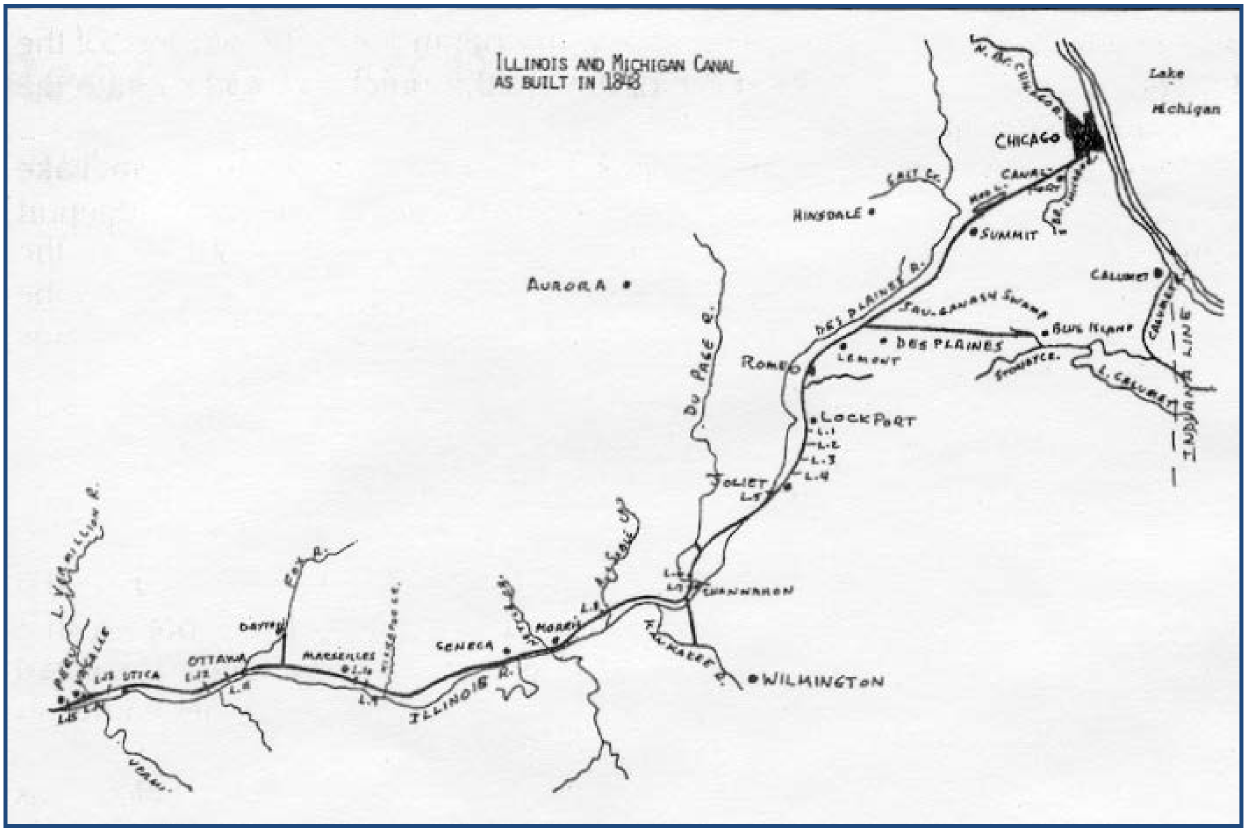


FIGURE B.14 Early Configuration of the CAWS and Upper Illinois Waterway circa 1848

Traditionally, the CAWS has been defined as the waterways and connected rivers within the state of Illinois. For the GLMRIS study, the CAWS definition has been expanded to also include the LCR, GCR, and the connected channels in Indiana. For the purposes of the GLMRIS study, the following list provides channel definition and length of the CAWS for GLMRIS. These routes include mileage for the most direct (shortest) point-to-point distances between Lockport Lock and Dam and the five Lake Michigan access points:

1. Chicago River/CSSC
    a. Main Stem: Lockport to CRCW (Lake Michigan)—36.1 mi
    b. North Branch: Wolf Point to WPS (Lake Michigan)—15.2 mi
2. Calumet-Saganashkee (Cal-Sag) Channel/Calumet River
    a. CSC: Junction of CSSC/Cal-Sag to O'Brien Lock—22.9 mi
    b. Calumet River: O'Brien Lock and Dam to Lake Michigan—6.7 mi
3. Little Calumet River
    a. Little Cal: CSC to Hart Ditch—16.4 mi
    b. Little Cal: Hart Ditch to Deep River—11.5 mi
    c. Burns Ditch: Deep River to Lake Michigan—8.3 mi
4. Grand Calumet River
    a. West Grand Cal: Calumet River to Indiana Harbor Canal—6.1 mi
    b. Indiana Harbor Canal to Lake Michigan—5.1 mi
5. Total CAWS Length: 128.3 mi

Additional channels which may be of interest but not included in the CAWS calculation are as follows:

- Bubbly Creek: Racine Avenue Pumping Station to the SBCR—1.6 mi
- North Branch Canal: Additional channel length around Goose Island—0.9 mi
- Indiana Harbor Canal: Lake George Branch—1.4 mi

B.1.2.5.1 Hydrology of the CAWS

Numerical models were developed for the CAWS, and selected events were simulated for baseline and FWOP conditions. Details on the development of the numerical models and the results of the baseline and FWOP conditions simulated are included in Appendix E, Hydrology and Hydraulics. A summary of the modeling results is also included in Section 2.2, Hydrology and Hydraulic Assessment, in this appendix.

The NBCR flows from north to south, parallel to the Lake Michigan shoreline, with its headwaters in Lake County. In Lake and northern Cook Counties, three branches of the River (West Fork, Middle Fork, and Skokie River) combine to form the NBCR, which flows through northern and central Chicago. The North Branch and much smaller South Branch join at Wolf Point in central Chicago about 2 mi west of the Lake, and the original flow of the Chicago River was from there eastward to the Lake. This flow pattern was changed by man in the late 1800s and early 1900s.

Historically, the Chicago River was a very important factor in the development of the City of Chicago, as it was part of an easy portage route for canoers between the Great Lakes and Mississippi River systems. The discharge of open sewers into the river and Lake Michigan led to severe health problems for city residents. To correct this problem, the entire city was raised 10 ft in elevation to improve sewer drainage to the river. This system of combined intercepting sewers discharging to the Chicago River was built, and the flow of the river was changed by construction of the CSSC. This work began in 1887 and was completed in 1900. This fabricated system, in conjunction with sluice gates and a lock at the old mouth of the Chicago River, closed off discharge to the Lake and forced flow westward down the South Branch down to the Illinois River. This is the flow pattern of the river system today, with sewage treatment plants constructed in the 1930s making up the majority of the flow. The sluice gates and lock at the mouth of the river is the CRCW.

Problems have arisen in the past when moderate to severe rainstorms have exceeded the capacity of the combined sewers and sewage treatment plants. This forces the sewage to be discharged into the Chicago River in the form of CSOs. If this overflow discharge is only moderate, the flow may still continue down the CSSC to the Illinois River. However, on occasions when this inflow volume is so great that Chicago River stages threaten to overflow the river banks, the sluice gates and lock on Lake Michigan at the original mouth of the River are opened to permit backflow to the Lake to prevent city floods.

There is also a lock and dam downstream on the CSSC at Lockport, Illinois, that affects upstream stages and flow patterns of the entire CAWS. When heavy rains are forecasted, pit gates in the Lockport powerhouse are opened to draw down the CAWS prior to the storm to maximize flow capacity. This procedure is always at least partially successful, but sometimes not enough to prevent backflows into Lake Michigan. There are other features of the entire system which impact flow in the Chicago River. These are the NSC, constructed in 1910, which runs from the WPS at the lakefront southward to the NBCR in Northern Chicago near Lawrence Avenue. The WPS regulates the flow to and from the Lake at this discharge point. The CSC in southern Cook County connects the CSSC to the Little Calumet River. The T.J. O'Brien Lock and Dam, located on the Calumet River about 0.5 mi upstream of the confluence with the GCR, controls flow between the CAWS and Lake Michigan at this point.

The Chicago Underflow Plan (CUP), was authorized, designed, and partially constructed. This is a project consisting of two large reservoirs and an underground system of massive sewer tunnels to convey large inflows of combined sewage to the reservoirs. The reservoirs and the tunnels both store water until the MWRDGC's sewage treatment plants can catch up with the inflow and begin treating this stored sewage before discharge into the CAWS. This plan was shown to be successful; however, it is not possible to store all the CSO from a severe rainstorm. The CUP project, therefore, will eliminate discharges of untreated sewage to the Chicago River for moderate rainfall events, but will not eliminate all discharges from severe rainfall events.

The Grand Calumet and Little Calumet Rivers both have a high point in the channel that induces bidirectional flow west of the divide toward the Mississippi River and east of the divide toward Lake Michigan during large storm events. The LCR flows between the Calumet River in Illinois and Lake Michigan at Burns Harbor in Indiana. The Great Lakes/Mississippi River (GL/MR) watershed divide runs through the LCR near the Hart Ditch confluence. In 1922, the CSC was constructed, which connected the Little Calumet River to the CSSC. This is a permanent connection. There are culverts and bridges on the LCR that would impede flow, but they could not serve as barriers for ANS transfer.

During floods, a portion of the water from Hart Ditch flows toward the west across the state boundary to join the CSC; the other portion of floodwater flows toward the east, combining with local inflows and finally exiting to Lake Michigan through Burns Harbor in Indiana. The Little Calumet River flows through a flood prone watershed characterized by flat terrain that is heavily urbanized. Many levees, federal and local, exist along the Little Calumet River in Illinois and Indiana. The USACE has nearly completed a levee system) along the Little Calumet River between Gary and Hammond/Munster in Indiana. The levee was designed to protect a 200-year flood event.

The Grand Calumet River lies between its confluence with the Calumet River in Illinois and Lake Michigan at Indiana Canal Harbor in Indiana. The GL/MR watershed divide runs through the West Branch of the GCR, somewhere between the Hammond WWTP outfalls and its confluence to the Indiana Canal depending on the water level on Lake Michigan. In 1922, a man-made canal, CSC, was constructed to connect the Calumet River watershed to the Mississippi River via rivers and canals in Illinois. This is a permanent connection. There are culverts and bridges on the GCR that would impede flow, but they could not serve as barriers for ANS transfer.

B.1.3 Biological Resources

B.1.3.1 Summary of CAWS Area Habitat

B.1.3.1.1 Lake Michigan

Lake Michigan habitat and littoral process within the study area have been altered from the natural state by the installation of engineered structures for recreational and storm damage protection purposes. Over time, the shoreline was sculpted and armored into its present form of headlands, promontories, small harbors, lagoons, piers, and pocket beaches. The long-term average lake level for Lake Michigan is approximately 578.9 ft but fluctuates with precipitation, stream inflows, evaporation, and discharge. Natural lacustrine habitat primarily consists of sand flats, beach surf, and open water, with small isolated pockets of aquatic vegetation, limestone shoals, and clay mounds. Man-made structures serving habitat purposes include riprap breakwaters, revetments, jetties, and piers. There are a few natural features of importance, such as Oakland Shoal and Morgan Shoals in Illinois and the clay mounds off the coast of Mt. Baldy in the Indiana Dunes National Lakeshore. It is believed that the limestone outcrops that form Oakland and Morgan shoals were historic spawning reefs for Lake Michigan whitefish (*Coregonus* spp.)

species. It is known that the clay mounds off of Mt. Baldy do indeed provide critical spawning habitat for yellow perch (*Perca flavescens*), amongst other nearshore fish and invertebrate species.

B.1.3.1.2 North Shore Channel

The NSC was constructed in 1910 for the sole purpose of conveying wastewater from North Chicago communities downstream. Located at the study site is the WPS, which allows the diversion of Lake Michigan water into the NSC to dilute and flush wastewater downstream through the NBCR. The channel has an average width of 90 ft and a channel depth that ranges between 5 and 10 ft. The banks are primarily earthen, except near the WPS where banks have been armored with vertical sheet piling. The channel bed is composed of a mixture of sand, silt, and fines. Sufficient aquatic habitat does exist within the NSC with the presence of aquatic plants, tree roots, and brush debris jams. The riparian corridor is poorly to moderately formed with vegetation partly shading the channels banks.

B.1.3.1.3 Chicago River North Branch

Although not man-made, this stream was historically straightened, widened, dredged, rip-rapped, and sheet-piled to accommodate increased wastewater volumes as a result of the NSC. The width of the channel typically ranges from 90 to 300 ft, while channel depth ranges between 10 and 15 ft. Sand and fine sediments compose the majority of the channel bed; however, some cobble substrates are present. The character of the NBCR varies along its length, since the upstream portion is in a more residential area while the downstream portion is in a more heavily industrialized area. The upstream portion of the NBCR has a poor to moderately developed riparian zone with instream habitat consisting of logs, boulders, and under-cut banks. In comparison, the downstream portion of the NBCR has a poor to non-existent riparian zone with virtually no instream habitat. The NBC makes up the remaining portion of the Chicago River North Branches. The canal was built in the 1870s and forms the east side of Goose Island. The width of the canal ranges from 80 to 120 ft, while the channel depth varies from 4 to 8 ft.

B.1.3.1.4 Chicago River and Sanitary & Ship Canal

Portions of the Chicago River and the CSSC were constructed in the native dolomite limestone. Accordingly, aquatic habitat within the canal is quite poor and fairly homogeneous, consisting of vertical limestone walls that extend 24 to 26 ft down to the bottom. These nearly perpendicular walls of the canal offer little or no littoral zone habitat for aquatic species. The walls have crumbled down enough at various locations along the reach and may now provide limited littoral habitat for present species. The bottom of the canal is very flat with limited fine substrates; however, rock or flagstone is present on the bottom of the canal. There are also intermittent areas of woody debris and detritus that may be used as cover for certain benthic organisms.

B.1.3.1.5 Cal-Sag Channel

Construction of the CSC was completed in 1922 and allowed for the flow reversal of the Calumet River. The CSC has an average width of 225 ft, with an average depth of 10 ft. Channel walls are still the original bedrock that the reach was carved into. Sludge and silt compose the majority of the channel bed sediment. The riparian zone is moderate mainly due to the numerous forest preserves in the surrounding area. Instream habitat is poor; logjams and boulders provide minimal habitat for aquatic species.

B.1.3.1.6 Lake Calumet

Lake Calumet used to be part of Calumet marshes, the heart of a vast prairie system spanning roughly 22,500-acres. The area was decimated as a result of industrialization and urbanization. In 1925, the City of Chicago authorized a project to turn Lake Calumet into an industrial harbor. Portions of the lake and surrounding marshes were filled, while the lake was dredged to create a deep draft harbor at its southern entrance. Today, the lake still contains deep draft areas at its entrance; however, the interior and northern portions of the lake have been left relatively undredged. Depth ranges from 2 to 20 ft. Suitable habitat is present with shallow backwaters and side channels, gravel bars, and submerged and emergent aquatic vegetation.

B.1.3.1.7 Little Calumet River and Burns Ditch

The stream channel in the study area is a combination of man-made canal and channelized stream. The former LCR was channelized in an east to west direction, while the Burns Ditch portion that runs north to south was completely excavated straight through the ridge, swale, and high dune formations that used to exist in the area. Stream habitat in this portion of the system is typical of a channelized ditch having low diversity of hydraulic flow parameters and minimal instream structure. Streambanks within the Burns Ditch area are primarily armored with small rock/riprap and failing sheet pile, while banks of the LCR are mainly earthen. The channel bed is mainly composed of sludge and silt with some gravel substrate. Instream aquatic habitat is limited to boulders and logjams.

B.1.3.1.8 Des Plaines River

The Des Plaines River starts near Union Grove, Racine County, Wisconsin. It then flows south through the center of Kenosha County, Wisconsin, eastern Lake County, the center of Cook County west of Chicago, the very southeast corner of DuPage County, then south–southwest through western Will County before merging with the Kankakee River to form the Illinois River in Grundy County. Habitats in the study area reach are varied. Some reaches are lower gradient and exhibit abundant backwater and side stream wetland habitats (near Channahon). Some reaches are higher gradient where the channel braids and exhibits swift currents over bedrock, thus forming many riffles (near Lockport and Romeoville). The Des Plaines River below Lockport is deeper and wider, a result of modification for commercial navigation.

B.1.3.2 Plant Communities

Generally, the riparian areas along the CAWS are highly disturbed lands with small patches of volunteer plant communities. These sites generally have the following composition.

Old field is dominated by late boneset (*Eupatorium serotinum*) and tall goldenrod (*Solidago altissima*). The woodland tree layer is dominated by white mulberry (*Morus alba*), and the shrub layer is dominated by elderberry (*Sambucus canadensis*). This area receives periodic floodwater. These species are indicative of a high level of past disturbance that decimated the original native plant species.

The forested areas are a mixture of wet floodplain forest and mesic woodland with small areas of emergent marsh. The forested areas are dominated by cottonwood (*Populus deltoides*), maple (*Acer sp*.), and ash (*Fraxinus* spp.), with a shrub layer dominated by Japanese bush honeysuckle (*Lonicera* spp.). The dominant vine is riverbank grape (*Vitis riparia*). The herbaceous layer is represented by mostly creeping Charlie (*Glechoma hederacea*) and white snakeroot (*Eupatorium rugosum*). The forested areas are of low quality, typified by low coverage of herbaceous species and dominance of the invasive shrub species (*Lonicera japonica*). The emergent marsh areas are dominated by a mix of cattails (*Typha* *latifolia*) and common reed (*Phragmites australis*). Although the cattails are native, their dominance, along with the high abundance of common reed, indicates this area is of low quality and is experiencing chronic disturbance.

The riverbanks are wooded with openings dominated by herbaceous species. The herbaceous species are dominated by reed canary grass (*Phalaris arundinacea*), which is a highly invasive species and is typical of wet/mesic disturbed areas. The wooded areas are low quality as well, with some larger trees and a shrub layer dominated by Japanese bush honeysuckle and European buckthorn (*Rhamnus cathartica*), both non-native, highly invasive species.

B.1.3.3 Macroinvertebrates

Macroinvertebrates play a vital role in aquatic ecosystems by providing a food source and acting as bio-processors of coarse and fine particulate organic matter. In addition, certain macroinvertebrate species may provide insight into the quality of the stream habitat they occupy. Macroinvertebrates communities were sampled within the Calumet River System and the Chicago River System most recently in 2005 by the MWRDGC (MWRDGC 2007). Data from this study were used to describe the macroinvertebrate communities in the two systems.

In the Calumet River System, the MWRDGC sampled three stations for macroinvertebrates in 2005. Samples were collected from the Calumet River, Little Calumet River, and the CSC using Hester-Dendy and Petite Ponar samplers. A total of 41 taxa were collected from the Calumet River System using data combined for both sampling methods (See CAWS Species List, Species 1). Thirty-one (31) taxa were collected using the Hester-Dendy sampler, while 20 taxa were collected using the petite ponar grab sampler. Overall, Ephemeroptera-Plecoptera-Trichoptera (EPT) richness was low in the Calumet River System, with EPT taxa richness 1 in petite ponar samples (combined) and 2 in Hester-Dendy samples (combined). Taxa comprising the majority of the Hester-Dendy samples were *Dreissena polymorpha* (85.01%), Gammarus (5.24%), *Dicrotendipes simpsoni* (3.73%), *Nanocladius distinctus* (1.20%), and Oligochaeta (1.03%). Taxa comprising the majority of the petite ponar grab samples were Oligochaeta (56.72%), *Dreissena polymorpha* (34.64%), and Procladius (5.20%).

In the Chicago River System, four stations in the NSC and three stations in the CSSC were sampled in 2005 by the MWRDGC. The sites were analyzed separately; however, results were similar, with the Oligachaeta taxon comprising the majority of the specimens collected in both reaches using both sampling methods. In the NSC, a total of 47 taxa were collected (See CAWS Species List, Species 2). Thirty-eight taxa were collected in Hester-Dendy samples, and 30 taxa were collected in petite ponar grab samples. Overall, EPT taxa richness was 2 in Hester-Dendy samples and 0 in petite ponar grab samples. Taxa comprising the majority of the organisms collected in the Hester-Dendy samples were Oligochaeta (32.94%), Turbellaria (25.6%), *Dicrotendipes simpsoni* (21.5%), Glyptotendipes (7.49%), *Hyalella azteca* (2.59%), *D. fumidus* (1.85%), *D. modestus* (1.43%), Caecidotea (1.15%), and Hydra (1.09%). Oligochaeta comprised 96.24% of the taxa collected in the petite ponar grab samples. In the CSSC, a total of 37 taxa were collected (See CAWS Species List, Species 3). Thirty-four (34) taxa were collected in Hester-Dendy samples while seven taxa were collected in petite ponar grab samples. Overall, EPT taxa richness was 3 in Hester-Dendy samples and 0 in petite ponar grab samples. Taxa comprising the majority of the organisms collected in the Hester-Dendy samples were Oligochaeta (51.74%), Turbellaria (21.11%), *D. simpsoni* (13.02%), Ferrissia (7.41%), and *H. azteca* (1.58%). Similar to NSC petite ponar grab samples, Oligochaeta comprised 98.45% of the taxa collected in the CSSC samples. In addition, the MWRDGC collected two crayfish species, *Ocronectes rusticus* and *O. virilis*, in the CSSC, although no crayfish were collected using the Hester-Dendy or petite ponar grab sampler in 2005 (MWRDGC 2007).

A majority of the CAWS is dominated by urban and industrial development which has changed the majority of the landscape and left patches of remnant high-quality habitats fragmented. Thus, a majority of the insect species found within the CAWS corridor are those that are known to thrive in degraded habitats. An increase in species richness is only found within the remnant high-quality habitats that are scattered throughout the riparian corridor.

There has been limited sampling of terrestrial insects within the Chicago region. However, sampling by Northeastern Illinois University (NEIU 2006) for grasshoppers, walking sticks, katydids, leafhoppers, froghoppers, planthoppers, butterflies, and micro moths has occurred since 1996. Species that are likely to be found in the urban areas of the CAWS are listed in CAWS Species List, Species 4.

B.1.3.4 Fishes

The Chicago and Calumet River Systems largely support tolerant fish species that colonized from the Des Plaines River, Lake Michigan, and several small streams that flowed into the constructed channels and canals. Monitoring in the CAWS has been occurring since the 1970s to the present day. Intensive monitoring in fixed locations has occurred since 2010 by federal and state agencies as part of the Monitoring and Rapid Response Workgroup. In 2011, a total of 58 species (See CAWS Species List, **Species 5**) were recorded from the CAWS (MRRWG 2012). The five most common species collected were gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), bluntnose minnow (*Pimephales notatus*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*). These species accounted for 74.3% of the total 2011 catch. More than 90% of the total 2011 catch can be attributed to the five common species combined with the following six species: largemouth bass (*Micropterus salmoides*), spotfin shiner (*Cyprinella spiloptera*), golden shiner (*Notemigonus crysoleucas*), white sucker (*Catostomus commersoni*), brook silverside (*Labidesthes sicculus*), and emerald shiner (*Notropis atherinoides*). Based on the 2011 collections, the majority of fish species that occur are either non-native (9 species) or ecologically tolerant, which means they are able to thrive in degraded habitats. Only one species collected, the banded killifish (*Fundulus diaphanus*), is listed as threatened in Illinois.

B.1.3.5 Reptiles and Amphibians

Similar to other taxa within the Chicago region, the richness of amphibian and reptile species has been in decline since European settlement began in the early 1800s. Extensive agriculture followed by rapid urbanization of the area has led to a fragmented urban environment. The Chicago region is currently a mosaic of urban, industrial, and small natural habitats. Natural areas within the riverine corridors of the Chicago and Calumet River Systems are where amphibians and reptiles are most likely to be abundant.

Amphibians typically prefer wooded areas where dense canopy cover provides cooler temperatures to the forest floor, and leaf litter helps retain moisture. Reptiles are more likely to be found in savanna habitats where an open canopy and a rich herbaceous understory provide habitat for sun-loving species. Although natural areas are spread throughout the Chicago region, a rich herpetofauna community is most likely to be present in those natural areas, having an approximately 200-acre buffer from the edge of an adjacent aquatic habitat (Semlitsch and Bodie 2003). Therefore, areas with the greatest richness and abundance of reptile and amphibian species are most likely near the CSSC and Cal-Sag junction where several forest preserves are located.

Of the 50 amphibian (See CAWS Species List, Species 6) and reptile species (See CAWS Species List, Species 7) that have historically occurred in the Chicago region, approximately 18 species are considered common in the region currently (Pope 1944; Mierzwa 2000; Mierzwa et al. 2000). Overall, no amphibians or reptiles within the Chicago region are listed as federally endangered or threatened;

however, the Massasauga (*Sistrurus catenatus catenatus*) is a federal candidate species. Within Illinois and Indiana, state-listed endangered, threatened, or species of concern include the Jefferson salamander (*Ambystsoma jeffersonianum*), four-toed salamander (*Hemidactylium scutatum*), mudpuppy (*Necturus maculosus*), blue-spotted salamander (*Ambystoma laterale*), northern leopard frog (*Rana pipiens*), northern cricket frog (*Acris crepitans*), ornate box turtle (*Terrapene ornata*), Kirtland's snake (*Clonophis kirtlandii*), Massasauga (*S. catenatus catenatus*), smooth green snake (*Liochlorophis vernalis*), western ribbon snake (*Thamnophis proximus*), spotted turtle (*Clemmys guttata*), and Blanding's turtle (*Emydoidea blandingii*).

B.1.3.6 Birds

Within the Chicago region, natural areas scattered along the Chicago and Calumet River Systems provide crucial foraging and breeding habitat for migratory birds. These fragmented refuges are important to numerous migratory song birds as well as other avian families (e.g., hawks, owls, and waterfowl.) that follow the Lake Michigan Flyway. This important flyway provides a visual north-south sight line, the coast of Lake Michigan, for which the birds have evolved to follow as they undergo migration. During the typical migration periods, March to May and September to mid-October, more than 5 million neotropical songbirds will pass through the area. Since 1970, over 300 species of birds have been recorded from the Chicago region (Schilling and Williamson 2012). Although the Chicago and Calumet River Systems have become highly degraded and riparian habitats have been fragmented by industrialization, the river systems still provide limited habitat for migratory neotropical bird species as well as resident species.

Common species inhabiting the area include marsh birds, nesting and migrant waterfowl, and woodland birds (See CAWS Species List, Species 8). Of the species common in the area, the black-crowned night-heron (*Nycticorax nycticorax*), common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), and little blue heron (*Egretta caerulea*) are listed as endangered by the State of Illinois. Within Indiana, the black-crowned night-heron (*N. nycticorax*) is listed as state endangered, while the great egret (*Myiarchus crinitus*) is considered a species of concern. Two species within the area, the golden-winged warbler (*Vermivora chrysoptera*) and the wood thrush (*Hylocichla mustelina*), are regarded as species of concern by the National Audubon Society. In addition, the common tern (*Sterna hirundo*), eastern meadowlark (*Sturnella magna*), and little blue heron (*Egretta caerulea*) are 3 of the 20 common declining birds in North America (Butcher 2007).

B.1.3.7 Mammals

The mammalian community within the study area has been degraded because of hydrologic and geomorphic alterations and fragmentation of habitats by industrialization. The majority of the site is covered in anthropogenically induced bottomland forest and ruined industrial parcels. Muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), American mink (*Mustela vison*), river otter (*Lontra canadensis*), and raccoon (*Procyon lotor*) are mammals often associated with bodies of water because they construct their shelters in or near rivers and streams as well as gather food. Aquatic dependent mammals, such as these, as well as other species of mammals (See CAWS Species List, Species 9), may be found utilizing the study area (Sanborn 1928; Hoffmeister 1989).

Listed species within the Chicago region include the Indiana bat (*Myotis sodalis*), hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), Franklin's ground squirrel (*Spermophilus franklinii*), river otter (*Lontra canadensis*), American badger (*Taxidea taxus*), and the gray wolf (*Canis lupus*). Only the Indiana bat (*M. sodalis*) and gray wolf (*C. lupus*) are considered federally endangered. Populations of the Indiana bat are not known within the study area; the gray wolf is considered extirpated from the Chicago region with only solitary animals entering primarily the northern portion of the area sporadically.

B.1.3.8 Aquatic Nuisance Species

The USACE, in collaboration with GLMRIS study partners, published the ANS White Paper: Non-native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study. The purpose of the ANS White Paper was to inventory potential non-native species within the Great Lakes and Mississippi River basins and the associated risk of their potential to disperse and become invasive.

A total of 254 alien aquatic species were originally identified to occur in one or both basins or with the threat of infiltrating a given basin. Of the 254 alien species, a total of 103 were found to already have established populations in both basins and were removed from the list. In addition, 31 species were removed because they were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or were believed to have no potential to cause adverse effects on the invaded ecosystem.

Of the remaining 119 alien and native species, a final list of ANS of Concern was developed. In turn, 39 species were identified as having a potential risk for both transferring from one basin to another, and a potential risk in that if they do disperse, the invaded ecosystem type would be moderately to severely affected by their colonization.

The following 10 species were deemed as a potential risk to the Great Lakes Basin: *Alosa chrysochloris* (skipjack herring), *Channa argus* (northern snakehead), *Hypopthalmichthys molitrix* (silver carp), *Hypophthalmichthys nobilis* (bighead carp), *Menidia beryllina* (inland silverside), *Mylopharyngodon piceus* (black carp), *Apocorophium lacustre* (scud), *Landoltia* (Spirodela) *punctata* (dotted duckweed), *Murdannia keisak* (marsh dewflower), and *Oxycaryum cubense* (Cuban bulrush).

The following 24 species were deemed as a potential risk to the Mississippi River Basin: *Alosa aestivalis* (blueback herring), *Gasterosteus aculeatus* (threespine stickleback), *Gymnocephalus cernuus* (ruffe), *Petromyzon marinus* (sea lamprey), *Proterorhinus semilunaris* (tubenose goby), *Cercopagis pengoi* (fish-hook water flea), *Daphnia galeata galeata* (water flea), *Hemimysis anomala (*bloody red shrimp), *Schizopera borutzkyi* (harpacticoid copepod), *Neoergasilus japonicas* (parasitic copepod), *Carex acutiformis* (swamp sedge), *Glyceria maxima* (reed sweetgrass), *Trapa natans* (water chestnut), *Bangia atropurpurea* (red algae), *Cyclotella cryptic* (cryptic algae), *Enteromorpha flexuosa* (grass kelp), *Stephanodiscus binderanus* (diatom), *Pisidium amnicum* (greater European pea clam), *Sphaerium corneum* (European fingernail clam), *Valvata piscinalis* (European stream valvata), *Psammonobiotus communis* (testae amoeba), *Psammonobiotus dziwnowi* (testae amoeba), *Psammonobiotus linearis* (testae amoeba), and *Lophopodella carteri* (bryozoan). An additional species, *rhabdovirus* sp (Viral Hemorrhagic Septicemia Virus) was added to the list of High and Medium Species during agency reviews.

B.1.3.9 Summary of CAWS Natural Areas and Parks

Natural areas, parks, and other significant open spaces were identified along the CAWS. Utilizing geographical information system (GIS) analytical tools, all of these areas were selected within 1,000 ft of CAWS waterways. Approximately 231 parks, nature preserves, natural areas, and greenways were identified (Figure B.15). Significant natural areas and nature preserves such as Lockport Prairie, Waterfall Glen, Burnham Prairie, Midewin National Tallgrass Prairie, Indiana Dunes National Lakeshore, and Portage Park warrant special attention when assessing affects/effects of considered alternatives.

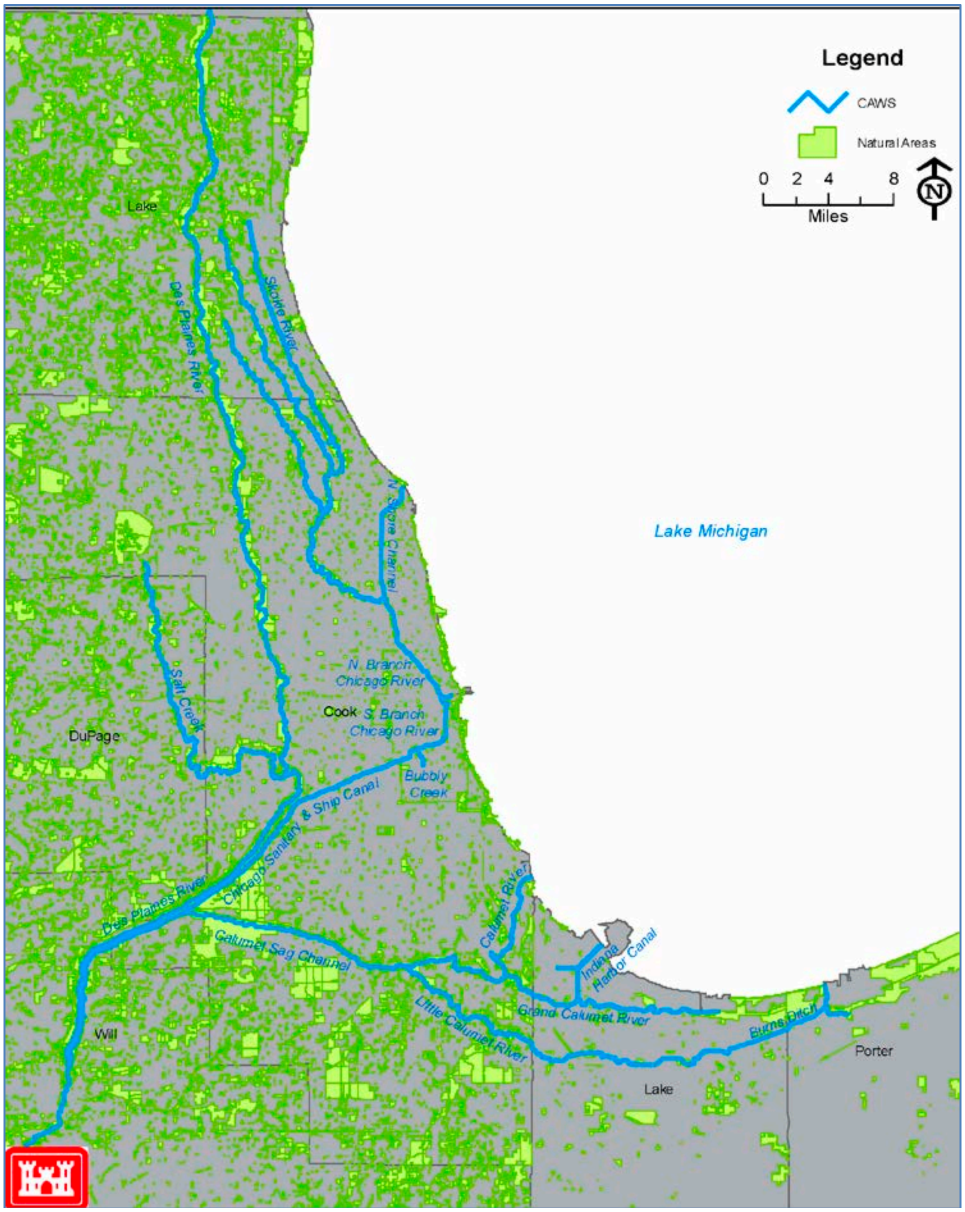


FIGURE B.15 Natural Areas, Parks, Greenways, and other Open Space

B.1.3.10 Threatened and Endangered Species

Federally listed Threatened, Endangered, Proposed, and Candidate Species were reviewed for the project area by the Chicago District. Federally listed species, status, and their critical habitats are identified by the U.S. Fish and Wildlife Service (USFWS) as occurring within Cook, DuPage, and Will Counties in Illinois, and Lake County, Indiana (Table B.7).

TABLE B.7 Federally Listed Species by County

Species	Status	County List	Critical Habitat	Potential to Effect
Piping plover (*Charadrius melodus*)	Endangered	Cook	Wide, open, sandy beaches with very little grass or other vegetation	No
Eastern massasauga (*Sistrurus catenatus*)	Candidate	Cook, DuPage, Will	Graminoid dominated plant communities (fens, sedge meadows, peat lands, wet prairies, open woodlands, and shrublands)	No
Eastern prairie fringed orchid (*Platanthaera leucophaea*)	Threatened	Cook, DuPage, Will	Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie	No
Hine's emerald dragonfly (*Somatochlora hineana*)	Endangered	Cook, DuPage, Will	Spring fed wetlands, wet meadows, and marshes. Within Cook county, critical habitat has been designated along the Des Plaines River	Yes
Leafy-prairie clover (*Dalea foliosa*)	Endangered	Cook, DuPage, Will	Prairie remnants on soil over limestone	Yes
Mead's milkweed (*Asclepias meadii*)	Threatened	Cook, DuPage, Will, Lake-IN	Late successional tallgrass prairie, tallgrass prairie converted to hay meadow, and glades or barrens with thin soil	No
Prairie bush clover (*Lespedeza leptostachya*)	Threatened	Cook, DuPage, Will	Dry to mesic prairies with gravelly soil	No
Sheepnose mussel (*Plethobasus cyphyus*)	Endangered	Will	Shallow areas in larger rivers	Yes
Snuffbox (*Epioblasma triquetra*)	Endangered	Will	Found in small to medium sized creeks and some larger rivers in areas with a swift current	Yes
Lakeside daisy (*Hymenopsis herbacea*)	Threatened	Will	Found in dry rocky prairies	Yes
Indiana bat (*Myotis sodalis*)	Endangered	Lake-IN	Winter hibernation habitat is cool, humid caves with stable temperatures. In Indiana, overwintering habitat is typically found in the southern part of the state. Summer habitat includes wooded areas with standing dead or dying trees	Yes
Karner blue butterfly (*Lycaeides melissa samuelis*)	Endangered	Lake-IN	Pine barrens and oak savannas on sandy soils containing wild lupines (Lupinus perennis), the only known sustenance plant of the larvae.	No
Pitcher's thistle (*Cirsium pitcheri*)	Threatened	Lake-IN	Found growing on the open sand dunes and low open beach ridges of the Great Lakes' shores. Typically found in nearshore plant communities but it can grow in all nonforested areas of a dune system.	No

B.1.4 Cultural and Archeological Resources

B.1.4.1 Prehistoric and Historic Archeological Sites

The Chicago Portage National Historic Site is the only known prehistoric archaeological site located on the CAWS.

B.1.4.2 Historic Structures

B.1.4.2.1 Illinois

The three counties in northeastern Illinois contain a large number of historic structures listed on the *National Register of Historic Places* (NRHP). Cook County contains 437 individual properties as well as 65 historic districts. DuPage County has 34 individual properties and 4 historic districts on the NRHP. Thirty individual properties and 6 historic districts in Will County are on the NRHP. Only a few of these properties are located adjacent to the CAWS.

B.1.4.2.2 Chicago

Chicago maintains its own list of City Landmarks and Historic Districts, totaling 256 individual structures and 47 historic districts. Many of these landmarks are also on the NRHP. Only the city's Ogden Historic District, located directly on the Chicago River, is directly associated with the CAWS.

Three properties listed on the NRHP could be affected by changes in the operation of the Illinois Waterway. These properties include the structures within the boundaries of the Illinois and Michigan National Heritage Corridor (Brandon Road Lock and Dam; T.J. O'Brien Lock and Dam; Lockport Lock; Dresden Island Lock and Dam; Marseilles Lock, Dam, and Canal; Starved Rock Lock and Dam Historic District; I&M Canal; and CSSC Historic District. The CSSC Historic District consists of three structures (Main Channel, Willow Springs Spillway, and the Lockport Controlling Works), one site (Butterfly Dam Remnant), and one district (Lockport Lock, Dam, and Power House Historic District).

B.1.4.2.3 Indiana

Numerous properties in northern Indiana are listed on the NRHP. These include 34 individual properties and 6 historic districts in Lake County, 17 individual properties and 3 historic districts in Porter County, and 13 individual properties and 2 historic districts in La Porte County. None of these properties will be affected by operational changes of the waterway.

B.1.5 Infrastructure

The City of Chicago is the third largest city in the United States with a population of approximately 2.7 million residents. Those physical structures that support and maintain this region's economy, considered herein, are the transportation networks (water, rail, and roads), sanitary sewers, conveyance of stormwater, and water supply.

A majority of the road network in Chicago is utilized for the movement of daily commuters and commodities to destinations with the region. Each day, the Regional Transportation Authority (Chicago Transportation Authority [CTA], Metropolitan Rail Corporation [Metra], and Pace) provides more than two million rides a day in a six-county region of almost eight million people. A share of this rail and road capacity in the Chicago region gives the nation one of its major hubs for intermodal transfer for rail and truck movements between the east and west coast markets.

The CAWS is both a natural and artificial system for the conveyance of sanitary and stormwater. The predominate direction of flow for the CAWS is toward the Mississippi River, but it has the capacity to convey extreme stormwater overflow events to Lake Michigan. The upper portions of the watersheds that drain the CAWS are non-navigable waterways and primarily function to drain storm runoff and some sanitary overflow. The lower portions of the NBCR and a small portion of the South Branch are maintained for navigation of commercial vessels. The primary navigable waters in use are the CSSC, CSC, and the Calumet River.

In addition to the natural riverine and canal system, the region has invested heavily in the conveyance of stormwater through a complex network of combined sewer and separated stormwater networks. The MWRDGC, in cooperation with the USACE, is currently implementing the TARP that will assist with the water quality issues associated with combined sewer overflows in Chicago and 51 suburban communities.

The City of Chicago supplies just fewer than one billion gallons of water a day to the residents of Chicago and neighboring communities. A crib, located 2 mi out into Lake Michigan, sends water to two purification plants located along the shores of Lake Michigan.

The region's water resources and water infrastructure have supported the economic growth of the City of Chicago and the region since the settlement of the region in the late 18th century. Overland modes of transportation (rail and road) have provided addition economic growth and prosperity during the 19th through the 21st centuries.

B.1.6 Recreation

The numerous community and county parks in the six counties provide a wide range of public recreational facilities, including tennis courts, field houses, and soccer and baseball facilities. Chicago's Lake Michigan shoreline includes 29 public beaches. The Indiana Dunes National Lakeshore provides public beaches for swimming and surfing. The undeveloped nature of large portions of the area makes it a popular destination for outdoor sports, including picnicking, bird watching, hunting, fishing, and boating.

B.1.7 Hazardous, Toxic, and Radioactive Wastes

A Hazardous, Toxic, and Radioactive Waste (HTRW) investigation was conducted for the GLMRIS Report, as required by Engineer Regulation (ER) 1165-2-132, Hazardous, Toxic and Radioactive Waste Guidance for Civil Works Projects. Twelve GLMRIS project locations were investigated in order to identify Recognized Environmental Conditions (RECs) that may impact or be impacted by GLMRIS project implementation. The investigation was performed at the level of detail required for a Reconnaissance Phase investigation and relied on observations made through database research, existing sediment and water quality data, and historical aerial photograph and topographic map review. Several CERCLA, Resource Conservation and Recovery Act (RCRA) Corrective Action, RCRA-Treatment, Storage, and Disposal (TSDF), RCRA hazardous waste generator, leaking underground storage tank, landfill, site remediation program, and manufactured gas plant sites were found at or near proposed GLMRIS project features. At this stage of the investigation, it is unclear to what extent these sites have the potential to impact project implementation. If a GLMRIS project is selected for implementation, additional review and investigation of the project sites will be necessary once the project locations and work limits are finalized. Phase II investigations may be required at some project sites to determine the scope and scale of site impacts from adjacent regulated activities.

B.2 SPECIFIC FUTURE WITHOUT-PROJECT CONDITION ASSESSMENTS

Gathering information about potential FWP and FWOP conditions requires forecasts, which should be made for selected years over the period of analysis (2017–2067) to indicate how changes in targeted resource conditions are likely to have an effect on problems and opportunities. This section summarizes the methods and forecasted baseline conditions for the resources in the CAWS that could be affected by the implementation of an alternative and require quantitative or qualitative analysis. These categories are ANS, Hydrology and Hydraulics, and Water Quality. Forecasting of the Great Lakes and Mississippi River basin resources, including Focus Area 2 locations, would be included in the environmental compliance documentation that would be developed to support a recommendation. Detailed analysis at that scale was not completed for this report.

B.2.1 ANS Risk Assessment

In support of the GLMRIS, an initial list of Special Concern ANS species was compiled in an effort to identify those ANS that had the greatest potential for interbasin transfer. An initial screened list of 39 Species of Concern was identified to proceed into the qualitative Risk Assessment. As refinement of the species information progressed, it was discovered that 5 species no longer fit the criteria set forth in the ANS White Paper and were removed for further consideration under the risk assessment. The risk assessment was then conducted for 34 ANS that were considered to be established in either the Great Lakes or Mississippi River basins but not both, and for which a concern of interbasin transfer has been identified. During agency collaboration, an additional ANS, viral hemorrhagic septicemia (VHS) was added, bringing the total High and Medium Risk ANS to 35. The Risk Assessment was conducted to identify the potential for ANS establishment within either the Great Lakes Basin or the Mississippi River Basin and the consequences of adverse impacts that could be incurred following establishment. The Risk Assessment also characterized and ranked the five pathways within the CAWS that connect the two basins with regard to the number of ANS that could successfully use each pathway for successful interbasin transfer and the level of potential consequences associated with establishment of those species within a new basin. The Risk Assessment is summarized in Chapter 2 of the main report and discussed in detail in Appendix C, Risk Assessments.

B.2.1.1 CAWS Pathway-Specific Risks

Because of pathway-specific differences in physical and environmental conditions, some pathways may be more amenable to support interbasin transfer for some ANS, while other pathways may be more suitable for transfer by other ANS. The following procedure was used to rank the five CAWS pathways on the basis of potentially supporting interbasin transfer of ANS, see Appendix C, Risk Assessments, for a detailed description of this procedure.

First, the total number of ANS with a specific risk level rating (high, medium, low, and none) was tabulated for each CAWS pathway. The number of ANS in each risk level was then multiplied by the appropriate risk-level-specific weighting factors:

- High Risk = 3
- Medium Risk = 2
- Low Risk = 1
- No Risk = 0

The resulting numerical risk values within each CAWS pathway were then summed to provide an overall CAWS-specific risk value. The CAWS pathways were then ranked from highest to lowest in risk value.

The pathway with the highest risk value is considered to have the greatest potential for supporting interbasin transfer of ANS with the greatest potential for adverse impacts.

The characterization of ANS-related risks relied on the evaluation and interpretation of existing scientific information, together with professional judgment of the GLMRIS risk assessment team. The amount of information available for supporting the risk assessment varied widely among the ANS evaluated. For some ANS, there were relatively few published studies or other available information, while for others there was a relatively large number of published studies, agency reports, and other data. Thus, the risk assessment included identification of the level of uncertainty associated with the designation of the ANS-specific establishment, consequences, and risk ratings. Please see Appendix C, Risk Assessments, for further details.

B.2.1.2 ANS Risk Assessment Baseline Conditions

Baseline conditions were assessed at time step 0 (T_0). The risk of adverse impacts as the result of transfer from one basin to another via the CAWS was evaluated with the methodology described above. The results are presented in Table B.8. Just one species, bloody red shrimp, was assessed as a high risk at the current time step. Nine species were evaluated as having a medium risk; the remaining species were assessed as posing a low risk.

TABLE B.8 Summary of the Risk of Adverse Impacts per ANS Baseline Conditions (T_0)

Common Name	Scientific Name	CAWS 1[a]	CAWS 2[b]	CAWS 3[c]	CAWS 4[d]	CAWS 5[e]
Testate amoeba	*Psammonobiotus communis*	Low	Low	Low	Low	Low
Testate amoeba	*Psammonobiotus dziwnowi*	Low	Low	Low	Low	Low
Testate amoeba	*Psammonobiotus linearis*	Low	Low	Low	Low	Low
Cryptic algae	*Cyclotella cryptica*	Low	Low	Low	Low	Low
Grass kelp	*Enteromorpha flexuosa*	Low	Low	Low	Low	Low
Red algae	*Bangia atropurpurea*	Medium	Medium	Medium	Low	Low
Diatom	*Stephanodiscus binderanus*	Medium	Medium	Medium	Low	Low
Freshwater bryozoan	*Lophopodella carteri*	Low	Low	Low	Low	Low
Greater European pea clam	*Pisidium amnicum*	Low	Low	Low	Low	Low
European fingernail clam	*Sphaerium corneum*	Low	Low	Low	Low	Low
European stream valvata	*Valvata piscinalis*	Low	Low	Low	Low	Low
Scud	*Apocorophium lacustre*	Low	Medium	Medium	Low	Low
Fishhook waterflea	*Cercopagis pengoi*	Medium	Medium	Medium	Medium	Medium
Waterflea	*Daphnia galeata galeata*	Low	Low	Low	Low	Low
Bloody red shrimp	*Hemimysis anomala*	High	High	High	Medium	Medium
Parasitic copepod	*Neoergasilus japonicas*	Low	Low	Low	Low	Low
Harpacticoid copepod	*Schizopera borutzkyi*	Low	Low	Low	Low	Low
Northern snakehead	*Channa argus*	Medium	Medium	Medium	Medium	Medium
Skipjack herring	*Alosa chrysochloris*	Low	Low	Low	Low	Low

TABLE B.8 (CONT.)

Inland silverside	*Menidia beryllina*	Low	Low	Low	Low	Low
Black carp	*Mylopharyngodon piceus*	Medium	Medium	Medium	Medium	Medium
Bighead carp	*Hypophthalmichthyes nobilis*	Medium	Medium	Medium	Medium	Medium
Silver carp	*Hypophthalmichthys molitrix*	Medium	Medium	Medium	Medium	Medium
Blueback herring	*Alosa aestivalis*	Low	Low	Low	Low	Low
Threespine stickleback	*Gasterosteus aculeatus*	Medium	Medium	Medium	Medium	Medium
Ruffe	*Gymnocephalus cernuus*	Low	Low	Low	Low	Low
Sea lamprey	*Petromyzon marinus*	Low	Low	Low	Low	Low
Tubenose goby	*Proterorhinus semilunaris*	Low	Low	Low	Low	Low
Marsh dewflower	*Murdannia keisak*	Low	Low	Low	Low	Low
Cuban bullrush	*Oxycaryum cubense*	Low	Low	Low	Low	Low
Dotted duckweed	*Landoltia punctata*	Low	Low	Low	Low	Low
Swamp sedge	*Carex acutiformis*	Low	Low	Low	Low	Low
Reed sweetgrass	*Glyceria maxima*	Low	Low	Low	Low	Low
Water chestnut	*Trapa natans*	Low	Low	Low	Low	Low
Viral hemorrhagic septicemia	*Novirhabdovirus* sp.	Medium	Medium	Medium	Medium	Medium

[a] WPS to Brandon Road Lock and Dam.
[b] CRCW to Brandon Road Lock and Dam.
[c] Calumet Harbor to Brandon Road Lock and Dam.
[d] Indiana Harbor to Brandon Road Lock and Dam.
[e] BSBH to Brandon Road Lock and Dam.

The risk per pathway proved to be fairly consistent among ANS for baseline conditions. However, CAWS pathways 4 and 5 were considered a low risk for the diatom and red algae, while CAWS pathways 1 through 3 were considered a medium risk. The scud was assessed as having a medium risk along CAWS pathways 2 and 3, and as having a low risk along pathways 1, 4, and 5. In addition, the bloody red shrimp was assessed as having a high risk along pathways 1 through 3 and a medium risk along pathways 4 and 5. At this time step, only CAWS pathways 1, 2, and 3 are predicted to support interbasin transfer of a high-risk ANS (the bloody red shrimp into the Mississippi River Basin). Because the direction of current flow for CAWS pathways 4 and 5 is into Lake Michigan, this species is not expected to be able to enter either pathway from Lake Michigan at this time step. Each of the five CAWS pathways could support interbasin transfer of a similar number (6–8) of medium-risk species.

The study baseline (or base year) is defined in conjunction with the period of analysis and FWOP project conditions (ER 1105-2-100; Planning Guidance Notebook, para 2-4(b)(1)). The base year is defined as the year in which the project (or elements of the project) could be operational. The GLRMIS Team expected that the suite of alternatives would include nonstructural measures that could be implemented quickly, due to continued public concern about the impacts of invasive species on the natural resources of the Great Lakes and Mississippi River basins. The GLMRIS Team selected 2017 as the baseline.

In further defining the baseline conditions, the completion of significant regional projects that will impact the GLMRIS analysis were also captured. By 2017, the USACE's Electric Barrier System will be augmented by the operation of Permanent Barrier I. It is also expected that the Thornton Reservoir will be completed and accepting CSOs that currently discharge to the LCR, Calumet River, and CSC. Also by 2017, it is expected that Stage 1 of the McCook Reservoir will be completed and accepting CSOs that discharge to the NSC, NBCR, Chicago River main stem, SBCR, Bubbly Creek, and CSSC. Other significant changes that the analysis may include are the expected adoption of new WQS for the CAWS and the decommissioning of two power plants that discharge water to the CAWS.

B.2.1.3 ANS Risk Assessment Future without-Project Condition Results

Future-without-project (FWOP) conditions were projected through time, from the current time period to 50 years in the future (T_{50}). A total of 10 ANS were evaluated for risks to the Great Lakes Basin and its resources. These ANS included 6 fish species, 1 crustacean species, and 3 plant species (Table B.9). None of these 10 ANS were found to pose a high risk to the Great Lakes Basin, while 5 of the 10 were found to pose a medium risk. The 5 remaining ANS currently in the Mississippi River Basin (2 fish and 3 plants) were found to pose only a low risk to the Great Lakes Basin; these species are discussed in Appendix C, Risk Assessments.

A total of 24 ANS were evaluated for risks to the Mississippi River Basin and its resources. These ANS included 5 crustacean species, 5 fish species, 4 algae species, 3 plant species, 3 species of mollusk, 3 protozoan species, and 1 bryozoan species (Table B.10). Only 2 of these 24 ANS were found to pose a high risk, and 7 of the 24 to pose a medium risk, to the Mississippi River Basin. The 15 remaining species were found to pose only a low risk to the Mississippi River Basin; these species are discussed in Appendix C, Risk Assessments.

TABLE B.9 Aquatic Nuisance Species of Concern for the Great Lakes Basin (T_{50})

Species	Mode of Interbasin Transfer
Species Posing High Risk	
None	
Species Posing Medium Risk	
Scud (*Apocorophium lacustre*)	Passive drift, hull fouling
Silver carp (*Hypophthalmicthys molitrix*)	Active swimming
Bighead carp (*Hypophthalmicthys noblis)*	Active swimming
Species Posing Low Risk	
Northern snakehead (*Channa argus*)	Active swimming
Black carp (*Mylopharyngodon piceus*)	Active swimming
Skipjack herring (*Alosa chrysochloris*)	Active swimming
Inland silverside (*Menidia beryllina*)	Active swimming
Cuban bulrush (*Oxycaryum cubense*)	Passive drift
Dotted duckweed (*Landoltia punctata*)	Temporary vessel attachment, passive drift
Marsh dewflower (*Murdannia keisak*)	Passive drift, temporary vessel attachment

TABLE B.10 Aquatic Nuisance Species of Concern for the Mississippi River Basin (T_{50})

Species	Mode of Interbasin Transfer
Species Posing High Risk	
Bloody red shrimp (*Hemimysis anomala*)	Passive drift
Fishhook waterflea (*Cercopagis pengoi*)	Passive drift, hull fouling
Species Posing Medium Risk	
Grass kelp (*Enteromorpha flexuosa*)	Passive drift, temporary vessel attachment
Red algae (*Bangia atropurpurea*)	Passive drift, temporary vessel attachment
Diatom (*Stephanodiscus binderanus*)	Passive drift, temporary vessel attachment
Reed sweetgrass (*Glyceria maxima*)	Passive drift
Threespine stickleback (*Gasterosteus aculeatus*)	Active swimming
Tubenose goby (*Proterorhinus semilunaris*)	Active swimming
Ruffe (*Gymnocephalus cernuus*)	Active swimming
Viral hemorrhagic septicemia (*Novirhabdovirus* sp.)	Passive drift; host transport
Species Posing Low Risk	
Sea lamprey(*Petromyzon marinus*)	Active swimming, temporary vessel attachment
Blueback herring (*Alosa aestivalis*)	Active swimming
Parasitic copepod (*Neoergasilus japonicas*)	Host fish movement, passive drift
Waterflea (*Daphnia g. galeata*)	Passive drift, hull fouling
Harpacticoid copepod (*Schizopera borutzkyi*)	Passive drift
European fingernail clam (*Sphaerium corneum*)	Temporary vessel attachment, passive drift
Greater European peaclam (*Pisidium amnicum*)	Temporary vessel attachment, passive drift
European stream valvata (*Valvata piscinalis*)	Temporary vessel attachment, passive drift
Testate amoeba (*Psammonobiotus communis*)	Passive drift
Testate amoeba (*Psammonobiotus dziwnowi*)	Passive drift
Testate amoeba (*Psammonobiotus linearis*)	Passive drift
Cryptic algae (*Cyclotella cryptica*)	Temporary vessel attachment, passive drift
Water chestnut (*Trapa natans*)	Passive drift, temporary vessel attachment
Swamp sedge (*Carex acutiformis*)	Passive drift, temporary vessel attachment
Freshwater bryozoan (*Lophopodella carteri*)	Passive drift, hull fouling

In conclusion, 13 of the 35 ANS examined were determined to pose either a high or medium risk of adverse impacts on either the Great Lakes Basin (5 species) or Mississippi River Basin (9 species). These medium- and high-risk species include 7 fish species, 3 crustacean species, 1 plant species, and 3 algae species.

Each of the five CAWS pathways provides a complete year-round waterway connection between the two basins that could allow the interbasin transfer for all 35 of the ANS of concern. However, successful interbasin transfer and establishment, and thus potential risks of adverse impacts, are not indicated to be equally supported by the five CAWS pathways or for each of the four time steps evaluated in the risk assessment. Only 2 of the 35 ANS are indicated as posing high risks to either the Mississippi River Basin or the Great Lakes Basin at any time step. Both of these species (the bloody red shrimp [*Hemimysis anomala*] and the fishhook waterflea [*Cercopagis pengoi*]) may each pose a high risk to the Mississippi River Basin (see Chapter 6). No species were identified as posing a high risk to the Great Lakes Basin. The bloody red shrimp could pose a high risk to the Mississippi River Basin at all time steps when considering interbasin transfer through CAWS Pathways 1 through 3. When considering CAWS

Pathways 4 and 5 as the means for interbasin transfer, this species would not begin to pose a high risk to the Mississippi River Basin until at least T_{25}. For Pathways 4 and 5, the direction of current flow at the entry points of each pathway is toward Lake Michigan, which is expected to reduce the potential for successful movement of this species from Lake Michigan into the CAWS and subsequent entry into the Mississippi River Basin.

There are no differences among the five CAWS pathways in the number of high- and medium-risk ANS species undergoing interbasin transfer by T_{50}. A 50-year time period is assumed to provide sufficient time for all of the high and medium risk ANS to access, enter, and pass through any of the CAWS pathways. All five pathways are predicted to support the same number of high-(2) and medium-(12) risk species undergoing interbasin transfer.

B.2.2 Hydrologic and Hydraulic Assessment

Many different hydrologic and hydraulic computer models were used to model the complex hydrology and hydraulics of the CAWS for the GLMRIS Study. Table B.11 lists the hydrologic and hydraulic models used for the GLMRIS.

Hydrologic and hydraulic models were developed to analyze the maximum water levels on the CAWS subject to large rainstorms. These models were run under the baseline and FWOP conditions to establish

TABLE B.11 Hydrologic and Hydraulic Models Used for the GLMRIS Study[a]

River	Hydrologic Model		Hydraulic Model	
CAWS	HSPF/SCALP	USACE	Unsteady HEC-RAS	USACE (AECOM)
			DUFLOW	MWRDGC/USACE (Dr. Melching)
Upper North Branch Chicago River	HEC-HMS	MWRDGC (HDR)	Unsteady HEC-RAS	MWRDGC (HDR)
	HEC-1 (Lake County, IL)	USACE		
Little Calumet River	HEC-HMS	MWRDGC (CDM et al.)	Unsteady HEC-RAS	MWRDGC (CDM et al.)
	HEC-1	USACE	Unsteady HEC-RAS	USACE
Grand Calumet River (included w/CAWS)	HSPF/SCALP	USACE	Unsteady HEC-RAS	USACE
	HSPF/SCALP	USACE	UNET	USACE
Cal Sag Region	HEC-HMS	MWRDGC (CH2M Hill)	Unsteady HEC-RAS	MWRDGC (CH2M Hill)
Sewer Network (City of Chicago)	InfoWorks	City of Chicago (CDM et al.)	InfoWorks	City of Chicago (CDM et al.)
Sewer Network (Suburban Communities)	InfoWorks	Corps (CH2M Hill)	InfoWorks	Corps (CH2M Hill)

[a] AECOM = ?; CAWS = Chicago Area Waterway System; HDR = ?; HEC-HMS = Hydrologic Modeling System; HEC-RAS = Hydrologic Engineering Centers River Analysis System; HSPF = Hydrologic Simulation Program Fortran; MWRDGC = Metropolitan Water Reclamation District; SCALP = Scenario-Determined Computer-Assisted Logistics Planning; USACE = U.S. Army Corps of Engineers.

the bases for the economic assessment of flood damage and the overbank flood mitigation measures needed at the timeframe that the basin separation project will be implemented. Appendix D, Hydrologic and Hydraulic Analyses, provides detailed information about the CAWS watershed, watershed hydrology, waterway hydraulics, hydrologic and hydraulic numerical models, and modeling results for the FWOP conditions. This Appendix also documents the assumptions that were used in defining the future condition based on inputs from various governmental agencies.

B.2.2.1 Hydrologic Modeling

Hydrologic models are used to transform rainfall to runoff and route runoff to the WRPs, TARP or CAWS, as overflows during rainstorm events. In this study, 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year events were chosen. The depth and distribution of precipitation follow the guidelines documented in Illinois State Water Survey (ISWS) Bulletins 70 and 71. Precipitation durations of 3, 12, 24, and 48 hours were analyzed, and a critical duration was determined. This critical duration was used in the final production run. An areal reduction factor was used to reduce the point precipitation depth to the uniform areal precipitation throughout the watershed tributary to the CAWS. A large portion of the watershed is serviced by combined sewer systems. The sewer network, which consists of lateral, sub-main, and main trunk sewers and intercepting sewers, collects storm runoff and sanitary flows and conveys them to the WRPs (i.e., sewage treatment plants or WWTPs). When the combined sewer flows exceed the plant capacity, they will be diverted to the TARP system if the sewer has a drop shaft connection to the TARP system and the TARP system has available storage. Otherwise, excess flows will be directed to the CAWS via CSO discharge points (i.e., outfalls, along the waterway). Most of the combined sewer area in the Metropolitan Chicago area is not gauged.

B.2.2.2 Hydraulic Modeling

Hydraulic modeling uses the inflows from the hydrologic modeling as the forcing function to drive water movement in conduits or open channels. To model the CAWS, two hydraulic models were developed—Tunnel NETwork (TNET) and Hydrologic Engineering Centers River Analysis System (HEC-RAS). The InfoWorks model was used as the hydraulic model for the sewer network modeling impacted by the CAWS.

B.2.2.3 Hydrologic and Hydraulic Baseline Conditions

B.2.2.3.1 Critical Duration

The CAWS model was run for the 100-year event for both the baseline and future condition. In most reaches of the CAWS, the highest water levels were corresponding to the 24-hour event. The maximum water levels on the CAWS for 3-, 12-, 24-, and 48-hour events are summarized in Appendix D, Hydrologic and Hydraulic Analyses, Enclosure A. Displays include the maximum water levels on various reaches of CAWS for the future condition, and the maximum water levels on various reaches of CAWS for the existing condition. On the basis of various considerations, 24 hours was chosen to be the critical duration for the CAWS.

B.2.2.3.2 Maximum Water Levels on CAWS

The simulated maximum water levels on the CAWS from 1- through 500-year events are summarized in Appendix D, Hydrologic and Hydraulic Analyses, Enclosure B. Displays show the modeling results for the baseline condition, including the maximum water levels on the CSSC, the South Branch of Chicago River and the NBCR, the CSSC, CSC, North Little Calumet River and Calumet River, and the West

Branch of Grand Calumet River; the stage hydrographs for the Chicago River at CRCW, Calumet River at O'Brien Lock and Dam, and NSC at the WPS, respectively. Also provided are the modeling results for the corresponding future conditions, which include the difference of the maximum water levels on the main CAWS for the 500-year event for the baseline condition with the lake level at 580 ft North American Vertical Datum (NAVD) vs. 583 ft NAVD. Inundation maps for the 500-year event for the baseline and future conditions are provided as well.

B.2.2.4 Hydrology and Hydraulics Future-without-Project Conditions

B.2.2.4.1 Land Use

The historical land use data show that the land cover in the CAWS basin in the past couple decades has not changed significantly. In addition, the coverage and strictness of stormwater management ordinances have grown continuously in the CAWS basin since the first ordinance promulgated by the MWRDGC in 1972. By 1986, the State of Illinois passed legislation that authorized northeastern Illinois counties to develop their own regional stormwater management programs. These stormwater management programs restricted the increase of peak runoff from the new developed land or reconstructed pavement surfaces. The impact of the stormwater detention can be confirmed by analyzing the annual maximum series of the streamgage records at the gaging stations in the CAWS or surrounding watersheds. A recent U.S. Geological Survey (USGS) study (Over et al. 2012) attempted to correlate the timeframe of county-wide ordinance with the observed trends in the flood-peak records. The flood peaks did not show a definitive increase in the past two decades.

In addition to the land use change and implementation of stormwater management ordinances, the hydrology of the CAWS basin may also be affected by major flood control projects, climate change, and green infrastructure implementation.

B.2.2.4.2 Flood Control Projects

Between the mid-1980s through 2006, the MWRDGC completed three TARP tunnel systems—O'Hare, Mainstream and Des Plaines, and Calumet systems. The main function of these tunnel systems was to reduce the frequency of CSOs. As part of the TARP, an excavated reservoir is linked to each TARP tunnel system. The small O'Hare reservoir has been in operation since the early 1990s. The Thornton Reservoir in the Calumet TARP system is scheduled to be completed in 2015, and the McCook Reservoirs in the Mainstream and Des Plaines TARP system will be completed in 2017 and 2029 for Stage 1 and Stage 2, respectively. The storage capacity of these reservoirs has been provided in a previous section. The purposes of these TARP reservoirs consist of further CSO containment and flood risk management. During significant flood events, the reservoirs can alleviate the flood stages on the CAWS system. The availability of these reservoirs is the most significant factor affecting the hydrology and hydraulics during flood events in the CAWS basin in the future. Therefore, the reservoirs were included in the modeling for the baseline and future conditions.

B.2.2.4.3 Climate Change

In performing hydrologic analyses for the synthetic events in the GLMRIS project area, there are two choices: ISWS Bulletin 70 and National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (NOAA 2004). Although the precipitation depth-duration-frequency curves presented in NOAA Atlas 14 were developed including more recent precipitation data from the precipitation gaging stations than the dataset used in ISWS Bulletin 70, the precipitation depths from Atlas 14 are slightly lower. For conservative and consistent reasons, the precipitation information provided in ISWS Bulletin 70 was used in developing the synthetic rain events for the GLMRIS hydrologic study. The ISWS acknowledged that the hydrologic modeling community has a strong interest to have an updated Bulletin 70, but this large effort could not start without committed funds. At the time this report is being prepared, the ISWS does not have a firm plan when Bulletin 70 will be revised.

As part of the analysis in NOAA Atlas 14, the trends in the historical record for the mean and variance of the annual maximum series were examined. These statistics were used in producing new precipitation frequency estimates. These analyses for the Ohio River Basin and its surrounding states were included in Appendix 3, entitled "Trend," in Volume 2 of the Atlas 14 publication (NOAA 2004). NOAA found that historically it is a mixed bag. Both increases and decreases in the trend were observed in a small proportion of observing stations. In other words, there is little spatial coherence.

Given that both the ISWS and NOAA have neither published new precipitation intensity-duration frequency (IDF) including more recent precipitation data nor qualitatively confirmed the potential climate change effect on the precipitation, adjustment of precipitation for the future condition is not warranted at this point.

B.2.2.4.4 Green Infrastructure

The City of Chicago, MWRDGC, and Lake County, Illinois, are increasingly promoting green infrastructure as part of the solution to flooding and CSO problems. Green technologies such as green roofs, pervious pavements, rain gardens, and bioswales aim to reduce inflows to the sewer and TARP systems, thereby reducing the chance of a CSO event. Green infrastructure practices also include control measures to harvest and reuse stormwater, such as rain barrels and cisterns. A 2011 consent decree settlement requires MWRDGC to complete a suite of CSO remedial measures, including a Green Infrastructure program worth $25 million to $50 million. MWRDGC's Green Infrastructure program is expected to provide two million gallons of retention capacity within 5 years, five million gallons of retention capacity within 10 years, and 10 million gallons of retention capacity within 15 years of the consent decree. Data collected by the City of Chicago from 2008 to 2011 estimated that green infrastructure projects would provide an estimated 80 million gallons of detention capacity each year if current trends continue. This would amount to a cumulative storage increase of 1,843 million gallons between 2007 and 2030 (HDR 2012). While the data show that green infrastructure has the potential to be effective for the majority of rainfall events which generate less than 0.5 in. of precipitation, it will be of little use during large storms, when the flood and CSO risks are greatest.

B.2.2.4.5 Floodplain Regulation

The State of Illinois, the State of Indiana, and the City of Chicago have not indicated there would be any regulatory changes in the future. Therefore, it is assumed that the existing regulations will be effective for the project baseline year of 2017, the projected start of a GLMRIS project implementation. In addition, the federal (Federal Emergency Management Agency [FEMA]) requirements on the floodplain mapping for the 100-year event (i.e., the base level flood ([BLF]), will continue without modifications.

B.2.2.4.6 Summary of Future Conditions

In the future, climate change might increase the volume of runoff and the severity of rainfall events, as noted. Regional stormwater management regulations and the implementation of green infrastructures might reduce the storm runoff. However, without specific modeling to quantify the impacts of climate change and changes in regulations and design practices, it is not possible to forecast conditions that include these potential future changes to the region. Modeling for the GLMRIS project does takes into account the effect of the Thornton and McCook Stage 1 reservoirs in the hydrologic analysis for the baseline condition, and it includes the additional effect of the McCook Stage 2 reservoirs in the hydrologic analysis for the future condition. Regarding the potential or continued changes in climate, land use, and implementation of green infrastructures in the future, at present these are qualitative considerations. It is assumed in the current study that the effects induced by these factors are quantitatively undeterminable with acceptable confidence or would be mostly offset amongst themselves.

B.2.3 Water Quality Assessment

B.2.3.1 Water Quality Modeling

B.2.3.1.1 DUFLOW Modeling

The DUFLOW modeling tool is a software package jointly developed by the Rijkswaterstaat (i.e., Dutch Ministry of Public Works), the International Institute for Hydraulic and Environmental Engineering (IHE) of the Delft University of Technology, STOWA (i.e., Dutch Foundation for Applied Water Management), and the Agricultural University of Wageningen. It is used for water quality modeling in the CAWS. The DUFLOW model includes two major parts—hydraulics and water quality. The hydraulic portion is similar to the HEC-RAS one-dimensional unsteady flow model in rivers, except the Chezy roughness coefficient is used in lieu of Manning's *n* value in computing hydraulic resistance. In the water quality portion, the DUFLOW water-quality simulation option that adds the DiToro and Fitzpatrick (1993) sediment flux model to the Water Quality Analysis Simulation Program (WASP4) (Ambrose et al. 1988) model of constituent interactions in the water column is applied. Since water quality is a concern for conditions under both wet and dry periods, continuous simulation over a period of 1 year was performed. The hydro-meteorological conditions for water years 2001, 2003, and 2008, which represent typical average, dry, and wet years, respectively, were used in DUFLOW simulation to compute DO, organic nitrogen, ammonia, nitrate/nitrite, chemical and biological oxygen demand (CBOD), TSS, total phosphorus, algae as chlorophyll a, fecal coliform, and Cl concentrations, as well as pH. DUFLOW does not compute temperature, which must be input to the model based on observed data and manual calculation, adjusting for the difference in the modeling conditions. The DUFLOW model includes the domain of CAWS model less the GCR. The flows and stages at internal and external model boundaries were obtained from recorded stream gage data, plant operation data, or hydrologic and hydraulic simulation.

B.2.3.1.2 FVCOM Modeling

The Finite Volume Coastal Ocean Model (FVCOM) software is used to model the lake current in the southwestern corner of Lake Michigan, from Wilmette Harbor in Illinois, to Burns Harbor Ditch in Indiana. FVCOM is a three-dimensional (3-D) model which is based on solving the governing equations of mass, momentum, and heat. The model domain is represented by an unstructured grid system that allows the near-shore features to be modeled in detail. FVCOM computes both the longshore and onshore velocities and water temperature. The hydrodynamics of the lake model will be calibrated using available data to provide an accurate flow field for modeling water quality, as well as nutrient and bacterial transport in the lake by the FVCOM biological modules. FVCOM takes atmospheric data as the driving force for the lake hydrodynamics and uses the discharges, water quality, and pollutant concentrations at the mouth of NSC, Chicago River, Calumet River, and IHC as loadings to the water quality of the lake.

B.2.3.2 Water Quality Baseline Conditions

The DUFLOW water quality model was calibrated and verified for water years 2001 and 2003 in an earlier study (Melching et al. 2010). For the GLMRIS, the DUFLOW model was applied to water year 2008 for the first time. Especially for the lower DO concentrations, the DUFLOW water-quality model predicted measured DO concentrations with relatively high accuracy. The DUFLOW model and its calibration and verification are summarized in Appendix F, Water Quality Analyses.

The DUFLOW model input for the baseline condition was modified to account for two major inflow changes: (1) changes in discretionary diversion from Lake Michigan, and (2) changes in CSOs to the CAWS. A 1967 U.S. Supreme Court Consent Decree limits Illinois' diversion of water from Lake Michigan to 3,200 cfs per year. The Illinois DNR is charged with allocating these withdrawals and has permitted the MWRDGC to divert an annual average of 305 cfs until 2015. Thirty-five (35) cfs is for the purpose of maintaining navigable water depths throughout the CAWS, and 270 cfs is used for improving water quality and is said to be "discretionary." In water year 2015 (starting October 1, 2014) MWRDGC's diversion will be reduced to 136 cfs (35 cfs navigation makeup; 101 cfs discretionary) (MWRDGC 2008). Thus, for the baseline conditions, which represent operations and facilities expected to be implemented by 2017, the model represents a discretionary diversion limited to 101 cfs concentrated into the months of June through August.

By 2017, it is expected that the Thornton Reservoir will be completed and accepting CSOs that currently go into the LCR, Calumet River, and CSC. Also by 2017, it is expected that Stage 1 of the McCook Reservoir will be completed and accepting CSOs that currently go into the NSC, NBCR, Chicago River main stem, SBCR, Bubbly Creek, and CSSC. With the reservoirs operational, the models yielded significant reductions in CSOs. Stage 1 of the McCook Reservoir captured 90.0, 83.6, and 60.2% and the Thornton Reservoir captured 99.8, 95.7, and 49.9% of the pre-reservoir CSO flows in water years 2001, 2003, and 2008, respectively. In most cases, the post-reservoir flow was less than the pre-reservoir flow, but there were some cases where the post-reservoir flow was higher than the pre-reservoir flow. Such flow increases were attributed to the variations in the filling and draining of the tunnel system versus that of the tunnel and reservoir system. For example, if only the tunnel needs to be drained, storage for a new event may be more quickly obtained than if both the tunnel and reservoir need to be drained.

On the basis of the recently finalized upgrade of WQS for the CAWS, draft permits for the North Side and Calumet WRPs now contain fecal coliform limits. MWRDGC's Disinfection Task Force Advisory Committee selected chlorination/dechlorination as the best disinfection technology for the Calumet WRP, and recommended ultraviolet disinfection for the North Side WRP. Construction will be completed by December 2015, and disinfection will be in service for the 2016 recreational season. Thus, in this study it is assumed that the new bacterial standard, 400–colony-forming units (CFU) per 100 mL, will be effective for the North Side and Calumet WRPs for the baseline condition of 2017. This is being simulated by assuming a 2-log (99%) reduction of fecal coliform concentrations in the WRP effluent. The North Side, Calumet, and Stickney draft NPDES permits also contain a phosphorus limit of 1 mg/L. Thus, the DUFLOW model assumes that the 1-mg/L phosphorus limit will be effective for all three WRPs for the baseline condition of 2017, and all effluent concentrations greater than 1 mg/L are reduced to this value.

The inflow changes described above, plus the recent closure of two coal-fired power plants that discharge to the CAWS, will result in temperature changes in the CAWS for the 2017 baseline condition. The mean daily temperatures were computed using linear regression and mass balance equations developed to describe the temperatures in the CAWS on the basis of the available hourly temperature record in the CAWS collected by the MWRDGC.

FVCOM Scenario 1 describes existing water quality conditions in Lake Michigan in the report, "Modeling the Effects of Hydrologic Separation on the Chicago Area Waterway System on Water Quality in Lake Michigan," provided in Appendix F, Water Quality Analyses. Scenario 1 simulates the seasonal variations in the concentrations of water quality constituents in the nearshore region as well as over the entire lake and is used to calibrate the hydrodynamic and water quality models against the field data collected in the summer of 2012. FVCOM Scenario 4, Episodic Release (2017), represents the GLMRIS Baseline Condition, when Thornton and McCook Stage 1 reservoirs are scheduled to come online and accept CSOs from the Chicago River and Calumet River systems. Results for FVCOM Scenario 4 illustrate impacts on DO, BOD, Cl, bacteria, etc., near Lake Michigan drinking water intake structures during the September 2008 storm event.

B.2.3.3 Water Quality Future-without-Project Conditions

B.2.3.3.1 Water Quality Model Results

The discretionary diversion and the CSOs to the Calumet River, Little Calumet River, and CSC are the same for the baseline and FWOP conditions. However, the CSOs to the NSC, NBCR, Chicago River main stem, South Branch Chicago River, Bubbly Creek, and CSSC are further reduced because both Stages 1 and 2 of the McCook Reservoir will be operational under the WFOP condition. In total, Stages 1 and 2 of the McCook Reservoir captured 99.3, 100.0, and 73.2% of the pre-reservoir CSO flows for water years 2001, 2003, and 2008, respectively. However, from the model results it can be seen that having both stages of the McCook Reservoir on line does not necessarily mean that more CSO flows are captured for every event at every location. For example, higher peak inflows result for the September 4, 2008, storm event for Stages 1 and 2 on line than for Stage 1 alone. These unexpected differences in CSO capture are attributed to the variations in the filling and draining of the two different tunnel and reservoir systems. For example, if only the tunnel needs to be drained, storage for a new event may be more quickly regained than if both the tunnel and reservoir need to be drained.

Comparisons of the simulated DO concentrations for the current, baseline, and future conditions for water year 2008 indicate that for much of the time, the future and baseline conditions yield nearly identical results. The baseline and future conditions yield slightly lower DO concentrations during periods when the discretionary diversion has been reduced; however, the concentrations still are substantially higher than the DO standards and ecological stress is unlikely. Substantial improvements in DO concentrations compared with current conditions can be seen during storm periods at all locations for both baseline and FWOP conditions, because CSO flows are being captured in the reservoirs. The review of the compliance results show that baseline and future conditions yield much higher compliance with the IEPA-proposed DO standards at the locations prone to low compliance under the current condition (e.g., Loomis Street, Cicero Avenue on the CSSC, and Bubbly Creek). The DUFLOW model baseline and future without project results are documented further in Appendix F, Water Quality Analyses.

FVCOM Scenario 5, Episodic release (2029), describes the expected FWOP water quality conditions near Lake Michigan drinking water intakes. "Modeling the Effects of Hydrologic Separation on the Chicago Area Waterway System on Water Quality in Lake Michigan," provided in Appendix F, Water Quality Analyses, describes the model results in full.

B.2.3.3.2 Future Water Quality Regulatory Standards

On September 7, 2012, Canada and the United States amended the bi-national Great Lakes Water Quality Agreement first established in 1972. The amendments include new phosphorus objectives to reduce harmful algae blooms, ballast water restrictions for ships to curb transfer of invasive species, plans to invigorate nearshore restoration efforts, controls on discharges from vessels, and other measures to prevent ecological harm. This Agreement provides the general framework for bi-national coordination of Great Lakes water quality for the coming years.

New and revised use designations protecting recreation on the CAWS were approved in May 2012. The IEPA is in the process of developing numeric water quality criteria and TMDLs for these waters, and will subsequently revise NPDES discharge permits along the waterway. The IEPA has also proposed changes to the Illinois Pollution Control Board (IPCB) that revise the aquatic life use designations and associated criteria for the CAWS and LDPR. The IEPA anticipates that the IPCB will finalize its state rulemaking efforts on the proposed changes within the next 5 years. The IEPA will then need to review and approve or disapprove any such changes before they will become effective under the CWA. These WQS, if adopted consistent with the IEPA's proposal and approved by the EPA, will result in: new or revised aquatic life uses and new or revised criteria for ammonia, DO, temperature, Cl, sulfate, benzene, ethylbenzene, toluene, xylene, and several metals. Indiana has adopted revised WQS at 327 *Indiana Administrative Code* 2-1.3 that will apply in the Indiana portion of the Lake Michigan watershed and are now in effect under the CWA. Implementation of new and/or revised WQS may include development of a TMDL, more stringent point source permit limits, better stormwater control, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of stormwater controls, or improved instream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required.

In the long term, the EPA is working toward CWA Section 101(a)(2) goals of “water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water” for all segments of the CAWS and LDPR. To this end, the EPA is working on the revision of the ammonia, selenium, Cl, and conductivity aquatic life criteria recommendations. New or revised criteria are also being considered for triclosan, ethinyl estradiol, atrazine, acetochlor, metalachlor, pyrethroids, aluminum, cadmium, cyanide, polybrominated diphenyl ethers, sulfate, perfiuorooctanoic acid, perfiuorooctante sulfate, and cyanobacteria. Contaminants of emerging concern (CECs), including trace chemicals from pharmaceuticals and personal care products, nanomaterials, and perfluorinated compounds, are being researched extensively to determine their risk to human health and the environment. These CECs may be subject to regulation in the long term.

B.2.4 Economic Resources Assessment

B.2.4.1 Overview

The Navigation and Economics Project Delivery Team (PDT) assessed several economic parameters that could change given the implementation of the various alternative plans considered in GLMRIS, to include both FWOP and FWP conditions. Eight economic sub-teams were formed, each of which addresses a specific economic category that could change in the FWOP and/or FWP condition, including (1) fisheries-dependent activities, (2) commercial cargo navigation, (3) non-cargo navigation, (4) flood risk management, (5) water quality, (6) water supply, (7) hydropower, and (8) regional economics. All of the economic assessments completed serve to assist in fully describing the implications associated with the implementation of (or lack of) a GLMRIS project.

Each economic sub-team focused on the specific study area for which economic values could change in the FWOP and/or FWP conditions.

B.2.4.1.1 Basin-Wide Study Area

In the FWOP condition, *no* new federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River basins. Since the transfer and establishment of the 39 high and medium risk species identified in the GLMRIS risk assessment could impact the quality or quantity of fisheries within invaded waters (including the Great Lakes, Upper Mississippi River, and Ohio River basins), fisheries-dependent economic activities within these basins could be altered. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. In the FWP condition, new federal action *is* taken to prevent the transfer of ANS among the basins. However, this does not preclude the possibility for changes in fisheries-dependent economic activities since various factors, such as fisheries management techniques, could change the quality or quantity of available fisheries within the three basins. *The key fishing activities identified by the PDT that could change in FWOP and/or FWP conditions include: commercial fishing, recreational fishing, charter fishing, subsistence fishing, and professional fishing tournaments – exclusively within the GLMRIS detailed study area – to include the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. These assessments are not intended to serve as a comprehensive valuation of monetary and non-monetary features of the three basins, but rather, provide an indication of select economic activities that could change in the future given the implementation (or lack of) ANS controls.*

B.2.4.1.2 CAWS Study Area

The Navigation and Economics PDT also explored activities that could change in the FWP condition—the case where ANS controls, such as hydrologic separation within the CAWS, are implemented to prevent the transfer of ANS. *The majority of the ANS control technologies would be implemented within CAWS, and therefore, the PDT assessed various aspects of the economy within this region that could experience a change in the FWP condition – to include: commercial cargo and non-cargo navigation (passenger vessels, etc.), flood risk, water quality, water supply, and hydropower. These assessments are not intended to serve as a comprehensive valuation of monetary and non-monetary features of the CAWS, but rather, provide an indication of select economic activities that could change in the future given the implementation of ANS controls.*

An assessment of the regional economic activity associated with fishing activities within the Great Lakes, Upper Mississippi River, and Ohio River basins and the navigation activities within the CAWS was completed. This evaluation serves as an indicator of what regional economic activity (e.g., sales, employment) are at risk in the FWOP *and/or* FWP conditions.

B.2.4.2 Commercial Fishing

The Navigation and Economics PDT's Fisheries Economics Team developed a baseline assessment which evaluates the value of commercial fishing activities within the GLMRIS detailed study area, which includes the Great Lakes, Upper Mississippi River, and Ohio Rivers, as well as their tributaries up until the first impassible barrier (i.e., dams). The baseline assessment presents the current harvest level (in pounds) and associated harvest value (in Fiscal Year [FY] 2013 dollars) associated with commercial fishing activities within the three basins. The analyses presented here include economic outputs for recreational benefits of a natural resource and do not represent the ecological outputs, and do not imply the impacts on the ecosystem.

The *impacts* of the FWOP condition on commercial fishing are not presented. The GLMRIS qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since the fish species targeted by commercial fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the commercial fisheries baseline economic assessment demonstrates the commercial fishing activities within the three basins that *could* be affected in the FWOP condition.

Key findings for the commercial fisheries baseline economic assessment are presented in Table B.12.

TABLE B.12 Commercial Fishing Baseline Assessment – Key Findings[a]

Assessment	Key Findings
Baseline	• *Great Lakes Basin* - The average harvest level from the most recent 5 years (2005 through 2009) for the U.S. waters of the Great Lakes Basin was determined to be approximately 20.24 million pounds with an associated ex-vessel value of about $21.79 million. • *Upper Mississippi River Basin* - The average harvest level from the most recent 5 years (2001 through 2005) for the Upper Mississippi River Basin was determined to be approximately 10.0 million pounds with an associated ex-vessel value of about $3.84 million. • *Ohio River Basin* - The average harvest level from the most recent 5 years (2001 through 2005) for the Ohio River Basin was determined to be approximately 1.38 million pounds with an associated ex-vessel value of about $1.99 million.
FWOP	• A FWOP condition assessment for commercial fishing was not generated.
[a] All dollars are in FY 2013 price levels.	

B.2.4.3 Recreational Fishing

The Fisheries Economics Team also developed a baseline assessment of recreational fishing activities within the Great Lakes, Upper Mississippi River, and Ohio Rivers Basins which includes each water body, as well as their tributaries up until the first impassible barrier (i.e., dams). The baseline assessment presents the current net value of recreational fishing within the three basins.

The *impacts* of the FWOP condition on recreational fishing are not presented. The GLMRIS qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since the fish species targeted by recreational fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the recreational fishing baseline economic assessment demonstrates the recreational fishing activities within the three basins that *could* be affected in the FWOP condition.

Key findings for the recreational fishing baseline economic assessment are presented in Table B.13.

TABLE B.13 Recreational Fishing Baseline Condition – Key Findings[a]

Assessment	Key Findings
Baseline	• Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the GLMRIS detailed study area in 2011. • The average net value per angler day was $19.52. • The aggregate net value of recreational fishing in those portions of the Great Lakes Basin below barriers impassable to fish (i.e., dams) is estimated to be $1.228 billion for calendar year 2011. • The aggregate net value of recreational fishing in those portions of the Upper Mississippi River and Ohio River basins below barriers impassable to fish is estimated to be $1.124 billion.
FWOP	• A FWOP condition assessment for recreational fishing was not generated.
[a] Cornell University was tasked with generating the methods and results of this study. All dollars are FY 2012 price levels.	

B.2.4.4 Charter Fishing

The Fisheries Economics Team produced a baseline assessment of the charter fishing industry within the GLMRIS detailed study area, specifically focusing on the Great Lakes. The baseline assessment presents the current charter fishing revenues (in 2011 dollars) which were determined via a Great Lakes charter captain survey. Because of the low number of respondents to the Mississippi River Basin river guide survey, statistically reliable information is not presented for this group.

The *impacts* of the FWOP condition on charter fishing are not presented. The GLMRIS qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since the fish species targeted by charter fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the recreational fishing baseline economic assessment demonstrates the recreational fishing activities within the Great Lakes Basin that *could* be affected in the FWOP condition.

Key findings for the charter fishing baseline economic assessment are presented in Table B.14.

TABLE B.14 Charter Fishing Baseline Condition - Key Findings[a]

Assessment	Key Findings
Baseline	• In 2011, there were approximately 1900 active licensed charter captains in the Great Lakes. Of these, about 1,700 captains operated as an independent small business, while another estimated 200 were non-boat-owning captains. Together they generated between $34.4 million and $37.8 million in annual sales and salary.
FWOP	• A FWOP condition assessment for charter fishing was not generated.
[a] The Ohio State University Sea Grant Extension Office was tasked with generating the methods and results of this study. All dollars are FY 2011 price levels.	

B.2.4.5 Subsistence Fisheries

The Fisheries Economics Team developed a baseline assessment of subsistence fishing activities within the Great Lakes, Upper Mississippi River, and Ohio Rivers, as well as their tributaries, up until the first impassible barrier (i.e., dams). The baseline assessment identifies the tribes within the study area, as well as their subsistence fishing practices.

The *impacts* of the FWOP condition on subsistence fishing activities are not presented. The GLMRIS qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since the fish species targeted by charter fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the recreational fishing baseline assessment demonstrates the subsistence fishing activities within the three basins that *could* be affected in the FWOP condition.

Key findings for the subsistence fishing baseline assessment are presented in Table B.15.

TABLE B.15 Subsistence Fishing Baseline Condition - Key Findings[a]

Assessment	Key Findings
Baseline	• There are 37 federally recognized tribes in the study area. • Sixteen tribes engage in subsistence fishing under one of four treaties, mostly in the western Great Lakes Basin. • Subsistence harvesting is an important part of tribal cultural heritage that has value that extends beyond economics, and is an important element in maintaining the sovereign status of the tribes. • The annual value of subsistence fishing activities to an individual subsistence household would be between $15,000 and $16,500.
FWOP	• A FWOP condition assessment for subsistence fishing was not generated.

[a] Argonne National Laboratory was tasked with generating the methods and results for this study. All dollars are in FY 2011 price levels.

B.2.4.6 Pro-Fishing Tournaments

The Fisheries Economics Team developed a baseline assessment of professional (pro) fishing tournaments within the Great Lakes, Upper Mississippi River, and Ohio River Basins. The baseline assessment explores the various kinds of pro-fishing tournaments that take place within the three basins.

The *impacts* of the FWOP condition on subsistence fishing activities are not presented. The GLMRIS qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since the fish species targeted by charter fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the recreational fishing baseline assessment demonstrates the subsistence fishing activities within the three basins that *could* be affected in the FWOP condition.

Key findings for the pro-fishing baseline assessment are presented in Table B.16.

TABLE B.16 Pro-Fishing Tournaments Baseline Condition - Key Findings[a]

Assessment	Key Findings
Baseline	• The report summarizes the elements of fishing tournaments which occur on the Great Lakes, Ohio River, and Upper Mississippi River. Given the vast number of tournaments which occur on the various water bodies and the varying information available, the analysis provides a snapshot of the fishing tournaments.
FWOP	• A FWOP condition assessment for pro-fishing activities was not generated.
[a] The pro-fishing tournament report was a qualitative assessment.	

B.2.4.7 Commercial Cargo Navigation

The Navigation and Economics PDT's Commercial Cargo Navigation Team developed baseline and FWOP condition assessments of the commercial cargo navigation movements on the CAWS. While the baseline report established the past and current commodity movements in the CAWS, the FWOP condition report provided a forecast of commodity movements during the project evaluation period (2017– 2066).

Key findings for the commercial cargo navigation baseline and FWOP condition analyses are presented in Table B.17.

TABLE B.17 Commercial Navigation Baseline and FWOP Conditions – Key Findings

Assessment	Key Findings
Baseline	• Tonnage on the CAWS has decreased since 1994 when 24.6 million tons moved on the system. After achieving a 5-yr low in 2010 at 13.2 million tons, CAWS shallow draft traffic (i.e., vessels with a draft less than 15 ft), experienced a slight increase to 13.6 million tons. However, deep draft traffic' (i.e., vessels with a draft of 15 ft or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last 10 years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage. • In 2011, the total traffic was 22.0 million tons, with the three main shallow draft commodities in the CAWS being coal (33%), iron and steel (15%), and aggregates (12%), and the three main deep draft commodities being coal (45%), ores and minerals (19%), and all other group (13%). Lockport Lock typically experiences the highest tonnages, largest tows, and greatest numbers of tows and barges on the CAWS. The smallest tows, least tonnage, and the smallest numbers of tows and barges pass through Chicago Harbor Lock.
FWOP	• CAWS traffic is projected to increase by six million tons by 2020, allowing traffic to recover to pre-recessionary levels. • The largest increases are projected to be in the aggregates commodity group, consisting of sands, pebbles, and crushed stone; limestone; and other related commodities. • Several reasons are given for expecting an increase in future CAWS tonnage, including tonnage currently not being counted, company plans for expansion, and reversal of tonnage declines due to the recession in the mid to late 2000s.

B.2.4.8 Non-Cargo Navigation

The Navigation and Economics PDT's Non-Cargo Navigation Team developed baseline and FWOP condition assessments regarding the non-cargo navigation movements on the CAWS. Non-cargo vessels include passenger, recreational, and government vessels, amongst others. While the baseline report established the past and current non-cargo movements in the CAWS, the FWOP condition report provided a forecast of non-cargo vessel movements during the project evaluation period (2017 through 2066).

Key findings for the non-cargo navigation baseline and FWOP condition analyses are presented in Table B.18.

TABLE B.18 Non-Cargo Navigation Baseline and FWOP Conditions – Key Findings[a]

Assessment	Key Findings
Baseline	• The locks examined have the following average one-way trips by non-cargo vessels on an annual basis: – Chicago Lock has the majority of the non-cargo lock traffic of all the locks examined with about 41,000 one-way trips. – O'Brien Lock sees about 19,000 trips. – Lockport Lock sees about 1,000 trips. – Brandon Lock sees about 1,200 trips. – The WPS does not have vessel crossings.
FWOP	• A summary, including the total present value for each category, includes the following: – Commercial Passenger Business Revenues: $776.2 million – Commercial Passenger Business Expenses: $643.9 million – Commercial Passenger Unit Day Value: $69.5 million – Recreational User Unit Day Value: $13.8 million – Recreational User Willingness To Pay to Keep Locks Open: $127 million to $169 million – Recreational User Transportation Cost (Seasonal Mobilization): $13.7 million to $24.6 million

[a] All dollars are FY 2013 price levels.

B.2.4.9 Flood Risk Management

The Navigation and Economics PDT's Flood Risk Management (FRM) Team developed a baseline economic assessment of flood risk within the CAWS. The FRM Team assessed the flood risk impacts associated with the potential implementation of the various alternative plans considered in GLMRIS, to include both FWOP and FWP conditions. The first step of this analysis was to complete a baseline assessment, which characterizes the flood risk in the Chicago metropolitan area from both overland flooding and sewer backup flooding. The baseline economic assessment yields the expected annual damage (EAD) associated with flooding in the Chicago metropolitan area for the years 2017 (base year; i.e., the year that Phase 1 of the McCook Reservoir is expected to become operational) until 2029 (future year; i.e., the year that Phase 2 of the McCook Reservoir is expected to become operational).

The FRM Team then generated a FWOP condition assessment which characterizes foreseeable changes in flood risk in the Chicago metro area, assuming no new federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River basins. The baseline

FWOP condition assessment yields the EAD associated with flooding in the Chicago metropolitan area for the year 2029 (the year that Phase 2 of the McCook Reservoir is expected to become operational) until 2066 (the final year of the 50-year planning horizon).

Key findings for the flood risk management baseline and FWOP condition economic assessments are presented in Table B.19.

TABLE B.19 Flood Risk Management Baseline and FWOP Conditions – Key Findings[a]

Assessment	Key Findings
Baseline	• For the base year (2017) until 2028, the mean value of EAD is $254 million. • Approximately 90% ($227 million) of the mean EAD is attributable to sewer backup flood, and an estimated 10% ($27 million) is attributable to overland flooding. • Approximately 43% ($110 million) of the total damage occurs to residential structures, while 57% ($144 million) occurs to commercial, industrial, or public structures.
FWOP	• For the future years (2029–2066), the mean value of EAD is $215 million. • Approximately 90% ($194 million) of the mean EAD is attributable to sewer backup flood, and an estimated 10% ($21 million) is attributable to overland flooding. • Approximately 43% ($92 million) of the total damage occurs to residential structures, while 57% ($122 million) occurs to commercial, industrial, or public structures.

[a] EAD in FY 2012 price levels.

B.2.4.10 Water Quality

The Navigation and Economics PDT's Water Quality Team developed a baseline economic assessment that pertains to water quality within the CAWS and Lake Michigan. The purpose of the CAWS water quality assessment is to establish a baseline of water use for water users in the CAWS, as well as the costs associated with that water usage. A brief description of the locks and their location that exist in the system and their water usage needs is also provided. Estimates of usage needs/discharges per day were compiled for the major water users/dischargers. The costs associated with water withdrawals and discharges were evaluated for the three WWTPs. The Lake Michigan water quality baseline economic assessment identifies the number of beaches that currently exist in Chicago's 28 mi of shoreline. This document provides the location and amenities offered at these beaches, as one travels geographically from north to south along the Chicago shoreline. An estimate of the value of beach usage was also identified.

A FWOP condition water quality economic assessment was also generated for the CAWS and Lake Michigan. The CAWS water quality report provides a general description of the usages that will exist under FWOP conditions, while the Lake Michigan water quality report identifies the number of future beaches that could be impacted by ANS control measures in the FWP condition.

Key findings for the water quality baseline and FWOP condition economic assessments are presented in Table B.20.

TABLE B.20 Water Quality Baseline and FWOP Conditions - Key Findings

Assessment	Key Findings
Baseline – CAWS	• Public users of water included three key waste water treatment plants: North Side WW TP, Calumet WWTP, and Stickney WWTP. • Base year annual water treatment costs for the three WWTPs are $151,079,700 (2012 dollars).
Baseline – Lake Michigan	• *Number of Beach Visits* – there were 20 million beach visits in the Chicago area in 2004. • *Value of the Beach Season* **-** the total value of the 2004 beach season was determined to be approximately $800 million (2004 price levels).
FWOP – CAWS	• FWOP condition water treatment costs for the three WWTPs are $156.7 million annually (2012 price levels).
FWOP – Lake Michigan	• There are 33 beaches, 28 of which could be impacted by changes in water quality (algae growth, turbidity, E. Coli) due to implementation of an ANS control measure. • A 2009 plan called "The Last Four Miles: A Plan to Complete Chicago's Lakefront Parks," calls for the construction of 100 acres of new parks and beaches on the north lakefront and 400 acres of new parks and beaches on the south lakefront.

B.2.4.11 Water Supply

The Navigation and Economics PDT's Water Supply Team developed a baseline economic assessment regarding water supply within the CAWS. The assessment addresses how Lake Michigan's water is utilized by the Chicago area. Specifically, the analysis focused on the current demand for water within the Chicago area

A FWOP condition economic assessment was not developed for water supply, as this analysis would involve coordination with the major water providers in the area as well as an estimate of future water demand. This information was not available at the time of the study.

Key findings for the water supply baseline condition economic assessment are presented in Table B-21.

TABLE B.21 Water Supply Baseline Conditions - Key Findings

Assessment	Key Findings
Baseline	• The majority of the region's water comes from Lake Michigan, allocated to approximately 200 communities. • In 2005, Lake Michigan provided about 69% of water used for all purposes except power generation, and about 85% of public water supply. • The Lake Michigan diversion is limited to 2.1 billion gallons per day. • Water users are expected to rely more heavily on water taken from Lake Michigan in the future.
FWOP	• A FWOP condition was not generated for water supply.

B.2.4.12 Hydropower

The Navigation and Economics PDT's Hydropower Team developed a baseline economic assessment regarding hydropower generation at the Lockport Powerhouse. The assessment identifies the annual value of hydropower generation at Lockport. A FWOP condition was also produced for hydropower generation at the Lockport Powerhouse which identifies the future value of hydropower generation at Lockport.

Key findings for the Lockport Powerhouse hydropower generation baseline and FWOP condition economic assessments are presented in Table B.22.

TABLE B.22 Hydropower Baseline and FWOP Conditions - Key Findings[a]

Assessment	Key Findings
Baseline	• The current annual energy value of the Lockport Powerhouse is $1.3 million per year.
FWOP	• The future value of the Lockport Powerhouse is $1.4 million per year.
[a] All dollars are in FY 2012 price levels.	

B.2.4.13 Regional Economics

ANS transfer between the Great Lakes and Mississippi River basins could impact the fishing industries within these basins. Further, the implementation of various fisheries management plans within the basins could also impact the fishing activities within the basins, even if ANS control measures are implemented. The Navigation and Economics PDT's Regional Economics Team assessed the significance of commercial, recreational, and charter fishing industries to the national economy. This is the level of regional economic activity at risk given ANS transfer or its prevention (i.e., the FWOP or FWP conditions).

Commercial cargo and passenger navigation are most at risk from the FWP conditions that include hydrologic separation implementation and/or new lock construction within the CAWS. The regional economics baseline assessment displays the significance of commercial cargo and non-cargo navigation industries within the CAWS to the national economy. This is the level of regional economic activity at risk given the implementation of various ANS controls (i.e., the FWP condition).

The *impacts* associated with the FWOP condition are not presented for fishing-related industries. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this baseline economic assessment demonstrates the fishing industries within the Great Lakes, Upper Mississippi River, and Ohio River basins that *could* be impacted if no federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River basins (i.e., the FWOP condition).

ANS transfer is not anticipated to have a significant impact on navigation activities within the CAWS.

Key findings for the baseline regional economic assessment are presented in Table B.23.

TABLE B.23 Regional Economics Baseline Condition - Key Findings

Assessment	Key Findings
Baseline	• Significance of commercial, recreational, and charter fishing industries to the national economy • Significance of commercial cargo and non-cargo navigation industries within the CAWS to the national economy
FWOP	• A FWOP condition was not developed.

B.2.5 FWOP Actions by Others

Quantification of target resources expected to change is not the only consideration for determining the future without project conditions. It is also important to have a general idea of area activities, plans, operations, and significant changes that lie in the future.

B.2.5.1 USACE Outreach

The USACE sent letter requests (Appendix M, Correspondence) to agencies whose missions (1) could impact relevant future conditions in and around the CAWS, and (2) address ANS prevention, control, and abatement in the Mississippi River and Great Lakes basins. The USACE requested information for a 50-year time period ending in 2067. Information-gathering meetings were held with the agencies to discuss the information required. The USACE presented an overview of GLMRIS and detailed how each respective agency's actions could impact planning for the study. After the submission deadline date passed, non-responsive agencies were contacted by phone or e-mail. Any agency that did not respond was assumed to not have any changes to its current operating conditions that would impact GLMRIS.

TABLE B.24 Information Gathering Meetings for FWOP Conditions

Date	Meeting Attendees
July 23, 2012	Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)
July 24, 2012	U.S. States Environmental Protection Agency (EPA), Illinois Environmental Protection Agency (IEPA), Illinois Department of Natural Resources (Illinois DNR), Indiana Department of Environmental Management (IDEM), Indiana Department of Natural Resources (Indiana DNR), United States Coast Guard (USCG)
July 26, 2012	EPA, IEPA, Illinois DNR, IDEM, INDNR, USCG, International Joint Commission, Great Lakes Fishery Commission, Great Lakes Commission, U.S. Geological Survey (USGS), States in study area
July 30, 2012	City of Chicago (CoC): Mayor's Office, Department of Transportation (DOT), Water Management, Planning, Office of Emergency Management, and Chicago Park District (CPD)
August 1, 2012	Lake, Will, and DuPage Stormwater Commissions; Thorncreek Waste Water Treatment Plant; North Shore Sanitary District (NSSD) Clavey Road Plant; Plum Creek Aqua Illinois; University Park Aqua Illinois; Dyer, Schererville, Hammond, East Chicago, and Gary Waste Water Treatment Plants
August 1, 2012	U.S. Department of Transportation, Illinois Department of Transportation, Indiana Department of Transportation, Chicago Area Metro Planning Commission, International Port District, Ports of Indiana, Northern Indiana Regional Planning Commission

B.2.5.2 ANS Prevention and Control

B.2.5.2.1 Chicago Park District (CPD)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the CPD submitted information on plans for future capital projects and ANS management. ANS management is through listed local ordinances.

B.2.5.2.2 City of Chicago (CoC)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the CoC submitted information on plans for future capital projects and ANS management. The information submitted does not affect the GLMRIS at this time.

B.2.5.2.3 Great Lakes Fisheries Commission (GLFC)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the GLFC submitted a risk assessment for bighead and silver carp. The Bi-national Ecological Risk Assessment of Bigheaded Carps was submitted and makes various recommendations and attempts to answer questions for the prevention of this species spread into the Great Lakes.

B.2.5.2.4 Iowa Department of Natural Resources (Iowa DNR

In response to USACE's request for information regarding future ANS prevention and controls plan, Iowa DNR submitted a list of current management plans for the management of ANS. The plans lay out current procedures the state utilizes in managing ANS and legislation associated with the plans.

B.2.5.2.5 International Joint Commission (IJC)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the IJC submitted a risk assessment for ANS in the Great Lakes/St. Lawrence basin, ANS rapid response reports, and chemical controls report.

B.2.5.2.6 Illinois Department of Natural Resources (Illinois DNR)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the Illinois DNR submitted a list of future plans for the management of ANS. The plans are in the development stage.

B.2.5.2.7 Kentucky Department of Fish and Wildlife (KDFW)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the KDFW submitted information summarizing current ANS control efforts.

B.2.5.2.8 Michigan Department of Environmental Quality (MDEQ)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the MDEQ submitted recommendations to prevent the spread of ANS and current progress toward enacting a previously established ANS plan.

B.2.5.2.9 Michigan Department of Natural Resources (Michigan DNR)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the Michigan DNR submitted its Asian Carp Management Plan. The document lays the framework for prevention and control of ANS.

B.2.5.2.10 Minnesota Department of Natural Resources (MNDNR)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the MNDNR submitted information on current laws enacted to prevent the spread of ANS. The MNDNR also submitted recommendations and current plans for preventing the spread of ANS.

B.2.5.2.11 Missouri Department of Conservation (MDC)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the MDC submitted information on species management plans and an ANS management plan. The ANS plan establishes a framework for future efforts regarding ANS.

B.2.5.2.12 Pennsylvania Fish and Boat Commission (PFBC)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the PAFBC submitted action plans for ANS. The plans submitted were for Asian carp and water chestnut.

B.2.5.2.13 U.S. Fish and Wildlife Service (USFWS)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the USFWS submitted an ANS prevention plan. The plan discusses current approaches to prevent the spread of ANS, as well as future suggestions.

B.2.5.2.14 West Virginia Department of Agriculture (WVDA)

In response to the USACE's request for information regarding future ANS prevention and controls plan, the WVDA submitted a letter informing the USACE of no future plans to affect the study area.

B.2.5.3 Fisheries

B.2.5.3.1 Great Lakes Fisheries Commission (GLFC)

In response to the USACE's request for information regarding future fisheries plans, the GLFC submitted the Fish Community Objectives for Lake Michigan. The document lays the framework for handling important issues and communicating priorities to fishery and environmental managers.

B.2.5.3.2 Missouri Department of Conservation (MDC)

In response to the USACE's request for information regarding future fisheries plans, the MDC submitted information on the recovery of certain species. The information submitted does not affect the GLMRIS study at this time.

B.2.5.3.3 Michigan Department of Natural Resources (Michigan DNR)

In response to the USACE's request for information regarding future fisheries plans, the Michigan DNR submitted information on objectives for three of the Great Lakes fish communities. The plans set objectives for local fisheries programs of each respective lake.

B.2.5.3.4 U.S. Fish and Wildlife Service (USFWS)

In response to the USACE's request for information regarding future fisheries plans, the USFWS submitted the National Fisheries Strategic Plan. The plan sets objectives for how well the fisheries program performs.

B.2.5.4 Water Quality

B.2.5.4.1 North Shore Sanitary District (NSSD) Clavey Road Plant

In response to the USACE's request for information regarding future water quality standards, the NSSD Clavey Road plant submitted a letter informing the USACE of no future plans to affect the study area.

B.2.5.4.2 Schererville Waste Water Treatment Plant (Schererville WWTP)

In response to the USACE's request for information regarding future water quality standards, the Schererville WWTP submitted a letter informing the USACE of no future plans to affect the study area.

B.2.5.4.3 Thorncreek Basin Sanitary District

In response to the USACE's request for information regarding future water quality standards, the Thorncreek Basin Sanitary District submitted information on plans for future capital projects and nutrient levels.

B.2.5.4.4 Will County Stormwater Management

In response to the USACE's request for information regarding future water quality standards, the Will County Stormwater Management Committee submitted a letter informing the USACE of no future plans to affect the study area.

B.2.5.4.5 Indiana Department of Natural Resources (Indiana DNR

In response to the USACE's request for information regarding future water quality standards, the Indiana DNR submitted a letter regarding future construction projects along the CAWS. Also, the Indiana DNR submitted plans for environmental restoration along Lake Michigan.

B.2.5.4.6 U.S. Environmental Protection Agency (EPA)

In response to the USACE's request for information regarding future WQS, the EPA submitted information on plans for future changes to water quality standards. This includes working with the IEPA on TMDLs and making changes to limits of other pollutants.

2.5.5 CAWS Operation and Regulation

B.2.5.5.1 Federal Emergency Management Agency (FEMA)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, FEMA submitted a letter informing the USACE of no future plans to affect the study area.

B.2.5.5.2 Illinois State Water Survey (ISWS)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, the ISWS submitted information on current projects or research ongoing in the study area. The projects listed ranged from monitoring Lake Michigan levels to climate forecasting.

B.2.5.5.3 Indiana Department of Environmental Management (IDEM)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, the IDEM submitted a letter informing the USACE of no future plans affecting the CAWS.

B.2.5.5.4 Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, the MWRDGC submitted information on plans for future capital projects. The projects listed ranged from maintenance on existing facilities to habitat restoration projects.

B.2.5.5.5 U.S. Environmental Protection Agency (EPA)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, the EPA submitted information on plans for changes to the CWA and to the NPDES permit system.

B.2.5.5.6 Illinois Environmental Protection Agency (IEPA)

In response to the USACE's request for information regarding future CAWS operation and regulation projects, the IEPA submitted information on TMDL allowances for the NBCR and Lake Michigan beaches.

B.2.5.6 Transportation

B.2.5.6.1 Chicago Metropolitan Area Planning Commission (CMAPC)

In response to the SACE's request for information regarding future transportation projects, the CMAPC submitted information on plans for future capital projects. The projects listed ranged from new bridges to resurfacing of roadways. The information submitted does not affect the GLMRIS study at this time.

B.2.5.6.2 Illinois Department of Transportation (IDOT)

In response to the USACE's request for information regarding future transportation projects, IDOT submitted information on plans for future capital projects and shared concerns about future stormwater management issues.

B.2.5.6.3 City of Chicago Department of Transportation (CDOT)

In response to the USACE's request for information regarding future transportation projects, CDOT submitted information on plans for future capital projects improving the local area transportation system.

B.2.5.6.4 Indiana Department of Transportation (INDOT)

In response to the USACE's request for information regarding future transportation projects, INDOT submitted information on plans for future bridge building and restoration along portions of the CAWS.

B.2.5.6.5 Northwest Indiana Regional Planning Commission (NIRPC)

In response to the USACE's request for information regarding future transportation projects, the NIRPC submitted information on plans for future capital projects.

B.2.5.6.6 Ports of Indiana (PoI)

In response to the USACE's request for information regarding future transportation projects, the PoI submitted information on impacts of waterborne shipping to the Lake Michigan shoreline.

B.2.5.6.7 U.S Department of Transportation (DOT)

In response to the USACE's request for information regarding future transportation projects, the DOT submitted information on future capital rail projects and future freight demands for the railroads and maritime shippers.

B.2.5.6.8 United States Coast Guard (USCG)

In response to the USACE's request for information regarding future transportation projects, the USCG submitted information on current ballast water standards with no current plans to change them.

B.3 REFERENCES

2011 Asian Carp Monitoring and Rapid Response Plan Interim Summary Reports. 2012. Monitoring and Rapid Response Group. Http://www.asiancarp.us/documents/mrrpinterimsummaryreports.pdf.

Alp, E., and C. S. Melching (2009), Evaluation of the Duration of Storm Effects on In-Stream Water Quality, Journal of Water Resources Planning and Management, 135(2), 107–116, doi:10.1061/(ASCE)0733-9496(2009)135:2(107).

Ambrose, R.B., Wool, T.A., Connolly, J.P., and Schanz, R.W. 1988. WASP4, A Hydrodynamic and Water Quality Model—Model Theory, User's Manual, and Programmer's Guide, U.S. Environmental Protection Agency, EPA/600/3-87-039, Athens, Ga.

Butcher, G. (2007) Common birds in decline, a state of the birds report. *Audubon* 109: 58–60.
Hoffmeister, D.F. 1989. Mammals of Illinois. University of Illinois Press.

Butts, T.A., et al. 1983. *The Effects of Lake Michigan Discretionary Diversion Strategies on Illinois Waterway Dissolved Oxygen Resources*. Illinois Department of Energy and Natural Resources, State Water Survey Division, Peoria, Illinois. http://www.isws.illinois.edu/pubdoc/CR/ISWSCR-324.pdf.

CDM (Camp, Dresser, and McKee, Inc.). 2004. *Chicago Area Waterway System Use Attainability Analysis Draft Report*.
http://www.csu.edu/cerc/documents/ChicagoAreaWaterwaySystemUseAttainabilityAnalysisUAA-November2004.pdf.

CDM (2005), Collection and Analysis of Sediment Samples From the South Fork South Branch, Chicago River, US Army Corps of Engineers.

Collier, D., and S. Cieniawski (2003), October 2000 and August 2002 Survey of Sediment Contamination in the Chicago River - Chicago, Illinois, U.S. Environmental Protection Agency Great Lakes National Program Office. [online] Available from: http://www.epa.gov/glnpo/sediment/ChgoRvr/index.html

Corsi, S. R., D. J. Graczyk, S. W. Geis, N. L. Booth, and K. D. Richards (2010), A Fresh Look at Road Salt: Aquatic Toxicity and Water-Quality Impacts on Local, Regional, and National Scales, Environmental Science & Technology, 44(19), 7376–7382, doi:10.1021/es101333u.

Di Toro, D. M. and Fitzpatrick, J. 1993. Chesapeake Bay Sediment Flux Model. HydroQual, Inc. Mahwah, N.J. Prepared for U.S. Army Engineer Waterway Experiment Station, Vicksburg, Miss. Contract Report EL-93-2.

Edsall, T.A. 1998. Great Lakes. Pp. 219-226 in Mac, M. J., P. A. Opler, C. E. Puckett Haecker, and P. D. Doran (eds.). Status and trends of the nation's biological resources. Vol. 2. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA. 436 pp.

HDR (2012), Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins in the Chicago Area Waterway System: Technical Report Appendix to the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative, [online] Available from: http://www.glc.org/caws/pdf/FinalHDRAppendix12512.pdf

Hoffmeister, D.F. 1989. Mammals of Illinois. University of Illinois Press.

Hubbs, C.L., K.F. Lagler. 1958. Fishes of the Great Lakes Region. The University of Michigan

Hubbs, C.L. and K.F. Lagler. 2004. Fishes of the Great Lakes region (rev ed.). University of Michigan Press, Ann Arbor, MI.

Huff, F. A. and J. R. Angel, 1989. Frequency Distributions of Heavy Rainstorms in Illinois (Circular 172). Illinois State Water Survey. This is a condensed version of Bulletin 70.

Huff, F. A. and J. R. Angel, 1992. Rainfall Frequency Atlas of the Midwest (Bulletin 71). Illinois State Water Survey.

IDEM (2012a), 2012 303(d) List of Impaired Waters Revised and Submitted to U.S. EPA on December 28, 2012 as an Addendum to IDEM's 2012 Integrated Report, Indiana Department of Environmental Management. [online] Available from: http://www.in.gov/idem/nps/2647.htm

IDEM (2012b), Northwest Indiana Criteria Pollutants Air Quality Trends Analysis Report (1980-2010), Indiana Department of Environmental Management, Office of Air Quality. [online] Available from: http://www.in.gov/idem/6784.htm

IEPA (Illinois Environmental Protection Agency). 2012. *Illinois Integrated Water Quality Report and Section 303(d) List; Water Resource Assessment Information and List of Impaired Waters*. Bureau of Water. http://www.epa.state.il.us/water/tmdl/303-appendix/2012/iwq-report-surface-water.pdf.

Kelly, W. R., S. V. Panno, and K. C. Hackley (2009), Impacts of Road Salt on Water Resources in the Chicago Region, vol. 5. [online] Available from: http://opensiuc.lib.siu.edu/ucowrconfs 2009/5

LimnoTech. 2010. *Chicago Area Waterway System Habitat Evaluation and Improvement Study: Habitat Evaluation Report*.
http://www.mwrd.org/pv_obj_cache/pv_obj_id_35725F1D00642DDDC82B6B4A94D35C0BBCFEA700/filename/Habitat_Evaluation_Report_FINAL_1-4-10.pdf.

Melching, C.S., Alp, E., and Ao, Y., 2010. Development of Integrated Strategies to Meet Proposed Dissolved Oxygen Standards for the Chicago Waterway System, Institute for Urban Environmental Risk Management Technical Report No. 20, Marquette University, Milwaukee, Wis.

Meyer, E., and J. Wernau (2012), Power plants releasing hotter water, Chicago Tribune, 20th August. [online] Available from: http://articles.chicagotribune.com/2012-08-20/news/ct-met-nuclear-water-20120820_1_power-plants-midwest-generation-plant-operators (Accessed 12 December 2012)

Metropolitan Water Reclamation District of Greater Chicago Research and Development Department. 2007. A study of the benthic macroinvertebrate community in selected Chicago metropolitan area waterways during 2005. EA project 61755.01.

Mierzwa, K. 2000. Amphibian and reptile habitat in the Chicago wilderness region: savannas and woodlands. Online publication: http://kmier.net/ecology/publications/. Accessed 12/18/2013.

MWRDGC (Metropolitan Water Reclamation District of Greater Chicago). 2006. *Ambient Water Quality Monitoring in the Chicago, Calumet, and Des Plaines River Systems: A Summary of Biological, Habitat, and Sediment Quality During 2006*.

MWRDGC (2008a), Ambient Water Quality Monitoring in the Chicago Area Waterway System: A Summary of Biological, Habitat, and Sediment Quality Between 2001 and 2004, Metropolitan Water Reclamation District of Greater Chicago.

MWRDGC (2008b), Ambient Water Quality Monitoring in the Chicago, Calumet, and Des Plaines River Systems: A Summary of Biological, Habitat, and Sediment Quality During 2005, Metropolitan Water Reclamation District of Greater Chicago.

MWRDGC (2008c), Description of the Chicago Waterway System for the Use Attainability Analysis, Metropolitan Water Reclamation District of Greater Chicago.

MWRDGC. 2010. "Contract Plans for Stop Logs and Diversion Pumps at Wilmette Pumping Station and Evanston Pump Station Rehabilitation." Contract 06-023-3P.

MWRDGC (2011a), Ambient Water Quality Monitoring in the Chicago, Calumet, and Des Plaines River Systems: A Summary of Biological, Habitat, and Sediment Quality During 2007, Metropolitan Water Reclamation District of Greater Chicago.

MWRDGC (2011b), 2010 Annual Summary Report: Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago, Report No. 11-59.

MWRDGC (2012), Outfalls Along Waterways, Metropolitan Water Reclamation District of Greater Chicago. [online] Available from: https://www.mwrd.org/pv_obj_cache/pv_obj_id_E30761980284E6D0F3E5A96284549871D87C0000/filename/Outfalls_Along_Waterways.pdf

Panzer, R., K. Gnaedinger, and G. Derkovitsz. The conservative prairie and savanna insects of the Chicago Wilderness Region. 2006. Northeastern Illinois University, updated Apr. 2009. http://www.neiu.edu/~cwinsect/index.html. Accessed 12/18/2013.

"Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3.0, G. M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, NOAA, National Weather Service, Silver Spring, Maryland, 2006.

Over, Thomas, David Soong, and T-Y Su, "The Effect of Urbanization on Peak Streamflows in Northeastern Illinois," Illinois Water 2012, Champaign, IL 2012.

Panzer, R., K. Gnaedinger, and G. Derkovitsz. 2006. The conservative prairie and savanna insects of the Chicago Wilderness Region. Northeastern Illinois University, updated Apr. 2009. http://www.neiu.edu/~cwinsect/index.html. Accessed 12/18/2013.

Pope, C.H. 1944. Amphibians and reptiles of the Chicago area. Chicago Natural History Museum Press, Chicago, IL.

Sanborn, C.C. 1925. Mammals of the Chicago area. Field Museum of Natural History, Zoology leaflet 8, pp. 129-151.

Schilling, T. and C. Williamson. 2012. The Lake Michigan flyway: Chicagoland's role in the miracle of the bird migration. A Green Paper by the Bird Conservation Network. http://www.bcnbirds.org/greenpapers_files/GPflyway.html. Accessed 12/18/2013.

Semlitsch, R.D. and J.R. Bodie. 2003. Biological criteria for buffer zones around wetland and riparian habitats for amphibians and reptiles. Conservation Biology. 17(5) p. 1219-1228.

Smiley, C.W. 1882. Changes in the Fisheries of the Great Lakes During the Decade, 1870 - 1880. Bulletin of the US Fish Commission. Vol.I for 1881.

Theiling CH, Korschgen C, DeHaan H, Fox T, Rohweder J, and Robinson L. 2000. Habitat Needs Assessment for the Upper Mississippi River System: Technical Report. U.S. Geological Survey, Upper Midwest Environmental Science Center, La Crosse, Wisconsin. Contract report prepared for the U.S. Army Corps of Engineers, St. Louis District, St. Louis, Missouri. 248 pp. + Appendices A to AA. www.umesc.usgs.gov/habitat_needs_assessment/emp_hna.html

USACE 2005. U.S. Army Corps of Engineers, Chicago District. Known and Potential Environmental Effects of Oil and Gas Drilling Activity in the Great Lakes. 2005.

USEPA 2006. U.S. Environmental Protection Agency. State of the Great Lakes, What is the State of Great Lakes Birds?. EPA 905-F-06-907, IISG-05-33. February 2006.

USEPA 2011. U.S. Environmental Protection Agency, Great Lakes National Program Office. Invasive Species. http://www.epa.gov/glnpo/invasive/ 2011.

USEPA 2012a, Grand Calumet River Legacy Act Cleanup: Grand Calumet River Area of Concern, U.S. Environmental Protection Agency. [online] Available from: http://www.epa.gov/glla/grandcal/index.html (Accessed 3 January 2013)

USEPA 2012b, Roxanna Marsh Legacy Act Cleanup: Grand Calumet River Area of Concern, U.S. Environmental Protection Agency. [online] Available from: http://www.epa.gov/glla/roxanna/index.html (Accessed 3 January 2013)

U.S. National Archives and Records Administration (2010), Approval and Promulgation of Implementation Plans and Designation of Areas for Air Quality Planning Purposes; Indiana; Redesignation of Lake and Porter Counties to Attainment for Ozone, Federal Register, 75(90). [online] Available from: http://www.gpo.gov/fdsys/pkg/FR-2010-05-11/html/2010-11009.htm

USACE (U.S. Army Corps of Engineers). 2004. *Total Maximum Daily Load (TMDL) Study for Grand Calumet River/Indiana Harbor Canal Watershed in Lake County, Indiana*.

CAWS SPECIES LISTS

Species 1: Macroinvertebrates Collected from the Calumet River System by the MWRDGC in 2005

Taxa	Hester-Dendy (HD)	Petite Ponar (PP)	%HD	%PP
Ablabesymia mallochi	7.2	7.2	0.01%	0.10%
Ablabesymia janta	98.7	-	0.10%	0.00%
Argia	5.4	-	0.01%	0.00%
Bithynia tentaculata	3.6	-	0.00%	0.00%
Caecidotea	7.2	-	0.01%	0.00%
Chironomus	7.2	21.5	0.01%	0.29%
Coelotanypus	-	7.2	0.00%	0.10%
Collembola	9	-	0.01%	0.00%
Corbicula fluminea	77.2	14.4	0.08%	0.20%
Cricotopus bicinctus grp.	27	-	0.03%	0.00%
Cryptochironomus	-	14.4	0.00%	0.20%
Cyrnellus fraternus	663.8	-	0.67%	0.00%
Dicrotendipes modestus	-	28.7	0.00%	0.39%
Dicrotendipes simpsoni	3677.7	14.4	3.73%	0.20%
Dicrotendipes neomodestus	100.5	7.2	0.10%	0.10%
Dreissena polymorpha	83,929	2533.3	85.01%	34.67%
Enallagma	5.4	-	0.01%	0.00%
Ferrissia	741	-	0.78%	0.00%
Gammarus	5170.4	14.4	5.24%	0.20%
Glyptotendipes	244	-	0.25%	0.00%
Helisoma	1.8	-	0.00%	0.00%
Hyalella azteca	109.4	-	0.11%	0.00%
Hydra	656.6	-	0.67%	0.00%
Hydroptila	-	7.2	0.00%	0.10%
Mooreobdella microstoma	5.4	-	0.01%	0.00%
Nanocladius distinctus	1189.5	-	1.20%	0.00%
Oligochaeta	1020.8	4148.1	1.03%	56.78%
Parachironomus	39.5	7.2	0.04%	0.10%
Parakiefferiella	-	14.4	0.00%	0.20%
Paratanytarsus	-	21.5	0.00%	0.29%
Physa	12.6	-	0.01%	0.00%
Pisidium	-	21.5	0.00%	0.29%
Plumatella	-	7.2	0.00%	0.10%
Polypedilum halterale grp.	-	14.4	0.00%	0.20%
Porifera	3.6	-	0.00%	0.00%
Procladius	61	380.4	0.06%	5.21%
Psectrocladius	-	21.5	0.00%	0.29%
Sisyridae	1.8	-	0.00%	0.00%
Stenochironomus	292.4	-	0.30%	0.00%
Turbellaria	184.8	-	0.19%	0.00%
Xenochironomus xenolabis	374.9	-	0.38%	0.00%

Species 2: Macroinvertebrates Collected from the NSC in the Chicago River System by the MWRDGC in 2005

Taxa	Hester-Dendy (HD)	Petite Ponar (PP)	%HD	%PP
Ablabesymia annulata	50.2	-	0.11%	0.00%
Ablabesymia mallochi	-	7.2	0.00%	0.00%
Baetis intercalaris	9	-	0.02%	0.00%
Caecidotea	523.8	100.5	1.15%	0.05%
Cercaclea maculata	3.6	-	0.01%	0.00%
Chironomus	204.5	1873.1	0.45%	0.88%
Cladopelma	26.9	947.4	0.06%	0.44%
Cricotopus bicinctus grp.	75.3	-	0.17%	0.00%
Cricotopus sylvestric grp.	118.4	215.3	0.26%	0.10%
Cricotopus tremulus grp.	9	-	0.02%	0.00%
Cryptochironomus	9	71.8	0.02%	0.03%
Crypto tendipes	12.6	-	0.03%	0.00%
Dicrotendipes fumidus	841.4	-	1.85%	0.00%
Dicrotendipes modestus	647.6	258.3	1.43%	0.12%
Dicrotendipes simpsoni	9761.4	430.5	21.50%	0.20%
Dreissena polymorpha	-	7.2	0.00%	0.00%
Enallagma	3.6	-	0.01%	0.00%
Gammarus	247.6	114.8	0.55%	0.05%
Glyptotendipes	3399.7	86.2	7.49%	0.04%
Gyraulus	46.6	-	0.10%	0.00%
Helisoma	1.8	-	0.00%	0.00%
Helobdella stagnalis	55.6	136.4	0.12%	0.06%
Helobdella triserialis	3.6	-	0.01%	0.00%
Hyalella azteca	1175.1	78.9	2.59%	0.04%
Hydra	495.1	-	1.09%	0.00%
Menetus dilatatus	5.4	-	0.01%	0.00%
Mooreobdella microstoma	-	21.5	0.00%	0.01%
Nanocladius distinctus	204.5	-	0.45%	0.00%
Oligochaeta	14,951.50	205,330.80	32.94%	96.27%
Parachironomus	373.1	222.5	0.82%	0.10%
Parakiefferiella	32.3	14.4	0.07%	0.01%
Paratanytarsus	62.8	71.8	0.14%	0.03%
Phaenopsectra obediens grp.	12.6	14.4	0.03%	0.01%
Phaenopsectra punctipes grp.	80.7	14.4	0.18%	0.01%
Physa	3.6	-	0.01%	0.00%
Pisidium	-	28.7	0.00%	0.01%
Polypedilum flavum	-	7.2	0.00%	0.00%
Polypedilum halterale grp.	-	689	0.00%	0.32%
Polypedilum illinoense	30.5	-	0.07%	0.00%
Procladius	86.1	947.3	0.19%	0.44%
Psectrotanypus	-	71.8	0.00%	0.03%
Sphaerium	-	366	0.00%	0.17%
Tanypus	-	7.2	0.00%	0.00%
Tanytarsus	154.3	947.3	0.34%	0.44%
Thienemannimyia grp.	16.2	-	0.04%	0.00%
Turbellaria	11,648.80	200.9	25.66%	0.09%

Species 3: Macroinvertebrates Collected from the CSSC in the Chicago River System by the MWRDGC in 2005

Taxa	Hester-Dendy (HD)	Petite Ponar (PP)	%HD	%PP
Ablabesymia janta	134.6	-	0.58%	0.00%
Cladotanytarsus mancus grp.	17.9	-	0.08%	0.00%
Corbicula fluminea	53.8	150.7	0.23%	0.75%
Cricotopus bicinctus grp.	5.4	-	0.02%	0.00%
Cricotopus sylvestrus grp.	3.6	-	0.02%	0.00%
Cryptochironomus	-	71.7	0.00%	0.36%
Cyrnellus fraternus	138.1	-	0.60%	0.00%
Dicrotendipes neomodestus	7.2	-	0.03%	0.00%
Dicrotendipes simpsoni	3017.5	-	13.02%	0.00%
Dubiraphia	-	7.2	0.00%	0.04%
Ferrissia	1718.7	-	7.41%	0.00%
Gammarus	16.1	-	0.07%	0.00%
Glyptotendipes	12.6	-	0.05%	0.00%
Helisoma	14.4	-	0.06%	0.00%
Helobdella triserialis	5.4	-	0.02%	0.00%
Hyalella azteca	366	7.2	1.58%	0.04%
Hydra	208.1	-	0.90%	0.00%
Hydropsyche	5.4	-	0.02%	0.00%
Hydroptila	1.8	-	0.01%	0.00%
Musculium	48.5	-	0.21%	0.00%
Nanocladius distinctus	134.6	-	0.58%	0.00%
Oligochaeta	11,993.10	19,656.80	51.74%	98.45%
Parachironomus	39.5	-	0.17%	0.00%
Physa	25.1	-	0.11%	0.00%
Plumatella	1.8	-	0.01%	0.00%
Polypedilum flavum	5.4	-	0.02%	0.00%
Polypedilum halterale grp.	-	7.2	0.00%	0.04%
Polypedilum scalaenum grp.	5.4	-	0.02%	0.00%
Procladius	1.8	64.6	0.01%	0.32%
Pseudochironomus	179.4	-	0.77%	0.00%
Stenacron	21.5	-	0.09%	0.00%
Stenochironomus	48.4	-	0.21%	0.00%
Thienemannimyia grp.	1.8	-	0.01%	0.00%
Thienemannimyia similis	5.4	-	0.02%	0.00%
Turbellaria	4894.1	-	21.11%	0.00%
Urnatella gracilis	1.8	-	0.01%	0.00%
Xenochironomus xenolabis	44.9	-	0.19%	0.00%

Species 4: Terrestrial Insects Likely to Inhabit Urban Areas of the CAWS

Order	Family	Common (Family)	SubFamily	Species
Homoptera	Cicadellidae	Leafhoppers	Megophthalminae	*Agallia constricta*
Homoptera	Cicadellidae	Leafhoppers	Megophthalminae	*Agalliopsis novella*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Amblysellus curtisii*
Homoptera	Cicadellidae	Leafhoppers	Deltocephaline	*Bandara parallela*
Homoptera	Cicadellidae	Leafhoppers	Athysaninae	*Commellus comma*
Homoptera	Cicadellidae	Leafhoppers	Cicadellinae	*Draeculacephala antica*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Endria (Amplicephalus) inimica*
Homoptera	Cicadellidae	Leafhoppers	Cicadellinae	*Graphocephala coccinea*
Homoptera	Cicadellidae	Leafhoppers	Gyponinae	*Gyponana octolineata serpenta*
Homoptera	Cicadellidae	Leafhoppers	Deltocephaline	*Hecalus viridis*
Homoptera	Cicadellidae	Leafhoppers	Idiocerinae	*Idiocerus crataegi*
Homoptera	Cicadellidae	Leafhoppers	Idiocerinae	*Idiocerus ramentosus*
Homoptera	Cicadellidae	Leafhoppers	Idiocerinae	*Idiocerus raphus*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Idiodonus kennecottii*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Latalus missellus*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Latalus sayii*
Homoptera	Fulgoroidea	Planthoppers	Delphacinae	*Liburniella ornata*
Homoptera	Cicadellidae	Leafhoppers	Macropsinae	*Macropis basalis*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Macrosteles variata grp.*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Osbornellus jucundus*
Coleoptera	Silphidae	Carrion Beetles	-	*Necrophila americana*
Homoptera	Cicadellidae	Leafhoppers	Coelidiinae	*Neocoelidia tumidifrons*
Homoptera	Cicadellidae	Leafhoppers	Cicadellinae	*Neokolla hieroglyphica*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Osbornellus sp.*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Menosoma cincta*
Homoptera	Cicadellidae	Leafhoppers	Aphrodinae	*Platymetopius vitellinus*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Polyamia weedi*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Prescottia lobata*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Psammotettix knullae*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Sanctanus cruciatus*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Scaphoideus sp.*
Homoptera	Cicadellidae	Leafhoppers	Deltocephalinae	*Sorhoanus flavovirens*
Homoptera	Cicadellidae	Leafhoppers	Cicadellinae	*Tylozygus bifida*

Source: NEIU (2006).

Species 5: Fish Species Collected by Illinois DNR, USFWS, and USACE during 2011 CAWS Monitoring

Common Name	Scientific Name	Pollution Tolerance	Habitat Disturbance	Status
Alewife	*Alosa pseudoharengus*	T	T	I
Banded Killifish	*Fundulus diaphanus*	M	MT	T-IL
Bigmouth Buffalo	*Ictobius cyprinellus*	M	MT	-
Black Buffalo	*Ictiobus niger*	M	MT	-
Black Bullhead	*Ameirus melas*	M	T	-
Black Crappie	*Pomoxis nigromaculatus*	M	M	-
Blackstripe Topminnow	*Fundulus notatus*	M	MT	-
Bluegill	*Lepomis macrochirus*	M	M	-
Bluntnose Minnow	*Pimephales notatus*	T	MT	-
Bowfin	*Amia calva*	M	MT	-
Brook Silverside	*Labidesthes sicculus*	M	MT	-
Brown Bullhead	*Ameiurus nebulosus*	T	MI	-
Brown Trout	*Salmo trutta*	M	I	I
Bullhead Minnow	*Pimephales vigilax*	M	NR	-
Central Mudminnow	*Umbra limi*	M	NR	-
Channel Catfish	*Ictalurus punctatus*	M	MT	-
Chinook Salmon	*Oncorhynchus tshawytscha*	M	NR	I
Coho Salmon	*Oncorhynchus kisutch*	M	NR	I
Common Carp	*Cyprinus carpio*	T	T	-
Creek Chub	*Semotilus atromaculatus*	T	MI	-
Emerald Shiner	*Notropis atherinoides*	M	MT	-
Fathead Minnow	*Pimephales promelas*	T	T	-
Flathead Catfish	*Pylodictis olivaris*	M	MT	-
Freshwater Drum	*Aplodinotus grunniens*	M	MT	-
Ghost Shiner	*Notropis buchanani*	M	NR	-
Gizzard Shad	*Dorosoma cepedianum*	T	T	-
Golden Shiner	*Notemigonus crysoleucas*	T	T	-
Goldfish	*Carassius auratus*	T	T	I
Grass Carp	*Ctenopharyngodon idella*	M	MT	I
Grass Pickerel	*Esox americanus vermiculatus*	M	MI	-
Green Sunfish	*Lepomis cyprinella*	T	T	-
Largemouth Bass	*Micropterus salmoides*	M	M	-
Mosquitofish	*Gambusia affinis*	T	T	-
Northern Pike	*Esox lucius*	M	MI	-
Orangespotted Sunfish	*Lepomis humilis*	M	M	-
Oriental Weatherfish	*Misgurnus anguillicaudatus*	T	T	I
Pumpkinseed	*Lepomis gibbosus*	M	NR	-
Quillback	*Carpiodes cyprinus*	M	MT	-
Rainbow Smelt	*Osmerus mordax*	M	MT	-
Rainbow Trout	*Oncorhynchus mykiss*	M	I	I
River Shiner	*Notropis blennius*	M	MT	-
Rock Bass	*Ambloplites rupsetris*	M	I	-
Round Goby	*Neogobius melanostomus*	T	T	I
Sand Shiner	*Notropis stramineus*	M	MI	-
Smallmouth Bass	*Micropterus dolomieu*	M	I	-
Smallmouth Buffalo	*Ictobius bubalus*	M	MT	-
Spotfin Shiner	*Cyprinella spiloptera*	M	I	-
Spottail Shiner	*Notropis hudsonius*	M	MT	-
Spotted Sucker	*Minytrema melanops*	M	I	-
Threadfin Shad	*Dorosoma pretenense*	T	T	-

Species 5: (CONT.)

Common Name	Scientific Name	Pollution Tolerance	Habitat Disturbance	Status
Walleye	*Sander vitreus*	M	MI	-
Warmouth	*Lepomis gulosus*	M	MT	-
White Bass	*Morone chrysops*	M	MT	-
White Crappie	*Pomoxis anularis*	M	M	-
White Perch	*Morone americana*	M	NR	-
White Sucker	*Catostomus commersoni*	T	I	-
Yellow Bass	*Morone mississippiensis*	M	MT	-
Yellow Bullhead	*Ameiurus natalis*	T	MT	-
Yellow Perch	*Perca flavescens*	M	MT	-

Pollution Tolerance: (T) Tolerant, (M) Intermediate, (I) Intolerant, (NR) No Ranking
Habitat Disturbance: (T) Tolerant, (MT) Moderately Tolerant, (MI) Moderately Intolerant, (I) Intolerant, (NR) No Ranking
Status: (I) Introduced and (T-IL) Threatened Illinois.

Species 6: Amphibian Community within the Chicago and Calumet River Systems

Common Name	Scientific Name	Historical	Current	Status
Jefferson Salamander	*Ambystoma jeffersonianum*	UC	-	T-IL
Blue-Spotted Salamander	*Ambystoma laterale*	-	C	SC-IN
Spotted Salamander	*Ambystoma maculatum*	MC	UC	-
Marbled Salamander	*Ambystoma opacum*	UC	R	-
Tiger Salamander	*Ambystoma tigrinum*	MC	C	-
Southern Two-Lined Salamander	*Eurycea cirrigera*	UC	UC	-
Four-Toed Salamander	*Hemidactylium scutatum*	-	EX	T-IL
Mudpuppy	*Necturus maculosus*	C	-	T-IL; SC-IN
Eastern Newt	*Notophthalmus viridescens*	C	MC	-
Eastern Red-Backed Salamander	*Plethodon cinereus*	UC	R	-
Lesser Siren	*Siren intermedia*	UC	R	-
Northern Cricket Frog	*Acris crepitans*	UC	UC	SC-IN
American Toad	*Bufo americanus*	C	C	-
Fowler’s Toad	*Bufo fowleri*	UC	R	-
Cope’s Gray Treefrog	*Hyla chrysoscelis*	UC	UC	-
Eastern Gray Treefrog	*Hyla versicolor*	C	C	-
Spring Peeper	*Pseudacris crucifer*	C	C	-
Western Chorus Frog	*Pseudacris triseriata*	C	C	-
Bullfrog	*Rana catesbeiana*	C	C	-
Green Frog	*Rana clamitans*	C	C	-
Pickerel Frog	*Rana palustris*	UC	R	-
Northern Leopard Frog	*Rana pipiens*	C	C	SC-IN
Wood Frog	*Rana sylvatica*	C	UC	-

Historical/Current: (C) common, (MC) moderately common, (UC) uncommon, (R) rare, and (EX) Extirpated
Status: (E-IL) Endangered Illinois, (T-IL) Threatened Illinois, and (SC-IN) Species of Concern Indiana.

Species 7: Reptilian Community within the Chicago and Calumet River Systems

Common Name	Scientific Name	Historical	Current	Status
Spiny Softshell	*Apalone spinifera*	C	-	-
Snapping Turtle	*Chelydra serpentine*	C	C	-
Painted Turtle	*Chrysemys picta*	C	C	-
Spotted Turtle	*Clemmys guttata*	UC	UC	E-IL; E-IN
Blanding's Turtle	*Emydoidea blandingii*	MC	-	E-IL; E-IN
Map Turtle	*Graptemys geographica*	MC	-	-
Stinkpot	*Sternotherus odoratus*	MC	-	-
Eastern Box Turtle	*Terrapene Carolina*	C	-	-
Ornate Box Turtle	*Terrapene ornata*	UC	-	T-IL; E-IN
Six-Lined Racerunner	*Cnemidophorus sexlineatus*	UC	UC	-
Common Five-Lined Skink	*Eumeces fasciatus*	UC	-	-
Slender Glass Lizard	*Ophisaurus attenuates*	UC	UC	-
Kirtland's Snake	*Clonophis kirtlandii*	MC	-	T-IL; E-IN
Eastern Racer	*Coluber constrictor*	UC	-	-
Gray Ratsnake	*Elaphe obsolete*	UC	-	-
Western Fox Snake	*Elaphe vulpine*	C	C	-
Eastern Hog-Nosed Snake	*Heterodon platirhinos*	UC	UC	-
Milk Snake	*Lampropeltis triangulum*	C	C	-
Smooth Green Snake	*Liochlorophis vernalis*	C	-	E-IN
Northern Water Snake	*Nerodia sipedon*	C	C	-
Smooth Greensnake	*Opheodrys vernalis*	MC	-	-
Gopher Snake	*Pituophis melanoleucus*	UC	-	-
Graham's Crayfish Snake	*Regina grahamii*	UC	-	-
Queen Snake	*Regina septemvittata*	UC	-	-
Massasauga	*Sistrurus catenatus*	UC	UC	E-IL, E-IN, C-US
DeKay's Brownsnake	*Storeria dekayi*	C	C	-
Redbellied Snake	*Storeria occipitomaculata*	C	C	-
Western Ribbonsnake	*Thamnophis proximus*	UC	UC	SC-IN
Plains Gartersnake	*Thamnophis radix*	C	C	-
Common Gartersnake	*Thamnophis sirtalis*	C	C	-

Historical/Current: (C) common, (MC) moderately common, (UC) uncommon, (R) rare, and (EX) Extirpated
Status: (E-IL) Endangered Illinois, (T-IL) Threatened Illinois, (E-IN) Endangered Indiana, (SC-IN) Species of Concern Indiana, and (C-US) Federal Candidate Species.

Species 8: Avian Community within the Chicago and Calumet River Systems as Documented by the Chicago Audubon Society (2000–2010)

Common Name	Scientific Name	Resident	Migrator	Migrator Breeder	Status
American Crow	*Corvus brachyrhychos*	X			
American Goldfinch	*Carduelis tristis*	X			
American Redstart	*Setophaga ruticilla*			X	
American Robin	*Turdus migratorius*	?		X	
Bald Eagle	*Haliaeetus leucocephalus*	X			
Baltimore Oriole	*Icterus galbula*			X	
Bank Swallow	*Riparia riparia*			X	
Belted Kingfisher	*Ceryle alcyon*	X			
Black-and-White Warbler	*Mniotilta varia*		X	?	
Black-Capped Chickadee	*Parus atricapillus*	X			
Black-Crowned Night-Heron	*Dendroica virens*		X		E-IL; E-IN
Black-Throated Green Warbler	*Dendroica virens*		X		
Blue Jay	*Cyanocitta cristata*	X			
Blue-Gray Gnatcatcher	*Polioptila caerulea*			X	
Brown-Headed Cowbird	*Molothrus ater*	X		X	
Caspian Tern	*Sterna caspia*		X		
Chestnut-Sided Warbler	*Dendroica pennsylvanica*		X	?	
Chimney Swift	*Chaetura pelagica*			X	
Chipping Sparrow	*Spizella passerina*			X	
Common Grackle	*Quiscalus quiscula*	X			
Common Tern	*Sterna hirundo*		X		* E-IL
Common Yellowthroat	*Geothlyphis trichas*			X	
Cooper's Hawk	*Accipiter cooperii*	X			
Double-Crested Cormorant	*Phalacrocorax auritus*		X		
Downy Woodpecker	*Picoides pubescens*	X			
Eastern Meadowlark	*Sturnella magna*	?	X		*
Eastern Phoebe	*Sayomis phoebe*		X	?	
Eastern Wood-Pewee	*Contopus virens*			X	
Forster's Tern	*Sterna forsteri*			X	E-IL
Golden-Winged Warbler	*Vermivora chrysoptera*			X	+
Gray Catbird	*Dumetella carolinensis*			X	
Great Blue Heron	*Ardea herodias*			X	
Great Crested Flycatcher	*Myiarchus crinitus*			X	
Great Egret	*Ardea alba*		X		SC-IN

Species 8: (CONT.)

Common Name	Scientific Name	Resident	Migrator	Migrator Breeder	Status
Green Heron	*Butorides virescens*		X		
Herring Gull	*Larus argentatus*	X			
House Finch	*Carpodacus mexicanus*	X			
House Wren	*Troglodytes aedon*			X	
Indigo Bunting	*Passerina cyanea*			X	
Little Blue Heron	*Egretta caerulea*		X		* E-IL
Mallard	*Anas platyrhynchos*	X		X	
Mourning Dove	*Zenaida macroura*		X		
Northern Cardinal	*Cardinalis cardinalis*	X			
Northern Flicker	*Colaptes auraus*	?		X	
Northern Parula	*Parula Americana*		X		
Northern Rough-Winged Swallow	*Stelgidopteryx serripennis*			X	
Red-Bellied Woodpecker	*Melanerpes carolinus*	X			
Red-Eyed Vireo	*Vireo olivaceus*			X	
Red-Headed Woodpecker	*Melanerpes erythrocephalus*	X			+
Red-Tailed Hawk	*Buteo jamaicensis*	X			
Red-Winged Blackbird	*Agelaius phoeniceus*	?		X	
Ring-Billed Gull	*Larus delawarensis*	X			
Rose-Breasted Grosbeak	*Pheucticus ludovicianus*			X	
Ruby-Crowned Kinglet	*Regulus satrapa*		X		
Scarlet Tanager	*Piranga oliviciea*			X	
Song Sparrow	*Melospiza melodia*	X			
Tennessee Warbler	*Vermivora peregrina*		X		
Tree Swallow	*Tachycineta bicolor*		X		
White-Breasted Nuthatch	*Sitta carolinensis*	X			
White-Crowned Sparrow	*Zonotrichia leucophrys*		X		
White-Throated Sparrow	*Zonotrichia albicollis*		X		
Winter Wren	*Troglodytes troglodytes*		X	?	
Wood Thrush	*Hylocichla mustelina*			X	+
Yellow-Rumped Warbler	*Dendroica coronata*		X		

Status: (+) National Audubon Society Species of Concern, (*) National Audubon Society Common Declining Birds, (E-IL) Endangered Illinois, (E-IN) Endangered Indiana, (SC-IN) Species of Concern Indiana.

Species 9: Mammalian Community within the Chicago and Calumet River Systems

Common Name	Scientific Name	Status
Virginia Opossum	*Didelphis virginiana*	C
Northern Short-Tailed Shrew	*Blarina brevicauda*	C
Least Shrew	*Cryptotis parva*	UC
Masked Shrew	*Sorex cinereus*	C
Eastern Mole	*Scalopus aquaticus*	C
Star-Nosed Mole	*Condylura cristata*	C
Big Brown Bat	*Eptesicus fuscus*	C
Silver-Haired Bat	*Lasionycteris noctivagans*	C
Red Bat	*Lasiurus borealis*	C; SC-IN
Hoary Bat	*Lasiurus cinereus*	MC; SC-IN
Little Brown Myotis	*Myotis lucifugus*	C
Indiana Myotis	*Myotis sodalis*	E-IL; E-US
Evening Bat	*Nycticeius hurneralis*	UC
Eastern Pipestrelle	*Pipistrellus subflavus*	UC
Eastern Cottontail	*Sylvilagus floridanus*	C
Beaver	*Castor canadensis*	MC
Meadow Vole	*Microtus pennsylvanicus*	C
Woodland Vole	*Microtus pinetorum*	C
Pine Vole	*Pitymys pinetorum*	UC
House Mouse	*Mus musculus*	I
Muskrat	*Ondatra zibethicus*	C
White-Footed Mouse	*Peromyscus leucopus*	C
Deer Mouse	*Peromyscus maniculatus*	UC
Norway Rat	*Rattus norvegicus*	I
Black Rat	*Rattus rattus*	I
Western Harvester Mouse	*Reithrodontomys megalotis*	MC
Southern Bog Lemming	*Synaptomys cooperi*	MC
Porcupine	*Erethizon dorsatum*	EX
Southern Flying Squirrel	*Glaucomys volans*	C
Woodchuck	*Marmota monax*	C
Gray Squirrel	*Sciurus carolinensis*	C
Fox Squirrel	*Sciurus niger*	C
Franklin's Ground Squirrel	*Spermophilus franklinii*	MC; T-IL; E-IN
Thirteen-Lined Ground Squirrel	*Spermophilus tridecemlineatus*	C
Eastern Chipmunk	*Tamias striatus*	C
Red Squirrel	*Tamiascurus hudsonicus*	UC
Meadow Jumping Mouse	*Zapus hudsonius*	MC
Coyote	*Canis latrans*	C
Gray Wolf	*Canis lupus*	EX; T-IL; E-US
Gray Fox	*Urocyon cinereoargenteus*	MC
Red Fox	*Vulpes vulpes*	C
Mountain Lion	*Felis concolor*	EX
Canada Lynx	*Lynx canadensis*	EX
Bobcat	*Lynx rufus*	UC
River Otter	*Lontra canadensis*	UC; SC-IN
American Marten	*Martes Americana*	EX
Fisher	*Martes pennant*	EX
Striped Skunk	*Mephitis mephitis*	C
Ermine	*Mustela ermine*	PO
Long-Tailed Weasel	*Mustela frenata*	C
Least Weasel	*Mustela nivalis*	UC

Species 9: (CONT.)

Common Name	Scientific Name	Status
American Mink	*Mustela vison*	C
Eastern Spotted Skunk	*Spilogale putorius*	PO
American Badger	*Taxidea taxus*	MC; SC-IN
Raccoon	*Procyon lotor*	C
Black Bear	*Ursus americanus*	EX
American Bison	*Bison bison*	EX
American Elk	*Cervus elaphus*	EX
Eastern White-Tailed Deer	*Odocoileus viginianus*	C

Status: (C) common, (MC) moderately common, (UC) uncommon, (I) Introduced, (EX) Extirpated, (E-IL) Endangered Illinois, (T-IL) Threatened Illinois, (E-IN) Endangered Indiana; (SC-IN) Species of Concern Indiana; (E-US) Federally Endangered, and (PO) Possible Occurrence.

ATTACHMENT A

AQUATIC HABITAT TYPES AND METHODOLOGY

The GLMRIS Report

Attachment A: GLMRIS Aquatic Habitat Types and Methodology

USACE
1/6/2014

Introduction

This section presents the development and results of the GLMRIS Aquatic Habitat Types delineation. The results were used in the Risk Assessment.

I. Habitat Types within River/Stream Channel

Large and Medium Order Rivers (non-wadable):
When two sixth order rivers or streams combine they form a seventh order river. These are large order rivers. These form the main networks of freshwater drainage within North America. The largest order river within North America is the Mississippi River (tenth order). Large order rivers are considered between seventh and twelfth order rivers. When two third order streams combine, a fourth order stream/river is formed, these are referred to as medium order rivers and streams. These form further down the watershed, typically right before one watershed combines with the next. Medium order streams and rivers are classified between fourth and sixth order.

1. **High Gradient Large/Medium Order Rivers**:
These are large order rivers that exhibit a steep slope and rapid flow of water.

2. **Low Gradient Large/Medium Order Rivers**:
These are large order rivers that exhibit a subtle slope resulting in a flatter stream bed and sluggishly moving water.

Small Order Streams:
These are the smallest waterways. They are first to third order streams, commonly referred to as headwater streams. They form in the upper reaches of the watersheds and are the most numerous flowing waterway type. These streams then flow or feed into medium order streams and rivers.

3. **High Gradient Small Order Streams:**
Streams that exhibit a steep slope and rapid flow of water.

4. **Low Gradient Small Order Streams:**
Streams that exhibit a subtle slope resulting in a flatter stream bed and sluggishly moving water.

5. **Intermittent (seasonal) Streams:**
Streams that exhibit periodic flow, usually as a result of spring thaw or a flood event.

II. Habitat Types Adjacent to River/Stream Channel

Floodplain Herbaceous Marsh:
Based on the FEMA 100 year floodplain map, any area within the floodplain not forested or with a high coverage of shrubs will be considered to be a Floodplain herbaceous marsh. A herbaceous marsh is also assumed to exhibit the required hydrology to sustain hydric herbaceous vegetation. NLCD No.95 states that emergent herbaceous wetlands are where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

6. Perennial Floodplain Herbaceous Marsh:
Marshes that exhibit year round surface water or soil saturation.

7. Annual (Seasonal) Floodplain Herbaceous Marsh:
Marshes that exhibit periodic surface water or soil saturation, usually as a result of a seasonal flood event.

Floodplain Forest
Based on the FEMA 100 year floodplain map, or other similar designations, any area within the floodplain that is forested or has a high coverage of shrubs will be considered a Floodplain Forest. NLCD No.90 states that woody wetlands are where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is at least periodically saturated with or covered with water.

8. Perennial Floodplain Forest:
Forested floodplains that exhibit year round surface water or soil saturation. Traditionally been referred to as backwater sloughs or swamps.

9. Annual (Seasonal) Floodplain Forest:
Forested Floodplains that exhibit periodic surface water or soil saturation, usually as a result of a seasonal flood event.

Connected Inland Lakes
Bodies of water that are connected to a floodplain by either draining into an adjacent stream or river or receive floodwaters by over land flow.

10. Connected Lakes Open water:
These areas are considered to be far enough away from the shore to support little to no vegetation. In some instances, the open water may start a few feet from the shore, in other instances, open water may be a distance from the shoreline. Larger lakes may have to be verified visually through inspection of aerials, however, open water is assumed to occur twenty feet from the shore of connected lakes. NLCD No. 11 states that open water

are areas of open water, generally with less than 25% cover of vegetation or soil.

11. Connected Lakes Littoral Zone:
The littoral zone of a lake occurs along the shoreline and typically is vegetated with either floating or emergent plant species. The littoral zone is assumed to occur from the shoreline to twenty feet out. Larger connected lakes and reservoirs may need to be visually inspected to ensure the validity of this assumption.

III. Habitat Types of the Great Lakes

Coastal Zone

This area encompasses the shoreline (e.g., littoral zone), where there is dynamic wave and sand movement and extends from the exposed substrate out into the open water portion of the lakes. The shoreline can support a variety of aquatic obligate species. The area from the shoreline to 12 feet in depth can support emergent wetlands and floating aquatic vegetation that can combine with algae to form floating mats. This area is commonly referred to as the Nearshore, but for the purposes of this study effort, this area is grouped into the coastal zone category.

12. Coastal Shoreline:
This area is comprised of substrate deposited or revealed by wind, wave and lake current action. This area is subject to high degrees of disturbance, such as, wind, wave and ice movement. Disturbance within this area heavily influences the potential colonization and further establishment of plants. In general, the vegetation communities associated with this area are typically formed from the initial establishment of beach grass. Succession of the plant community is then dependent on the timing and severity of further disturbance events. Common names associated with this area include beach, rocky shoreline and sand dunes or dunes.

13. Coastal Nearshore:
This area is located adjacent to the Coastal Shoreline area, extending out into the lakes, up to 12 feet in depth. This habitat type contains a significant coverage of aquatic plant species along with a diverse array of physical substrate types. Coastal wetlands can be found within rivermouth estuaries and sheltered areas (e.g., harbors or bays). This type includes sandy shoals, rocky shoals and clay shoals.

Open Water Zone

Extending beyond the coastal zone, this area is non-vegetated and can reach great depths.

14. Open Water:

This habitat type covers the majority of the lakes, located 13 feet deep to the greatest depths of Lake Superior.

IV. Habitat Type and Associated ANS Species

Table 1. Habitat Type and Associated ANS Species

	River/Stream Channel Habitat					Floodplain Habitat				Connected Inland Lakes		Great Lakes		
	L/M High Grad	L/M Low Grad	Small High Grad	Small Low Grad	Intermittent	Perennial Marsh	Annual Marsh	Perennial Forest	Annual Forest	Open Water	Littoral Zone	Coastal Shoreline	Coastal Nearshore	Open Water
WaterChestnut	May be suitable in slow water	May be suitable in slow water	Not likely suitable	Suitable	May be suitable	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
Alewife (Spawning)	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	May be suitable	Suitable	Suitable	Not likely suitable
Adults	Not likely suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	Suitable	Suitable
BigheadCarp (Spawning)	Suitable	Suitable if high flow	Not likely suitable (needs long streams)	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable
Adults	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable
BlackCarp (Spawning)	Suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable
Adults	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	Suitable	Suitable	Suitable
BloodRedShrimp	May be suitable	Suitable over hard substrate	Not likely suitable	May be suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable

Table 1. Habitat Type and Associated ANS Species

BluebackHerring (Spawning)	Suitable	Suitable	Suitable	Suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable
Adults	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	Suitable	Suitable <100 m
CubanBulrush	May be suitable on channel edge in slow water	May be suitable on channel edge	Suitable on channel edge	Suitable on channel edge	May be suitable	Suitable	May be suitable if hydrology is adequate	Suitable	May be suitable if hydrology is adequate	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
CyclotellaCryptic	May be suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	May be suitable	May be suitable
CyclotellaPseudotel	Suitable	Suitable	May be suitable (highland streams in Germany)	May be suitable (highland streams in Germany)	May be suitable	Suitable	Suitable (fens)	Suitable	Suitable (fens)	Suitable	Suitable	Suitable	Suitable	May be suitable
Daphnia	May be suitable	Suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	May be suitable	Suitable	Suitable
DottedDuckweed	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	May be suitable	Suitable	Suitable (if adequate hydrology)	Suitable	Suitable (if adequate hydrology)	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
Europamphipods	Suitable along rock shoreline or dreissena shells or hard bottom	Suitable along rock shoreline or dreissena shells or hard bottom	Not likely suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	May be suitable	Suitable	Suitable	May be suitable
EuropFingernailClam	May be suitable in slow water areas	Suitable	May be suitable	Suitable	Not likely suitable	Not if ephemeral	Not if ephemeral	Not if ephemeral	Not if ephemeral	Suitable	Suitable	Suitable	Suitable	May be suitable

Table 1. Habitat Type and Associated ANS Species

EuropPeaClam	Suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	May be suitable
EuropStreamValvate	May be suitable in slow microhabitats along edge	Suitable along edge	Not likely suitable	Suitable	May be suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	Suitable	Suitable	Suitable
FishhookWaterFlea	Suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	May be suitable	May be suitable	Suitable
FreshwaterBryozoan	May be suitable	Suitable	May be suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Not likely suitable
GrassKelp	May be suitable (slow water along channel edge)	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Not likely suitable
InlandSilverside (Spawning)	Suitable	Not likely suitable	Suitable	Not likely suitable	Not likely suitable	May be suitable in high water	Suitable	May be suitable in high water	Suitable	Low	Suitable	Suitable	Suitable	Not likely suitable
Adults	Suitable	Suitable	Suitable	Not likely suitable if DO low	Not likely suitable	May be suitable in high water	Not likely suitable	May be suitable in high water	Not likely suitable	May be suitable	May be suitable	Suitable	Suitable	Not likely suitable
MarshDewflwer	May be suitable in shallow, slower areas	May be suitable in shallow, slower areas	May be suitable in shallow, slower areas	May be suitable in shallow, slower areas	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Suitable	May be suitable	Suitable	Not likely suitable
NewZealndMudSnail	Suitable	Suitable	May be suitable <15 cm/s	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable

Table 1. Habitat Type and Associated ANS Species

NorthSnakehead (Spawning)	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
Adults	May be suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
ParasiticCopepod	May be suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
PondSedge	Not likely suitable	Not likely suitable	May be suitable	Suitable	Not likely suitable	Suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
RedAlgae	Only on channel edged if hard substrate present	Only on channel edged if hard substrate present	Only on channel edged if hard substrate present	Only on channel edged if hard substrate present	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Suitable	Not likely suitable
ReedSweetGrass	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	May be suitable	Suitable	Suitable	Suitable	Not likely suitable
Ruffe (Spwning)	Not likely suitable	Suitable	Not likely suitable	Suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	Suitable	Suitable	Not likely suitable
Adults	May be suitable in low flow along edge	Suitable	Not likely suitable	Suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	May be suitable	Suitable	Suitable
Schizopera	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable

Table 1. Habitat Type and Associated ANS Species

Scud	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	Not likely suitable
SeaLamprey (Spawning)	Suitable	Not likely suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable
Adults	Suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Suitable	Suitable
SilverCarp (Spawning)	Suitable	May be suitable	Not suitable	Not suitable	Not likely suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable	Not suitable
Adults	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	May be suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable
SkipjackHerring (Spawning)	Suitable	May be suitable	Suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable
Adults	Suitable	Suitable	May be suitable	May be suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	May be suitable	May be suitable	Suitable
SpinyWaterFlea	May be suitable along channel edge	May be suitable along channel edge	May be suitable along channel edge	May be suitable along channel edge	May be suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	May be suitable	Suitable	Suitable	Suitable
StephanodiscusBin	Suitable at mouth	Suitable at mouth	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Suitable	Suitable

Table 1. Habitat Type and Associated ANS Species

TestateAmoeba	Present only in sand	Present only in sand	Present only in sand	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Not likely suitable	Suitable	Not likely suitable	Not likely suitable
ThreespineStickleback (Spawning)	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Suitable	Suitable	May be suitable	May be suitable	Suitable	Suitable	Not likely suitable	Suitable	Not likely suitable
Adults	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Suitable	Suitable	May be suitable	May be suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Tubnose Goby (Spawning)	May be suitable on channel edge	May be suitable on channel edge	Not suitable	Suitable	Not likely suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	May be suitable	Suitable	Not suitable
Adults	May be suitable on channel edge	Suitable on channel edge	Not likely suitable	Suitable	Not likely suitable	May be suitable	May be suitable	May be suitable	May be suitable	Suitable	Suitable	May be suitable	Suitable	Not likely suitable
Tubificid	Suitable	Suitable	Suitable	Suitable	Not likely suitable	Suitable	Suitable if adequate hydrology	Suitable	Suitable if adequate hydrology	Suitable	Suitable	Not likely suitable	Suitable	Not likely suitable

V. Habitat Type and Associated Dominant Species

Table 2. Great Lakes Basin Dominant Species

	Within River/Stream Channel				Adjacent to River/Stream Channel					Great Lakes Coastal Zone			Great Lakes Open Water Zone				
					Floodplain Herbaceous Marsh												
	Large Order Rivers	Medium Order Rivers and Streams	Small Order Streams	Intermittant streams	Annually flooded (seasonal)	Perennially flooded (all round year water)	Floodplain Forest	Connected Lakes Open Water	Connected Lakes Littoral Zone	Coastal Shoreline (Beach within OHW levels)	Nearshore (emergent herbaceous)	Nearshore (non-vegetated)	Rocky Islands	Sandy Shoals	Rocky shoals	Deep water (20-50 feet)	Deep water (> 50 feet)
Algae	Fragilaria capucina, Stephanodiscus niagarae, Melosira binderana, Frailaria crotonesis, Stephanodiscus hantzschii, Melosira islandica, Tabellaria fenestrata, Melosaria islandica, Stephanodiscus sp. (Great Lakes Sea Grant 2012)	Fragilaria capucina, Stephanodiscus niagarae, Melosira binderana, Frailaria crotonesis, Stephanodiscus hantzschii, Melosira islandica, Tabellaria fenestrata, Melosaria islandica, Stephanodiscus sp. (Great Lakes Sea Grant 2012)	-	-	-	-	-	Chlamydomonas sp., Closterium sp. , Sphaerocystis sp., Cryptomonas erosa (Lavrentyev et al. 2004)	Fragilaria crotonensis (Great Lakes Sea Grant 2012)	-	Fragilaria crotonensis (Great Lakes Sea Grant 2012)	Fragilaria crotonensis (Great Lakes Sea Grant 2012); Rhodomonas minlma, Actinocyclus normanii, Asterionella formosa, Stephanodiscu s rotula (Lavrentyev et al. 2004)	Fragilaria sp. And Tabellaria (Damann 1945); Fragilaria crotonensis, Asterionella formosa, Diatoma tenue (Herdendorf 1992)	Fragilaria crotonensis (Great Lakes Sea Grant 2012)	Fragilaria crotonensis (Great Lakes Sea Grant 2012)	Aulacoseira islandica, Aulacoseira subarctica, Stephanodiscus subtransylvanicu s, Stephanodiscus alpinus, Fragilaria crotonensis (Great Lakes Sea Grant 2012)	Aulacoseira (Fahnenstiel & Scavia 1987)
Annelid	Limnodrilus hoffmeisteri (Hiltunen 1969)	Limnodrilus hoffmeisteri (Hiltunen 1969); Hellobdella fusca, Helobdella stagnalis, Helobdella triserialis, Plaeobdella montifera, Plaeobdella ornata, Plaeobdella parasitica, Myzobdella lugubris, Haemopis grandis, Macrobdella decora, Erpobdella puncata puncata (Klemm 1985)	Uncinais uncinata and Piguetiella michiganensis (Hiltunen 1967); Hellobdella fusca, Helobdella stagnalis, Helobdella triserialis, Plaeobdella montifera, Plaeobdella ornata, Plaeobdella parasitica, Myzobdella lugubris, Haemopis grandis, Macrobdella decora, Erpobdella puncata puncata (Klemm 1985)	-	Hellobdella fusca, Helobdella stagnalis, Helobdella triserialis, Plaeobdella montifera, Plaeobdella ornata, Plaeobdella parasitica, Myzobdella lugubris, Haemopis grandis, Macrobdella decora, Erpobdella puncata puncata (Klemm 1985)	Uncinais uncinata and Piguetiella michiganensis (Hiltunen 1967)	-	Uncinais uncinata and Piguetiella michiganensis (Hiltunen 1967)	Uncinais uncinata and Piguetiella michiganensi s (Hiltunen 1967)	-	-	Limnodrilus hoffmeisteri, Piguetiella michiganensis , Uncinais uncinata, Stylodrilus heringianus, Potamothrix moldaviensis, Potamothrix veidovskyi (Stimpson et al. 1975); Tubifex tubifex; Peloscolex multisetosus (Cook & Johnson 1974)	Stylodrilus heringianus (Cook & Johnson 1974)	Stylodrilus heringianus (Cook & Johnson 1974); Limnodrilus hoffmeisteri (Hiltunen 1967, 1969)	Limnodrilus hoffmeisteri (Nalepa et al. 1998)	Potamothrix vejdovskyi (Nalepa et al. 1998); Tubifex tubifex (Hiltunen 1967)	Stylodrillus heringianus and Peloscolex variegatus (Cook & Johnson 1974; Nalepa et al. 1998; Hiltunen 1967)
Bryozoan	Paludicella articulata, Pactinatella magnifica, and Pllumatella reticulata (Ricciardi & Reiswig 1994)	Hyalinella punctata (Ricciardi & Reiswig 1994)	Plumatella emarginata (Bushnell, Jr. 1965)	-	-	Federicella sultana (Bushnell, Jr. 1965)	-	Pactinatella magnifica (Ricciardi & Reiswig 1994)	Federicella sultana (Davenport 1904), Plumatella repens (Ricciardi & Reiswig 1994)	-	Plumatella repens (Ricciardi & Reiswig 1994)	Federicella sultana (Bushnell, Jr. 1965)	Paludicella articulata (Ricciardi & Reiswig 1994)	Federicella sultana (Bushnell, Jr. 1965)	Paludicella articulata (Ricciardi & Reiswig 1994)	Paludicella chrenbergii and Fredericella sultana (Davenport 1904) Fredericella indica (Ricciard & Reiswig 1994)	Fredericella indica (Ricciardi & Reiswig 1994)
Crustacean	Cercopagis pengoi, Diacyclops thomasi, Skistodiaptomus oregonensis	Cercopagis pengoi, Diacyclops thomasi (Central Michigan University 2012)	Cercopagis pengoi, Diacyclops thomasi, Chirocephalopsis bundyi (Central	Chirocephalops is bundyi (Central Michigan University 2012)	Chirocephalops is bundyi (Central Michigan University 2012)	Polyphemus pediculus (Central Michigan University 2012)	-	Bythotrephes cederstroemi, Cercopagis pengoi, Diacyclops thomasi,	Bosmina longirostris, Cercopagis pengoi, Simocephalu s sp.,	-	Bosmina longirostris, Simocephalus sp. (Central Michigan University 2012)	-	Hemimysis anomala (Central Michigan University 2012);	-	Hemimysis anomala (Central Michigan University 2012);	Skistodiaptomus oregonensis, Daphnia pulicaria, Limnocalacnus macrurus	Limnocalacnus macrurus (Watson 1974; Central Michigan University

Table 2. Great Lakes Basin Dominant Species

	(Central Michigan University 2012)		Michigan University 2012)					Skistodiaptomus oregonensis (Central Michigan University 2012)	Diacyclops thomasi, Eurytemora affinis (Central Michigan University 2012)				Pontoporeia affinis (Cook & Johnson 1974)		Gammarus sp.(Kuhns & Berg 1999)	(Central Michigan University 2012); Pontoporeia affinis (Cook & Johnson 1974); Daphnia retrocurva (Evans & Jude 1986)	2012); Pontoporeia affinis (Cook & Johnson 1974); Daphnia pulicaria (Evans & Jude 1986)
Fish	muskellunge (Esox masquinongy), northern pike (Esox lucius), lake sturgeon (Acipenser fulvescens), walleye (Stizostedoin vitreum), smallmouth bass (Micropterus dolomieui), quillback carpsucker (Carpiodes cyprinus), gizzard shad (Dorosoma cepedianum), freshwater drum (Aplodinotus grunniens), buffalo (Ictiobus spp.), common carp (Cyprinus carpio) (Karr et al. 1985)	burbot (Lota lota), black bullhead (Ameiurus melas), pirate perch (Aphredoderus sayanus), tadpole madtom (Noturus gyrinus), freshwater drum (Aplodinotus grunniens), logperch (Percina caprodes), rock bass (Ambloplites rupestris), smallmouth bass (Micropterus dolomieu), yellow perch (Perca flavescens), silver redhorse (Moxostoma anisurum) (Zorn et al. 1998, 2002)	blacknose dace (Rhinichthys atratulus), white sucker (Catostomus commersoni), creek chub (Semotilus atromaculatus), brook stickleback (Culaea inconstans),brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), hornyhead chub (Nocomis biguttatus) (Zorn et al. 1998, 2002)	-	-	longnose gar (Lepisosteus osseus), largemouth bass (Micropterus salmoides), rock bass (Ambloplites rupestris), bluegill (Lepomis macrochirus) (Uzaski et al. 2005)	-	bluegill (Lepomis macrochirus) , alewife (Alosa pseudoharengus) , bluntnose minnow (Pimephales notatus), emerald shiner (Notropis atherinoides), spottail shiner (Notropis hudsonius), johnny darter (Etheostoma nigrum), yellow perch (Perca flavescens) (Jude & Pappas 1992); lake whitefish (Coregonus clupeaformis), common carp (Cyprinus carpio), lake trout (Salvelinus namaycush), walleye (Sander vitreus) (Kinnunen 2003)	lake whitefish (Coregonus clupeaformis), yellow perch (Perca flavescens), common carp (Cyprinus carpio), lake trout (Salvelinus namaycush), walleye (Sander vitreus) (Kinnunen 2003)	-	black crappie (Pomoxis nigromaculatus), rock bass (Ambloplites rupestris), alewife (Alosa pseudoharengus) , gizzard shad (Dorosoma cepedianum), bluntnose minnow (Pimephales notatus), common carp (Cyprinus carpio), common shiner (Luxilus cornutus), emerald shiner (Notropis atherinoides), spotfin shiner (Cyprinella spiloptera), spottail shiner (Notropis hudsonius), white bass (Morone chrysops), yellow perch (Perca flavescens) (Jude & Pappas 1992)	bluntnose minnow (Pimephales notatus), emerald shiner (Notropis atherinoides), spotfin shiner (Cyprinella spiloptera), spottail shiner (Notropis hudsonius), white bass (Morone chrysops), yellow perch (Perca flavescens) (Jude & Pappas 1992)	white sucker (Catostomus commersoni), black bullhead (Ameiurus melas), rock bass (Ambloplites rupestris), alewife (Alosa pseudoharengus) , smallmouth bass (Micropterus dolomieu), pugnose shiner (Notropis anogenus) (Uzarski et al. 2005)	-	white sucker (Catostomus commersoni), black bullhead (Ameiurus melas), rock bass (Ambloplites rupestris), alewife (Alosa pseudoharengus) , smallmouth bass (Micropterus dolomieu), pugnose shiner (Notropis anogenus) (Uzarski et al. 2005)	spottail shiner (Notropis hudsonius), rainbow smelt (Osmerus mordax), johnny darter (Etheostoma nigrum), yellow perch (Perca flavescens), bloater (Coregonus hoyi), (Jude & Pappas 1992); Lake herring (Leucichthys artedi), white sucker (Catostomucs commersoni), longnose sucker (Catostomucs catostomus), walleye (Zander vitreum), yellow perch (Perca flavescens), lake whitefish (Coregonus clupeaformis), burbot (Lota lota) (Moffett 1957)	lake trout (Salvelinus namaycush), burbot (Lota lota), rainbow smelt (Osmerus mordax), deepwater cisco (Coregonus johannae), alewife (Alosa pseudoharengus) , lake whitefish (Coregonus clupeaformis) (Christie 1974); deep-water sculpin (Myxocephalus quadricornis) (Moffett 1957)
Mollusk	Dreissena polymorpha, Lampsilis siliquoidea, Fusconaia flava, Lampsilis cardium (McGoldrick et al. 2009)	Elliptio dilatata, Fusconaia flava, Venustaconcha ellipsiformis (Gruber et al. 2012); Villosa iris, Anodontoides ferrussacianus, Pyganodon grandis (Morowski et al. 2009)	-	-	-	-	Carychium exiguum, Planogyra asteriscus, Striatura exigua, Striatura milium, Vertigo nylanderi (Nekola 2003)	Dreissena polymorpha, Lampsilis siliquoidea, Fusconaia flava, Lampsilis cardium (McGoldrick et al. 2009)	Dreissena sp., Leptodea fragilis, Pyganodon grandis (Crail et al 2011) Quadrula quadrula (Bowers & de Szalay 2004)	-	-	Dreissena sp., Leptodea fragilis, Pyganodon grandis (Crail et al. 2011) Quadrula quadrula (Bowers & de Szalay 2004)	Dreissena polymorpha (Nalepa et al 1998); Dreissena rostriformis bugensis (Nalepa et al. 2009)	Pisidium casertanum, Pisidium compressum (Heard 1962)	-	Pisidium fallax, Pisidium henslowanum (Heard 1962)	Sphaerium nitidum (Heard 1962); Pisidium conventus (Cook & Johnson 1974)
Plant	bluejoint (Calamagrostis canadensis), woollyfruit sedge (Carex lasiocarpa), tussock sedge (Carx stricta), jewelweed (Impatiens capensis),	bluejoint (Calamagrostis canadensis), woollyfruit sedge (Carex lasiocarpa), tussock sedge (Carx stricta), jewelweed (Impatiens capensis),	bluejoint (Calamagrostis canadensis), cattail species (Typha sp). Reed canarygrass (Phalaris arundinacea) (Frieswyk et al. 2007)	bluejoint (Calamagrostis canadensis), cattail species (Typha sp). Reed canarygrass (Phalaris arundinacea) (Frieswyk et al. 2007)	jewelweed (Impatiens capensis), cattail species (Typha sp.) (Frieswyk et al. 2007)	cattails (Typha latifolia and T. angustifolia), pickerelweed (Pontederia cordata), arrowheads (Sagittaria spp.), yellow pond-lily (Nuphar lutea), white waterlily	silver maple (Acer saccharinum), green ash (Fraxinus pennsylvanica), American elm (Ulmus americana), nettles (Urtica dioica),	wild celery (Vallisneria americana), sago pondweed (Potamogeton pectinatus), curly pondweed (Potamogeton crispus), water-milfoil (Myriophyllum	duckweeds (Lemnaceae) , floating water fern (Azolla caroliniana), white water lilies (Nymphaea tuberosa), American	three-square bulrush (Scirpus pungens), bluejoint (Calamagrost is canadensis), prairie grass (Phragmites australis),	yellow pond-lily (Nuphar advena), arrow-arum (Peltandra virginica), coontail (Ceratophyllum demersum), giant duckweed (Spirodela polyrhiza), star	-	cattails (Typha spp.) (Herdendorf 1992)	wild celery (Vallisneria americana), sago pondweed (Potamogeton pectinatus), curly pondweed (Potamogeton	-	-	-

Table 2. Great Lakes Basin Dominant Species

	broadleaf arrowhead (Sagittaria latifolia), cattail species (Typha sp.) (Frieswyk et al. 2007)	broadleaf arrowhead (Sagittaria latifolia), cattail species (Typha sp.) (Frieswyk et al. 2007)				(Nymphaea odorata), softstem bulrush (Schoenoplectus tabernaemontani = Scirpus validus), bur-reeds (Sparganium spp.), wild rice (Zizania aquatica and Z. palustris). Bayonet rush (Juncus militaris), Common reed (Phragmites australis) (US Army Corps of Engineers 2012)	clearweed (Pilea pumila), sedges (Caryx sp.) and waterleaf (Hydrophyllaceae sp.). (Wisconsin DNR 2012)	spicatum), water star-grass (Heteranthera dubia) , coontail (Ceratophyllum demersum) , and waterweed (Elodea canadensis) (Herdendorf 1992)	lotus (Nelumbo lutea), yellow water lily (Nuphar advena), cattails (Typha spp.), bur reed (Sparganium eurycarpum), flowering-rush (Butomus umbellatus), water smartweed (Polygonum punctatum), and pickerel weed (Pontederia cordata) (Herdendorf 1992)	reed-canary grass (Phalaris arundinacea), rushes (Juncus spp.) (Herdendorf 1992)	duckweed (Lemna trisulca), and common duckweed (Lemna minor), bluejoint Calamagrostis canadensis (US EPA 2012)			crispus), water-milfoil (Myriophyllum spicatum), water star-grass (Heteranthera dubia) , coontail (Ceratophyllum demersum) , and waterweed (Elodea canadensis) (Herdendorf 1992)			
Protozoan	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc(Williams 1966)	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc(Williams 1966)	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc(Williams 1966)	-	-	Euglena sp. and Euglena proxima (Lavrentyev et al. 2004)	-	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966); Trachelomonas sp., Euglena acus (Lavrentyev et al. 2004)	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966)	-	-	-	-	-	-	Strobilidium so., Tintinnidium sp., Haiteria sp., Vorticella sp., Vaginacola sp., Gymnodinium helveticum, Gymnodinium sp., Strombidium viride, Urotricha sp. and Balanion sp., Askenasia sp., Mesodinium sp, Peridinium sp., Ceratium hirudinella (Carrick & Fahnenstiel 1990)	Strombidium viride, Codonella sp., Tintinnidium sp., Gymnodinium helveticum, Mesodinium sp., Urotricha pelagica and Urotricha sp., Stokesia vernalis (Carrick & Fahnenstiel 1990)

Table 3. Mississippi River Basin Dominant Species

	Within River/Stream Channel			Adjacent to River/Stream Channel				
	Large/Medium Order Rivers	Small Order Streams	Intermittent	Annual Floodplain Marsh	Perennial Floodplain Marsh	Floodplain Forest	Connected Lakes Open water	Connected Lakes Littoral Zone
Algae	Stephanodiscus hantzschii, Melosira ambigua, Cyclotella meneghiniana, Melosira granulate (Williams & Scott 1962)	-	-	-	Chrionomus plumosus (USACE 2010)	-	Chrionomus plumosus (USACE 2010)	-
Annelid	Limnodrilus hoffmeisteri (Sparks & Tazik 1986)	Limnodrilus hoffmeisteri (Sparks & Tazik 1986)	Limnodrilus sp. (Stehr & Branson 1934)	-	Nais variabilis (Sparks & Tazik 1986)	-	-	Limnodrilus hoffmeisteri (Sparks & Tazik 1986)
Bryozoan	Paludicella ehrenberghii (Davenport 1904)	Plumatella emarginata (Bushnell, Jr. 1965)	-	-	Federicella sultana (Bushnell, Jr. 1965)	-	Plumatella polymorpha (Davenport 1904); Plumatella repens (Bushnell, Jr. 1965)	Federicella sultana (Bushnell, Jr. 1965)
Crustacean	Hyalella azteca (Sparks & Tazik 1986)	-	Asellus communis (Stehr & Branson 1934)	-	Isopoda, Amphipoda (Elstad 1986)	-	Isopoda, Amphipoda (Elstad 1986)	-
Fish	bighead carp (Hypophthalmichthys nobilis), silver carp (Hypophthalmichthys molitrix) (Irons et al. 2007), spottfin shiner (Cyprinella spiloptera) (IL & IN DOTs 2012)	creek chub (Semotilus atromaculatus) (Karr et al 1985), striped shiner (Luxilus chrysocephalus), bluntnose minnow (Pimephales promelas), central stoneroller (Campostoma anomalum) (IL & IN DOTs 2012)	-	-	common carp (Cyprinus carpio), channel catfish (Ictalurus punctatus), bluegill (Lepomis macrochirus), black crappie (Pomixis nigromaculatus), smallmouth bass (Micropterus dolomieui), largemouth bass (Micropterus salmoids) (USACE 2010)	-	common carp (Cyprinus carpio), channel catfish (Ictalurus punctatus), bluegill (Lepomis macrochirus), black crappie (Pomixis nigromaculatus), smallmouth bass (Micropterus dolomieui), largemouth bass (Micropterus salmoids) (USACE 2010)	-
Mollusk	Megalonasas nervosa, Quadrula quadrula, Amlema plicata, Fusconaia flava, Obliquaria reflexa, Lampisilis cardium, Toxolasma parvus (Cummings 1992), Corbicula fluminea (Sparks & Tazik 1986)	Amblema plicata, Fusconia flava, Pyganodon (Andonta) grandis, Lasmigona complanata, Leptodea fragilis, Lampsilis siliquoidea, Toxolasma parvus, Lampsilis cardium (Cummings 1992)	Physa sp. (Stehr & Branson 1934)	-	Alblema plicata, Obliquaria reflexa, Gastropoda, Pelecypoda (USACE 2010, Elstad 1986)	Carychium exiguum, Planogyra asteriscus, Striatura exigua, Striatura milium, Vertigo nylanderi (Nekola 2003)	Alblema plicata, Obliquaria reflexa, Quadrula quadrula, Lampsilis siliquoidea, Toxolasma parvus, Gastropoda, Pelecypoda (USACE 2010, Elstad 1986, Cummings 1992)	Quadrula quadrula, Lampsilis siliquoidea, Toxolasma parvus (Cummings 1992)
Plant	Potamogeton pectinatus, Potamogeton crispus, Vallisneria americana, Myriophyllum sp. (Sparks et al. 1986); Eurasian watermilfoil, (Myriophhyllum spicatum), coontail (Ceratophyllum demersum) curly pondweed (Potamogeton crispus) (Rogers et al. 1998)	-	-	Eurasian watermilfoil (Rogers et al. 1998)	Eleocharis spp, , Typha spp, Saggitaria spp, Polygonum spp, Nuphar lutea (USACE 2010)	silver maple (Acer saccharinurn), eastern cottonwood (Populus deltoides), riverbank grape (Vitis riparia), poison ivy (Toxicodendron radicans) (Grubaugh & Anderson 1989)	Eleocharis spp, , Typha spp, Saggitaria spp, Polygonum spp, Nuphar lutea (USACE 2010); coontail (Ceratophyllum demersum) (Rogers et al. 1998)	Safittaria latifolia, Typha spp., Phragmites comminis (Sparks & Tazik 1986)
Protozoan	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966)	Brachionus (Williams 1966)	Keratella (Williams 1966)	-	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966)	-	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966)	Keratella, Polyarthra, Brachionus, Synchaeta, Trichocerc (Williams 1966)

VI. Federally Listed Species Associated with Habitat Types per Basin

Table 4. Great Lakes Basin Federally Listed Species

Common Name	Scientific Name	Taxon	Status	Habitat	GLMRIS Habitat Types
Piping Plover	*Charadrius melodus*	Bird	E	Lake Michigan beaches	Coastal Shore -Beach
Eastern massasauga	*Sistrurus catenatus*	Reptile	C	Wetlands and adjacent uplands. Shrub wetlands	Floodplain Marsh/Forest
Karner blue butterfly	*Lycaeidea melissa samuelis*	Invertebrate	E	Pine barrens and oak savannas on sandy soils and containing wild lupines *(Lupinus perennis)*, the only known food plant of larvae.	NA
Eastern prairie fringed orchid	*Platanthaera leucophaea*	Plant	T	Mesic to wet prairies and meadows	NA
Pitcher's thistle	*Cirsium pitcheri*	Plant	T	Lakeshores; stabilized dunes and blowout areas	Coastal Shore
Prairie bush clover	*Lespedeza leptostachya*	Plant	T	Dry to mesic prairies with gravelly soil	NA
Indiana bat	*Myotis sodalis*	Mammal	E	Hibernation occurs in caves and mines, with swarming in surrounding wooded areas. Summer roosting and foraging habitat occurs in wooded stream corridors and in bottomland and upland forests and woods. Caves, mines (hibernacula); small stream corridors with well developed riparian woods; upland forests (foraging)	Floodplain Forest
Mitchell's satyr	*Neonympha mitchellii*	Invertebrate	E	Fens	Floodplain Marsh/Forest
Mead's milkweed	*Asclepias meadii*	Plant	T	Prairies	NA
Canada lynx	*Lynx canadensis*	Mammal	T	Northern forest	Floodplain Forest
Gray wolf	*Canis lupus*	Mammal	E	Northern forested areas	Floodplain Forest
Kirtland's Warbler	*Dendroica kirtlandii*	Bird	E	Jack Pine forests	NA
Copperbelly watersnake	*Nerodia erythrogaster neglecta*	Reptile	T	Wooded and permanently wet areas such as oxbows, sloughs, brushy ditches and floodplain woods	Floodplain Forest
Hine's emerald dragonfly	*Somatochlora hineana*	Invertebrate	E	Spring fed wetlands, wet meadows and marshes; calcareous streams & associated wetlands overlying dolomite bedrock	Floodplain
Hungerford's crawling water beetle	*Brychius hungerfordi*	Invertebrate	E	Cool riffles of clean, slightly alkaline streams; known to occur in five streams in northern Michigan.	Small Streams

Table 4. Great Lakes Basin Federally Listed Species Cont.

Common Name	Scientific Name	Taxon	Status	Habitat	GLMRIS Habitat Types
Poweshiek skipperling	*Oarisma poweshiek*	Fish	C	Wet prairies and fens	Floodplain Marsh
Clubshell mussel	*Pleurobema clava*	Mollusk	E	Found in coarse sand and gravel areas of runs and riffles within streams and small rivers	Small Streams
Northern riffleshell mussel	*Dysnomia torulosa rangiana*	Mollusk	E	Large streams and small rivers in firm sand of riffle areas; also occurs in Lake Erie	L/M Rivers & Small Streams
Rayed bean mussel	*Villosa fablis*	Mollusk	E	Belle, Black, Clinton, and Pine Rivers	Large/Medium Rivers
Snuffbox mussel	*Epioblasma triquetra*	Mollusk	E	Small to medium-sized creeks in areas with a swift current and some larger rivers	High Gradient L/M Rivers & High Gradient Small Streams
American hart's tongue fern	*Asplenium scolopendrium var. americanun = Phyllitis japonica ssp. a.*	Plant	T	Cool limestone sinkholes in mature hardwood forest	NA
Dwarf lake iris	*Iris lacustri*	Plant	T	Partially shaded sandy-gravelly soils on lakeshores	Lake Littoral & Coastal Shoreline
Houghton's goldenrod	*Solidago houghtonii*	Plant	T	Sandy flats along Great Lakes shores	Coastal Shore -Beach
Lakeside daisy	*Hymenoxy acaulis var. glabra*	Plant	T	Dry, rocky prairie grassland underlain by limestone	NA
Michigan monkey-flower	*Mimulus michiganesis*	Plant	E	Soils saturated with cold flowing spring water; found along seepages, streams and lakeshores	Small Streams & Lake Littoral
Small whorled pogonia	*Isotria medeoloides*	Plant	T	Dry woodland; upland sites in mixed forests (second or third growth stage)	NA
Fassett's locoweed	*Oxytropis campestris var. charteceae*	Plant	T	Open sandy lakeshores	Lake Littoral & Coastal Shoreline

E = Endangered

T = Threatened

P = Proposed

C = Candidate

Table 5. Mississippi River Basin Federally Listed Species

Common Name	Scientific Name	Taxon	Status	Habitat	GLMRIS Habitat Types
Clubshell	*Pleuorbema clava*	Mussel	E	Medium to small rivers and streams	Large/medium rivers and streams high gradient, small streams high gradient
Fanshell Mussel	*Cyprogenia stegaria*	Mussel	E	Large to medium rivers, moderate current	Large/medium rivers and streams high gradient
Fat Pocketbook	*Potamilus capax*	Mussel	E	Large to medium rivers	Large/medium rivers and streams high gradient and low gradient
Higgin's Eye Pearlymussel	*Lampsilis higginsii*	Mussel	E	Large rivers, moderate current	Large/medium rivers and streams high gradient
Orange-Foot Pimpleback Pearlymussel	*Plethobasus cooperianus*	Mussel	E	Large to medium rivers, steady to moderate current	Large/medium rivers and streams high gradient
Pink Mucket	*Lampsilis abrupta*	Mussel	E	Large to medium rivers and streams, high to moderate current	Large/medium rivers and streams high gradient
Purple Cat's Paw	*Epioblasma obliquata obliquata*	Mussel	E	Large to medium rivers and streams, high current	Large/medium rivers and streams high gradient
Rayed Bean	*Villosa fabalis*	Mussel	E	Primarily smaller, headwater streams, sometimes in large rivers and litoral zone of lakes	Intermittent, small streams, large/medium rivers and streams, littoral zones
Ring Pink	*Obovaria retusa*	Mussel	E	Large river, high current	Large/medium rivers and streams high gradient
Scaleshell	*Leptodea leptodon*	Mussel	E	Large to medium river, moderate current	Large/medium rivers and streams high gradient
Sheepnose	*Plethobasus cyphyus*	Mussel	E	Large to medium rivers and streams, high to moderate current	Large/medium rivers and streams high gradient
Snuffbox	*Epioblasma triquetra*	Mussel	E	Medium to small streams, high current	Large/medium rivers and streams high gradient, small streams high gradient

Table 5. Mississippi River Basin Federally Listed Species Cont.

Common Name	Scientific Name	Taxon	Status	Habitat	GLMRIS Habitat Types
Spectaclecase	*Cumberlandia monodonta*	Mussel	E	Large rivers, slow to moderate current	Large/medium low gradient
Tubercled-Blossom Pearly Mussel	*Epioblasma torulosa torulosa*	Mussel	E	Large rivers, high current	Large/medium rivers and streams high gradient
Winged Mapleleaf	*Quadrula fragosa*	Mussel	E	Large rivers to small streams, moderate current	Large/medium rivers and streams high gradient, small streams high gradient
Pallid Sturgeon	*Scaphirhynchus albus*	Fish	E	Large rivers, natural hydrology	Large/medium rivers and streams high and low gradient
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	Fish	T	Large rivers, high to moderate current	Large/medium rivers and streams high gradient
Topeka Shiner	*Notropis topeka*	Fish	E	Primarily in perennial prairie streams in pools with clear water, sometimes in headwaters	Small streams high and low gradient, intermittant
Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	Reptile	T	Lowland swamps or other warm, quiet waters. Upland woods are used as winter hibernation sites.	Perennial/annual forest floodplain
Eastern Massasauga	*Sistrurus catenatus catenatus*	Reptile	C	Open shallow wetlands or shrub swamps, uplands in summer	Perennial/annual floodplain marsh and forest
Dakota Skipper	*Hesperia dacotae*	Invertebrate	C	Wet prairie (woody lilly, harebell and smooth camas) and dry prairie (pale purple coneflowers, upright coneflowers and balnketflower)	NA
Hine's Emerald Dragonfly	*Somatochlora hineana*	Invertebrate	E	Calcareous spring-fed marshes and sedge meadows	Perennial/annual floodplain marsh
Karner Blue Butterfly	*Lycaeides melissa samuelis*	Invertebrate	E	Dry prairies, pine and oak savannas supporting wild lupine and nectar plants	NA
Illinois Cave Amphipod	*Gammarus acherondytes*	Invertebrate	E	Dark cold cave streams	NA

Table 5. Mississippi River Basin Federally Listed Species Cont.

Common Name	Scientific Name	Taxon	Status	Habitat	GLMRIS Habitat Types
Interior Least Tern	*Sterna antillarum*	Bird	E	Sparesly vegetated sandbars along rivers, sand and gravel pits, or lake and reservoir shorelines	Large/medium rivers and streams low gradient, lake littoral zone
Gray Bat	*Myotis grisescens*	Mammal	E	Caves, hunt over forested areas	Perennial/annual floodplain forest
Indiana Bat	*Myotis sodalis*	Mammal	E	Humid caves, hunt along rivers, lakes and uplands, roost in trees.	Inland lakes, forest floodplain
Decurrent False Aster	*Boltonia decurrens*	Plant	T	Moist, sandy floodplains and prairie wetlands along IL River. Relies on flood events.	Perennial/annual floodplain marsh
Dwarf Trout Lily	*Erythronium propullans*	Plant	E	Moist woodlands and floodplains.	Marsh and forest floodplain
Leafy Prairie-Clover	*Dalea foliosa*	Plant	E	Prairies and Cedar glades	NA
Leedy's Roseroot	*Sedum integrifolium leedyi*	Plant	T	Cliffsides	NA
Prairie Bush Clover	*Lespedeza leptostachya*	Plant	T	Tallgrass prairie	NA
Western Prairie Fringed Orchid	*Platanthera praeclara*	Plant	T	Mesic to wet tallgrass prairie, sedge meadows, bogs, fens and sometimes in old fields and roadside ditches	NA

E = Endangered

T = Threatened

P = Proposed

C = Candidate

VII. Methods

The spatial component of this study was carried out using the ESRI ArcGIS Desktop geospatial software package, including ArcMap and ArcCatalog. For display purposes, data was clipped to a regional map such as HUC areas, state boundaries, or counties, depending on purpose.

Data Sources

For this study, datasets were obtained from a number of sources.
Majority of data was from the National Hydrography Dataset Plus (NHD or NHDPlus).
Flowlines, waterbodies layers and data tables were utilized.
Others include:
Great Lakes Bathymetry Data, National Geophysical Data center, NOAA Great Lakes Environmental Research Lab, NOAA National Ocean Service, Canadian Hydrographic Service.
Hydrologic Unit Code Boundaries (HUC) U.S. Geological Survey (USGS) and U.S. Department of Agriculture, Natural Resources Conservation Service, 2011.
National Inventory of Dams (NID), U.S. Army Corps of Engineers, 2010.
National Land Cover Database (NLCD), U.S. Environmental Protection Agency and U.S. Geological Survey, 2006.
National Wetlands Inventory (NWI), U.S. Fish and Wildlife Service
Waterfall data was compiled by geology.com from U.S. Geological Survey 7.5 minute maps.

Dam/Waterfall Inventory

The purpose of the dam/waterfall inventory was to determine if any streams were cut off from transfer. The team was looking to answer the question, 'once a species had crossed the basin divide was it prevented from moving upstream due to a dam or waterfall'? For this exercise, the National Inventory of Dams (USACE), record flood event data from USGS River/Stream Gages, and waterfall data from USGS was used. Dam operators and Forest Preserve District employees were also called to confirm 'pass-ability'.

Habitat Types within River/Stream Channel

In order to determine the 5 stream habitat type designations, Strahler stream order and mean annual velocity of each polyline feature was used. This information was provided in the NHDPlus dataset. The NHDPlus stream order is based on the Strahler Method, a classic method for ranking streayms according to size. Stream order computed for the NHDPlus flowlines is distributed as an NHDPlus data extension in a table called SOSC.dbf. Mean Annual Velocity (fps) at the bottom of a flowline (MAVelU) was computed by the Jobson Method (1996) using the mean annual flow in cubic feet per second (cfs) at the bottom of flowline as computed by the Unit Runoff Method . For intermittent streams, a selection on FCode "46003", Hydrographic Category|intermittent was performed. Stream selection was done using the following definition queries and a new column (ECOCAT) was created and populated using the field calculator with the following numbers to designate stream habitats.

ECOCAT	*Selection*	*Description*
1	SO <= 4 & MAVELU <= 4	Low Gradient Small Order Streams
2	SO > 4 & MAVELU <= 4	Low Gradient Large/Medium Order Rivers
3	SO >4 & MAVELU > 4	High Gradient Small Order Streams
4	SO >4 & MAVELU > 4	High Gradient Large/Medium Order Rivers
5	46003	Intermittent (seasonal) Streams

Habitat Types Adjacent to River/Stream Channel Habitats
In ArcMap add US State Boundaries and US Land Cover Image (NLCD). Select each state within study area and clip NLCD.
Open ArcMap toolbox -> Data Management -> Raster -> Raster Processing -> Clip
Clip (Data Management) tool creates a spatial subset of a raster dataset.

Use resulting clipped US Landcover image and create polygons
Open ArcMap toolbox -> Conversion Tools -> From Raster -> Raster to Polygon
Raster to Polygon (Coversion) converts a raster dataset to polygon features.

Select and Export each of the following Gridcode fields from the resulting polygons 11, 90 and 95. These were chosen from the NLCD Legend Land Cover Class Description to best fit into the GLMRIS Habitat Types.

Gridcode	*NLCD Description*
No. 11	Open Water – all areas of open water, generally with less than 25% cover or vegetation or soil.
No. 90	Wood Wetlands – Areas where forest or shrub land vegetation accounts for great than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
No. 95	Emergent Herbaceous Wetlands – Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

In order to create the littoral zone from open water a buffer was used. ArcMap toolbox -> Analysis Tools -> Proximity -> Buffer -> - 20 ft, Side Type -> outside only. Buffer (Analysis) creates buffer polygons in or around input features to a specified distance.

Select all features with Gridcode 11 and resulting buffer. Open ArcMap toolbox -> Analysis Tools -> Overlay -> Symmetrical Difference. Symmetrical Difference (Analysis) writes features or portions of features from input classes that do not overlap to the output feature class. The result in this instance will be open water habitat and the buffer created in the previous step is the littoral zone.

Differentiate between Connected Lakes/Littoral Zone and Non-Connected (still) water. Select By Location: Select features from target layer (habitat layer) that intersects the source layer (NHD flowlines) by a search distance of 100 feet. Reverse Selection.

Perform a manual check and de-select anything that is connected. Delete resulting selection. Only want LTCs that are part of the continuous aquatic pathways.
Separate out perennial and annual habitat types for Gridcodes 90 and 95. Add NWI data to ArcMap. ArcMap toobox -> Analysis Tools -> Overlay -> Identity
The Identity tool computes a geometric intersection of the input features and identity features. The input features or portions thereof that overlap identity features will get the attributes of those identity features.

Use resulting features, add new field titled "Peren_Annual".
Select by the following attribute "Attribute like 'L%' and attribute like '%K%'". Leaving those features selected, select by location using NWI selected data as your source layer and features with Gridcode 90 as your target layer. Calculate the selected feature's "Peren_Annual" field with 'Perennial'. Repeat this step using the following attributes as a selection criteria; "Attribute like 'L%' and attribute like '%K'", and "Attribute like '%H' or attribute like 'H%'". Repeat all selection using features with Gridcode 95 instead of 90. After calculations are complete, the remaining features with Gridcode 90 or 95 should be annual, select all and calculate "Peren_Annual" field to 'Annual'.

The final result is six different Gridcodes delineating habitat types as follows:

Gridcode	*Description*
95.1	Perennial Floodplain Herbaceous Marsh
95.5	Annual (Seasonal) Floodplain Herbaceous Marsh
90.1	Perennial Floodplain Forest
90.5	Annual (Seasonal) Floodplain Forest
11	Connected Lakes Open water
5	Connected Lakes Littoral Zone

Habitat Types of the Great Lakes
The reclassify tool was used on bathymetric data for lakes Superior, Michigan, Erie, Huron and Ontario.
Spatial Analyst Tools -> Reclass -> Reclassify
The Reclass (Spatial Analyst) tool reclassifies (or changes) the values in a raster.

Old values	*New values*	*Description*
=< -12	-1	Open Water
-12 – 0	0	Coastal Nearshore
>0	1	Coastal Shoreline

VIII. Results

Acreages/Miles of Habitat Types
The following tables are the acreage/mileage outputs of the aquatic habitat types delineated in the above exercise.

Great Lakes Basin - Habitat Types Adjacent to River/Stream Channel

Gridcode	*Description*	*Acres*
95.1	Perennial Floodplain Herbaceous Marsh	67,668.17
95.5	Annual (Seasonal) Floodplain Herbaceous Marsh	403,601.78
90.1	Perennial Floodplain Forest	76,776.61
90.5	Annual (Seasonal) Floodplain Forest	3,421,750.35
11	Connected Lakes Open water	995,852.45
5	Connected Lakes Littoral Zone	29,954.66

Great Lakes Basin - Habitat Types Within River/Stream Channel

ECOCAT	*Description*	*Miles*
1	Low Gradient Small Order Streams	51,751.78
2	Low Gradient Large/Medium Order Rivers	3,716.48
3	High Gradient Small Order Streams	0.00
4	High Gradient Large/Medium Order Rivers	0.20
5	Intermittent (seasonal) Streams	36,798.79

Mississippi River Basin - Habitat Types Adjacent to River/Stream Channel

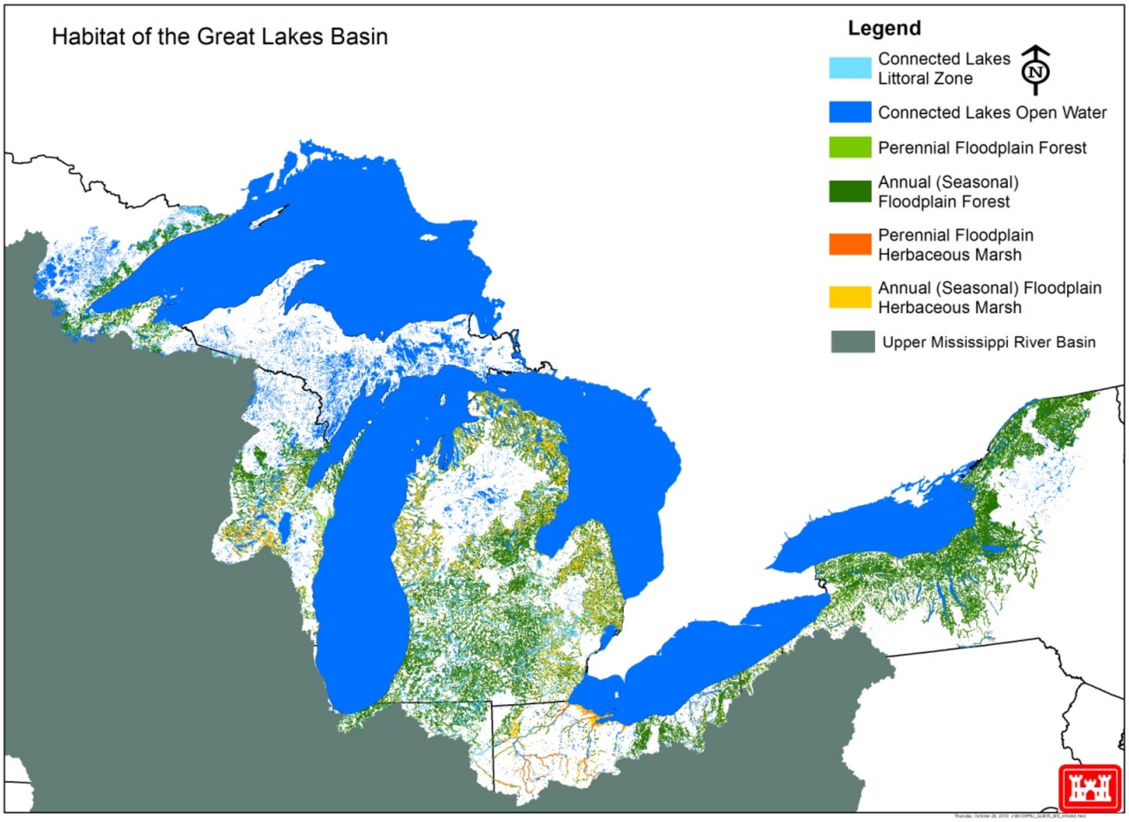
Gridcode	*Description*	*Acres*
95.1	Perennial Floodplain Herbaceous Marsh	441,619.60
95.5	Annual (Seasonal) Floodplain Herbaceous Marsh	4,345,226.34
90.1	Perennial Floodplain Forest	7,214,908.56
90.5	Annual (Seasonal) Floodplain Forest	6,608,349.44
11	Connected Lakes Open water	4,677,211.90
5	Connected Lakes Littoral Zone	171,332.85

Mississippi River Basin - Habitat Types Within River/Stream Channel

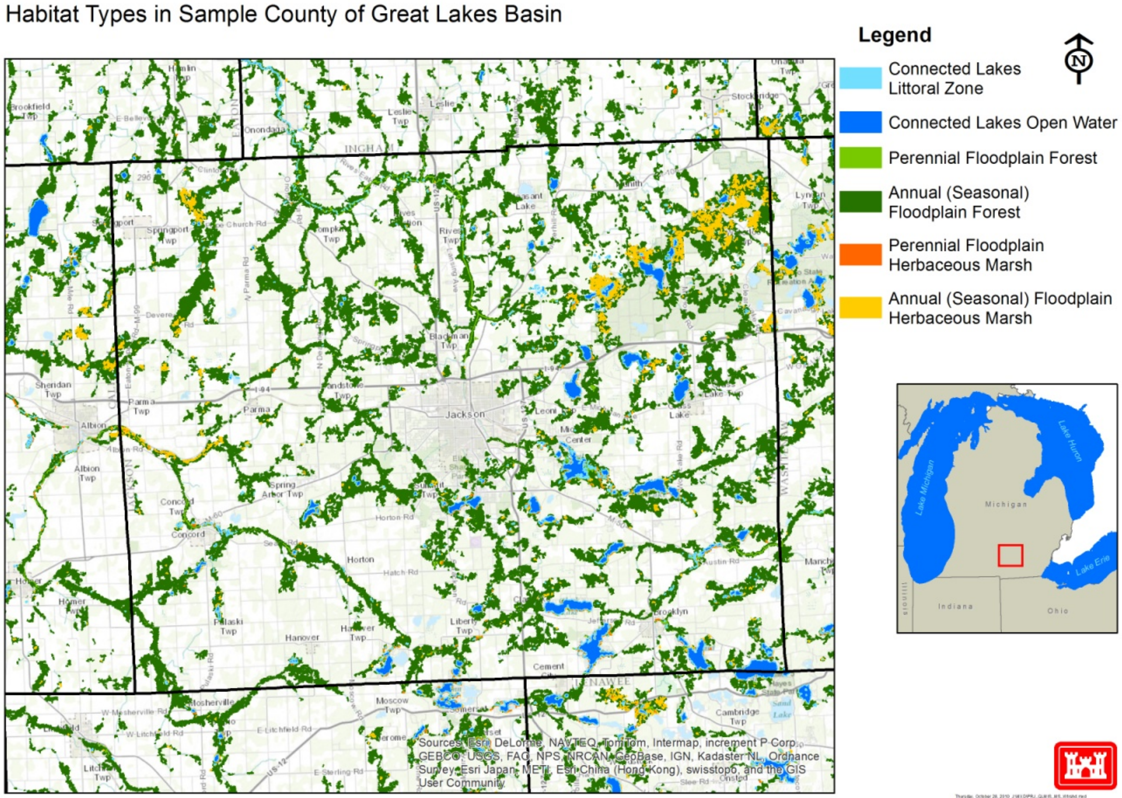
ECOCAT	*Description*	*Miles*
1	Low Gradient Small Order Streams	495,629.45
2	Low Gradient Large/Medium Order Rivers	79,994.85
3	High Gradient Small Order Streams	0.01
4	High Gradient Large/Medium Order Rivers	1,404.87
5	Intermittent (seasonal) Streams	942,501.60

Habitat Types of the Great Lakes

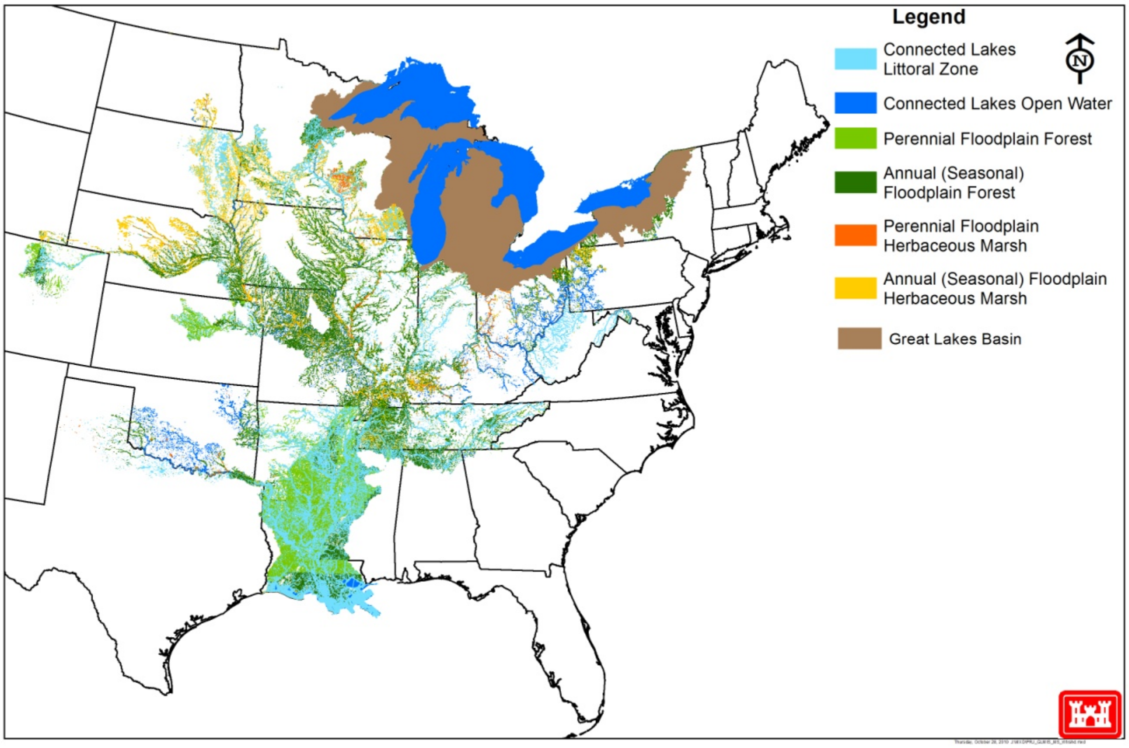
Lake	*Code*	*Description*	*Acres*
Lake Erie	-1	Open Water	6,028,246.13
Lake Erie	0	Coastal Nearshore	233,032.66
Lake Erie	1	Coastal Shoreline	59,738.72
Lake Huron	-1	Open Water	14,113,202.10
Lake Huron	0	Coastal Nearshore	576,236.29
Lake Huron	1	Coastal Shoreline	1,277,252.96
Lake Michigan	-1	Open Water	1,4073,619.49
Lake Michigan	0	Coastal Nearshore	151,046.60
Lake Michigan	1	Coastal Shoreline	162,132.57
Lake Ontario	-1	Open Water	4,535,529.52
Lake Ontario	0	Coastal Nearshore	118,727.45
Lake Ontario	1	Coastal Shoreline	369,290.92
Lake Superior	-1	Open Water	20,022,962.76
Lake Superior	0	Coastal Nearshore	175,623.07
Lake Superior	1	Coastal Shoreline	884,020.35


Habitat of the Great Lakes Basin
Legend
Connected Lakes Littoral Zone
Connected Lakes Open Water
Perennial Floodplain Forest
Annual (Seasonal) Floodplain Forest
Perennial Floodplain Herbaceous Marsh
Annual (Seasonal) Floodplain Herbaceous Marsh
Upper Mississippi River Basin
N

Habitat Types in Sample County of Great Lakes Basin



Land Cover Types of the Mississippi River Basin



Habitat Types in Sample County of Great Lakes Basin