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STATE of the STRAIT 2023

THE CONTAMINATED SEDIMENT REMEDIATION CHALLENGE

Complicated Problems that Require Interdisciplinary & Creative Solutions

Front cover photo: Contaminated sediment remediation at the former UniRoyal site on the Detroit River (Photo Credit: Detroit Riverfront Conservancy)

The Contaminated Sediment Remediation Challenge: Complicated Problems that Require Interdisciplinary and Creative Solutions

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Preface

The Potawatomi people were Great Lakes area inhabitants who often chose to live near waterways. Being near water, our communities were able to use the water for fishing, harvesting, and spiritual purposes. It has been our tradition to respect the Earth and strive to cultivate its resources carefully, while also providing a harvest for our families.

The Nottawaseppi Huron Band of the Potawatomi was the most recent nation to occupy the Detroit River region. This region was an important homeland of our ancestors dating back to the 1700s and 1800s. Our ancestors, having been in the region for a long time already, also established a village near Fort Pontchartrain in 1704. In 1732 a Potawatomi Village was established near the present location of Historic Fort Wayne. We recognize our long history in the Detroit River region and have a spiritual connection to it.

One of our goals is to re-establish our living and spiritual presence here. One of the ways we want to do this is to re-establish wild rice. This was part of our migration story. Our teachings and prophecies taught us to migrate west from the east coast before the non-native face arrived prior to 1492. The old ones told the people to leave if the new face comes with cruelty and greed, but if the new face comes in peace and shares love then, that will predict the future of our people. We may live in unity. Consequently, greed and cruelty were the majority face and problem that led the Anishinabek to migrate west to travel to all the sacred locations – our journey to the last location where water grows food. This is the place of the wild rice, the place of the great lakes – Michimackilac or Michgami. This is the Anishinabek migration story and as Anishinabek we are considered one of the Three nations (Ojibway, Ottawa, and Potawatomi). The three nations are formally called the Three Fires confederacy.

We have learned that what grows on the Earth will heal us. And we have been taught to only take what we need and not what we want. It's a natural law to take care of Mother Earth, use the medicine from her, and offer sema (Tobacco) first. We are Bode wadmi (Potawatomi) which translates to fire keepers. The Mnomen (wild rice) is one of the sacred foods we use for our feast. Wild rice is a staple of our ceremonies and diet. It's a sacred food we prepare for our feasts and offerings to the Sacred fire. We feel that this region and all life are sacred. And we have a duty to be good stewards of it. We are all part of the Earth and must take care of it. Please be thankful and honor the Earth at all times and it will take care of our children and grandchildren.

Thank you for the honor of having us open your conference and we look forward to working with you in the future.

wawa smo gishek (my spirit name – lightning in a distance)
Chi migwetch aho! (Big thank you)
Kevin Harris, Cultural Specialist
Nottawaseppi Huron Band of the Potawatomi

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Acknowledgements

The State of the Strait Conference is a biennial meeting convened through a boundary network of Canadian and U.S. agencies, institutions, and organizations promoting ecosystem-based management of the Detroit River and western Lake Erie. Any binational effort covering such a broad scope, by nature, requires considerable collaboration and numerous contributions. The 2022 State of the Strait Conference and this report would not be possible without the generous support of our many sponsors, including:

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We also gratefully acknowledge the members of the steering committee who helped organize and convene the conference. Special recognition is given to Chancellor Domenico Grasso and the University of Michigan-Dearborn staff, especially Tracy Hall, David Disney, and Molly Manley, for their outstanding work on local arrangements and their instrumental role in making the conference such a success. We gratefully acknowledge the University of Michigan's Rackham Graduate School for providing a fellowship to Brianna Ellis to help with this conference and report.

We would also like to thank the speakers and panelists for their outstanding presentations and for sharing their knowledge and ideas that made the conference a success. We also thank those who attended the conference, including local citizens, environmental and conservation organization staff,

researchers, students, and government and industry representatives, for their significant contributions to the conference and this report. Finally, we thank Environmental Consulting & Technology, Inc. and Tennille Newsome for their help with the design and layout of this report.

1.0 Executive Summary

Contaminated sediments continue to limit the ecological recovery of the Detroit and Rouge River ecosystems. In the Detroit River, up to 5.1 million m^3 of contaminated sediments on the U.S. side have been targeted for remediation by state and federal governments. In the Rouge River, scientists are determining just how much contaminated sediment will require remediation. The good news is that the Great Lakes Legacy Act will provide 65% of the funding through federal dollars, with local nonfederal partners providing the 35% match funding.

The 2022 State of the Strait Conference was held at the University of Michigan-Dearborn to review the history and current status of sediment contamination in these two rivers, share other Great Lakes case studies of successful cleanup to identify lessons learned, and explore collaborative approaches and creative financing to continue ecological recovery and support community revival. Experience has shown that cleanup will result in a healthier ecosystem for both wildlife and humans. It was noted that removal of beneficial use impairments and delisting of these Great Lakes Areas of Concern (AOCs) should not be the only goal. Efforts should also be made to ensure that ecosystem restoration improves the lives of people living in the watershed.

Control of contaminants at their source through pollution prevention remains the primary imperative for action. Experience has shown that pollution prevention is much more ecologically sound and cost-effective than contaminated sediment remediation.

The conference noted that the window of opportunity to receive federal funding, through the Bipartisan Infrastructure Law/Great Lakes Legacy Act, for the remediation of nearly 5.1 million m^3 of contaminated sediment on the U.S. side of the Detroit River and additional volumes in the lower Rouge River is narrow – about 4-5 years. If this window of opportunity is missed, there is no guarantee that federal money will be available at these scales in the future. However, U.S. Environmental Protection Agency (EPA) is committed to delisting all U.S. AOCs.

At the conference, U.S. EPA issued a call to action to collaborate on the necessary contaminated sediment remediation to restore all beneficial uses in these AOCs and to realize concomitant community and economic benefits. Conference recommendations include:

- **It is recommended that environmental justice become a key priority in the process of remediating contaminated sediments in the Detroit and Rouge Rivers, including making sure that there is meaningful action and improvement in the ecosystem, community, and lives of underserved residents of Detroit, River Rouge, and Ecorse toward a more sustainable and just society.**

- **It is recommended that a high priority be placed on full remediation of the up to 5.1 million m^3 of contaminated sediment in the Detroit River and the Lower Rouge River Main Stem (turning basin to the cut-off channel) and Old Channel through the Great Lakes Legacy Act.**

- **It is recommended that all relevant stakeholders of the Detroit and Rouge River watersheds work with a deep a sense of urgency to recruit partners to help make the necessary 35% non-federal match on sediment remediation projects.**

- **It is recommended that the State of Michigan fund the Renew Michigan Fund (designed to help fund environmental cleanup and redevelopment) at an adequate level or create a similar mechanism with adequate funding to be able to help meet the non-federal match on Great Lakes Legacy Act projects for the Detroit and Rouge Rivers.**

- **It is recommended that Detroit and Rouge River stakeholders pursue both collaborative funding and creative financing – moving beyond federal and philanthropic grants, including environmental, social, and governance (ESG) and sustainability-linked investment opportunities (e.g., green or impact bonds) to address contaminated sediment remediation in the Detroit and Rouge Rivers that achieves associated social and economic benefits.**

- **It is recommended that Detroit and Rouge River stakeholders and communities develop a unified bold and compelling vision for their watersheds that is carried in the hearts and minds of all watershed denizens and that this is coupled with a complementary investment thesis to help make these watersheds more investable.**

2.0 Introduction

Detroit, Michigan and Windsor, Ontario are the automobile capitals of the United States and Canada, respectively. Both cities have historically been engines of regional and national economic growth and were later considered part of the Rust Belt. In pursuing this level of economic activity and output the region also created great wealth for over a century, though it was not always equitably distributed. Not surprisingly, the health of the Detroit and Rouge Rivers precipitously declined as industry and the metropolitan areas expanded along its shores. This was a time when wealth creation and industrial output dramatically increased at the expense of a healthy and resilient environment as the waterways received the effluent and waste of that production. We are now on the road to supporting a long overdue repairing of the harm that has been done to our regional ecosystem.

During the 1960s, the Detroit River was considered one of the most polluted aquatic ecosystems in the United States (Hartig, 2019). Examples of pollution and resource degradation from the 1960s include: oil spills and pollution killing substantial numbers of waterfowl; the Rouge River catching fire from unabated oil discharges; discharges from industries and municipalities that were not adequately regulated; wastewater treatment plants only providing primary treatment with disinfection; Detroit's regional combined storm and sanitary sewer system discharging more than 117.3 billion liters of untreated wastewater per year from combined sewer overflows; the macrobenthic invertebrate community being highly degraded throughout large portions of the river; no bald eagles, peregrine falcons, or osprey reproducing in the watershed; and lake sturgeon and lake whitefish not spawning in the river (Hartig et al., 2020a; 2021).

Starting in the 1960s and growing in the 1970s, public outcry over pollution culminated in the enactment of many important environmental laws and a binational agreement, including the Canada Water Act of 1970, the U.S. National Environmental Policy Act of 1970, the Canada-U.S. Great Lakes Water Quality Agreement of 1972, the U.S. Clean Water Act of 1972, the U.S. Endangered Species Act of 1973, and the U.S. Toxic Substances Control Act of 1976. These laws, the Agreement, and complementary state, provincial, and local programs such as Remedial Action Plans initiated in 1985 to restore Great Lakes Areas of Concern (AOC), provided the framework and impetus for investing billions of dollars on pollution prevention and mitigation over the last 50 years. We came to a point where a sliver of the wealth that was created needed to be put to work to clean up that which we nearly destroyed.

Water and sediment monitoring has now documented that the changes made and investments related to regulation and restoration have remarkably improved water quality in the Detroit River since the 1960s resulting in the return of bald eagles, peregrine falcons, osprey, lake sturgeon, lake whitefish, walleye, beaver, and river otter (Hartig et al., 2020a; 2021). However, despite this success, further improvements in aquatic ecosystem health are limited by legacy pollution commonly referred to as contaminated sediments (Ellison et al., 2020). With concerted effort and attention, these remaining impediments to a revitalized and vibrant environment can be removed. While there is more work to do, we have shown that these efforts and the resilience of the Great Lakes can ensure healing from the abuses of the past.

The State of the Strait Conference (SOS) is a Canada-U.S. forum held every two years that brings together government managers, researchers, students, business representatives, members of environmental and conservation organizations, and concerned citizens to assess ecosystem status and provide advice to improve research, monitoring, and management programs for the Detroit River and western Lake Erie. The Conference now has a 24-year history of documenting and supporting transboundary cooperation to better inform ecosystem-based management of these shared waterways. A summary of past SOS meeting themes is provided in Table 1.

Table 1. Biennial State of the Strait Conferences and themes, 1998-2022.

Date	Conference Theme	Reference
1998	Rehabilitating and conserving Detroit River habitats	Tulen et al., 1998
1999	Best management practices for soft engineering of shorelines	Caulk et al., 2000; Hartig et al., 2001
2001	Status and trends of the Detroit River ecosystem	Read et a. 2001
2004	Monitoring for sound management	Eedy et al. 2005
2006	Status and trends of key indicators	Hartig et al., 2007; Hartig et al., 2009
2009	Ecological benefits of habitat modification	Hartig et al., 2010; Hartig et al., 2014
2011	Use of remote sensing and GIS to better manage the Huron-Erie Corridor	Francoeur et al., 2012
2013	Setting ecological endpoints and restoration targets	No report
2015	Coordinating conservation in the St. Clair-Detroit River System	Francoeur et al., 2016
2017	Urban Bird Summit: Status, trends, and risks to species that call the corridor home	Francoeur et al., 2018
2019	Assessing ecosystem health of the Detroit River and western Lake Erie	Hartig et al., 2020a; Hartig et al., 2021
2022	Contaminated sediment remediation	This report

In 2019, the research and monitoring leading up to the conference documented that all contaminated sediment remediation identified for use restoration on the Canadian side of the Detroit River had been completed (Sanders et al., 2020), but an additional 5.1 million m^3 of contaminated sediment requires remediation to restore beneficial uses on the U.S. side (Ellison et al., 2020). Further, additional contaminated sediment remediation will be needed on the lower Rouge River. The good news is that the Great Lakes Legacy Act will continue to provide 65% of the necessary funding through federal dollars, with local non-federal partners required to provide the 35% match funding into the foreseeable future. However, such long-term funding is never guaranteed. The successful completion of those projects faces several challenges including: extensive planning to determine which sediments need remediation; identifying match funding to initiate projects; and tracking the outcomes of those remedial efforts within the aquatic, coastal, and human communities surrounding the corridor. While 65% federal funding is a substantial contribution, that still places 35% of the cost burden on communities with fiscal challenges. Further work is needed on how to creatively and collaboratively make the 35% local match so that restoration and revitalization can be realized.

The 2022 State of the Strait Conference was convened at the University of Michigan-Dearborn to address this contaminated sediment challenge. The conference reviewed the history and current status of sediment contamination in the Detroit and Rouge Rivers, shared other Great Lakes case studies of successful cleanup to identify lessons learned, and explored collaborative approaches and creative financing to continue ecosystem recovery. Experience throughout the Great Lakes has shown that contaminated sediment cleanup will result in a healthier ecosystem for both wildlife and humans, and can be a catalyst of waterfront revitalization (Hartig et al., 2020b). This report provides an overview of the conference discussions and a summary of key findings and recommendations.

This opportunity and challenge are best framed by the questions “Where have we come from?”, “Where are we now?”, and “Where do we want to be in the future?”. Think of this as being part of an arc – a storyline. Detroit became the Arsenal of Democracy to help win World War II in part due to its location and access to raw materials and the ability to use the lakes for supply and transportation. However, these factors left a crushing legacy of pollution in the form of contaminated sediments and ruined shorelines and habitat. Now, for more than 20 years, investments in science have helped us to understand the severity and geographic extent of this problem and to evaluate remedial options. While the remediation of contaminated sediments has begun, much more is needed – up to 5.1 million m^3 in the Detroit River and additional volumes in the Lower Rouge River Main Stem (turning basin to the cut-off channel) and Old Channel. The key question is how to ensure that these sediment remediation actions propel us toward more sustainable communities that provides justice for all.

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3.0 Where We Have Come From – Growing the Industrial Age

Detroit played an important role in facilitating the settlement of the west. By the late-1700s and 1800s Detroit had become a major center of trade and commerce. As both a way station and an embarkation point for the lands farther west, Detroit felt the tremendous stirrings of the continent (Hatcher 1945). Metropolitan Detroit helped address the immediate and pressing demand for transportation of passengers and freight by becoming one of the greatest shipbuilding ports in the United States, given its strategic location within the Great Lakes, its position as a center of commerce, and the availability of essential resources.

Detroit's first shipyard was constructed by the British in 1760 to produce armed naval vessels and commercial sailing craft. By logical extension, Detroit soon became a major center for the production of paint varnish, steam, and gasoline engines, metal pipe and parts, and over 100 other marine parts. By the 1890s, more ships were built along the Detroit River than in any other city in America. The significance of the Detroit River as a transportation corridor became manifest on December 3, 1819 when the Detroit River was declared a public highway by an Act of Congress. In addition, more passenger travel went out of Detroit in the 1890s than anywhere in the world. Shipbuilding provided jobs and supported families locally, but it also had a significant impact on the region, the nation, and the world. Over the years these ships would help further and enable billions of dollars of commerce and trade.

Metropolitan Detroit's expertise in building steam engines for ships and practical experience in manufacturing coaches and carriages positioned it well for becoming a leader of automobile manufacturing. This technological capacity and practical experience enabled Henry Ford, Ransom Olds, the Dodge Brothers, and other entrepreneurial automakers to put together their first models with off-the-shelf parts.

Detroit's first car company started in 1899. However, it did not take long for automobile manufacturing to take off. Henry Ford believed that cars should be affordable to everyone. To help achieve that goal, he created more efficient manufacturing systems, including assembly lines. By 1913 the industry grew to the point where there were 43 different automobile companies operating in the Detroit area. In 1914, Henry Ford announced that pay for an eight-hour shift in his Highland Park plant would be $8 per day (Cowles 1975). Henry Ford's practice of providing loans to consumers to buy cars made the Model T affordable to the middle class. Ford's most well-known factory was the Rouge Plant (opened in 1915) which included 93 buildings, 1.5 km^2 of factory floor space, 160 km of interior railroad track, and more than 190 km of conveyors, all housed on 810 ha alongside the Rouge River. Automobile manufacturing would soon dominate the economy of the Detroit area. In 1904, 3.8% of Detroit's 60,554 industrial employees were employed in the automobile industry (Holli 1976). In 1919, 45% of Detroit's 308,520 industrial employees were employed in the automobile industry. Detroit became the Motor City and one of the largest industrial manufacturing centers in the world. By the early 1930s Ford was the single largest employer of African American workers in the country.

Following the Japanese attack on Pearl Harbor in 1941, the United States plunged into World War II. President Roosevelt recognized the need to help supply Europe with the implements of war and implored Americans to stand up as the "Arsenal of Democracy" as though it was their own war (Pringle, Section 9.1). The president called on the nation to unite with swift cooperation in producing vast shipments of weaponry to aid Europe. Detroit responded by redeploying its vast industrial capacity from automobile production to rapidly produced jeeps, M-5 tanks, and B-24 bombers, playing a critical role in the ultimate Allied victory in 1945 (Davis, 2007). Metropolitan Detroit companies received contracts worth about $14 billion or 10% of all U.S. military output in 1943 (Pringle, Section 9.1). Ford Motor Company's Rouge Plant was converted into a tank arsenal and by the summer of 1944, its Willow Run plant cranked out one B-24 Liberator Bomber an hour and contributed to Metropolitan Detroit becoming the leading supplier of military goods in the United States. Approximately 610,000 people across the region were employed in this military production that ranged from ball bearings to bombers and trucks to tanks. In total, the region responded to the "Arsenal of Democracy" paradigm shift by tapping its manufacturing capability and technical expertise to produce about $29 billion of military output between 1942-1945, significantly helping the military contribute to an Allied victory.

But Detroit being an unparalleled leader of shipbuilding for 100 years, the "Silicon Valley" of the industrial age, and the unquestioned leader of the Arsenal of Democracy would have unintended consequences. There were no major environmental regulations throughout these periods, which occurred before the U.S. National Environmental Policy Act of 1970, the Canada Water Act of 1970, the U.S. Clean Water Act of 1972, the Canada-U.S. Great Lakes Water Quality Agreement of 1972, and the U.S. Endangered Species Act of 1973. One of the major unintended consequences was contaminated sediments of the Detroit and lower Rouge Rivers. Contaminated sediments are often called legacy pollution because these industrial chemicals remain in the ecosystem long after they were first introduced, resulting in detrimental effects on flora, fauna, and people. Therefore, contaminated sediments became the focus of this year's State of the Strait Conference.

In 1985, as a result of a recommendation of the International Joint Commission's Great Lakes Water Quality Board, the Canadian and U.S. federal governments, in cooperation with the eight Great Lakes states and the Province of Ontario, committed to developing and implementing Remedial Action Plans to restore impaired beneficial uses in 42 AOCs, including the Detroit and Rouge Rivers. In the early 1990s, the U.S. Environmental Protection Agency (EPA) initiated the Assessment and Remediation of Contaminated Sediment (ARCS) Program to evaluate the severity and extent of sediment contamination at chosen sites on the Great Lakes, recommend approaches to measure the effects of these contaminants on aquatic life, recommend approaches to assess risks to wildlife and human health posed by the contaminants, and test technologies that might be used to clean up these contaminated sediments. In Canada, a Canada Ontario Agreement Sediment Committee was also formed in 1989 to provide guidance and funding to Remedial Action Plan teams for sediment assessment in AOCs. Soon after, the Canadian federal government created the Contaminated Sediment Removal and Contaminated Sediment Treatment Technology Programs to assist Remedial Action Plan teams with addressing contaminated sediment by demonstrating new technologies.

4.0 Where Are We Now

Not only is it important to know where we have come from and how we have ended up with such substantial contaminated sediment problems, but it is also important to provide a proper assessment of where we are now in terms of the severity and geographic extent of contaminated sediment in the Detroit and Rouge Rivers in order to develop plans to remediate contaminated sediment hotspots and realize concomitant ecosystem health, community, and economic benefits.

4.1 Contaminated Sediments on the Canadian Side of the Detroit River

Over the past several decades, legislation and pollution prevention and control programs have been enacted on both the Canadian and U.S. sides of the Detroit River to reduce the amount of contaminants entering the water. As a result, improvements are being measured in sediment quality, particularly on the Canadian side. Where "severe effects levels" contamination exists, it is localized in nature, indicating that severe biological impairment, due to contaminated sediment on the Canadian side of the river, is unlikely (Serran and Drouillard, Section 9.2). Therefore, there have been no sediment remediation projects in the Canadian waters of the Detroit River to remove contaminated sediment.

There has been one sediment remediation project in Turkey Creek – a subwatershed of the Detroit River. In 2008, 975 m^3 of sediments contaminated with heavy metals and polychlorinated biphenyl (PCBs) were excavated to a target PCB concentration of less than 1µg/g (parts per million) in the Grand Marais Drain upstream of Walker Road (Serran and Drouillard, Section 9.2). Reductions in PCB concentrations in sediments and water decreased bioavailability, and reduced metal concentrations in sediment were observed in the Turkey Creek Grand Marais Drain in 2012 when a study was conducted to determine the success of the sediment remediation.

A decline in contaminants (and thus toxicity) in sediments in the Detroit River AOC has also resulted in the improvement of benthic invertebrate communities throughout the river. In part, this is because of Canadian and U.S. environmental laws and pollution prevention and control programs. Research has shown that potential benthos impairment on the Canadian side of the Detroit River is highly localized, with the vast majority of the Canadian portion of the AOC demonstrating no evidence of biological impairment, and sediment "Contaminants of Primary Concern" are below provincial "Severe Effects Levels" (Serran and Drouillard, Section 9.2). The vast majority of the Canadian side of the Detroit River also shows minimal benthos impairment and potential for bioaccumulation. Therefore, benthic communities are considered to have now recovered to a point where they meet the restoration criteria which indicate that they are no longer impaired on the Canadian side of the Detroit River. As a result, the status of the "Degradation of Benthos" beneficial use impairment was changed from impaired to not impaired in 2020.

4.2 Contaminated Sediments on the U.S. Side of the Detroit River and in the Rouge River

As noted earlier, Metropolitan Detroit has a long history of industrial and municipal development that has left a legacy of contaminated sediment in the Detroit and Rouge Rivers. In order to identify remediation sites, the Detroit River AOC Public Advisory Council (PAC) and the Friends of the Detroit

River partnered with the University of Windsor, U.S. EPA, Michigan Department of Environment, Great Lakes, and Energy (EGLE), and others in 2012 to gather and review all the existing data on Detroit River sediment, some dating back 40 years. These data were used to create hazard index maps to show the risk factor for the three most concerning contaminants in the river: mercury, polycyclic aromatic hydrocarbons (PAHs), and PCBs (Figure 1). These hazard index maps were used to develop a weight-of-evidence approach to develop areas for characterization in the Detroit River.

Beginning in 2013, the U.S. EPA and EGLE conducted a series of sediment characterization investigations which were completed in 2018. These surveys characterized nearly the entire western shoreline of the Detroit River for contaminants, including PCBs, PAHs, and metals. Information gained from these sampling efforts was used to delineate known areas of contaminated sediment, referred to as sediment remediation targeted areas (Figure 2). A total of six sediment remediation targeted areas were identified and explored with additional sampling to further refine areas that may require remediation. These sediment remediation targeted areas, from upstream to downstream, have been designated as: Harbortown Upstream, Harbortown, Riverbend, River Rouge-Ecorse Shoreline, Mid-Lower Trenton Channel (i.e., Monguagon Creek, former McLouth Steel site, and Elizabeth Park), and the Celeron Island/Gibraltar canals.

Following the analysis of the field data, each hot spot was evaluated using a set of criteria which included several factors: chemical concentration, potential toxicity, presence of bioaccumulative chemicals, and potential volume of contamination. These factors were scored and evaluated within each targeted area. The sites were then discussed with the Detroit River PAC as well as with other experts from the U.S.EPA, EGLE, and the University of Windsor. These targeted sediment remediation sites were approved by this committee as sites for future remedial investigation.

EGLE and U.S. EPA continue to investigate these sediment remediation targeted areas within the Detroit River. U.S. EPA and EGLE have entered into a Cooperative Agreement, funded by the Great Lakes Restoration Initiative, to conduct remedial investigations of the sediment remediation targeted areas. Sediment investigations were conducted in 2021 along the former McLouth Steel and Grosse Ile shorelines which is within the Mid-Lower Trenton Channel sediment remediation targeted area. In 2022, EGLE and U.S. EPA completed additional remedial investigations in the Harbortown Upstream and Riverbend areas.

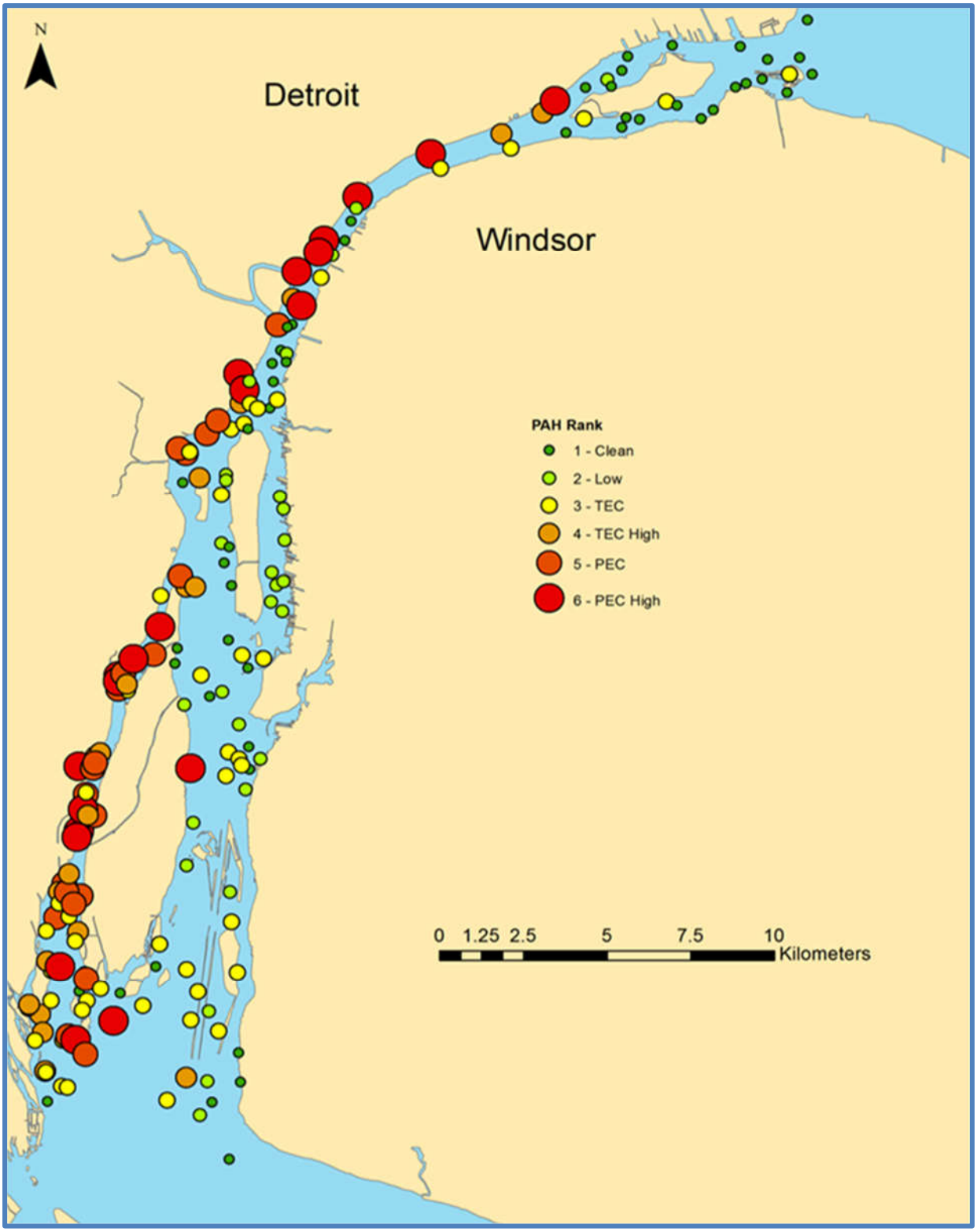

Figure 1. PAH Hazard Categories developed by the University of Windsor, from Detroit River AOC PAC, EGLE pass through grant (hazard map generated by A. Grigicak-Mannion of University of Windsor's Great Lakes Institute for Environmental Research using data reported by Szalinska et al., 2013).

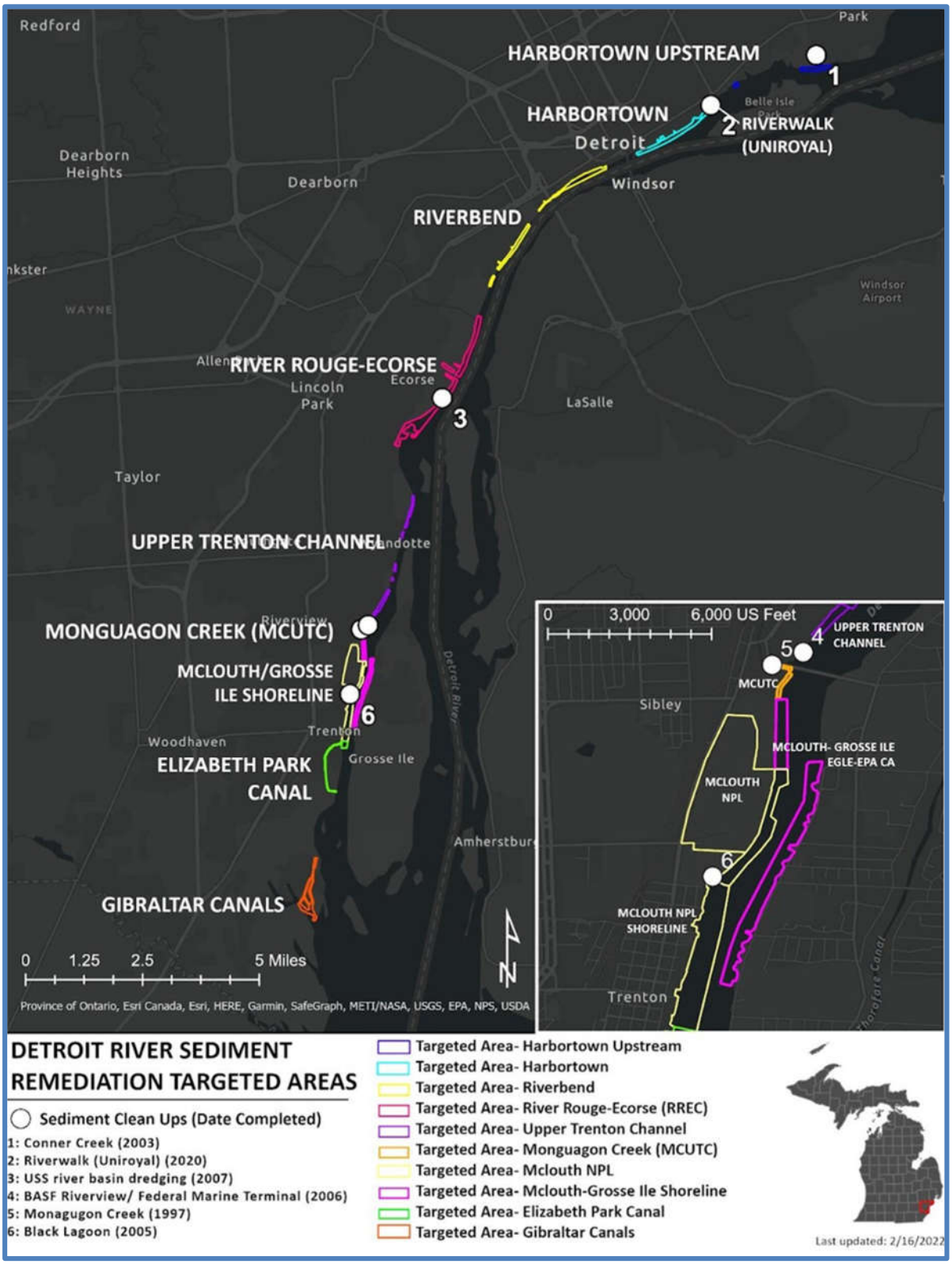

Figure 2. Map of Detroit River AOC sediment remediation targeted areas (Noffke, Section 9.3).

During 1993-2020 there have been eight sediment remediation projects in the Detroit River addressing about 274,000 m^3 of contaminated sediment at a cost of approximately $40 million (USD) (Table 2). There are an additional three projects currently underway that will address another 218,000 m^3 of contaminated sediment: Upper Trenton Channel, Monguagon Creek/Upper Trenton Channel, and Ralph C. Wilson, Jr. Park in Detroit. Future sediment remediation projects in the Detroit River include investigations into Harbortown Upstream, Harbortown Shoreline area, Riverbend Shoreline area, River Rouge/Ecorse Shoreline area, Elizabeth Park Canal area and the Gibraltar Canals area.

Table 2. Contaminated sediment remediation in the U.S. portion of the Detroit River, 1993-2020. Note all funds are in U.S, dollars.

Location or Site	Nature of Project	Volume of Sediment	Year	Estimated Cost
Elizabeth Park Marina	Dredging and disposal	3,100 m^3	1993	$1.3 million
Monguagon Creek – Riverview	Dredging and disposal	19,300 m^3	1997	$3 million
Conner Creek	Dredging and disposal	111,630 m^3	2004	$4 million
Black Lagoon – Trenton Channel	Dredging and disposal	88,440 m^3	2004-2005	$9 million
U.S. Steel	River basin dredging and disposal	11,500 m^3	2007	Unknown
BASF Riverview	Removal of contaminated soils, creation of an on-site disposal cell with an inward hydraulic gradient, removal and disposal of contaminated sediments, and creation of shoreline habitat and 0.4-ha of fish spawning habitat	30,000 m^3	2007-2008	$19.5 million
Refuge Gateway's Monguagon Creek – Trenton	Dredging and disposal	70 m^3	2008	$0.15 million

Location or Site	Nature of Project	Volume of Sediment	Year	Estimated Cost
Old Uniroyal Site near MacArthur Bridge	Capping	Approximately 9,940 m^3 of sediment along 640 m of shoreline (isolate, stabilize, and cap with clean material)	2020	$2.9 million
Ralph C. Wilson, Jr. Centennial Park	Capping contaminated sediments and creation of shoreline habitat	Approximately 23,000 m^3 of river sediments	2022-2023	$17 million

Between 1986 and 2020 there has been 396,800 m^3 of contaminated sediment remediated in the lower Rouge River at a cost of $62.75 million (USD) (Table 3). A cooperative agreement has been signed between the U.S. EPA and EGLE to undertake the necessary remedial investigation work on the Lower Rouge River Main Stem.

Table 3. Contaminated sediment remediation in the Rouge River, 1986-2020. Note all funds are in U.S. dollars.

Location or Site	Nature of Project	Volume of Sediment	Year	Cost
Lower River near Double Eagle Steel	Dredging and disposal	30,000 m^3	1986	$1 million
Evans Products ditch	Dredging and disposal	7,300 m^3	1997	$750,000
Newburgh Lake	Dredging and disposal	306,000 m^3	1997-1998	$11 million
Lower River – Old Channel	Dredging and disposal	53,500 m^3	2019-present	$50 million

5.0 Where Do We Want To Be

Successful remediation of contaminated sediment will require both thorough scientific assessment of the severity and geographic extent of the problems (Noffke, Section 9.3; Ellison, Section 9.4) and modeling to predict the response of the ecosystem and recovery of key beneficial use impairments (Drouillard and Grgicak-Mannion, Section 9.7) once the restoration actions have been completed. As the old adage states: first direction, then velocity.

U.S. EPA and EGLE have identified that up to 5.1 million m^3 of contaminated sediment in the Detroit River require remediation to meet long-term goals of restoring beneficial uses (Ellison et al., 2020). That does not mean every molecule or atom of contamination is to be removed, but enough so that the system can heal and function well over time. Work is also now underway to identify how much contaminated sediment requires remediation in the lower Rouge River (Luke, Section 9.5; Tewkesbury, Section 9.6). These contaminated sediment "hot spots" in both the Rouge and Detroit Rivers likely contribute to biomagnification of contaminants in fish and birds and to impairments in the benthic macroinvertebrate community. High priority needs to be placed on remediation of contaminated sediment along the U.S. shoreline of the Detroit River and within the Lower Rouge River Main Stem. The best opportunity to achieve this remediation is through the U.S. federal programs of the Great Lakes Restoration Initiative and Great Lakes Legacy Act, in partnership with local sponsors. If successful, this effort could remove all of the remaining beneficial use impairments and will be a huge step in the eventual delisting of both of these AOCs. While delisting is the administrative marker or goal, the return of the rivers to healthy status is the desire. For it is healthy waters that enable and support healthy and vibrant communities and economies. We must ensure that ecosystem restoration improves not only the ecological health but the lives of people living in and along the waterways.

A recent example of joint investment in remediation and accessibility is the Detroit RiverWalk. Cleanup of the Detroit River has helped catalyze a total transformation of the waterfront, including the creation of an 8.8-km Detroit RiverWalk to provide public access. The investment of over $80 million (USD) in the first 10 years, including a $60 million (USD) endowment for long-term operation and maintenance, has already returned over $1 billion (USD) of public and private sector investments. Mark Wallace, President and Chief Executive Officer of the Detroit Riverfront Conservancy, notes that "without this early focus on cleaning up the river and improving water quality, this transformation of the river's edge would not have been possible."

In the lower Rouge River contaminated sediment remediation could also be a catalyst for integrated solutions that address all the problems in the lower river. For example, there are many similarities between the lower Rouge River in metropolitan Detroit and the Don River in Toronto, Ontario. Both were and are working rivers that supported industry and commerce, were polluted waterways that were designated Great Lakes AOCs, and were infamous for catching on fire. However, the lower Don River is currently going through an ecological transformation and restoration that could help inform what could be done for metropolitan Detroit's lower Rouge River. Don River stakeholders developed a shared bold vision to address everything at once: remediation, restoration, revitalization, community integration, and economic benefit. The Don River naturalization project cost was $1.25 billion (CAD), but economic benefits have been projected to include $1.1 billion (CAD) in construction

value to the Canadian economy and $4-5 billion (CAD) of potential new development on land that would otherwise be undevelopable. With the imminent provision of federal money to clean up contaminated sediments in the lower Rouge River, stakeholders have a unique opportunity to transform this waterway into a 21st century model of sustainable redevelopment, where contaminated sediments are remediated, habitats restored, stormwater properly managed, green and sustainable industry flourishes, people are reconnected to the lower river through greenways, and where the river forms the basis of play, recreation, and celebration and interpretation of history and culture.

It should be noted that Great Lakes Restoration Initiative has funded other AOC projects that included improving public access for community benefit. For example, a kayak launch was constructed with Great Lakes Restoration Initiative funding as part of habitat restoration in Belle Isle Park's Lake Okonoca. Similarly, as part of a $1.46 million (USD) habitat restoration project at Belle Isle Park's Blue Heron Lagoon, a new pedestrian bridge was built to improve public access. Such projects are precedents for accessing some Great Lakes Restoration Initiative funds targeted for habitat restoration (following sediment remediation) in the Lower Rouge River for improving public access to the river. Improving public access and recreation are important tenets of the Rouge River Gateway Master Plan designed to advance redevelopment projects that achieve the goals of ecosystem restoration, heritage preservation, increased recreation, and economic development along the lower river (Cave et al., 2004).

We believe that future State of the Strait Conferences, while still focused on ecological restoration, can highlight and stimulate further visioning and consideration of the future of the rivers and waterfronts as restoration efforts accelerate and improvements manifest.

5.1 Environmental Justice

Clean water and healthy ecosystems are basic human rights. Despite improvement in the water quality of the Detroit River, exposure to contaminants and pathogens continues to disproportionately affect communities of color. There is an urgent need for the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws and policies, i.e., environmental justice.

Communities like Southwest Detroit, River Rouge, and Ecorse have been waiting for decades for consequential responses to long-standing issues of poor air quality, contaminated sediments, contamination associated with industrial brownfields, noise pollution from truck traffic, and water inequity. These underserved residents deserve meaningful action and improvement in their ecosystems, communities, and lives, and to see movement toward a more sustainable and just society. Through efforts to remediate contaminated sediment, we need to make sure that meaningful progress is made toward environmental justice as well.

At the conference, Monica Lewis-Patrick of We the People of Detroit painted a vivid picture of historic and on-going environmental racism and injustice. She promotes the use of State Revolving Funds to build connective tissue and collective power, create jobs, and fill local and regional budgetary gaps (Lewis-Patrick, Section 9.8). We the People of Detroit have been working diligently to get technology to those who are most impacted by environmental injustice. Southwest Detroit, River

Rouge, and Ecorse should be made priorities in the new Justice40 Initiative that is designed to deliver the benefits of hundreds of federal programs to communities that are marginalized, underserved, and overburdened by pollution. Further, communication should be improved on how to secure and target these federal dollars and ultimately to tell stories of success from past, current, and future equitable and restorative investments.

Recommendation:

It is recommended that environmental justice become a key priority in the process of remediating contaminated sediments in the Detroit and Rouge Rivers, including making sure that there is meaningful action and improvement in the ecosystem, community, and lives of underserved residents of Detroit, River Rouge, and Ecorse toward a more sustainable and just society.

5.2 Accelerating Sediment Remediation Through Partnerships

The United States is fortunate to have the Great Lakes Legacy Act, authorized in 2002 and first appropriated in 2004, to clean up contaminated sediments in Great Lakes AOCs. Through this Act, we now have 20 years of success in creating public-private partnerships and establishing cost-sharing incentives to remediate contaminated sediment in less time and with more efficiency than could ever have occurred under federal or state regulatory/enforcement programs (Nadeau, Section 9.9; Bridges et al., 2012).

Both the Detroit and Rouge Rivers have already benefited from Great Lakes Legacy Act projects – we know this works. Remediation of the Detroit River's Black Lagoon was completed in 2002, the first fully funded Great Lakes Legacy Act project in the Great Lakes. The Rouge River Old Channel project was initiated in 2019 and is not yet complete. The Uniroyal site project on the Detroit River was completed in 2020. Although the primary goal is the remediation of contaminated sediments, a bonus is habitat rehabilitation and enhancement following sediment remediation. Sediment remediation projects underway include the Ralph C. Wilson, Jr. Centennial Park and the Monguagon Creek-Upper Trenton Channel projects, both on the Detroit River. Great Lakes Legacy Act projects require a non-federal cost-sharing partner. Advice from those involved in completed projects includes the following:

- be creative,
- think big and think outside the box, and
- explore public-private partnerships (Nadeau, Section 9.9).

Experience has shown that following this advice can save significant time and transactional costs (e.g., the number of meetings) and realize substantial community benefits. If we do not accelerate our work, we fall behind and condemn those that have endured contamination to years more of waiting and harm.

In Ohio's Ashtabula River, the use of a public-private partnership was instrumental in achieving $86 million (USD) of sediment remediation that led to the delisting of this AOC in 2021 (Pickard, Section 9.10; Pickard et al., 2021). The Ashtabula River Partnership created the framework and conditions for private sector involvement in the cleanup, established trust, and ensured cooperative learning

necessary for achieving a common goal. Lessons learned from this partnership include engage all major stakeholders, secure long-term technical and scientific assistance, reach agreement on problems and quantitative goals/targets, build a record of success (it took 36 years to clean up the Ashtabula River AOC), and share credit (Pickard, Section 9.10).

At the conference, Scott Cieniawski of the U.S. EPA's Great Lakes National Program Office gave a keynote address on contaminated sediment remediation where he issued a call to action (Cieniawski, Section 9.11). Since 2004, EPA and its partners have completed sediment remediation projects at 30 sites around the Great Lakes at a cost of approximately $1 billion (USD) (Tuchman et al., 2021).

The recently passed U.S. Bipartisan Infrastructure Law provides $1 billion USD ($200 million per year for five years) in additional funding to the Great Lakes Restoration Initiative, the overarching program that also funds the Great Lakes Legacy Act. EPA recently announced that the majority of these funds will be targeted towards cleaning up and restoring the AOCs, including the Detroit and Rouge Rivers. However, to seize this opportunity for potential federal investment, the local, state, and industry partners that are active in the Detroit River and Rouge River AOCs need to come together and provide substantial technical and financial contributions to cost share in the implementation of these important projects.

The contaminated sediment remediation challenges of the Detroit and Rouge Rivers are substantial, including 30 miles of the Detroit River and up to 5.1 million m^3 of contaminated sediment. The Great Lakes Legacy Act is but one part of the solution, though not the sole solution to contaminated sediment problems. The Great Lakes Legacy Act can provide up to 65% of the cost of contaminated sediment remediation projects in AOCs. Non-federal partners are responsible for making the 35% match. The call to action, mentioned above, includes helping recruit non-federal partners, providing suggestions on making match requirements, and more. This must be a creative and urgent process.

U.S. EPA has stated that while cash is the preferred match option, there are other options, including providing material and other project support like staging areas/real estate, landfill space, technical assistance, transportation and disposal services, source control, and habitat rehabilitation and enhancement. U.S. EPA encourages local partners to reach out with creative ideas for making match requirements.

The St. Louis River AOC in Minnesota and the Milwaukee Estuary AOC in Wisconsin provide good examples of making these match requirements and moving forward with substantial sediment remediation (French et al., 2021). For example, in the St. Louis River AOC the Minnesota State Bond program provided $25 million (USD) and active industrial partners have provided $100 million (USD) to help make non-federal match requirements. In Milwaukee, a coalition of partners has provided more than $155 million (USD) to meet the non-federal match requirement for contaminated sediment remediation.

Finally, the window of opportunity for federal funding for necessary contaminated sediment remediation in the Detroit and Rouge Rivers is small – about 4-5 years. The steps in the process are time consuming, including site characterization, remedial investigation, feasibility study, remedial design, design selection, partnership development, implementation of the preferred sediment remediation option project, and post-project monitoring of effectiveness. While it is EPA's stated

planning goal to complete all necessary sediment remediation by 2030, this still remains a tall task. If our region misses this window of opportunity, there is no guarantee that federal money will be available again in the future.

Recommendations:

It is recommended that a high priority be placed on full remediation of the up to 5.1 million m^3 of contaminated sediment in the Detroit River and the Lower Rouge River Main Stem (turning basin to cut-off channel) and Old Channel through the Great Lakes Legacy Act.

It is recommended that all relevant stakeholders of the Detroit and Rouge River watersheds work with a deep sense of urgency to recruit partners to help make the necessary 35% non-federal match on sediment remediation projects.

It is recommended and urged that the State of Michigan fund the Renew Michigan Fund (designed to help fund environmental cleanup and redevelopment) or create a similar mechanism with adequate funding to be able to help meet the non-federal match on Great Lakes Legacy Act projects for the Detroit and Rouge Rivers.

5.3 Creative Funding and Financing

The State of the Strait Conference included a panel discussion on creative funding and financing that was moderated by Jon W. Allan of the University of Michigan and former Director of Michigan's Office of the Great Lakes and included three panelists – Grace Edinger of the Environmental Policy Innovation Center, Dr. Sanjiv K. Sinha of Environmental Consulting & Technology, Inc., and Dr. Peter Adriaens of the University of Michigan's Center for Smart Infrastructure Finance.

The panel discussion was boldly initiated by Jon Allan who stated: "Acts of restoration are not just matters of ecological restoration but are acts of restoring the human soul." He added:

> "They should be viewed as restoring unique places, locations, and communities. They are restorative in terms of community, identity, place, and social fabric. Are we of a place that is degraded and suffers loss or are we of a place where hope and a future is at our fingertips? We need to take up this challenge of restoring not just environments, but communities, economies, and cultures that all are interconnected."

For the sake of conference discussions, a scenario was presented where it could hypothetically cost up to $2 billion (USD) to remediate all remaining contaminated sediments in the Detroit and Rouge Rivers. In this hypothetical scenario, $1.3 billion (USD)(65%) would likely come from federal funding under the Great Lakes Legacy Act and $700 million (USD)(35%) would need to come from local or non-federal match. There is no local "magic pot of money" of that magnitude (or any magnitude) that can meet this obligation and we can't continue to go to the same partners all the time. All of us working on solving this contaminated sediment problem will have to be creative, thoughtful, and inventive regarding how we approach the problem of attaining non-federal match. We also must have a sense of urgency to take full advantage of these Great Lakes Legacy Act funds while they are available. So, on one hand we are telling our communities that there are considerable resources available, but on the other hand saying that it essentially does not apply given the immense size of

the non-federal match burden. But do we act now, or do we wait? Communities have already been waiting for decades for an effective response to this long-standing issue of contamination and the harm caused by it. They need to see meaningful action and improvement in their ecosystem, community, and lives, and to see actions toward a more sustainable and just society. Can we find the path that bridges the need for local match with efforts that build capacity from many entities to meet this pressing and compelling need? We believe so.

Today, we face a massive gap on the funding/financing side. Beginning towards the end of the 20th and now well into the 21st century we are experiencing a massive restructuring of how capital (debt and equity) is moving through society. We also now have environmental, social, and governance investing (often called ESG), green and social impact bonds, and sustainability-linked investment opportunities, and new tools are on the way (see Text Box with an example of issuance of a private finance bond to green up the Greater Buffalo region). The above financial instruments or lenses factor in environmental, social, economic, and cultural factors in measuring the sustainability and ethical/just impact of an investment in a business, company, or project. So, while on one hand we see cleanup as requiring a federal, state, and private set of contributions, we also see it in terms of investment potential – investment in place, community, people.

The panelists argued that we need to look at every opportunity to make up the 35% non-federal match requirements on future sediment remediation projects, including acts/projects that we are already engaged in (e.g., green stormwater infrastructure, habitat rehabilitation, combined sewer overflows, and other related water quality improvements at the local and regional level), and to be thoughtful and creative. Additionally, considering the legacy of racism, abuse, and harm, we also see pathways for society (state and federal) to decrease the local match requirements in cases such as Detroit and in metropolitan areas.

It was pointed out that funding (or fundraising) is not the same thing as financing. Funding is getting government grants or loans towards a stated purpose, but without expected financial returns or costs to the funded entity. In contrast, financing refers to a loan, bond, or other debt obligation, or private equity investment in a project that needs to be repaid, with an interest or other financial return, and thus incurs a cost to the project. The panelists viewed cleanup as both an act of restoration and also investment. Thus, tools of the investment community as well as public funding and philanthropy need to be employed. This includes:

- **environmental or social impact bonds**, an innovative financing tool that uses a “pay for success” approach to provide up-front capital from private investors for environmental projects, either to pilot a new approach whose performance is viewed as uncertain or to scale up a solution that has been tested in a pilot program);
- **green or sustainability-linked bonds**, fixed-income financial instruments which are used to fund projects that have positive environmental benefits (see Text Box on next page);
- **tax increment financing**, an economic instrument that captures the increase in property taxes, and sometimes other taxes, resulting from new development, and diverts that revenue to subsidize that development; and
- others.

Buffalo Sewer Authority issued Nation's largest Environmental Impact Bond and first in Great Lakes region (adapted from Higgins et al., 2021).

In June 2021, the Buffalo Sewer Authority (BSA) issued a $54 million (USD) Environmental Impact Bond (EIB) to incentivize the installation of green infrastructure throughout the city. A special kind of municipal bond, an EIB focuses on the prediction, measurement, and public reporting of environmental outcomes and can include features that link financing terms to the achievement, or non-achievement, of those outcomes.

The proceeds from the BSA EIB will fund the design and implementation of green infrastructure in Buffalo, New York – such as rain gardens, green roofs, stormwater planters, and permeable pavers – to store and control the flow of stormwater, reduce combined sewer overflows, enhance community benefits, and support an estimated 700 local jobs. This approach enables BSA to achieve some of the economic, environmental, and health co-benefits associated with nature-based solutions to stormwater management through its Rain Check 2.0 Program.

The plans for the EIB came together after The Ralph C. Wilson, Jr. Foundation and the Community Foundation for Greater Buffalo funded Ann Arbor-based Environmental Consulting & Technology, Inc. (ECT) to bring newer models of delivery, including alternative financing options, to the Greater Buffalo region. ECT leads Resilience Infrastructure Sustainable Communities (RISC), and in turn, hired Washington D.C.-based Quantified Ventures to explore custom EIB structures that fit this unique program. Quantified Ventures has successfully structured EIBs in other cities, including Washington, D.C., and Atlanta, Georgia, though this issuance was the first EIB in the Great Lakes region. It builds on previous bonds, while tailoring the structure and outcome metrics to the Buffalo context, ultimately benefiting the people, ecosystems, and water resources of the city.

Through this EIB, BSA is the first municipal issuer in the United States to link a positive incentive to performance through an outcomes-based call feature. The Authority set a June 2028 target to achieve the "outcome threshold" of at least 200 acres of impervious surface area (such as asphalt roads) managed by green infrastructure. If the Authority meets the outcome threshold by June 2028, subject to independent verification by a third party, it can call the bonds at par. That is, BSA can refinance the bond or pay off the debt early before the rates in the coupon step portion start to increase.

BSA also plans to track several green infrastructure co-benefits related to environmental justice, workforce development, health, and climate change resilience. This may include metrics associated with local hiring, women and minority business inclusion, air quality benefits, property value benefits, wildlife benefits, and potential greenhouse gas benefits (the vegetation in rain gardens managing one acre of impervious surface will sequester almost 12 tons of carbon per year).

Ultimately, BSA's EIB is designed to provide multiple benefits to the city and its residents and to ensure enhanced data gathering, transparency, and accountability. These features made the issuance attractive to a broad set of investors, including ESG-oriented buyers, and the demand put downward pressure on yield. This is a great model for future, similar initiatives across the Great Lakes region.

Panelists suggested that if we are only looking for traditional funding partners (federal, state, philanthropic, and corporate) to remediate contaminated sediments and not looking at a wide range of related investment and financing instruments that achieve additional community and economic benefits, then we are missing a broad swath of capital resources that have been developed under the umbrella of conservation, green financing, and social impact.

It is also important to think about how to facilitate private investment and incentivize it. It was suggested that "winning slowly is the same as losing" as was observed by McKibben (1989). If restoration takes decades, more degradation is happening as time goes on, harm continues to accrue to those that have felt it the longest, and the opportunity for restoration is missed. To address this, we need to pay for outcomes-based contracting. Instead of paying for environmental services, pay for environmental outcomes.

As an example of community fiscal capacity building, the Norwegian Sovereign Wealth Fund was presented as a case study. Whereas Norway has a population of 5.4 million people and Michigan has a population of nearly 10 million people, Norway has amassed a sovereign wealth fund of $1.35 trillion (USD) set aside by government (from oil and gas revenues) to benefit its economy and citizens for generations to come. The money placed in a sovereign wealth fund comes from the country's reserves that have grown due to budget surpluses, trade surpluses, and revenue gained from exporting natural resources like North Sea oil. Is it worth creating such an investment thesis for investing in environmental, social, and governance in the Great Lakes region? Can a small portion of the wealth output from the use and reliance on the Great Lakes, for instance, be set aside to tend to our legacy contamination and to build capacity to manage the system, once restored in perpetuity? Can we create a wealth fund, derived from economic activity of all manner, to be set aside to fund the management of the very thing we say we love, the rivers and the Great Lakes? If we do not do this, we will always and forever be hostage to annual budgets, annual funding, transient priorities, and project uncertainty. We cannot manage what we cannot pay for. We cannot sustain the rivers and lakes unless we build durable and sustained fiscal mechanisms.

We need to put contaminated sediment in a broader context – for it is a vision we tend to invest in over the long term and not just "projects" per se. Do we have a broad, shared, compelling vision for the Detroit River, Rouge River, and relatedly for the Great Lakes that is carried in the hearts and minds of all watershed stakeholders? For example, Milwaukee, Wisconsin has a laudable goal to be the greenest city in the Great Lakes basin. Toronto wants to be the most sustainable city in North America. What is our compelling vision and actionable thesis for the Rouge and Detroit River systems? Having such a bold vision and a compelling investment thesis to support that vision in perpetuity makes them more interesting, attractive, compelling, and ultimately investable. There isn't enough philanthropic, state, or federal funding to achieve the "closed-eye" vision we all want, in which there are no more use impairments, delisted AOCs, and vibrant communities. These are important steps, but they do not make a compelling long term investable vision. With the restructuring of trillions of dollars of wealth looking for compelling investments worldwide, we will either:

- be a place that attracts that level of (sustainably informed) investment or it will go somewhere else, and the remaining contamination and harm will continue; or
- be a place where the restoration of the Rouge and Detroit Rivers is put in proper context, against the backdrop of a compelling investable proposition that is just, equitable, fair, and

> sustainable, and attracts the kinds of investments (debt and equity) that allow us to create the future we seek, as opposed to one where we suffer a future that is much like the past.

While we must think about leveraged investment that uses borrowed capital to undertake some manner of environmental remediation, we must also tie it to efforts that will achieve social, economic, and cultural benefits.

Recommendations:

It is recommended that Detroit and Rouge River stakeholders pursue both collaborative funding and creative financing – moving beyond federal and philanthropic grants, including environmental, social, and governance and sustainability-linked investment opportunities (e.g., green or impact bonds) to address contaminated sediment remediation in the Detroit and Rouge Rivers and achieve associated social and economic benefits.

It is recommended that Detroit and Rouge River stakeholders and communities develop a unified bold and compelling vision for their watersheds that is carried in the hearts and minds of all watershed denizens and that this is coupled with a complementary investment thesis to help make these watersheds more investable.

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6.0 Concluding Remarks and Recommendations

Contaminated sediments have long been a significant environmental problem in the Detroit and Rouge Rivers. And we have known of this problem for a long time even if we did not fully understand this consequence initially. Ignorance is no longer an excuse.

The control and prevention of contaminants at their source remains an imperative for action. Experience has shown that pollution prevention is much more ecologically sound and cost-effective than environmental remediation. Examples of important programs to prevent any new contaminated sediment problems include: "cradle-to-cradle" design for a circular economy (i.e., a product design approach that seeks to reuse all materials and eliminate waste), Design for Environment, Life Cycle Assessment and Management, and Full Cost Accounting. Such initiatives are consistent with the U.S.-Canada Great Lakes Water Quality Agreement goals of "zero discharge" and virtual elimination of persistent toxic substances.

As was noted and discussed at the conference, the window of opportunity to receive federal funding from the Bipartisan Infrastructure Law for the remediation of nearly 5.1 million m^3 of contaminated sediment on the U.S. side of the Detroit River and additional volumes in the lower Rouge River is small – about 4-5 years. If this window of opportunity is missed, there is no guarantee that federal money will again be available. However, U.S. EPA remains committed to delisting all U.S. AOCs.

As was also noted at the conference, we must all respond to the EPA's call to action to collaborate on the necessary contaminated sediment remediation to restore uses in these AOCs and to realize concomitant community and economic benefits. Conference recommendations include the following:

It is recommended that environmental justice become a key priority in the process of remediating contaminated sediments in the Detroit and Rouge Rivers, including making sure that there is meaningful action and improvement in the ecosystem, community, and lives of underserved residents of Detroit, River Rouge, and Ecorse toward a more sustainable and just society.

It is recommended that a high priority be placed on full remediation of the up to 5.1 million m^3 of contaminated sediment in the Detroit River and the Lower Rouge River Main Stem (turning basing to cut-off channel) and Old Channel through the Great Lakes Legacy Act.

It is recommended that all relevant stakeholders of the Detroit and Rouge River watersheds work with a deep sense of urgency to recruit partners to help make the necessary 35% non-federal match on sediment remediation projects.

It is recommended that the State of Michigan fund the Renew Michigan Fund (designed to help fund environmental cleanup and redevelopment) at an adequate level or create a

similar mechanism with adequate funding to be able to help meet the non-federal match on Great Lakes Legacy Act projects for the Detroit and Rouge Rivers.

It is recommended that Detroit and Rouge River stakeholders pursue both collaborative funding and creative financing – moving beyond federal and philanthropic grants, including environmental, social, and governance and sustainability-linked investment opportunities (e.g., green or impact bonds) to address contaminated sediment remediation in the Detroit and Rouge Rivers that achieves associated social and economic benefits.

It is recommended that Detroit and Rouge River stakeholders and communities develop a unified bold and compelling vision for their watersheds that is carried in the hearts and minds of all watershed denizens and that this is coupled with a complementary investment thesis to help make these watersheds more investable.

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8.0 Appendix A – 2022 Conference Program

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2022 State of the Strait Conference
Program

May 11, 2022, University of Michigan-Dearborn, Engineering Laboratory Building

8:00-9:00 AM **Coffee and Pastries**

9:00-9:30 AM Welcome and introductory remarks, John Hartig and Casey Godwin

- First Nations Opening Prayer and Message: *Michael Medawis, Cultural Department Language Coordinator, Nottawaseppi Huron Band of the Potawatami and Kevin Harris, Cultural Specialist, Nottawaseppi Huron Band of the Potawatami*
- Welcome from UM-Dearborn Chancellor Domenico Grasso
- Remarks from Congresswoman Debbie Dingell
- Remarks from the Canadian Consul General Steve Neves
- Sponsorship Recognition

9:30-10:00 AM Keynote: Detroit as the Arsenal of Democracy. Bill Pringle, Detroit Historical Society

10:00-10:20 AM Contaminated Sediment Remediation on the Canadian Side of the Detroit River and Removal of the Degradation of Benthos Beneficial Use Impairment. *Jackie Serran and Gina Pannunzio (presenter), Detroit River Canadian Cleanup; Ken Drouillard, Great Lakes Institute for Environmental Research, University of Windsor*

10:20-10:50 AM **Coffee Break**

10:50-11:10 AM Characterization of Detroit River Sediments, 2012-2022. *Sam Noffke, Michigan Department of Environment, Great Lakes, and Energy*

11:10-11:30 AM Contaminated Sediment Remediation Completed on the U.S. Side of the Detroit River and the Path Forward on Remaining Sites. *Rose Ellison, U.S. Environmental Protection Agency – Great Lakes National Program Office*

11:30-11:50 AM U.S. Army Corps of Engineers Dredging, Sampling and Authorities to Assist in Contaminated Sediment Remediation. *James Luke, Detroit District, U.S. Army Corps of Engineers*

11:50-12:10 PM Contaminated Sediments in the Rouge River Area of Concern: Past, Present, and Future. *Jennifer Tewkesbury, Michigan Department of Environment, Great Lakes, and Energy*

12:10-1:15 PM **Lunch**

1:15-1:35 PM Food Web Bioaccumulation Model Simulations to Estimate Benefits of U.S. Sediment Restoration Initiatives in the Detroit River. *Ken Drouillard and Alice Grgicak-Mannion, Great Lakes Institute for Environmental Research, University of Windsor*

1:35-1:55 PM Prevailing Environmental Racism and Injustice and a New Vision for Detroit. *Monica Lewis Patrick, We The People*

1:55-2:20 PM Facilitating and Accelerating Sediment Remediation in the Straits Utilizing the Great Lakes Legacy Act. *Steven C. Nadeau, Honigman LLP*

2:20-2:40 PM	Ashtabula River Partnership for Sediment Remediation - Collaborative Efforts to Build Partnerships to Enable Legacy Act Projects. Scott Pickard, *Buffalo District, U.S. Army Corps of Engineers*
2:40-3:00 PM	**Coffee Break**
3:00- 3:30 PM	Keynote: The Great Lakes Legacy Act: Forging a Cleaner Future Through Partnerships. *Scott Cieniawski, U.S. Environmental Protection Agency – Great Lakes National Program Office*
3:30-4:45 PM	Collaborative Financing Panel Discussion Facilitator: *Jon Allan, University of Michigan* *Peter Adriaens, University of Michigan* *Grace Edinger, Environmental Policy Innovation Center* *Sanjiv Sinha, Environmental Consulting & Technology, Inc.*
4:45-5:00 PM	Conference concluding remarks and next steps
5:00 PM	**Reception -** Sponsorship recognition and select comments at reception

A poster session was available during lunch, coffee breaks, and the reception. This session showcased community science projects on the Rouge and Detroit Rivers from local high school students working with Friends of the Rouge and University Prep Schools, as well as a wide range of relevant research projects from university students and faculty.

9.0 Appendix B - Abstracts of conference talks

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9.1 Abstract of Detroit as the Arsenal of Democracy – Bill Pringle

Detroit as the Arsenal of Democracy

Bill Pringle, Detroit Historical Society, billp@detroithistorical.org

On December 29, 1940, President Franklin D. Roosevelt (FDR) delivered one of his famous "fireside chats" to the American public via radio. The United States had not yet entered World War II, but theaters of battle were already ablaze in Europe and the Pacific. To support the nation's allies already at war, FDR called upon the U.S. to become "the great arsenal of democracy," in order to arm and support those fighting against the Axis powers. Detroit, with its robust manufacturing infrastructure, was uniquely suited to meet this challenge, and in its efforts through the next several years truly earned its moniker as *the* Arsenal of Democracy.

In 1940, Detroit's population tallied above 1.6 million people, compared to today's approximate 670,000. It was a multi-national city, with immigrants coming to Detroit for work in great numbers ever since the birth of the auto industry – though such immigration was taking place before the automobile's dominance of Detroit. More recent immigrant groups in the 1940s included folks from Poland, Russia, Greece, Hungary, Czechoslovakia, Austria, Serbia, and more. People flowed into Detroit from other regions of the U.S. as well – Including Appalachia and the rural South. Detroit's varied ethnic web led to degrees of support for the war.

The existing manufacturing infrastructure of not only large automotive operations like Ford's sprawling Rouge Complex or the Packard Plant, but the hundreds of ancillary operations around the city (and region as a whole) – tool and die shops, and even non-automotive businesses – began producing war materiel almost exclusively once the U.S. entered into the war. All civilian automotive production ceased. Instead, firms produced military vehicles, tanks, helmets, ammunition, the thousands of individual parts it takes to produce a bomber, and much more. Beyond turning out weapons of war, Detroit pharmaceutical giant Parke-Davis produced drugs and field dressing that would aid soldiers overseas. Commercial film producer Jam Handy was recruited by the Office of War Information to produce wartime films. Detroit personnel stepped into national roles, such as General Motors' William Knudsen, who became FDR's Director of War Production.

Even with existing manufacturing muscle in place, there were ambitious goals to achieve which necessitated even more output. FDR in early 1942 called for 60,000 planes and 45,000 tanks to be produced that year, with a dramatic increase in 1943. The Willow Run Bomber Plant, an enormous new Ford facility made for building B-24 bombers, began production a mere five months after starting construction. Towards the end of the war, the plant had achieved the lofty dream of pumping out one bomber per hour. Another new wartime production facility was the Chrysler Tank Arsenal in Warren. Over 22,000 tanks were produced at the site, one of the first to receive an Army/Navy "E" award for production efficiency.

Of course, as all over the country Americans had to adjust to wartime life – to rationing, raid drills, new responsibilities, new fears – the people of Detroit dealt with these Homefront troubles in addition to the heat of a city in full production mode. The population swelled with workers arriving to take advantage of the abundant jobs. The wartime industry advanced a new workforce, perhaps most famously bringing women into a new spectrum of work, but also African Americans into jobs

that they had previously been restricted from holding. Additionally, the efforts of elderly folks as well as the differently abled were also critical to becoming the Arsenal of Democracy. But the stresses of a nation at war, racial discrimination, competition for housing and cramped city spaces often led to conflict – including the Race Riot of 1943.

Detroit was awarded about $14 billion worth of contracts, or about 10% of all government wartime spending. For several years the city was truly a production juggernaut, and fulfilled its mission. But it certainly wasn't all smooth sailing.

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9.2 Abstract of Contaminated Sediment Remediation on the Canadian Side of the Detroit River and Removal of the Degradation of Benthos Beneficial Use Impairment - Jacqueline Serran and Ken G. Drouillard

Contaminated Sediment Remediation on the Canadian Side of the Detroit River and Removal of the Degradation of Benthos Beneficial Use Impairment

Jacqueline Serran, Detroit River Canadian Cleanup, serran@detroitriver.ca

Ken G. Drouillard, Great Lakes Institute for Environmental Research (GLIER), University of Windsor, kgd@uwindsor.ca

Background

The Detroit River is a 51 km-long connecting channel that links Lake St. Clair to the western basin of Lake Erie. The river runs through two major urban areas (Detroit, MI and Windsor, ON) and has long been used for industrial and recreational purposes. Over the past 100 years, the shoreline and watershed of the river have experienced a large amount of urban, industrial, and agricultural development. As industry became more intensive, and the watershed more developed, water pollution, loss of habitat, and point- and nonpoint-source pollution became large issues, which led to the Detroit River being designated as a binational Great Lakes Area of Concern (AOC) through the Great Lakes Water Quality Board of the International Joint Commission in 1985 (Green et al., 2010).

Under the AOC program, 14 beneficial use impairments (BUIs, or environmental indicators) were established. The status of these environmental indicators (i.e., impaired or not impaired) was determined for each AOC. In 2010, nine beneficial uses were identified as impaired on the Canadian side of the Detroit River. The status of a number of these impaired beneficial uses, such as Degradation of Benthos, Fish Tumors and Other Deformities, and Fish and Wildlife Consumption, depend on the quality of the sediment in the river. Contaminants such as heavy metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), which were released from industry or entered the river via runoff, have a negative effect on wildlife, benthos, and fish living within the system (e.g., by increasing tumour prevalence in fish) and in humans through the bioaccumulation of toxic substances through the food web. Over the past several decades, legislation has been introduced on both sides of the border to reduce the amount of contaminants entering the Detroit River; however, these legacy contaminants still exist in the sediment.

Contaminants of primary concern

Elevated levels of contaminants have been found in sediments on both the Canadian and U.S. sides of the Detroit River. Thirteen priority contaminants: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc, hexachlorobenzene (HCB), dichlorodiphenyldichloroethylene (DDE), PCBs, and PAHs, represent the key contaminants of primary concern (COPCs). Many of these 13 COPCs exist naturally in the environment in trace amounts, however, observations of elevated concentrations are principally a result of anthropogenic discharges. Furthermore, each of these 13 COPCs has demonstrated toxic effects, resulting in biological impairment at high levels. In 1993, the Ontario Ministry of the Environment established Provincial Sediment Quality Guidelines (Fletcher et al., 2008), which determined the thresholds above which adverse effects will be experienced by various sediment-dwelling organisms. The Lowest Effect Level (LEL) of contaminants of potential

concern is the threshold of contaminants above which the most sensitive species may experience adverse effects; the Severe Effect Level (SEL) is the threshold above which ecological detriment to the majority of species will begin to be observed.

Contaminated sediment on the Canadian side of the Detroit River

Sediment samples were analyzed from the Detroit River AOC in 1999, 2001, 2009, and 2013 to determine whether contaminant levels exceeded SELs (Drouillard et al., 2010; 2014; 2015). Results show that there has been a general decline in SEL exceedances on both sides of the river and since 1999, only one SEL exceedance has been recorded (in 2013) on the Canadian side of the river (Drouillard et al., 2014; Table 1). The hot spots of contaminant accumulation were located along the American shoreline upstream of Belle Isle and downstream in the Trenton Channel, which is consistent with previous studies (i.e., Thornley and Hamady, 1984). The one Canadian site that had SEL exceedances in 2013 for chromium, lead, and copper was located near the Ambassador Bridge, just inside of the Canadian border (Drouillard et al., 2014; 2015).

Table 1. Summary of Severe Effect Level exceedances recorded in Canadian and American waters from 1990-2013. Columns labeled 'SEL' denote the number of SEL Exceedances; columns labeled 'Sites' denote the number of sites surveyed.

	1999		2001		2009		2013	
	SEL	Sites	SEL	Sites	SEL	Sites	SEL	Sites
Canada	9	74	0	10	0	34	1	37
United States	14	73	2	6	6	39	3	37

Sediment remediation projects

There has been one sediment remediation project in Turkey Creek (a subwatershed of the Detroit River). From 2001 to 2008, a series of studies were undertaken to determine the extent of historical and ongoing sources of PCB contamination within the watershed. During the 2001 sampling campaign, PCB concentrations exceeded provincial water quality objectives in each water sample collected during a 28-day time-integrated period. Trace metals also exceeded provincial objectives, with both trace metal and PCB concentrations increasing in the upstream reaches of Turkey Creek, indicating a potential contaminant source upstream. In 2005, the upstream reaches of Turkey Creek and the Grand Marais Drain were targeted for sampling to delineate areas of contamination and determine the bioavailability of PCBs. Water, sediment, soil, and young-of-year fish sampling were performed, and semi-permeable membrane devices were deployed from Walker Road to Central Avenue to track contaminants. Results showed that ongoing sediment transport and resuspension processes were maintaining an increased bioavailability of PCBs to organisms within the creek, that there were elevated PCB concentrations within the banks of the creek, and that just over 200 m of creek bed and banks were the likely contributors to the overall contamination in the Turkey Creek-Grand Marais drain. In 2008, 975 m^3 (34,500 ft^3) of sediments contaminated with heavy metals and PCBs were excavated to a target PCB concentration of less than one µg/g in the Grand Marais Drain upstream of Walker Road. Reductions in PCB concentrations in sediments and water, decreased bioavailability, and reduced metal concentrations in sediment were observed in the Turkey Creek Grand Marais Drain in 2012 when a study was conducted to determine the success of the sediment remediation. Overall, contamination at the mouth of the creek into the Detroit River has improved, although it is unclear as to whether this is a direct result of the remediation work.

Dredging for navigational purposes

While no locations have been identified for remedial dredging, dredging of sediments does take place in one area of the lower Canadian Detroit River for navigational purposes. The Canadian Coast Guard division of Fisheries and Oceans Canada currently assumes responsibility for these dredging projects. Today, routine maintenance dredging is conducted at least once every ten years to remove accumulated sediment to ensure that navigational channels are maintained at design depths (DFO, 2019). In the Detroit River, the Restrictions on Dredging Activities BUI was designated 'impaired' in the 1991 Stage 1 Remedial Action Plan Report because disposal of sediment on the Michigan side of the Detroit River and in the lower section of the Canadian side were not suitable for open water disposal because of heavy metals, PCBs, and contaminants. The Ontario Provincial Sediment Quality Guidelines came into effect in the early 1990s after this BUI was identified in most AOCs and, as a result, the regulations and practices for management of dredged material have evolved and improved significantly. Sediment analyses of dredge spoils from 2002 and 2007 show that the sediment quality of the dredged material from the Canadian side of the Detroit River has remained consistent from year to year, with minor exceedances of Provincial Sediment Quality Guidelines Lowest Effect Levels (LEL) for arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc, total organic carbon, total Kjeldahl nitrogen, and total phosphorus. In 2002, six samples showed LEL exceedances for several PAHs, as well as trace amounts of PCBs. Due to these exceedances and the high silt content which limits upland beneficial reuse, the dredged sediment is disposed of in a conveniently located confined disposal facility. No contaminants approached the Severe Effect Levels. Regulatory oversight in navigational dredging projects is achieved through the federal and/or provincial environmental protection legislation and approval process. Many jurisdictions now recognize that open water disposal is not without adverse environmental impacts, regardless of the contaminant level of the dredged material. In 2013, draft guidance from the Canada-Ontario Agreement federal and provincial remedial action plan management was produced. This guidance says:

"Restrictions on Dredging Activities" BUI may be considered "not impaired" in AOCs where dredging for commercial navigation may be undertaken and the agency responsible for the dredging activities requires that the dredged material be disposed of in an existing, regulated management facility in accordance with provincial and/or federal guidelines and regulations.

Based on this guidance, the status of the Restrictions on Dredging Activities BUI on the Canadian side of the Detroit River was officially changed to not impaired in April 2019.

Degradation of benthos beneficial use impairment

Benthos communities have been negatively affected by pollution and sediment contamination in the Detroit River for decades. Benthos are a group of organisms made up of aquatic worms, insects, and other invertebrates, which inhabit the bottom of lakes and rivers. Many benthos feed on algae, detritus (organic litter) or other benthos, and are a key source of food for fish, frogs, and other wildlife. Since benthos live in or near the sediment at the bottom of lakes and rivers, they respond to changes in sediment quality and are an important environmental indicator.

The Degradation of Benthos Beneficial Use Impairment (BUI) was designated as impaired for the Detroit River due to evidence that benthic community composition was degraded in several areas. The Detroit River Canadian Cleanup (DRCC) established two delisting criteria for this BUI. When

these criteria are met, the benthos community within the Detroit River would be considered no longer impaired. These criteria were:

1. When the benthic community composition is temporally and spatially identified as non-impaired based on an objective and quantitative community analysis and/or a comparison to appropriate reference sites within the river; and
2. When benthic organisms analyzed for persistent, bioaccumulative substances (e.g., PCBs and mercury) are below thresholds to protect fish and wildlife.

To determine whether the delisting criteria were met for the Canadian side of the Detroit River, four key lines of evidence were examined: sediment chemistry, bioaccumulation potential, sediment toxicity, and impairment of benthic community composition. More information about the analyses described below can be found in MacDougall and Drouillard (2020).

Sediment chemistry. Individually, COPCs represent important drivers of stress, however, it is possible that the COPCs may have synergistic or additive effects when co-occurring, resulting in detrimental effects below the SEL for any single COPC. McPhedran et al. (2016) recommend the use of the Hazard Score Approach (HZD) as an index approach to summarizing the cumulative effects of COPCs at a given site. The HZD approach assigns an effect value for each contaminant observed based on the relationship between the observed sediment chemistry concentration and the theoretical toxicity curve. The HZD score provides a single dimensional stressor value which is used in the assessment of detriment with respect to overall contaminant concentrations.

As previously mentioned, multiple sampling campaigns have been conducted to examine COPCs in Detroit River sediment. Results of these campaigns show that beginning in 1999 and continuing until 2013, there has been a general decline in SEL exceedances in both the Canadian and American waters. Furthermore, since 1999, only one of 81 sites has exceeded SEL on the Canadian side. There have also been no known sources of contaminants on the Canadian side of the Detroit River since 2013. Additionally, the distribution of HZD scores in the AOC has demonstrated continual decrease from 1999 until 2013, suggesting an overall decrease in COPC abundance within the Detroit River AOC.

Bioaccumulation potential. Bioaccumulation potential refers to the likelihood that contaminants found in benthos will be transferred further up the food web, resulting in contaminant concentrations that exceed acceptable fish tissue criteria for the protection of aquatic life or fish consumption criteria for human consumers. Typically, contaminants are retained within an organism, either in lipids or proteins and can persist within the environment and individuals for decades.

Mixed benthos tissue residue samples collected in 2008 and 2013, following methods outlined in Drouillard (2010), examined the relationship between benthos contaminant body burdens and sediment quality for the Canadian side of the Detroit River. Both methylmercury and PCB concentrations observed in benthos tissue residues were compared to the Canadian Council of Ministers of the Environment (CCME) Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota. Tissue residues of PCBs in benthos collected in Canadian sites were all found below the CCME guideline (Table 2). The exceptions were two samples collected from the same location in the upper Canadian waters where a sample of mayfly and mixed benthic

composition had PCB concentrations exceeding the mammalian CCME guideline but below the avian guideline. All other benthic samples collected in Canadian waters were below the PCB-CCME guideline. Further, a significant correlation between PCBs observed in sediments and tissue residues was observed ($R = 0.85$; p-value <0.001). Based on the linear relationship between sum PCB in sediment and benthos, a threshold sediment concentration of 0.074 µg/g dry weight has a likelihood of generating benthos-PCB bioaccumulation above CCME guidelines. For the 2013 sediment survey, only one of 33 Canadian survey stations exceeded this threshold.

For methylmercury, one of the seven sites examined within the Canadian portion of the AOC was found to exceed the CCME guideline. The remaining sites were found to have benthos methylmercury tissue values below CCME guidelines. Of the samples collected in 2013, six Canadian sites have sediment mercury concentrations higher than the one site that exceeded CCME guidelines for methylmercury.

Table 2. Summary of exceedances of CCME guidelines for U.S. and Canadian sites for PCBs (2008) and methylmercury (2013).

	PCB		MeHg	
	Exceedances	**Total Sites (Samples)**	**Exceedances**	**Total Sites**
Canada	2	12 (25)	1	7
United States	13	12 (32)	3	7

Sediment toxicity. Bioassays were conducted in 2001 and 2008 examining a range of endpoints. In 2001, Environment and Climate Change Canada (ECCC) examined 17 sites within the Detroit River AOC, assessing: *Chironomus riparius* growth, *Chironomus riparius* survival, *Hyallela azteca* growth, *Hyallela azteca* survival, Hexagenia *sp.* growth, Hexagenia *sp.* survival, *Tubifex* reproduction (number of cocoons per adult), *Tubifex* reproduction (percentage of cocoons hatched), *Tubifex* reproduction (number of young per adult), and *Tubifex* survival. Only one site on the U.S. side of the river demonstrated potential toxicity (HZD score = 469). The remaining sites which had HZD scores ranging as high as 131 were not observed to demonstrate evidence of sediment toxicity. In 2008, Great Lakes Institute for Environmental Research examined 48 sites for *Chironomus riparius* survivorship and 20 sites for *Chironomus riparius* growth. None of the sites examined, including sites containing the highest observed contaminant levels, were found to have toxic responses. This finding agrees with the 2001 bioassay, which also failed to observe a toxic response with *Chironomus riparius* endpoints with the sediment conditions observed within the Detroit River AOC.

Overall, only one U.S. site observed as part of the 2013 sampling event was found to have a higher HZD score than that of the one U.S. site that demonstrated toxicity in the 2001 survey. Although it is uncertain at what HZD score threshold sediment becomes consistently toxic to various invertebrate endpoints, it is expected that the threshold is greater than 131 for sensitive endpoints and greater than 214 for *Chironomus riparius*, as bioassays run at these levels failed to demonstrate a toxic response. Based on these thresholds, one Canadian site from the 2013 survey may experience toxic effects for the most sensitive endpoints and potentially experience toxic effects for more tolerant endpoints.

Impairment of benthic community composition. Site hazard scores (HZD) were used to determine community composition impairment and the community composition at various sites were compared to in-river reference sites. Prior to the assessment of sites based on community

composition, all of the potential sites were subdivided based on habitat conditions using k-means cluster analysis. Four cluster groups were identified to be optimal. Community composition for each cluster was examined with respect to sediment chemistry using Canonical Correspondence Analysis (CCA). This analysis provides insight into community structure as it is driven by the presence of legacy contaminants. Generally, for each of the four clusters, contaminants were found to be co-occurring. To further examine the relationship between total sediment contaminant concentration (represented by the HZD score) and individual taxa abundance, non-parametric Spearman correlation analysis was performed. Then, for each cluster, breakpoint analysis using a regression tree was used to identify potential biological thresholds in each of the identified taxa as a result of sediment contaminants. Using the reference groups established for each habitat cluster and each respective threshold point, test sites were evaluated through two methods: 1) Multivariate Community Assessment and 2) Unidimensional Species Assessment. Multivariate reference condition was established by actively plotting reference sites using a Detrended Correspondence Analysis (DCA). Unidimensional Species Assessment, establishes reference condition for each taxon demonstrating significant correlation with HZD scores.

The resulting statistical analyses showed that the lowest sediment COPC concentration where evidence exists of community composition impairment was HZD = 44. In 2013, only one Canadian site was found to exceed this HZD threshold (HZD = 333). Based on the sediment chemistry, as well as the sediment toxicity thresholds and community composition thresholds, it is possible that in 2013, this site would have demonstrated biological impairment. The remaining 36 Canadian sites from the 2013 survey are likely unimpaired based on their HZD scores.

In December 2020, the Degradation of Benthos BUI for the Canadian side of the Detroit River was deemed no longer impaired based on the aforementioned lines of evidence.

Conclusions and Recommendations

Over the past several decades, legislation has been enacted on both the Canadian and American sides of the Detroit River to reduce the amount of contaminants entering the river. As a result, we are seeing an improvement in sediment quality. Where SEL contamination exists, it is localized in nature, indicating that severe biological impairment due to contaminated sediment on the Canadian side of the river is unlikely. Therefore, there have been no sediment remediation projects in the Detroit River itself to remove contaminated sediment. The only dredging of sediment that occurs in the Detroit River is to ensure that navigational channels are maintained at the required depth. A decline in contaminants in sediments in the Detroit River AOC has also resulted in the improvement of benthos communities throughout the river. In part, this is because of legislation introduced by both Canadian and U.S. authorities to restrict the discharge of many pollutants into the river. Research shows that potential benthos impairment on the Canadian side of the Detroit River is highly localized, with the vast majority of the Canadian portion of the AOC demonstrating no evidence of biological impairment, and sediment COPCs below provincial SELs. The vast majority of the Canadian side of the Detroit River also shows minimal benthos impairment and potential for bioaccumulation. Therefore, benthos communities are considered to have recovered to a point where they meet the criteria which indicates that they are no longer impaired in the Canadian side of the Detroit River. As a result, the status of the Degradation of Benthos BUI was changed from impaired to not impaired in late 2020. However, given the cultural, ecological and functional importance of the Detroit River, continued monitoring is important to ensure the continued recovery of ecology integrity.

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9.3 Abstract of Characterization of Detroit River Sediments, 2012-2022 - Sam Noffke

Characterization of Detroit River Sediments, 2012-2022

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Background

The City of Detroit is the largest in the State of Michigan and one of the most important economic drivers in southeast Michigan, with a long history of industrial and residential development. Throughout this history, the Detroit River has been a source of water for a variety of industries and is a vital transportation corridor, with a rich fishery, and world-class recreation. For over a century, the river received untreated waste discharges from industrial use, as well as inputs from urban development and stormwater runoff, which degraded the river. These pollution sources have contributed to high levels of bacteria, organic contaminants, and metals within the sediment.

In the 1940s and 1950s, massive waterfowl kills at the scale of tens of thousands occurred due to oil pollution in the river. In 1965, Time Magazine declared Lake Erie to be "dead" due to massive toxic algal blooms (Time, 1965). In 1970, the entire Lake Huron and Lake Erie fishery was closed due to mercury discharges into the river. These environmental problems throughout the Great Lakes and including the Detroit River led to the passage of the Clean Water Act with new regulations to prevent pollution and the first Canada-United States Great Lakes Water Quality Agreement (GLWQA), both in 1972. Subsequently, the GLWQA was updated in 1987 to identify 43 geographic areas or Areas of Concern (AOC) throughout the Great Lakes in the U.S. and Canada that were the most polluted and most in need of clean up and restoration, including the Detroit River AOC (Michigan Department of Environmental Quality, 1996).

Sediment characterization and investigations

In order to identify remediation sites, the Detroit River AOC Public Advisory Council (PAC) and the Friends of the Detroit River partnered with the University of Windsor, United States Environmental Protection Agency (EPA), EGLE, and others in 2012 to gather and review all the existing data on Detroit River sediment, some dating back 40 years. This data was used to create hazard index maps, an example can be seen in Figure 1, to show the risk factor for the three most concerning contaminants in the river: mercury, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). These hazard index maps were used to develop a weight of evidence approach to develop areas for characterization in the Detroit River (Detroit River PAC, 2013).

Beginning in 2013, the EPA and EGLE conducted a series of extensive sediment sampling surveys which were completed in 2018. These surveys characterized nearly the entire western shoreline of the Detroit River for contaminants, including PCBs, PAHs, and metals (Table 1). Information gained from these sampling efforts were used to delineate known areas of contaminated sediment, referred to as "sediment remediation targeted areas" (Figures 2 and 3). A total of six sediment remediation targeted areas were identified and explored with additional sampling to further refine areas that may require remediation. These sediment remediation targeted areas, from upstream to downstream have been designated as: Harbortown Upstream, Harbortown, Riverbend, Lower Rouge-Ecorse Shoreline, Mid-Lower Trenton Channel, and the Celeron Island.

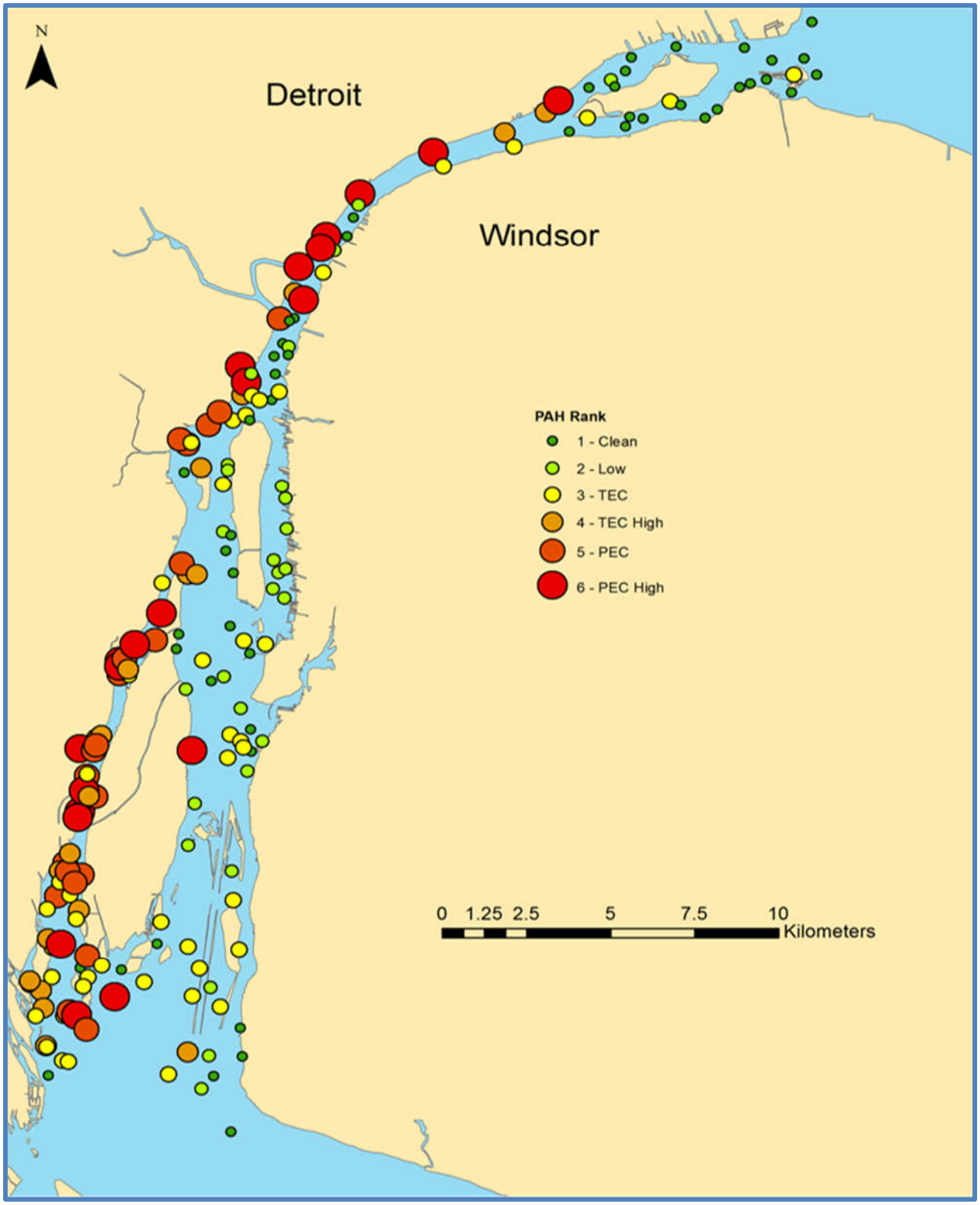

Figure 1. PAH Hazard Categories developed by the University of Windsor, from Detroit River AOC PAC, EGLE pass through grant.

Table 1. List of contaminants which were analyzed during the Detroit River during sediment characterizations.

Organics	PCB Aroclors, Polycyclic Aromatic Hydrocarbons, Diesel Range Organics, Oil Range Organics, Total Organic Carbon, PFAS Compounds
Metals	Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Iron, Nickel, Selenium, Silver, Zinc, Simultaneously Extracted Metals
Other Analytes	Ammonia, Cyanide, Acid Volatile Sulfide

The Harbortown Upstream targeted area includes the shoreline immediately upstream of the MacArthur Bridge up to the Albert Brush Ford Park. This characterization was carried out during the 2018 field season and resulted in five hot spots for future evaluation (EA, 2019).

The Riverbend targeted area includes the Joe Louis Arena downstream to the Lower Rouge Original Channel mouth. This characterization was carried out during the 2015 field season and resulted in four hot spots for future evaluation (EA, 2016a).

The River Rouge-Ecorse targeted area includes downstream of the mouth of the Rouge River Cut-off Channel to the mouth of the Ecorse River. This characterization was carried out during the 2013 field season and resulted in three hot spots for future evaluation (EA, 2014b).

The Upper Trenton Channel remediation area, starting in the City of Wyandotte and extending to the Grosse Ile Toll Bridge, was not included in this evaluation of the Detroit River sediments since it is currently the location of an EPA sediment remediation project area known as the Upper Trenton Channel project (CH2M, 2017).

The Mid-Lower Trenton Channel targeted area is located from the Grosse Ile Toll Bridge downstream to the Humbug Marsh National Wildlife Refuge. This characterization was carried out during the 2014 field season and resulted in nine hot spots for future evaluation (EA, 2015).

The Celeron Island targeted area consists of the area around the City of Gibraltar, the Gibraltar canals, and extending out to Celeron Island at the bottom of the Detroit River. This characterization was carried out during the 2013 field season and resulted in seven hot spots for future evaluation (EA, 2014a).

Following the analysis of the field data, each hot spot was evaluated using a set of criteria which included several factors: chemical concentration, potential toxicity, presence of bio- accumulative chemicals, and potential volume of contamination. These factors were scored and evaluated within each targeted area. These sites were then discussed with the Detroit River PAC as well as other experts from the EPA, EGLE, and the University of Windsor. These targeted sediment remediation sites were approved by this committee as sites for future remedial investigation.

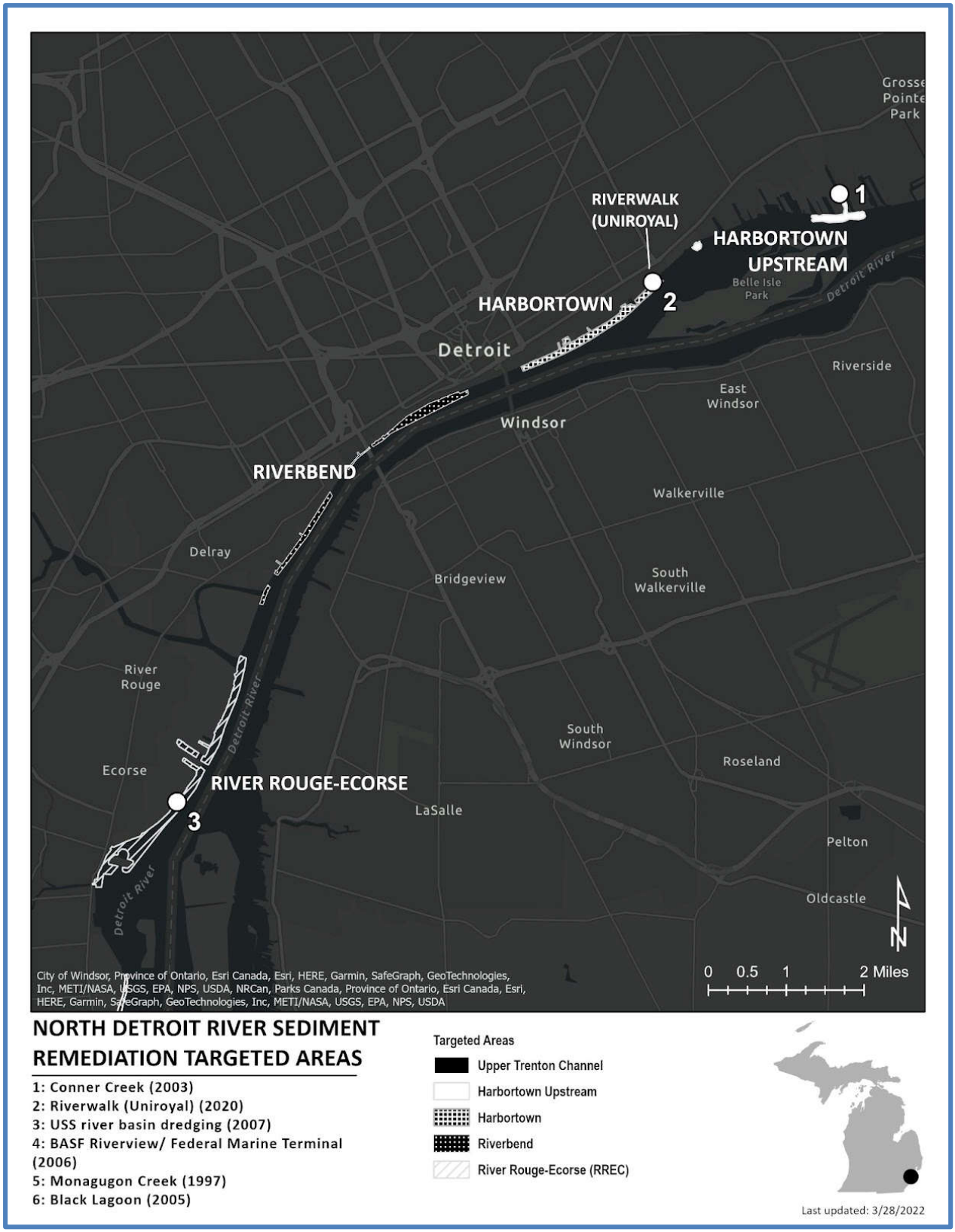

Figure 2. Map of North Detroit River AOC Sediment Remediation Targeted Areas

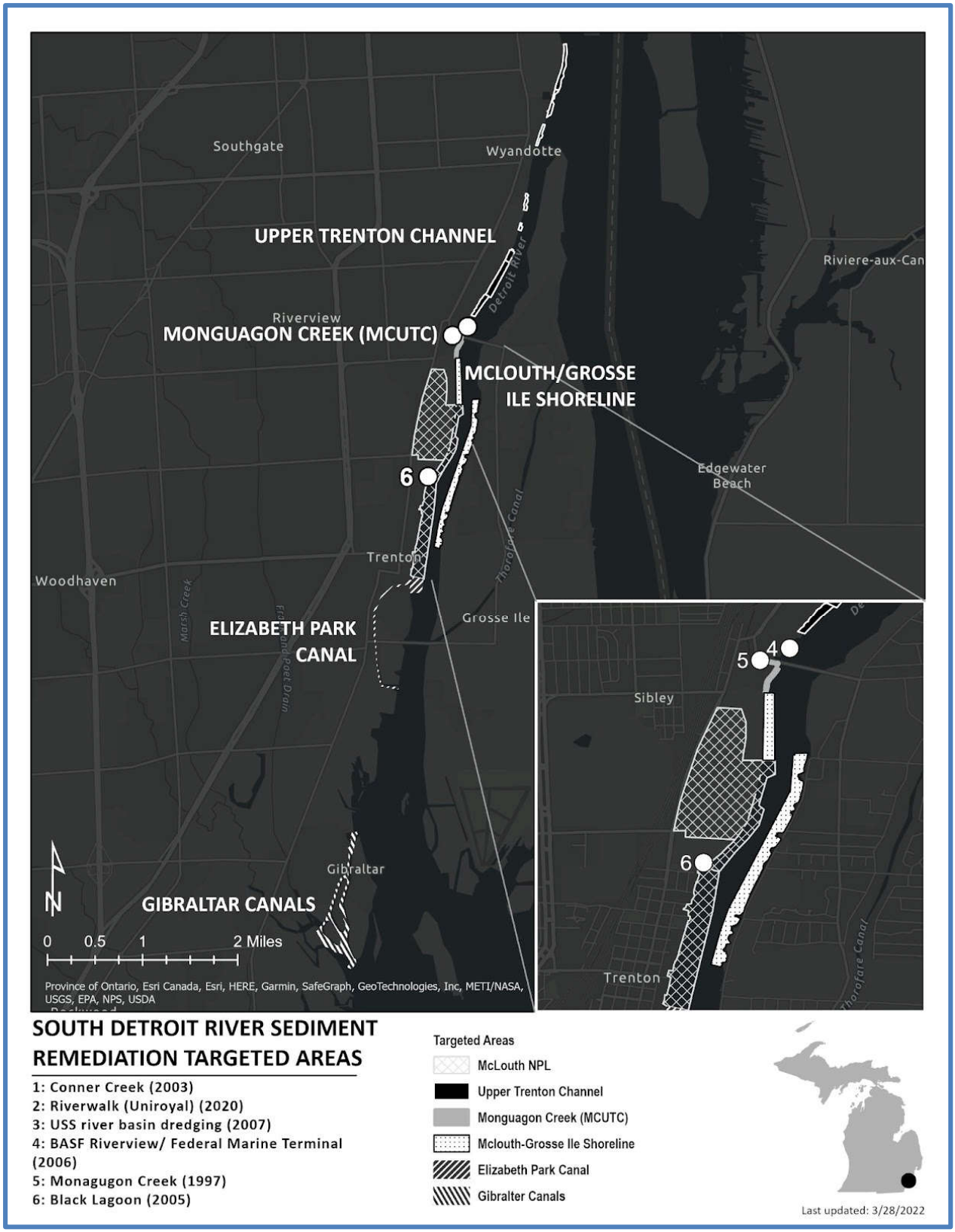

Figure 3. Map of South Detroit River AOC Sediment Remediation Targeted Areas.

The goal of this work is for the ultimate delisting of the Detroit River AOC. Interim success of this work is the removal of beneficial use impairments (BUIs). BUIs are identified in the GLWQA representing different types of significant environmental degradation. As cleanup work is completed, and monitoring demonstrates sufficient environmental health improvements, BUIs can be removed. The planned remediation of contaminated sediment will provide increased opportunities to support healthier populations of fish and wildlife throughout the entire Detroit River. The BUIs directly related to contaminated sediment remediation are Degradation of Benthos, Restrictions on Fish and Wildlife Consumption, Bird or Animal Deformities or Reproductive Problems, Fish Tumors or Other Deformities, and Restrictions on Dredging Activities. The complete BUI list below shows which impairments have been removed in the Detroit River AOC, and which remain. Once all BUIs are removed, the process of delisting the AOC can begin.

Complete list of BUIs for the Detroit River AOC:

1. Tainting of Fish and Wildlife Flavor – *Removed 2013*
2. Restrictions on Drinking Water Consumption or Taste and Odor – *Removed 2011*
3. Restrictions on Fish and Wildlife Consumption
4. Degradation of Fish and Wildlife Populations
5. Beach Closings
6. Fish Tumors or Other Deformities
7. Degradation of Aesthetics
8. Bird or Animal Deformities or Reproductive Problems
9. Degradation of Benthos
10. Restriction on Dredging Activities
11. Loss of Fish and Wildlife Habitat

Future sediment remediation projects will include investigations into Harbortown Upstream, Harbortown Shoreline area, Riverbend Shoreline area, River Rouge/Ecorse Shoreline area, Elizabeth Park Canal area and the Gibraltar Canals area. The EPA and EGLE are putting plans together to address the contamination and will be working with the Detroit River AOC PAC and the Friends of the Detroit River and future partners, to diligently carry out this work into the future to remove all BUIs and delist the Detroit River as an Area of Concern.

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9.4 Abstract of Contaminated Sediment Remediation Completed on the U.S. Side of the Detroit River and the Path Forward on Remaining Sites - Rose Ellison

Contaminated Sediment Remediation Completed on the U.S. Side of the Detroit River and the Path Forward on Remaining Sites

Rose Ellison, U.S. Environmental Protection Agency – Great Lakes National Program Office, ellison.rosanne@epa.gov

Background

Between 1997 and 2020 there have been six sediment remediation projects in the Detroit River addressing about 286,000 m^3 (374,000 yd^3) of contaminated sediment at a cost of about $30 million. There are an additional three projects currently underway that will address another 218,000 m^3 (285,000 yd^3) of contaminated sediment. This will total about 504,000 m^3 (659,000 yd^3) of remediated sediment in the Detroit River Area of Concern (AOC).

Under the Great Lakes Legacy Act (GLLA) (now part of the Great Lakes Restoration Initiative, GLRI) U.S. Environmental Protection Agency (EPA), Michigan Department of Environment, Great Lakes, and Energy (EGLE), and the Detroit River Public Advisory Committee (PAC) have focused near constant effort in further understanding and addressing the scope of remaining contaminated sediments along the Detroit River shoreline. From 2013-2018, EPA and EGLE have characterized sediments along 70% of the shoreline. And, another 7% had already been characterized as part of the Upper Trenton Channel GLLA project.

These sediment characterization investigations identify the significant work that remains to be completed in the AOC: about 14 sites, and somewhere between 2.25 million and 4.5 million m^3 (3 million to 6 million yd^3) of contaminated sediments. The remediation of these sediments will require the development of site-specific projects and the commitment of a non-federal sponsor.

Nevertheless, working with state and industry partners, EPA has been making progress. In 2020 EPA and our partner, with the help of U.S. Army Corps of Engineers (USACE), have completed a sediment capping project at the former Uniroyal site (also known as Detroit Riverwalk); are about to start a sediment capping and habitat restoration project at Ralph C. Wilson Centennial Park, starting the remedial engineering design for the Monguagon Creek site; and have completed the remedial engineering design for the Upper Trenton Channel site. EPA and EGLE also have recently laid out a plan for initiating actions on the remaining areas of contaminated sediment in the AOC. Past and current sediment remediation efforts in the Detroit River AOC are summarized in Table 1.

Table 1. Past and current sediment remediation efforts in the Detroit River AOC. Length of river or amount of sediment are listed for all projects; year and total funds spent are listed for completed projects.

Site Characterizations
• Detroit River (2012-2018), $3M, 52 km (32 mi)
Previous Projects
• Monguagon Creek (1997), $3M, 19,000 m^3 • Conner Creek (2003), $9M, 112,000 m^3 • Black Lagoon (2005), $9.3M, 88,000 m^3 • BASF Federal Marine Terminal (2006), 46,000 m^3 • USS River Basin dredging (2007), 11,500 m^3 • Detroit Riverwalk (2020), $2.9M, 9,900 m^3
Current Projects
• Upper Trenton Channel, 164,000 m^3 • Monguagon Creek/Upper Trenton Channel, 30,600 m^3 • Wilson Park Project (2022), $17M, 23,000 m^3

Recent sediment project highlights

Great Lakes Legacy Act Detroit River Site Characterizations. In late 2018, EPA, in partnership with EGLE, completed an effort that began in 2012 to identify and characterize contaminated sediments along the U.S. side of the Detroit River. In 2012, a bi-national group of federal, state, local, NGO, and university stakeholders worked together to compile data collected over the previous 40 years to target suspected contaminated areas in the Detroit River for further investigation. The characterization effort was carried out by EPA over six years, targeting six areas of the river that spanned the entire 52 km (32 mi) of Detroit River shoreline.

Overall, 219 stations were sampled, and 873 individual samples were analyzed. The result is a completed spatial modeling map that identifies the location of sediment contamination that will require additional investigation, and a preliminary estimate of contaminated sediment volume. The overall estimated contaminated sediment volume on the U.S. side of the Detroit River is expected to be reduced significantly upon further site-specific Remedial Investigations and Design.
EPA is currently working to find non-federal sponsors to engage with on the various sites. Since work was completed in 2018, the Detroit Riverfront Conservancy has come forward as a partner for two projects.

Great Lakes Legacy Act Project Upper Trenton Channel Project, Trenton, MI. The Upper Trenton Channel sediment site encompasses about 4.5 km (2.75 mi) of Detroit River shoreline within the cities of Wyandotte and Riverview, Michigan. EPA investigations have found sediments in this area to be toxic to the aquatic environment due to high levels of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated naphthalenes (PCNs), mercury, high pH, and non-aqueous phase liquids. EPA, along with project sponsors BASF, Arkema and Dow/Union Carbide, are

finalizing plans to address an estimated 165,000 m^3 (215,000 yd^3) of contaminated sediment. Other partners include the Michigan Department of Natural Resources (MDNR) and the Detroit River Public Advisory Council. A revised Remedial Design is expected to be completed in 2022.

Great Lakes Legacy Act Project Monguagon Creek Remedial Design Project Agreement (PA), Trenton, MI. On April 17, 2019, EPA signed a Project Agreement with Bridgestone Americas Tire Operations, the non-federal sponsor. The project will dredge about 30,500 m^3 (40,000 yd^3) of contaminated sediments (petroleum compounds, PAHs and heavy metals) in Monguagon Creek and part of the Trenton Channel. Remedial Design for this project will begin in 2022.

Great Lakes Legacy Act Detroit Riverwalk Project Remedial Design Agreement, Detroit, MI.
The Detroit Riverwalk extension is along a former industrial stretch of the Detroit River previously occupied by a Uniroyal Tire manufacturing facility. The river bottom along the shoreline is an area of known sediment contamination. The sediments are contaminated with petroleum byproducts. From 2019-2020, together Detroit Riverfront Conservancy (DRFC) and EPA designed and constructed a cap made of specialized material and rock to isolate, treat, and protect from erosion the contaminated sediments. The sediment cap is designed to last for at least 250 years into the future.

The GLLA Riverwalk remediation project addressed 4,860 m^2/9,900 m^3 (1.2 acres/13,000 yd^3) of contaminated sediments, with an overall cost of $2.9 million. Now that the cap is completed and the Michigan Department of Transportation (MDOT) has installed additional shoreline stabilization measures, the extension of the Riverwalk is ready for final completion.

Wilson Park Sediment Remediation Detroit, MI. Remedial construction at the Ralph C. Wilson Park GLLA site in Detroit will begin in 2022. The project is being undertaken by EPA and project partner DRFC. The remediation involves construction of an engineered cap to address contaminated sediments in an area adjacent to the Wilson Park shoreline. The cap is approximately 12,000 m^2 (three acres) in size, 640 m (2,100 ft) long, and will address approximately 23,000 m^3 (30,000 yd^3) of sediments contaminated with high PAHs.

This project also includes substantial habitat restoration in two areas. The first is landward of the cap and will encompass an 8,000-m^2 (two-acre) aquatic water feature known as the "Water Garden." The second habitat restoration area is on the river side where an extensive new soft shoreline will be constructed along much of the area adjacent to the Detroit Riverwalk and the Wilson Park's river edge. Habitat features here will be constructed in conjunction with the soft shoreline and cap components. The design will also incorporate fish spawning areas in the rock/shoreline as well as three fish-spawning eddies.

Remaining work and the path forward
Under the Great Lakes Legacy Act all sediment remediation projects must have a non-federal sponsor. Since the areas of possible sediment contamination on the U.S. side of the AOC have been identified, the immediate next step toward addressing contaminated sediments is to find non-federal sponsors to partner with for further investigation and possible remediation of specific sites. EPA has developed a historical baseline of industrial activity in each of the six project areas (listed below) and along with EGLE, has recently outlined an approach to evaluate the potential for non-federal sponsor engagement and bring partners on board.

Detroit River AOC Contaminated Sediment Project Areas and Sites.
Harbortown Upstream - Conner Creek
Harbortown - Harbortown Shoreline
Riverbend - Upstream Ambassador Bridge; Riverside Park; Waterfront Terminal-Del Ray Shoreline; Detroit Coke
River Rouge/Ecorse Shoreline - U.S. Steel Shoreline, North; Boat Slips; U.S. Steel Shoreline, South
Mid Lower Trenton Channel - McLouth Shoreline; Grosse Ile Shoreline; Black Lagoon to Maple Street (McLouth NPL); Elizabeth Park Canals
Celeron Island - Gibraltar Canals

Additional resources

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9.5 Abstract of U.S. Army Corps of Engineers Dredging, Sampling and Authorities to Assist in Contaminated Sediment Remediation - James Luke

U.S. Army Corps of Engineers Dredging, Sampling, and Authorities to Assist in Contaminated Sediment Remediation

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Background

The U.S. Army Corps of Engineers (USACE) has been responsible for the development and maintenance of navigable waterways in the United States since 1824 when Congressional authorization was received to remove sandbars and snags from major navigable rivers. Today, the role of the USACE, with respect to navigation, is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for the movement of commerce, national security needs, and recreation (Verna and Pointon, 2000). Navigable inland and coastal waterways, ports, and harbors are critical to the United States as a major means of commercial transportation and as an integral part of national defense.

The Great Lakes navigation system is a unique non-linear system, unlike the ocean coast ports. The Great Lakes navigation system consists of 60 federal deep draft commercial ports and 80 federal shallow draft recreational ports. The Great Lakes ports are dependent upon one another, so maintaining the system as a whole is necessary. For example, the ports of Chicago, Detroit, and Cleveland are dependent upon commercial traffic from Duluth and vice-versa.

Rouge River navigation

The Federal Navigation Channel in the Rouge River (Figure 1) was authorized by Congress in the Rivers & Harbors Acts of 8 Aug. 1917, 30 Aug. 1935, 3 Jul. 1958, 23 Oct. 1962. The navigation channel consists of 7.25 km (4.5 mi) of federal channels and one turning basin. It is considered a deep draft commercial harbor with authorized project depths between 5.2 to 7.6 m (17 to 25 ft). The Rouge River is one of the most important federal navigation projects in the Great Lakes and was ranked twelfth in tonnage among the Great Lakes harbors in 2019 (when considered separately from Port of Detroit) with approximately 7.1 million tons of material shipped and received. Dredged material from the Rouge River is transported to the Pointe Mouillee Confined Disposal facility located in Lake Erie and has sufficient capacity to accommodate Rouge River dredged material for the next 25 years.

The Rouge River historically requires maintenance dredging of 38,000 m^3 to 46,000 m^3 (50,000 yd^3 to 60,000 yd^3) on a two- to five-year cycle and sediment sampling occurs on a regular basis within the navigation channel. Maintenance dredging last occurred in 2019 and removed approximately 51,000 m^3 (67,000 yd^3) of material.

Rouge River remediation

The Rouge River is also located within the most populated area of Michigan and has a long history of industrialization. The high population and industrial use have led to the Rouge being impacted by nonpoint source pollution, combined sewer overflows, flooding, and sediment contamination from industrial development and discharges. USACE is continually communicating with communities

within the Rouge River watershed to address these issues through our various authorities and programs.

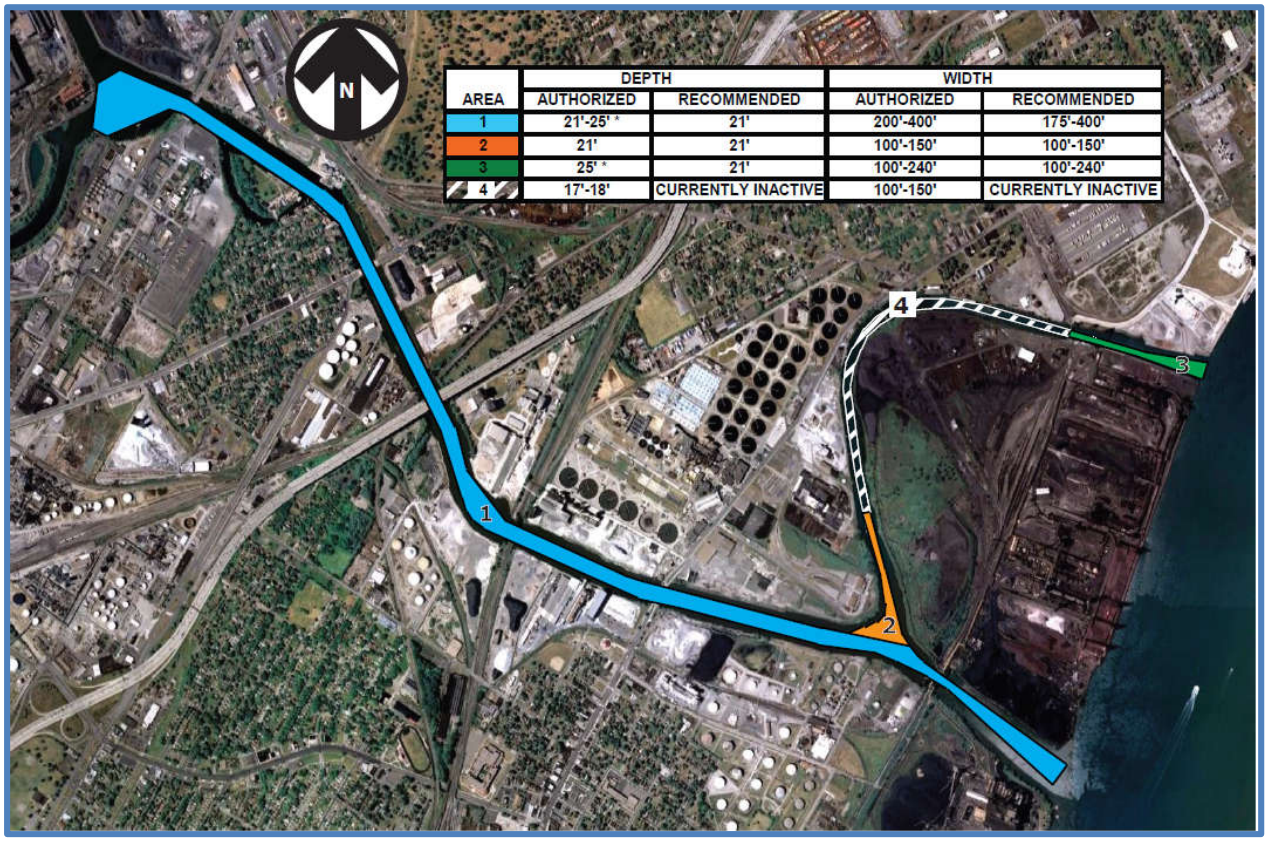

Figure 1. Functional Project Map of the Rouge River.

In addition to USACE dredging the federal navigation channel to maintain adequate depths for navigation, USACE is also working closely with the Environmental Protection Agency, Great Lakes National Program Office (GLNPO), the State of Michigan, and other partners to assist with the remediation of contaminated sediment in the Rouge River. Working under the Economy in Government Act, USACE is able to utilize GLNPO's Great Lakes Legacy Act Authority to apply our engineering, project management, and other technical expertise to provide assistance on sediment remediation and habitat restoration projects in the Rouge River. The Great Lakes Restoration Initiative (GLRI) is an extremely important investment in the Great Lakes to move these important projects forward.

USACE is continually looking for ways to assist with improvements to the Rouge River and its watershed. Partnerships between the federal agencies, state agencies, tribes, local governments and private industry will drive progress to revitalize this important Great Lakes resource.

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9.6 Abstract of Contaminated Sediments in the Rouge River Area of Concern: Past, Present, and Future - Jennifer Tewkesbury

Contaminated Sediments in the Rouge River Area of Concern: Past, Present, and Future

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History of settlement and industry

The Rouge River Area of Concern (AOC), located in southeast Michigan, is comprised of four separate branches, or 204 river km (127 river mi), and drains 1210 km^2 (467 mi^2) into the Detroit River (Figure 1). Within the AOC, there are over 1.35 million people in 48 municipalities and three counties (Oakland, Washtenaw, and Wayne).

Figure 1. Rouge River AOC map (Source: EPA).

Impacts to the river from combined sewer overflows (CSOs), sanitary sewer overflows, municipal and industrial discharges, and stormwater runoff have all contributed to contaminated sediments, specifically in the Lower Rouge River Main Channel (LRRMC) and the Lower Rouge River Old Channel (LRROC), near the confluence with the Detroit River. The LRRMC and LRROC have been heavily industrialized for over 100 years and have played key roles in numerous efforts that have formed and supported Southeast Michigan's industrial hub. Industries of note in this portion of the AOC have included automotive production, war time production, steelmaking, paper production, oil and chemical production and storage, energy production, trucking facilities, plating facilities, bulk material storage, and municipal wastewater treatment. In the 1980s, The Great Lakes Water Quality Agreement (GLWQA) between the United States and Canada identified the Rouge River as one of 43 "toxic hotspots", or AOCs, within the Great Lakes Basin (International Joint Commission United States

and Canada, 1987). Nine beneficial use impairments (BUIs) were identified in the Remedial Action Plan (RAP) Update (Michigan Department of Natural Resources [MDNR], 1994). These impairments include:

1. Restrictions on Fish and Wildlife Consumption
2. Degradation of Fish and Wildlife Populations
3. Beach Closings
4. Fish Tumors or Other Deformities
5. Degradation of Aesthetics
6. Degradation of Benthos
7. Restrictions on Dredging Activities
8. Loss of Fish and Wildlife Habitat, and
9. Eutrophication or Undesirable Algae

Currently, seven of the nine BUIs are directly or indirectly connected to contaminated sediments in the AOC. Sediment becomes contaminated when certain, persistent pollutants are released into the environment. These pollutants adhere to suspended sediment particles and eventually settle to the bottom of the river. Contaminated sediments degrade water quality and cause direct toxic effects to aquatic organisms.

Prior to settlement, the Rouge River was used by Native Americans, primarily the Potowatomi, for food, water, recreation, and transportation. They called the river “misua-sibe” or “mimosa-goink,” both terms meaning “Singeing Skin River,” referring to the place where game was dressed (Rouge River Advisory Council [RRAC], 2004). After settlement by the French in the late 1600s, the river was renamed the Rouge River because of its red color and its first commercial uses were for trapping and lumbering. In the 1700s, the river was comprised of “ribbon farms” providing all landowners river access; the first shipyard was built near the present-day Ford Rouge Plant (Figure 2).

Figure 2. Ribbon farms along the Rouge River, 1817 (Source: BLM).

Throughout the 1800s, sawmills and grist mills were built along the river throughout the watershed. The lower portion of the river also saw the addition of a railroad car maker, an additional shipyard, and copper, forging, and glassworks facilities. By the early 1900s, the river had become a supply for hydroelectric power, including at Henry Ford's Fairlane Estate. Around the same time, Henry Ford purchased eight km^2 (2,000 acres) along the lower Rouge River, west of Detroit, and over the next decade the Ford Rouge Plant was constructed as the most fully integrated automobile manufacturing facility in the world. During World War II, the Ford Rouge Plant repurposed its assembly lines to meet military manufacturing needs producing jeeps, amphibious vehicles, parts for tanks and tank engines, and aircraft engines used in fighter planes and medium bombers, before returning to automotive production during peacetime (Figure 3).

Figure 3. Amphibious vehicle testing in the Rouge River during World War II, (Source: William P. Reuther Library, Wayne State University).

Other industries also constructed operations on the LRRMC and LRROC, contributing to Detroit and Michigan's industrial might. However, after many decades of unregulated industrial and municipal waste discharging directly to the river untreated, the river had become discolored and in 1969, the Rouge River caught fire. In 1972, the Clean Water Act was passed, and Michigan began to implement the National Pollutant Discharge Elimination System (NPDES) Program requiring extensive abatement programs and the elimination of ongoing sources of contamination to the river. By the early 1980s, the Rouge River still did not meet the state's water quality standards and the entire Rouge River watershed was identified as an AOC requiring the development of a RAP. The first Rouge River RAP was published in 1989 (MDNR, 1989) and the Rouge River Advisory Council was established soon after. Throughout the late 1980s and 1990s, grassroots efforts began "clean ups" of the river, specifically by Friends of the Rouge, and in 1988 the federal government awarded the first round of funding for long-awaited sewer projects all aimed at cleaning up the Rouge River.

Past cleanup

Throughout the 1990s and 2000s, restoration and cleanup efforts continued, including a two-year project to remove polychlorinated biphenyl (PCB)-contaminated sediments from Newburgh Lake in the Middle Branch of the river. However, over the following two decades contaminated sediments

remained an issue in the LRRMC and LRROC. In 1997 and 1998, the State of Michigan completed investigations from the turning basin at the Ford Rouge Plant to the confluence with the LRROC that indicated the presence of elevated concentrations of PCBs and polycyclic aromatic hydrocarbons (PAHs). A follow up investigation in 2004, which focused on the turning basin and the Fordson Island channel, identified elevated concentrations of PCBs, PAHs, and various metals. Additional investigations were completed in limited portions of the lower river that found the presence of metals including cadmium, chromium, lead, mercury, arsenic, silver, and copper as well as PAHs and PCBs. Based on these historic sampling activities, the Environmental Protection Agency, Great Lakes National Program Office (EPA-GLNPO) determined multiple hotspots within the LRRMC and LRROC for further investigation in 2008 and 2009. Results of that investigation recommended even further sampling to better determine the extent of contamination and to fill remaining data gaps.

In 2010, EPA began working under a Great Lakes Legacy Act (GLLA) partnership with its non-federal sponsor, Honeywell Inc., to investigate, design, and clean up the 1.2-km (0.75-mi) stretch of the LRROC (Figure 4). The multi-year cleanup effort is being conducted in two phases. The first phase, conducted in 2018 and 2019, included the installation of a sheet pile wall along 762 m (2,500 ft) of the shoreline for bank stabilization during the dredging process.

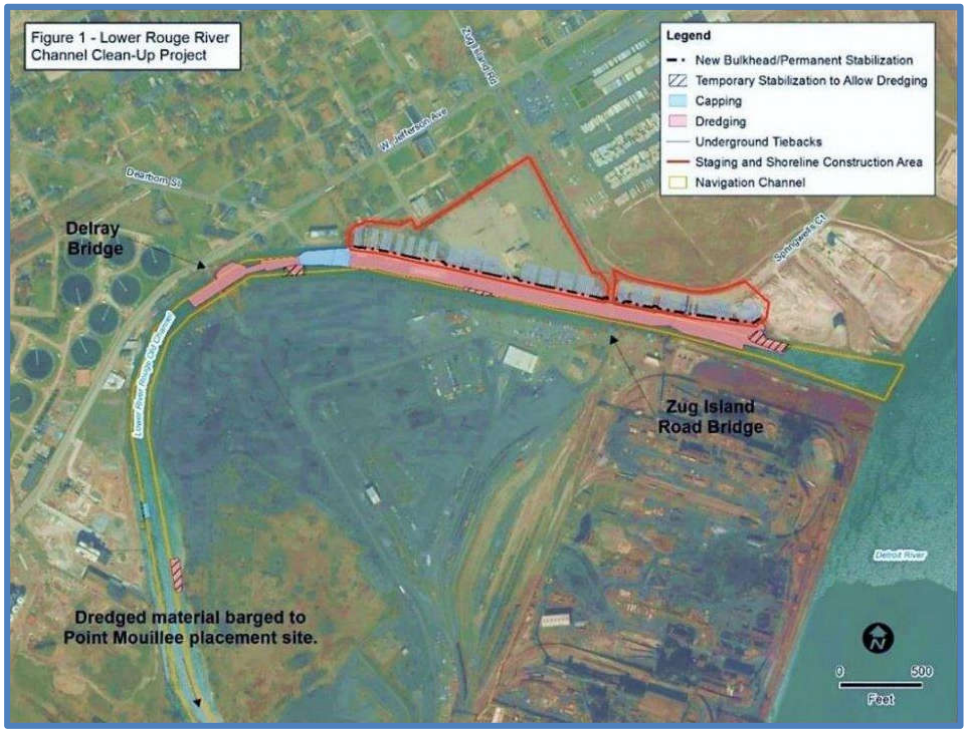

Figure 4. LRROC sediment remediation project footprint (Source: EPA).

Present and next steps

The second phase, anticipated to start in spring 2022, will include dredging and capping of contaminated sediments in the LRROC. Additional work included in the project's scope of work includes further stabilization of the shoreline and removing large debris, including vehicles, that have been discarded in the river. In 2021, EGLE entered a cooperative agreement with EPA-GLNPO for sediment sampling within the LRRMC to better characterize the contaminants of issue and to fill any previous sediment data gaps.

Over 75 samples were collected in fall 2021 and sent for lab analysis. The subsequent data will be used to draft a remedial investigation as the next step for a possible GLLA project in the LRRMC (Figure 5). Discussions are also ongoing between EPA-GLNPO, EGLE, and potential non-federal sponsors. Like the LRROC GLLA project, it is anticipated the LRRMC GLLA project will be a multi-year, multi-million dollar clean-up effort in the Rouge River AOC.

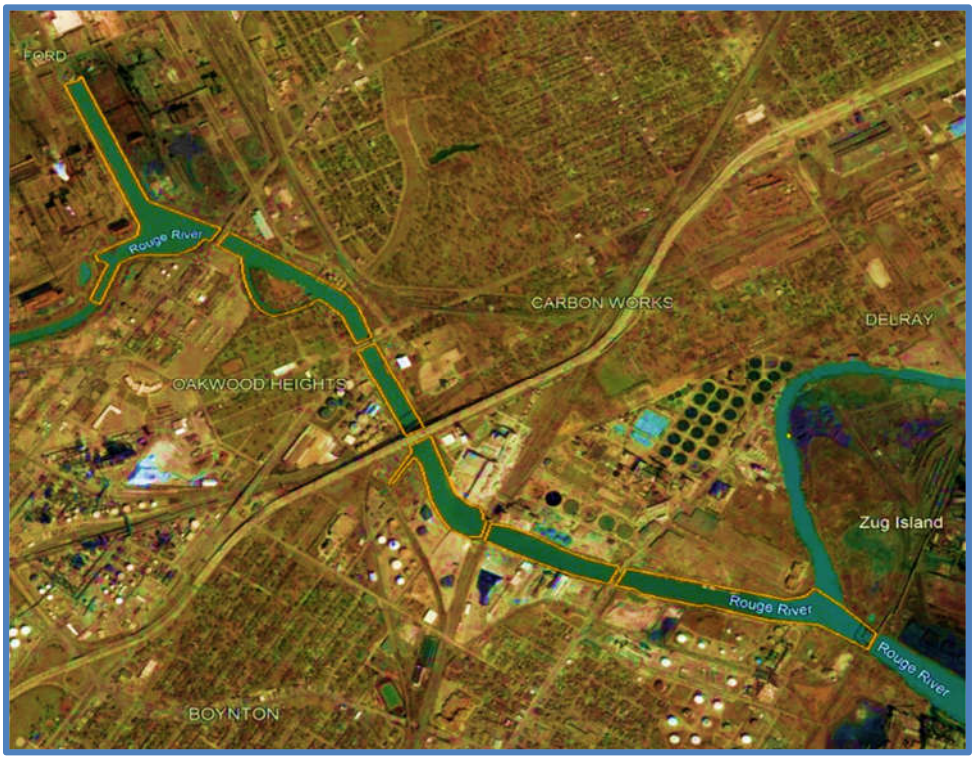

Figure 5. LRRMC sediment remediation project footprint (Source: EGLE).

Conclusion

In pre-settlement times, Rouge River sediments contained only background concentrations of natural elements and were uncontaminated by human-made chemicals like PCBs, PAHs, and heavy metals. A century of exposure to these chemicals from various industrial and municipal activities have created an environment unsuitable for aquatic life and human recreation. Efforts to assess the extent of these contaminants in the LRRMC and LRROC have been in motion for some time but will require further data collection and analysis before large-scale remediation efforts can be completed. As with all complex environmental challenges, consistent funding and cooperative partnerships will be key to the remediation of contaminated sediments in the Rouge River AOC.

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9.7 Abstract of Food Web Bioaccumulation Model Simulations to Estimate Benefits of U.S. Sediment Restoration Initiatives in the Detroit River - Ken G. Drouillard and Alice Grgicak-Mannion

Food Web Bioaccumulation Model Simulations to Estimate Benefits of U.S. Sediment Restoration Initiatives in the Detroit River

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Introduction

In 2013, the U.S. Environmental Protection Agency (EPA) and the State of Michigan initiated a series of enhanced site characterization studies in U.S. waters of the Detroit River to delineate prospective areas for sediment restoration (Ellison et al., 2019). Site characterization studies were completed in 2018 with EPA and Michigan designating nine areas for restoration (Figure 1). The restoration areas contain broad suites of contaminants including metals, mercury, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Contaminants in sediments at these locations were frequently observed to exceed probable effect level (PEL) sediment quality guidelines and have the potential to contribute to beneficial use impairments (BUIs) linked to sediment toxins including restrictions on fish and wildlife consumption, impaired benthic communities, fish and wildlife deformities and fish tumors and others. Although completion of restoration may take decades, model simulations can be used to predict recovery of key BUIs after the designated sediment restoration actions have been completed. This study used a spatially explicit food web bioaccumulation model, previously calibrated and optimized for the Detroit River (Li et al., 2019), to estimate the effect of sediment restoration on PCB bioaccumulation by fish and the effect this will have on government issued fish consumption advice.

Methods

Sediment and water chemistry data were obtained from previous bioaccumulation model simulations (Li et al., 2019) coupled with site characterization studies from EPA and Michigan Environment, Great Lakes and Energy (EGLE) and consultant reports. Required data for model simulations included congener specific PCB concentrations (PCBs IUPAC #: 31/28, 44, 49, 52, 70/76, 74, 87, 66/96, 99, 101, 105/132, 110, 118, 138, 149, 153, 156/171, 158, 170/190, 180, 183, 182/187, 194, 195/208, 199, 206) in water and sediments and sediment total organic carbon (TOC). PCBs in water were extrapolated from mussel biomonitoring programs implemented across various surveys in the Detroit River from 1996-2016 as described in Drouillard et al. (2013). Sediment PCB and TOC were collated from past GLIER datasets (1999, 2004, 2008, 2009, 2013; Drouillard et al., 2020) and EPA/EGLE Data (2007, 2006, 2011, 2015) contributed by Rose Ellison in 2018. Additional data on total PCBs were from the Harbortown Upstream Assessment report (EA Engineering, Science and Technology, 2019). In total, there were 440 georeferenced surface sediment samples compiled with both TOC and detected sediment PCBs. The above included 194 samples within targeted sediment restoration areas and 252 samples located within U.S. and Canadian waters of the Area of Concern (AOC) but outside of the proposed restoration areas.

Table 1 provides regional areas, geomean PCBs in sediment and % mass of sediment PCBs present in each restoration zone relative to the total mass of PCBs in U.S. surface sediments. Area and geometric mean PCB concentrations in regional zones (U.S. vs. Canadian waters) are provided for reference.

Figure 1. Designated sediment restoration zones in the Detroit River from Ellison et al., (2019).

Estimates of sediment PCBs post restoration were generated assuming the completion of U.S. restoration actions at all restoration areas. These simulations omitted restoration at McLouth Steel/Grosse Isle Shoreline and Elizabeth Park Canal sites because of a lack of sediment-PCB data available at the time of writing this report. For the remaining restoration sites, it was assumed that post-restoration, each restoration area achieves a new geomean sediment concentration equal to 0.345 µg/g TOC weight. This target was set to be equivalent to the mean sediment total PCB concentration determined across Canadian waters of the AOC. From this, a new weighted average U.S. AOC sediment PCB concentration was estimated for application in post-remediation bioaccumulation model simulations.

Table 1. Restoration site, regional areas and sediment PCB concentrations in the Detroit River.

Region	Area (m^2)	% Area Relative to U.S. waters	Geomean Sediment Total PCBs (µg/g TOC)	# Stations In Zone	% PCB Mass in Zone Relative to PCB mass in U.S. Sediments
Harbortown Upstream	665,421	1.07	1.50±6.66	53	1.03
Harbortown	565,770	0.91	5.32±32.62	7	3.03
Riverbend	573,416	0.91	4.32±22.31	11	2.51
River Rouge-Ecorse	1,682,021	2.71	6.06±11.31	14	9.73
UTC	175,848	0.28	19.98±232.84	88	1.09
Monguagon Creek	30,582	0.05	17.63±172.71	9	0.63
McLouth Steel/Grosse Isle West Shoreline	718,681	1.16	NA	1	----
Elizabeth Park Canal	649,872	1.05	NA	0	-----
Gibraltar Canals	40,521	0.07	4.39±1.24	5	0.73
Total	5,102,132	8.21			20.06
U.S. AOC Waters*	62,170,276		1.56±5.83	118	
Weighted Avg U.S AOC waters[#]	62,170,276		1.74[#]		
Canadian AOC Waters	43,372,959		0.35±2.74	137	
Total Detroit River*	105,543,235		0.69±4.66	255	

* Regional average for PCB concentrations excludes sediment data from within U.S. restoration zones.

[#] Weighted average U.S. AOC waters includes U.S. restoration and non-restoration areas

Food web bioaccumulation model simulations were set up to contrast PCB bioaccumulation in various sport fish species pre- and post-sediment restoration. Two scenarios were considered. The first scenario uses a two-zone model (U.S. vs. Canadian Zones) without fish movement. In this simulation all species of fish are assumed to stay contained within the U.S. boundary of the AOC. All simulated species are also assumed to exhibit spatial movements throughout U.S. waters of the AOC. The geometric mean congener specific PCB concentration in water and sediments for U.S. waters of the AOC are used as model inputs. Under the post sediment restoration simulation, the new estimate of U.S. weighted average sediment PCB concentration is substituted in the model simulation. It was further assumed that PCB concentrations in water decreased by a proportional amount to the change in regional wide sediment concentration.

The second scenario applied a fish movement scenario as outlined in Li et al. (2019) for three selected sport fish species. Under the spatial movement scenario, walleye, smallmouth bass and channel catfish are allowed to move between U.S. and Canadian waters of the AOC and therefore integrate spatial differences in PCB exposures between these different zones. Li et al. (2019) observed that the two-zone model predicted PCB exposures for a majority of sport fish species with sufficient accuracy (within two fold of observed fish contamination) except for a subset of species where the two-zone model consistently over-predicted PCB exposures in U.S. fish. Model calibration

was performed for each of the three species to estimate the time spent in U.S. and Canadian zones in order to bring calibrated model predictions within the acceptable two fold error margin. For channel catfish, the calibrated model indicated 81% of this species' time is spent in U.S. waters of the AOC and 19% in Canadian waters. For smallmouth bass it was 74.5 and 25.5% of time spent in U.S. and Canadian waters. For walleye, calibrated time estimates were 71.5 and 28.5% in U.S and Canadian waters, respectively (Li et al., 2019). Bioaccumulation model simulations for the selected species were re-run by taking the weighted average of PCB concentrations in water and sediments according to estimated time spent in U.S. and Canadian zones in pre-restoration and post-restoration model simulations. Model estimated PCB concentrations were converted into virtual meal advice using Ontario's fish contamination thresholds.

Results

Figure 2 presents the expected change in regional geometric mean U.S. sediment PCB concentrations after completion of sediment restoration at seven of nine designated restoration sites. The change in total PCB-sediment contamination in the upper (headwaters to top of Fighting Island) and lower zones (Fighting Island to AOC mouth) are outlined as well as the overall change in U.S. weighted average concentrations pre- and post-sediment restoration throughout the river length. The largest change in sediment contamination is notable for the upper U.S. reach where PCB concentrations could decrease by as much as 61.5% as a result of the restoration areas constituting such a large fractional area (18.5% of the total U.S. area in this river reach) of the upper U.S. river reach. By contrast, the area of restoration in the lower river reach is only 2.5% of the total U.S. lower river reach area and therefore PCBs will only decline by 6.8% following completion of proposed restoration actions. The expected decline of sediment PCB contamination across the entire U.S. AOC jurisdiction is 16.4%.

Table 2 presents food web bioaccumulation model forecasts of PCB concentrations achieved in individual sport fish species under pre- and post-sediment restoration conditions. All fish species are expected to exhibit declines in bioaccumulated PCBs as a result of the 16.4% change in U.S. sediment contamination and assumed similar change in water PCB concentration within the U.S. zone. Notably, five species of fish change their meal advice category following sediment restoration. These include largemouth bass and white sucker where meal advice would increase from four to eight meals per month, common carp and freshwater drum which increase from two meals per month to four meals per month and channel catfish which increases from one meal per month to two meals per month. In the spatial food web bioaccumulation model (scenario two), fish movements between U.S. and Canadian zones are allowed to occur for three fish species. For smallmouth bass, walleye and channel catfish, the estimated monthly meal allowance increases for these species in the pre-restoration simulations when contrasted against the non-spatial movement two-zone scenario model. However, for all three species there was no change in the post-sediment remediation meal allowance compared to the pre-sediment remediation meal advice. The overall benefit of increased meal allowances following completion of sediment restoration actions in scenario two is restricted to four fish species representative of those species which do not undergo movements between U.S. and Canadian waters. The four fish species showing decreased restrictiveness of monthly meal allowances are largemouth bass, white sucker, common carp and freshwater drum.

The main difference between scenarios one and two was observed for channel catfish. This species showed an increase in monthly meal allowance post-sediment restoration for the two-zone model,

but no difference in meal allowance for the spatial movement simulation. Therefore, the dilution of fish exposures by movements into Canadian waters of the AOC can attenuate the decrease in tissue contamination that would otherwise be observed under a restricted movement scenario. In part, this prediction is influenced by setting the sediment restoration target to equivalent to the Canadian zone wide average. If a lower sediment restoration target was used, the model would predict further declines in fish exposures.

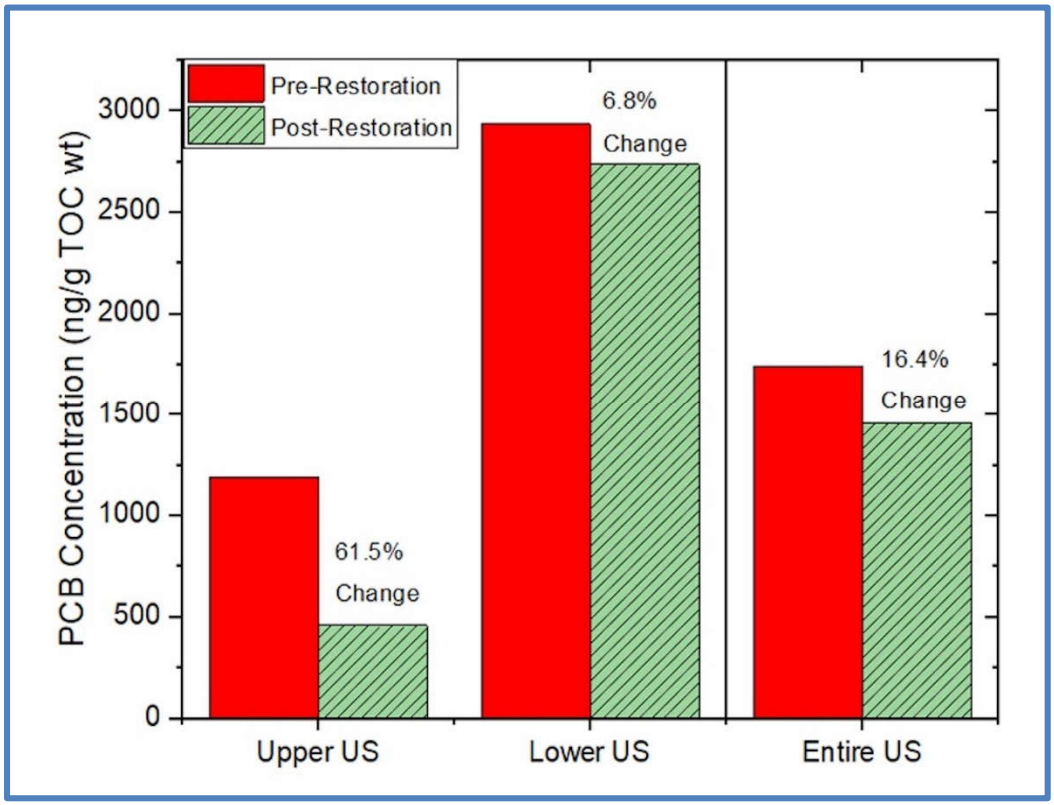

Figure 2. Estimated decline in regional specific sediment PCB concentrations of U.S. waters of the Detroit River following completion of sediment restoration at all seven designated restoration sites.

Table 2. Food web bioaccumulation prediction of fish contamination pre and post.

Species	Scenario One Two-Zone Model Pre-Restoration µg/g wet wt # meal/mo	Scenario One Two-Zone Model Post-Restoration µg/g wet wt # meal/mo	Scenario Two Fish Movement Pre-Restoration µg/g wet wt # meal/mo	Scenario Two Fish Movement Post-Restoration µg/g wet wt # meal/mo
Brown Bullhead	0.02 Unrestricted	0.02 Unrestricted	0.02 Unrestricted	0.02 Unrestricted
Yellow Perch	0.03 16 meals/month	0.03 16 meals/month	0.03 16 meals/month	0.03 16 meals/month
Bluegill Sunfish	0.03	0.03	0.03	0.03

Species	Scenario One Two-Zone Model Pre-Restoration µg/g wet wt # meal/mo	Scenario One Two-Zone Model Post-Restoration µg/g wet wt # meal/mo	Scenario Two Fish Movement Pre-Restoration µg/g wet wt # meal/mo	Scenario Two Fish Movement Post-Restoration µg/g wet wt # meal/mo
	16 meals/month	16 meals/month	16 meals/month	16 meals/month
Largemouth Bass	0.11 4 meals/month	0.09 **8 meals/month**	0.11 4 meals/month	0.09 **8 meals/month**
White Sucker	0.13 4 meals/month	0.11 **8 meals/month**	0.13 4 meals/month	0.11 **8 meals/month**
White Bass	0.17 4 meals/month	0.14 4 meals/month	0.17 4 meals/month	0.14 4 meals/month
Walleye	0.17 4 meals/month	0.14 4 meals/month	0.09 8 meals/month	0.08 8 meals/month
Common Carp	0.25 2 meals/month	0.20 **4 meals/month**	0.25 2 meals/month	0.20 **4 meals/month**
Freshwater Drum	0.25 2 meals/month	0.23 **4 meals/month**	0.25 2 meals/month	0.23 **4 meals/month**
Smallmouth Bass	0.27 2 meals/month	0.23 2 meals/month	0.15 4 meals/month	0.12 4 meals/month
Channel Catfish	0.50 1 meal/month	0.42 **2 meals/month**	0.33 2 meals/month	0.28 **2 meals/month**

Some study limitations are outlined as follows. Not all of the EPA/EGLE site characterization data were available at the time of writing this report. Additional sediment contamination from individual restoration site characterization studies should be secured for Harbortown, Riverbend, River Rouge/Ecorese, UTC, Monguagon Creek, Elizabeth Park Canal and Gibraltar Canals. A second limitation is related to the limited availability of congener specific bioavailable PCB concentrations in U.S. waters of the AOC. Data were obtained from prior mussel biomonitoring surveys completed in the U.S. and Canadian jurisdictions of the AOC. However, U.S. mussel biomonitoring surveys were limited to a single year (2002) whereas Canadian biomonitoring surveys have been implemented on a yearly basis between 1996-present. Empirical data show that along the Canadian side of the river PCBs in water have declined through time with half lives ranging from 13 to 26 years dependent on the congener and site (Drouillard et al., 2019). Since PCBs in U.S. waters were not adjusted for temporal trends, the simulations in this study may overestimate actual PCB exposures by fish. Beyond PCBs, sediments in the targeted restoration zones contain many other pollutants that, while not likely to bioaccumulate substantially in sport fish, are likely to cause toxicity to aquatic organisms. High trace metals and PAHs observed at concentrations exceeding sediment probable effect concentrations are likely to generate toxicity to benthic invertebrates and/or contribute to fish tumors among other ecosystem impacts. Therefore, the benefits of proposed restoration actions to other BUIs should be assessed by comparable approaches to the assessment performed here.

Conclusion

This study provided estimates of the decline in sediment-PCB contamination in U.S. waters of the Detroit River following completion of seven out of nine designated sediment restoration

projects. The geometric-mean-sediment-PCB concentrations in U.S. waters of the AOC related to restoration initiatives is expected to decrease by 16.4% relative to pre-restoration levels. Food web bioaccumulation model simulations show that the decline in sediment-PCB contamination, and assumed proportional decrease in water-PCB contamination, will lower exposures to PCBs in U.S. caught sport fish. Across model scenarios, largemouth bass, white sucker, common carp and freshwater drum are expected to decrease in PCBs resulting in less restrictive monthly meal advice issued to them after sediment restorations are completed. For at least one fish species (channel catfish) which exhibits movements between U.S. and Canadian waters of the AOC, the benefit of U.S. sediment restoration actions is unresolved and confounded by lower exposures of this species to Canadian locations of the AOC. Overall, this study provides support for EPA and EGLE sediment restoration initiatives linking these restoration actions to a critical BUI in the AOC – Restrictions of Fish and Wildlife Consumption. Additional studies should examine expected benefits of sediment restoration projects to other BUIs linked to sediment pollution.

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9.8 Abstract of Prevailing Environmental Racism and Injustice and a New Vision for Detroit - Monica Lewis-Patrick

Prevailing Environmental Racism and Injustice and a New Vision for Detroit

Monica Lewis-Patrick, We the People of Detroit, monica@wethepeopleofdetroit.com

Water affordability crisis in Detroit

We cannot talk about the importance of water in the Great Lakes region without talking about water crises, water injustices, and water insecurity. As We the People of Detroit (WPD) strives for water as a human right, we stand on the shoulders of black and indigenous women who have been working towards equitable water for decades.

We believe at WPD that the bankruptcy of Detroit was contrived to take over and regionalize the water asset of Detroit. In 2014, the Detroit Water and Sewage Department (DWSD) shut off water to thousands of households that had unpaid bills. With no relief in sight, a human rights' crisis occurred. The women of an organization called Welfare Rights called on activists to meet and over 100 mobilized to save the people of Detroit. Founding members of WPD undertook a water relief service for Detroiters, estimating such a service would only be needed for three weeks. Mistakenly, we thought the government and the mayor would not allow people to continue to go without water in a state surrounded by freshwater. Cecily McClellan helped operationalize a water assistance program, and still runs an emergency water relief program through WPD today.

During the bankruptcy, Detroiters had to fight the message that they had simply stopped paying their water bills. In reality, the lack of payment for water utilities arose due to disinvestment since 1977. Over decades, the federal government transferred its debts to states; states transferred debts to utilities; and utilities transferred debts to the ratepayers. From the 1970s to today, the amount of federal dollars invested in infrastructure fell from 67-69% to a dismal 7-9%. At the state level, we are obligated to sell water wholesale, yet at the municipal level, we sell it to households at retail with markups of 100-1000%. Though the racialized narrative in Michigan blames Detroiters for their lack of access to water, it was really a failure and disinvestment at all levels.

Mapping the water crisis

After suing the city eight times, WPD was able to get the municipal data to debunk the myth that Detroiters chose to stop paying their bills. By mapping water in Detroit, WPD showed that poor folks were struggling to pay bills that had risen 285-475% in just two decades (WPDCRC, 2016). And poor folks were not the only ones struggling. Across the city, affluent neighborhoods were struggling to pay the increasing rates as well (Figure 1).

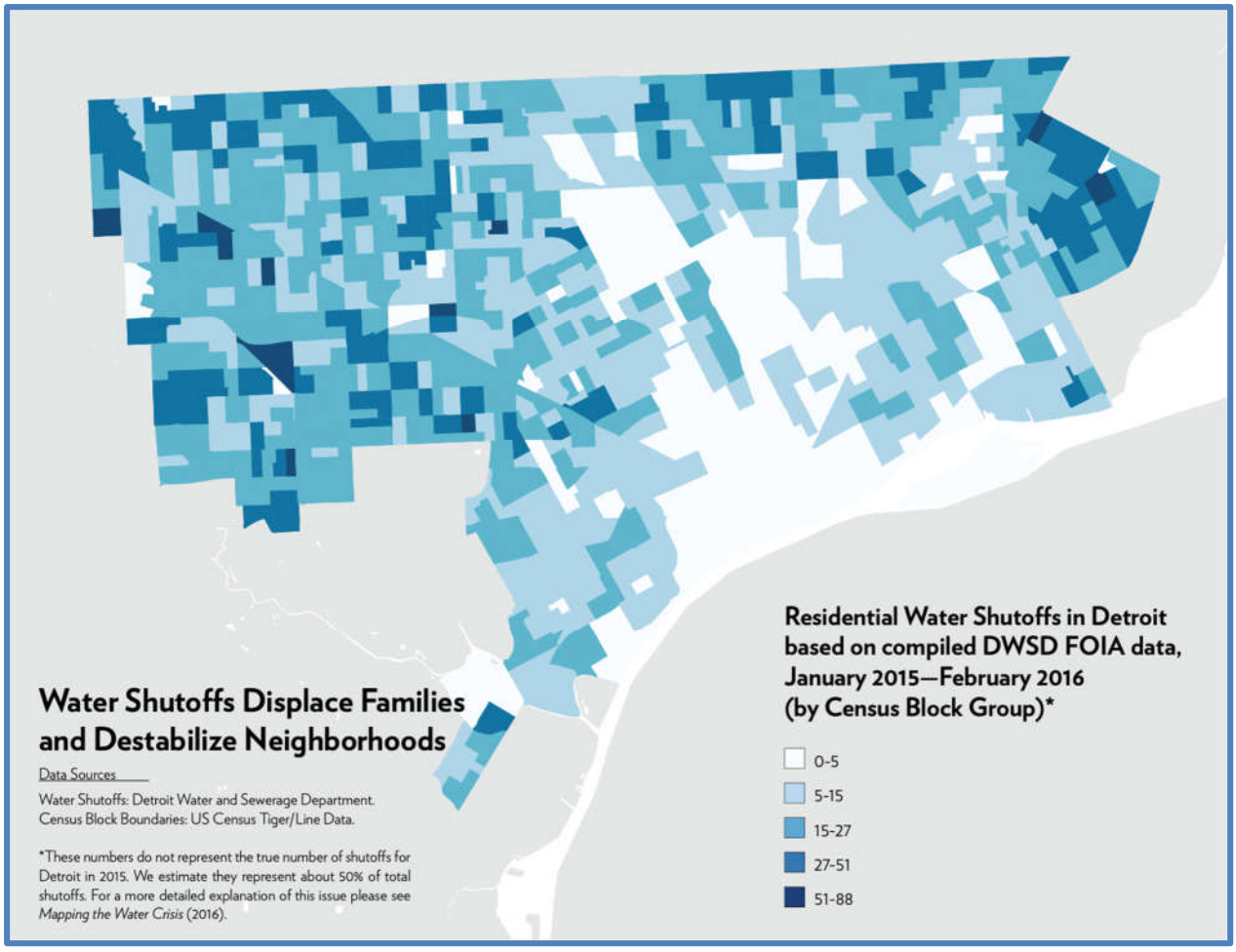

Figure 1. Map created by WPD displaying water shutoffs across Detroit's neighborhoods.

In 1955, the city of Detroit was legislated to build their water system out. Though the city's water director warned this would lead to bankruptcy, infrastructure was constructed to reach over 100 surrounding townships, supported by Detroit's tax base of two million people (Figure 2). Though that same infrastructure is used today, far fewer residents remain to pay for it. As unaffordable water rates were used as a tax lane, they contributed to the displacement of folks from homes their families had lived in for generations (Figure 3). Many remaining residents live in poverty, including 60% of the city's single mothers. Further, 70% of people working in the city are not residents, and do not contribute fully to the tax base. Though Detroit has been given reprieve with the reconfiguration, we have not been off the hook of the legacy debt. And Detroit still processes wastewater for 78 townships bearing 83% of the cost, while only 17% is spread among suburban customers.

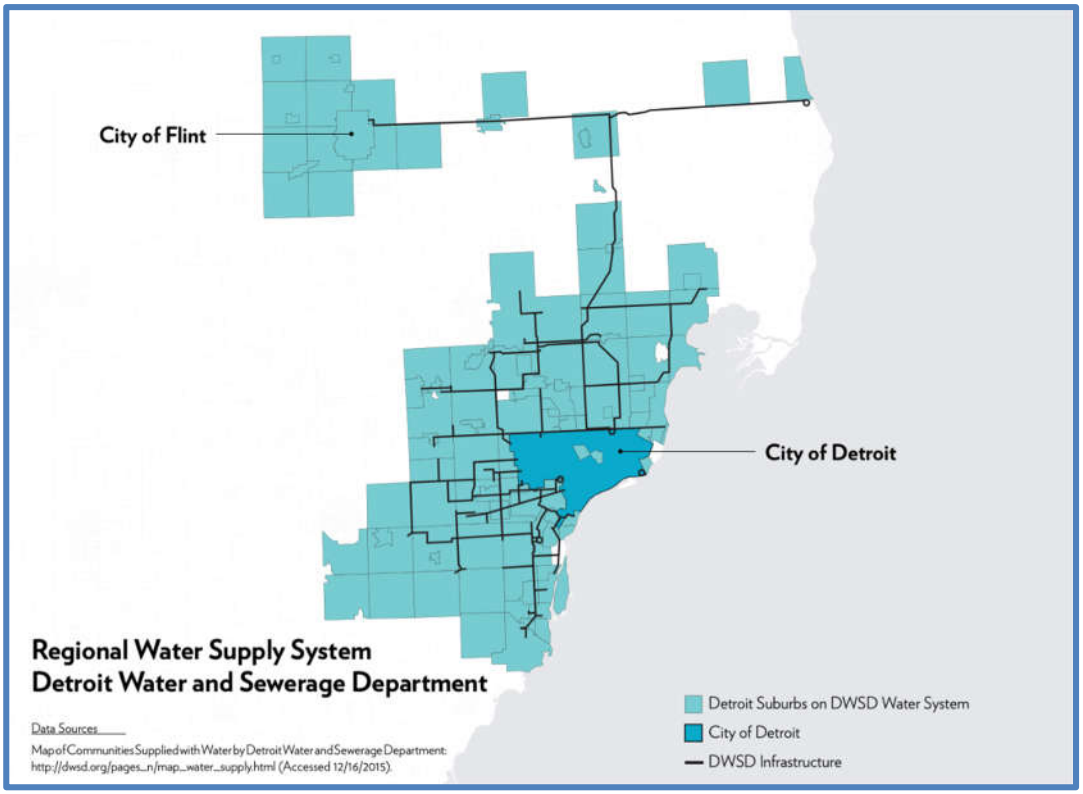

Figure 2. Map created by WPD displaying DWSD's regional water supply system.

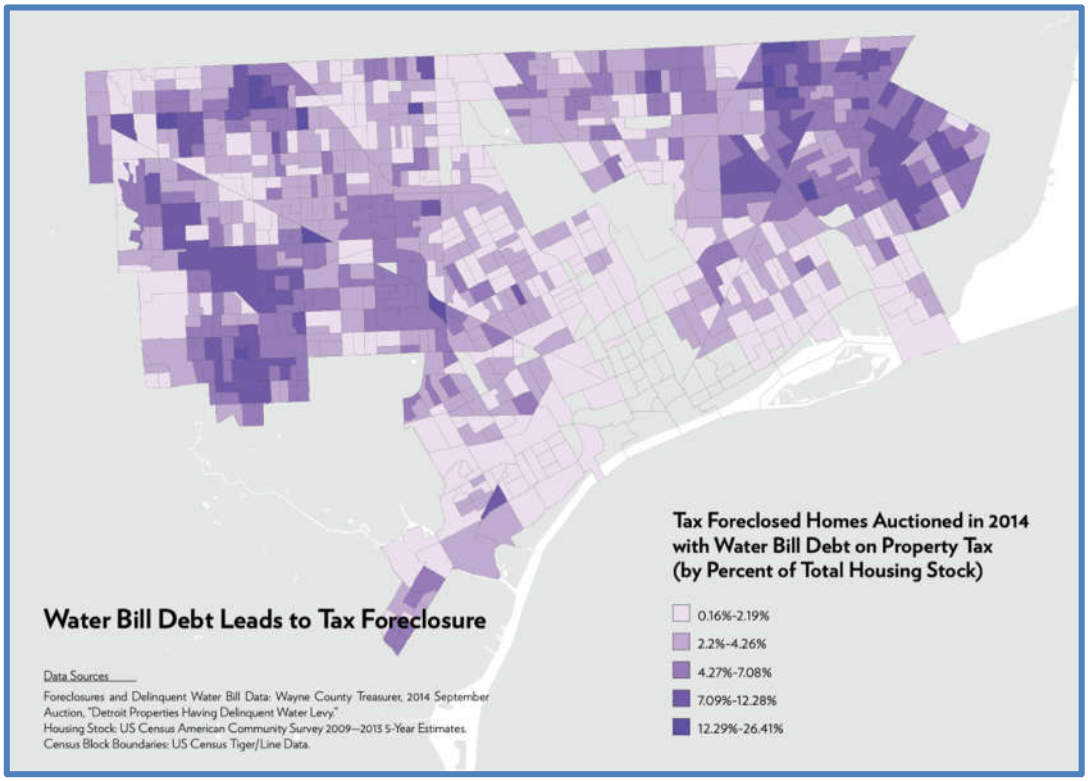

Figure 3. Map created by WPD displaying water bill debt in tax foreclosed homes.

The austerity of the Emergency Management and the rush to regionalize Detroit's water directly led to the Flint Water Crisis. WPD used maps as evidence in hearings during the crisis to demonstrate the historical pathways that contributed to Detroit's inability to pay for the system that had been supporting nearly 40% of the state's population, and the inflation of rates for Flint customers that followed (Figure 4). When you do not understand the connective tissue of underfunding and underfinancing, it's easy to justify the situation as resulting from someone choosing not to do their fair share.

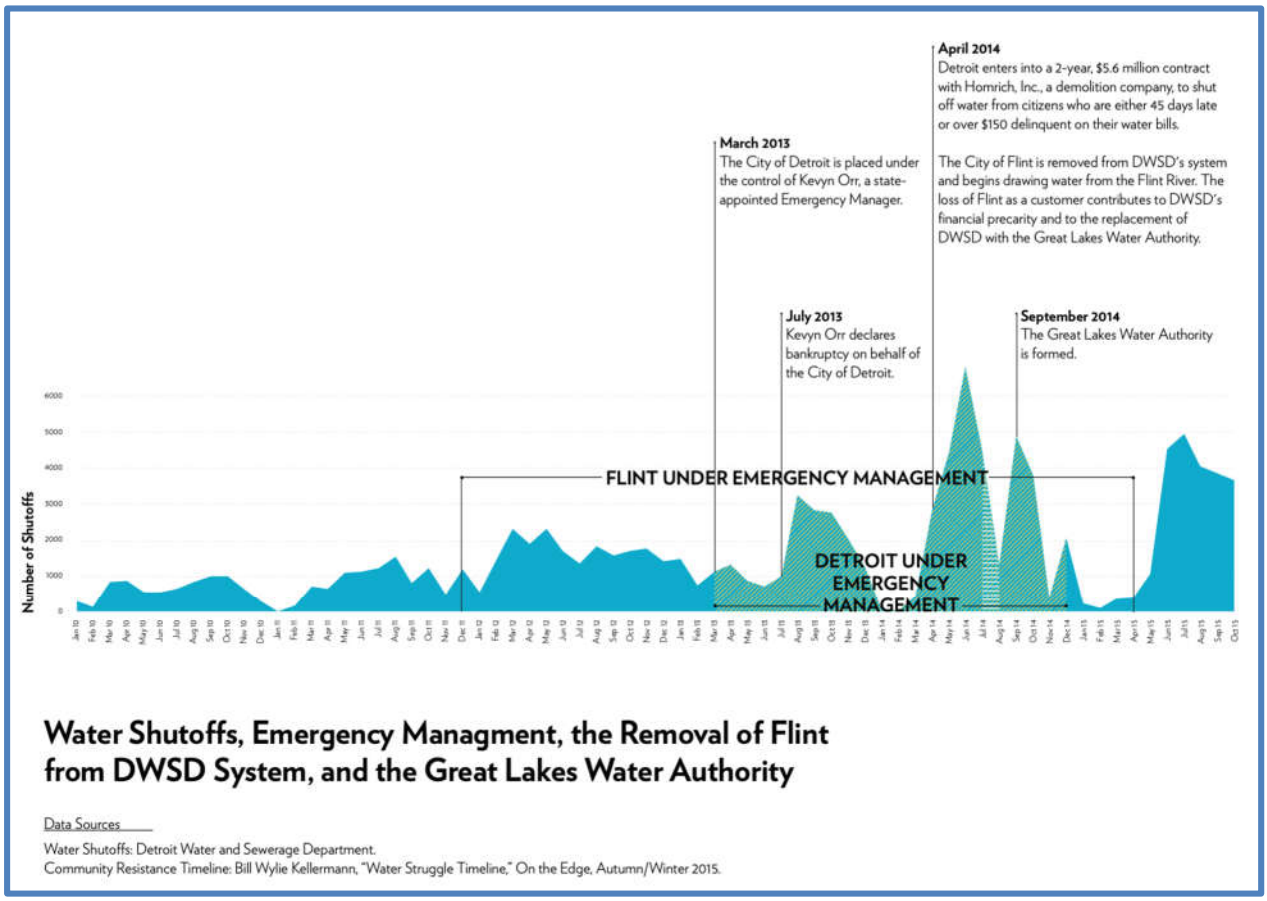

Figure 4. Water shutoffs, Emergency Management, and the removal of Flint from the DWSD System. Data sources: DWSD, Bill Wylie Kellermann, "Water Struggle Timeline," On the Edge, Autumn/Winter 2015.

Water shutoffs and COVID-19

Mapping the spread and severity of COVID-19 cases by zip code in Detroit also revealed a direct correlation with water shutoffs. By preventing households from activities that slow the spread of COVID-19, such as hand washing and laundering reusable face masks, Detroit's water shutoffs contributed to the spread of the disease throughout the city's vulnerable populations (Moody, Easley, and Sissen, 2021). Within the nine zip codes with the greatest number of shutoffs, over 90% of residents are Black (M-LEEaD, 2021). Further, three of the top-ten zip codes for shutoffs have the highest rates of elderly residents, and five of the zip codes had the highest rates of COVID-19 cases connected to nursing homes (WLNS 6, 2020). In sum, we see a greater public health burden in communities targeted by water shutoffs.

Fighting for water equity

When leadership has spent over half a century racializing and demonizing a particular set of folks, it is very difficult to believe those same leaders will work in the community's best interest. But WPD acts as a truth teller and convener. We are willing to say the hard things that leadership does not want to hear. Though we are all excited about the historical infusion of federal dollars to replace lead lines, it will be difficult for communities like Detroit, Flint, and Benton Harbor to return to their taps when they do not trust the water coming out, or the leadership and agencies with oversight and regulatory authority.

The results of WPD's community-based initiatives have been life changing. We have conducted cutting-edge psychosocial analyses that look at the psychological impacts of fearing your water, and of not being able to access or afford water (Figure 5). Such fears create community stress that we do not typically calculate when talking about access and affordability (Gaber et al., 2021).

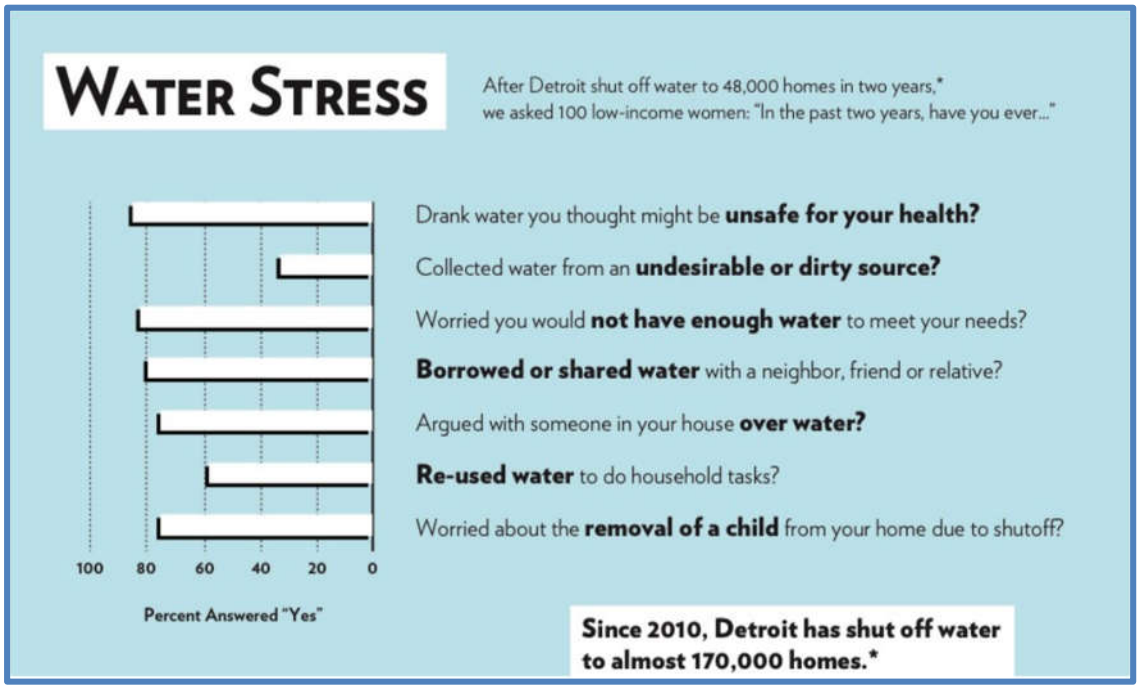

Figure 5. Results of a survey WPD conducted of low-income women in Detroit.

WPD has deputized ourselves to fight for water equity not just in Detroit, but across the state. We come to places like State of the Strait to provide information. We push back when information does not make sense, or when an algal bloom or bioswale is prioritized over a community's desperate need for water. We infuse dollars in places like Flint. Though Flint is often used as a whipping post for failures in water accessibility, they have created the first lead testing site in the nation. With technology WPD has integrated into this site, residents can see the testing of their water from beginning to end – a collaboration that ensures safety, rebuilds trust, and supports workforce development.

Moving forward

What can we do to ensure water equity? We can use State Revolving Funds (SRF) to build connective tissue and collective power, to create jobs, and to fill budgetary gaps. We can provide technology and technical assistance to rural communities so they can get into the cue to receive SRF dollars. We can make sure the new Justice40 Initiative from the Environmental Protection Agency is connected to this community so the high tide can lift our votes (EPA Press Office, 2021). We can improve communication about how to secure federal dollars, and tell stories of success from past investments. As the former Detroit Mayor Coleman Alexander Young once told us, our water is significant. We can remember his call, that if you find the good fight then get in it. Join WPD to work not just for the science, engineering, and technology of water, but for water as a human right.

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9.9 Abstract of Facilitating and Accelerating Sediment Remediation in the Straits Utilizing the Great Lakes Legacy Act - Steven C. Nadeau

Facilitating and Accelerating Sediment Remediation in the Straits Utilizing the Great Lakes Legacy Act

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Introduction
The Great Lakes have been impacted by legacy contamination of sediment from industrial and municipal activities dating back hundreds of years. However, significant progress in remediating and restoring our precious waterways has occurred over the last decade or so, largely as a result of the sediment remediation and restoration being conducted under the Great Lakes Legacy Act (GLLA). GLLA's purpose to address contaminated sediment in Areas of Concern (AOCs) that were languishing without remediation has proven its value in accelerating cleanup many times over. By creating public-private partnerships and establishing cost-sharing incentives, numerous cleanups have been completed in less time and with more efficiency than could ever have occurred under Federal or State regulatory or enforcement programs.

Background
Years after designation as AOCs, sites impacted by contaminated sediment were languishing without any potential remediation "in sight". In 2002, The Great Lakes Legacy Act was enacted with the goal of jump starting cleanups by remediating contaminated sediments; habitat restoration was a bonus. After 20 years of successful remediation, significant commercial and recreational redevelopment has followed behind GLLA completed projects and is well documented.

Jump starting cleanups
Jump starting remediation starts with Identifying potential sites in the community with contaminated sediment impact. Though public information with contaminated sediment data is available, contacting the Environmental Protection Agency, Great Lakes National Program Office (GLNPO) is a simple and efficient way to identify contaminated issues in your community. State and local officials are also great resources.

The GLNPO successfully forges partnerships
Cleanups under the GLLA are built on partnership and collaboration between GLNPO, non-federal sponsors, and local stakeholders. The GLNPO team works closely and collaboratively with the non-federal sponsors. From day one, GLNPO fosters communication and inclusiveness with local stakeholders. Among partners, there is an "atmosphere" at a GLLA site of "let's roll up our sleeves" and make progress together.

Lessons learned
The GLLA Program gets things done. The program fosters efficient evaluation of the issues posed and potential solutions, resulting in significantly shorter time from start to finish.

The GLNPO/GLLA approach saves significant time and transaction costs of funding work by environmental professionals and others as a result of the typically shorter time to commence

remedy implementation (e.g., getting to the remedy phase in a couple of years, as opposed to five or more). Lessons from the River Raisin, Detroit River and the opportunities underway at the Rouge River are examples of the GLLA benefits identified above.

9.10 Abstract of Ashtabula River Partnership for Sediment Remediation - Collaborative Efforts to Build Partnerships to Enable Legacy Act Projects - Scott Pickard

Ashtabula River Partnership for Sediment Remediation - Collaborative Efforts to Build Partnerships to Enable Legacy Act Projects

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Background

Polluted sediments in the lower approximate two miles of the Ashtabula River (Ashtabula County, Ohio) near its mouth on Lake Erie prompted the designation of the general vicinity of Ashtabula Harbor as a Great Lakes Area of Concern (AOC) (Figure 1). The designation was pursuant to a 1985 recommendation of the International Joint Commission's Great Lakes Water Quality Board and codification of AOCs in the 1987 U.S.-Canada Great Lakes Water Quality Agreement.

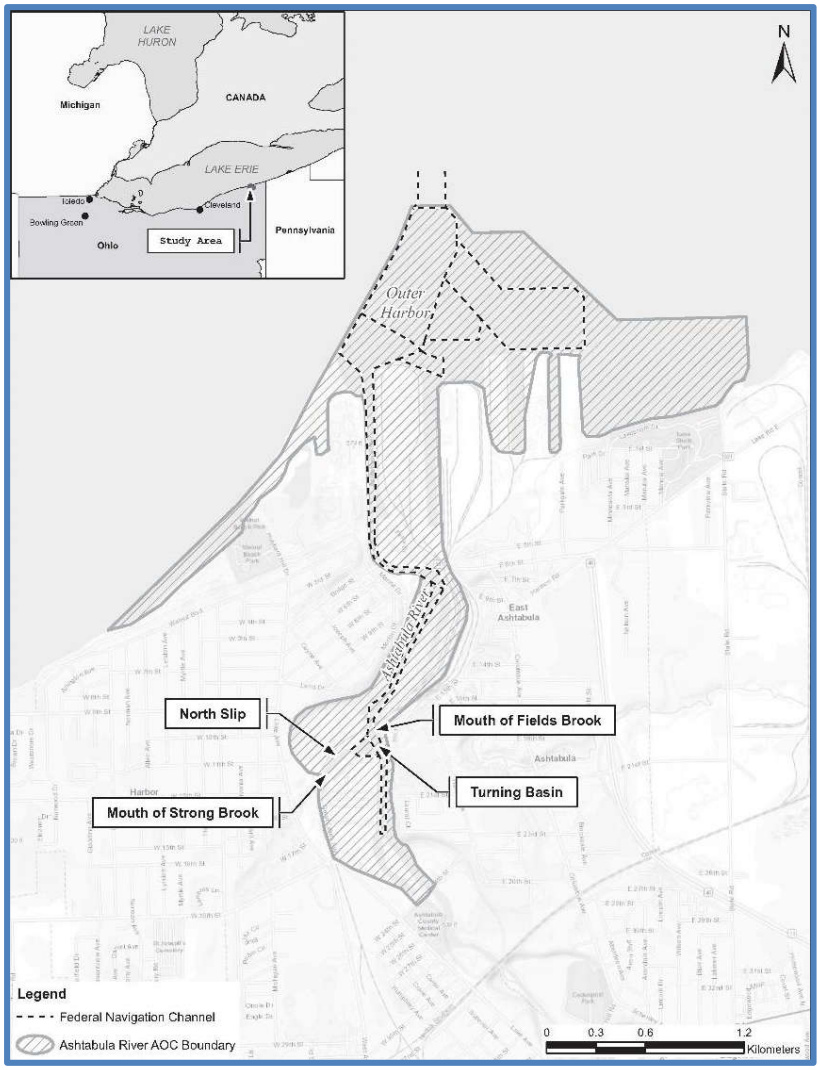

Figure 1. Ashtabula River AOC boundary map.

Cleanup and delisting of the Ashtabula AOC

In 1994, the Ashtabula River Partnership was formed to facilitate a voluntary cleanup focusing on Ashtabula River sediments in the AOC. This public-private collaboration would grow to 50 organizations, including federal and state environmental agencies, businesses, and citizens – all managed by the Ashtabula City Port Authority. The Partnership produced a Comprehensive Management Plan for the remediation of AOC sediments (Ashtabula River Partnership, 2001) laying the groundwork and path forward for large-scale remediation of AOC sediments. Ultimately, a diverse strategy utilizing various governmental authorities and funding streams evolved to accomplish the large-scale remedial works across three phases, including the Great Lakes Legacy Act (GLLA) of 2002, U.S. Army Corps of Engineers (USACE) Operations & Maintenance (O&M), Section 312(a) of the Water Resources Development Act (WRDA) of 1990, 2009 Great Lakes Restoration Initiative (GLRI), along with an array of non-federal resources. The Partnership empowered AOC restoration, which eventually resulted in the investment of nearly $86 million in the remediation of polluted sediments (Pickard et al., 2021).

Between 2006 and 2013, U.S. Environmental Protection Agency (EPA), USACE, Ohio Environmental Protection Agency (EPA), the Ashtabula City Port Authority, and many industrial partners collaborated to remove more than 474,000 m^3 of polluted sediment containing 6,350 kg (14,000 lb) of polychlorinated biphenyls (PCBs), plus low-level radioactive materials, heavy metals, and other pollutants from the AOC (Pickard et al., 2021). Considerable cleanup of the Fields Brook Superfund site has also occurred by responsible parties, likely in the range of tens of millions of dollars. This cleanup of Ashtabula River sediments led to the removal of all beneficial use impairments and the delisting as a Great Lakes AOC in 2021.

Success of partnerships

The remediation of the Ashtabula River sediments and removal from the Great Lakes AOC list in 2021 are considered major successes that give hope to other communities working to clean up their polluted waterways. Few people thought this was possible in the mid-1980s.

A key aspect of the cleanup was the establishment of the Ashtabula River Partnership in 1994 to facilitate a voluntary cleanup of the AOC. The Partnership created the framework and conditions for private sector involvement in the cleanup, and established trust and ensured cooperative learning necessary for achieving a common goal. The Partnership set far-sighted goals not only addressing sediment remediation, but also long-term maintenance of Ashtabula Harbor navigation channels.

The Ashtabula City Port Authority played a key role in facilitating the Partnership. USACE, EPA, and Ohio EPA played key roles in providing sound science for the sediment remediation.
The largest, approximately $60 million sediment remediation phase of the project was funded by the GLLA and the Ashtabula City Port Authority, with additional contributions from the Ohio and the Ashtabula River Cooperation Group II, a group of private companies. This was the first project to be funded by a consortium of industries as cost-share partners. Fourteen industry partners make up the Ashtabula River Cooperation Group II. The second and third phases, costing about $25.6 million, were funded by USACE O&M, Section 312(a) of WRDA, GLRI and GLLA, with non-federal contributions from Ohio and Ashtabula City Port Authority.

As the old adage says, if you cannot agree to the problems, you will never solve them. Members of the Ashtabula River Partnership had to keep their eyes on the ball of long-term restoration goals,

including quantitative targets, during all three phases of cleanup and make mid-course adjustments to achieve their common long-term restoration goals.

In any major environmental initiative, it is important to build a record of success, celebrate it frequently, and share credit. Building a record of success can help sustain momentum toward long-term goals. It took a 36-year investment to clean up the Ashtabula River AOC. In celebrating successes, it is important to lift up the important contributions of others to give credit. Such expansion of credit enhances team cohesion and trust, promoting more and better collaboration.

Next steps

A Natural Resource Damage Assessment is being undertaken by a group of natural resource management agencies to assess injuries to natural resources that have occurred as a result of the release of toxic and hazardous substances and determine whether compensation is due to the public. If compensation is warranted, the money will be used to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources and the services they provide. Additionally, "clean" sediment dredged from Ashtabula Harbor for the maintenance of navigation channels will be beneficially used to create a 67,000-m^2 (16.5-acre) wetlands in the Outer Harbor starting in 2022.

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9.11 Abstract of The Great Lakes Legacy Act: Forging a Cleaner Future Through Partnerships - Scott Cieniawski

The Great Lakes Legacy Act: Forging a Cleaner Future Through Partnerships

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Signed into law in November 2002, the Great Lakes Legacy Act (United States Environmental Protection Agency [EPA], 2021) was an innovative program designed to address contaminated sediments in Great Lakes Areas of Concern (EPA, 2022). The Great Lakes Legacy Act (GLLA) provided the EPA with funding (up to $50 million per year) and the authority to enter into cost sharing partnerships with non-federal partners to delineate the extent of sediment contamination within an Area of Concern (AOC) and design and implement a plan to clean up that contamination.

The GLLA has been a successful program since first receiving funding in 2004. Since 2004, EPA and our partners have completed remediation efforts at 30 sites around the Great Lakes at a cost of $650 million. These efforts have resulted in the remediation of over 3.4 million m^3 of contaminated sediments. Additionally, EPA and our partners have signed agreements for remediating an additional seven sites which will result in the cleanup of an additional 990,000 m^3 at a cost of $350 million. Currently, EPA is negotiating agreements for the remediation of an additional 1.5 million m^3 which would bring GLLA's remediation total to almost six million m^3.

It is important to understand that the GLLA is not a purely federal effort. Of the over $1 billion spent on GLLA work over the last 18 years, over $400 million has come from non-federal project partners. Partnerships are the key to the success of the GLLA, and the financial and technical partnerships that have been forged under GLLA ensure faster progress and mutually beneficial results.

The Detroit River and Rouge River AOCs have been the beneficiary of several completed and ongoing GLLA projects over the last 18 years. Four GLLA remediation projects have either been completed or are ongoing and remedial design work is underway at two additional sites. However, significant problems still remain. Preliminary estimates indicate that somewhere between 1.5 million and three million m^3 of contaminated sediment remain in the Detroit River and Rouge River AOCs and these sediments continue to impact the health of the aquatic ecosystems. These two AOCs continue to confront a daunting task, but an opportunity is available.

The recently passed Bipartisan Infrastructure Law (BIL) provide $1 billion ($200 million per year for five years) in additional funding to the Great Lakes Restoration Initiative (GLRI), the overarching program that also funds GLLA. EPA recently announced that a significant portion of these new funds will be targeted towards cleaning up and restoring the Areas of Concern, including the Detroit River and Rouge River AOCs. However, to seize this opportunity for potential federal investment, the local, state, and industry partners that are active in the Detroit River and Rouge River AOCs need to come together and provide substantial technical and financial contributions to cost share in the implementation of these important projects.

The Milwaukee Estuary AOC provides a great example for the Detroit River and Rouge River AOCs to follow. Non-federal partners representing the State of Wisconsin, the City of Milwaukee, Milwaukee County, the Port of Milwaukee, the Milwaukee Metropolitan Sewage District, and local industry came together to provide over $100 million in non-federal funding to support a GLLA project application that could result in leverage of an additional $200 million in federal funds to support a comprehensive and complete cleanup in the Milwaukee Estuary AOC.

There are many opportunities that are available to address the contamination in the Detroit and Rouge AOCs. Working together we can make significant progress towards that goal. Ask not what your AOC can do for you - ask what you can do for your AOC.

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