

SEPTEMBER 2020



Wisconsin Department of Natural Resources Office of Great Waters

This Remedial Action Plan includes updates from January 2018 through May 2020.

Compiled by Diane Packett

Water Resources Management Specialist Division of Environmental Management – Office of Great Waters Wisconsin Department of Natural Resources 101 S. Webster Street Madison, WI 53707 (608) 264-9220 DianeL.Packett@wisconsin.gov

With Input and Contributions From:

Brennan Dow, WDNR Donalea Dinsmore, WDNR Rebecca Fedak, WDNR Kendra Axness, WDNR Madeline Magee, WDNR Michelle Soderling, WDNR Olivia Colaianni, WDNR Stacy Hron, WDNR Steve Galarneau, WDNR

Cover Photo: Wildwood Island Habitat Restoration Area. Photo taken by Debbie Beyer.

Disclaimer

The Great Lakes Water Quality Agreement is a non-regulatory agreement between the U.S. and Canada, and criteria developed under its auspices are non-regulatory. The actions identified in this document as needed to meet Beneficial Use Impairment (BUI) delisting targets are not subject to enforcement or regulatory actions. The actions identified in this Remedial Action Plan Update do not constitute a list of preapproved projects, nor is it a list of projects simply related to BUIs or generally to improve the environment. Actions identified in this document are directly related to removing a BUI and are needed to delist the Area of Concern (AOC).

Additional Information

More information on the Great Lakes Area of Concern Program and Wisconsin-based AOCs can be retrieved from the following websites:

- Great Lakes Areas of Concern | US EPA
- Area of Concern (AOC) Restoration Wisconsin DNR

Table of Contents

Purpose Statement	1
Progress Summary	3
Beneficial Use Impairment Updates	7
Fish Tumors and Other Deformities	8
Bird or Animal Deformities or Reproductive Problems	10
Restrictions on Fish and Wildlife Consumption	13
Degradation of Phytoplankton and Zooplankton Populations	15
Degradation of Benthos	20
Restrictions on Dredging Activities	22
Loss of Fish and Wildlife Habitat	23
Degradation of Fish and Wildlife Populations	29
Eutrophication or Undesirable Algae	
References	
Appendices	
Appendix A - List of Acronyms	
Appendix B – BUI Tracking Matrix	42
Appendix C – Assessment of Skin and Liver Neoplasms in White Sucker (Catostomus	<i>commersonii</i>)51
Appendix D – Synthesis of Tree Swallow (<i>Tachycineta bicolor</i>) Data for Beneficial Use (BUI) Assessment at Wisconsin Areas of Concern	Impairment 81
Appendix E – Benthos and Plankton of Western Lake Michigan Areas of Concern in Co Non-Areas of Concern for Selected Rivers and Harbors	omparison to 95
Appendix F – An Evaluation of the Zooplankton Community at the Sheboygan River Ar and Non-Area of Concern Comparison Sites in Western Lake Michigan Rivers and Har	ea of Concern bors in 2016 159
Appendix G – Sheboygan River AOC 2018 Herptile Inventory Report	
Appendix H – Verification Monitoring of Biological Communities and Physical Habitat in Streams within the Sheboygan River Area of Concern 2014-2016	Select 297
Appendix I – Fish Assemblage Surveys in Select Streams in the Sheboygan River Area 2014-2016	a of Concern 333
Appendix J – Lower Sheboygan River Restoration Area of Concern Mussel Inventories	

List of Figures

Figure 1. The boundaries of the Sheboygan River AOC.	2
Figure 2. Effect of Sheboygan River water on phytoplankton growth	16
Figure 3.Effect of Sheboygan River water on zooplankton reproduction.	18

Remedial Action Plan Update for the Sheboygan River Area of Concern September 2020
Figure 4. Habitat restoration project locations in the Sheboygan River AOC
List of Tables

Table 1. Current status of Beneficial U	Jse Impairments	6
---	-----------------	---

Purpose Statement

This Remedial Action Plan (RAP), which updates the 2017 RAP, documents and communicates progress made in the Sheboygan River AOC in the last two years and shares the path forward with our partners and stakeholders. The RAP includes a summary of beneficial use impairment status and tracks progress on specific actions that are important for reaching BUI removal targets. These "actions" may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. As the primary agency with the responsibility to develop and implement the RAP, the Wisconsin Department of Natural Resources (WDNR) Office of Great Waters (OGW) is committed to making progress in remediating and restoring Wisconsin's Areas of Concern. In order to be lasting and effective, the RAP must be a program of continuous improvement, evaluating its course as new information and technology become available. Subsequent RAP updates will be produced as needed to incorporate new information.

Remedial Action Plans are required by Annex 1 of the Great Lakes Water Quality Protocol of 2012 (which replaced the 1987 Protocol amending the Revised Great Lakes Water Quality Agreement of 1978). The 2012 Protocol indicates that Remedial Action Plans must include the following elements:

- 1. Identification of BUIs and causes;
- 2. Criteria for the restoration of beneficial uses that consider local conditions and are established in consultation with the local community;
- 3. Remedial measures to be taken, including identification of entities responsible for implementing these measures;
- 4. A summary of the implementation of remedial measures taken and the status of the beneficial use; and
- 5. A description of surveillance and monitoring processes to track the effectiveness of remedial measures and confirm restoration of beneficial uses.



Figure 1. The boundaries of the Sheboygan River AOC. For additional information about the history of the AOC and a narrative description of the AOC boundary, please refer to previous RAP documents which are available online: http://dnr.wi.gov Search "Sheboygan River AOC"; RAP documents are stored on the "AOC Plans" tab.

Progress Summary

Projects to remediate contaminated sediments and restore habitat for fish and wildlife in the Sheboygan River AOC were completed in 2013. In 2015, following that work, the *Restrictions on Dredging Activities* and *Eutrophication or Undesirable Algae* Beneficial Use Impairments (BUIs) were removed. Since remediation and restoration were completed, wildlife and aquatic habitats have been monitored for signs of recovery. Within the last two years, assessment results have indicated that targets have been met for removing four additional BUIs: Degradation of Benthos, Degradation of Phytoplankton and Zooplankton Populations, Loss of Fish and Wildlife Habitat, and Degradation of Fish and Wildlife Populations. WDNR plans to present results to, and gather feedback from, technical experts and the public on the four proposed BUI removals. After feedback is received, WDNR will develop draft BUI removal documents that will be provided for public review and comment. The three remaining BUIs require additional monitoring for system recovery following the completed management actions and will undergo a BUI status check in 2021-2022.

The most recent RAP update for the Sheboygan AOC covered monitoring actions through 2017 and plans for 2018 (WDNR, 2018). This update recaps progress for the BUIs through May 2020. The following is a list of assessment and reporting actions undertaken by WDNR and/or partners since 2017 that represent progress toward removing the BUIs and eventually delisting the AOC. Details about projects in the AOC are included in Appendix B.

Fish tumors or other deformities

- The results of a 2017 fish tumor assessment on white suckers (*Catostomus commersonii*) conducted by the U.S. Geological Survey (USGS) and West Virginia University (WVU) showed that the incidence of liver tumors in white suckers is higher than the 5% target (Blazer *et al.*, 2017; Appendix C). Many of the captured fish were older than eight years and were therefore exposed to pre-cleanup concentrations of polychlorinated biphenyl (PCB) contaminants for several years.
- Fish tumor incidence rate will be re-assessed in 2021, when a smaller proportion of the population has been exposed to pre- sediment remediation conditions.

Restrictions on fish and wildlife consumption

 WDNR began reassessing waterfowl consumption advisories over a three-year period beginning in 2018. Ducks sampled in 2018 and early 2019 show substantially decreased PCB levels compared with 2011-2012. However, roughly 30% of samples collected from 2018 to present continue to remain higher than the "do not eat" PCB concentration advisory. Sampling for diving and dabbling ducks will continue in 2020.

- Geese will not be tested in 2020 due to the low levels of PCBs encountered in samples for the last two years, and levels are not expected to increase based on their feeding patterns.
- Consumption restrictions remain in place for waterfowl and fish. Fish consumption advisories are scheduled for reassessment in 2020 and 2021.

Bird or animal deformities or reproductive problems

- In 2018 USGS published a synthesis of their 2014-2017 studies on reproductive effects of PCB exposure on tree swallows (*Tachycineta bicolor*). Results indicate that exposure to sediment contaminants is not adversely affecting the reproduction of tree swallows in the Sheboygan River AOC (Custer *et al.*, 2018; Appendix D).
- In 2017, WDNR revised the mink sampling strategy and Quality Assurance Project Plan (QAPP) (Selle and Fischer, 2018). In 2018-2019 seven mink specimens were procured through WDNR trapping, local trappers, and roadkill. Hepatic tissue PCB levels were higher in the AOC than in the control area.
- Efforts to collect mink for PCB analysis will be enhanced in 2020 with the hiring of a local trapping expert and permission to collect mink outside the normal trapping season.
- WDNR will consult with U.S. Fish and Wildlife Service (USFWS) to determine additional species to be included in the assessment of this BUI.

Degradation of phytoplankton and zooplankton populations

- USGS published an interpretive report on its benthos and plankton studies in Lake Michigan AOCs from 2012 and 2014 (Scudder Eikenberry *et al.*, 2019; Appendix E), as well as a report on the follow-up study on zooplankton studies in Sheboygan in 2016 (Olds *et al.*, 2017; Appendix F). Results indicate that the phytoplankton communities in the AOC are similar to those in non-AOC sites.
- Results of 2016-2017 WDNR water column toxicity studies indicate that water in the Sheboygan AOC is not toxic to aquatic life.
- WDNR proposes to remove the Degradation of Phytoplankton and Zooplankton Populations BUI in 2020.

Degradation of benthos

- USGS published an interpretive report of its benthos and plankton studies in Lake Michigan AOCs from 2012 and 2014 (Scudder Eikenberry *et al.,* 2019; Appendix E). Results showed that the benthic macroinvertebrate and assemblages are similar to those in non-AOC sites.
- Preliminary results from a 2016 USGS sediment toxicity study suggest that sediments are not toxic to aquatic life.
- WDNR proposes to remove the Degradation of Benthos BUI in 2020.

Loss of fish and wildlife habitat

- GEI Consultants completed a thorough post-restoration assessment of the six Tier 1 habitat projects (Kiwanis Park; Taylor Drive and Indiana Avenue; Wildwood Island; Shoreline Stabilization in Problem Areas; In-Stream Habitat Improvements; and Targeted Invasive Species Control) and concluded that the eight conservation goals are being met (GEI, 2019a).
- WDNR proposes to remove the Loss of Fish and Wildlife Habitat BUI in 2021.

Degradation of fish and wildlife populations

- GEI completed a post-restoration herptile assessment in 2018 showing that herptile usage of areas within the AOC is expanding (GEI, 2019b; Appendix G).
- In 2018, WDNR completed a report synthesizing the results of pre- and post-restoration benthic macroinvertebrate assessments (Masterson, 2018; Appendix H). Results indicate that in all sites except at the Sheboygan River mouth, average macroinvertebrate assemblage scores rank "Fair" to "Excellent" and there is some evidence that communities are responding to restoration.
- Because of difficulty trapping mink and resulting low sample sizes, it was determined that they are not a suitable indicator species for assessing population status.
- WDNR proposes to remove the Degradation of Fish and Wildlife Populations BUI in 2021.

Table 1. Current Status of Beneficial Use Impairments in the Sheboygan River AOC. Information regarding specific projects addressing each BUI is found in Appendic C.

Beneficial Use Impairment	Beneficial Use Remains Impaired	Summary Status
Fish tumors or other deformities	Yes	A 2017 fish tumor study confirmed that the impairment still exists. Sampling will be conducted again in 2021.
Bird or animal deformities or reproductive problems	Yes	A study completed by USGS indicated that contaminants were present in tree swallow eggs at elevated levels, but below the lower limit at which number of eggs hatched begins to be negatively affected. WDNR mink trapping efforts will continue through 2020. BUI status will be re-evaluated after 2020 mink trapping efforts. WDNR will consult with USFWS on additional species that may be used to assess this BUI.
Restrictions on fish and wildlife consumption	Yes	DNR began a three-year reassessment of waterfowl consumption advisories in 2018. Ducks sampled in 2018 and early 2019 show substantially decreased PCB levels compared with samples collected in 2011-2012, but levels were still high enough that consumption advisories remain in effect. PCB levels in geese were comparable to pre-restoration levels and a consumption advisory remains in effect. More waterfowl sampling will be done in 2020. Fish consumption advisories will be assessed again in 2020 and 2021. BUI status will be evaluated again in 2022, following both the fish and waterfowl consumption advisory assessments.
Restrictions on dredging activities	No	BUI was removed in August 2015.
Degradation of phytoplankton and zooplankton populations	Yes	In 2019, USGS provided an interpretive report comparing pre- and post-restoration plankton assemblages in the AOC with non- AOC sites. An assessment of these data and water column toxicity data collected in 2016 and 2017 indicate that BUI removal targets have been met. This BUI will be proposed for removal in 2020.
Degradation of benthos	Yes	USGS benthos and plankton studies are complete and final reports have been published (Appendices E and F). A USGS report on sediment toxicity is forthcoming, but preliminary results indicate a lack of toxicity. An initial review of all available data on benthic macroinvertebrates, freshwater mussels, and sediment toxicity indicate targets for this BUI are being met. This BUI will be proposed for removal in 2020.
Loss of fish and wildlife habitat	Yes	The six tier 1 habitat restoration projects outlined in the Fish and Wildlife Plan are complete, and maintenance and monitoring of those projects continued through 2016. A habitat assessment of the restoration projects in 2019 indicated that restoration goals are being achieved. Water column toxicity data collected in 2016 and 2017 indicate that the 303(d) impaired waters listing is not due to aquatic toxicity. This BUI will be proposed for removal in 2021.
Degradation of fish and wildlife populations	Yes	Verification monitoring studies of macroinvertebrates, birds, bats, and mussels were completed in 2016. A verification monitoring study for herptiles was completed in 2018. Results indicate that populations are stable or recovering. This BUI will be proposed for removal in 2021.
Eutrophication or undesirable algae	No	BUI was removed in November 2015.

Beneficial Use Impairment Updates

For each BUI section, the following symbols indicate the status of the management actions listed:

- O Not Started
- Underway
- ✓ Complete



Fish Tumors and Other Deformities

Target	Status
All known sources of polycyclic aromatic hydrocarbons (PAHs) and chlorinated compounds within the AOC and tributary watershed have been controlled through issuance of the appropriate regulatory control document or eliminated.	Complete
The superfund PCB cleanup and Manufactured Gas Plant cleanup have been implemented.	Complete
There have been no reports of external Deformities, Lesions, and Tumors (DLTs) or internal organ/system impacts that have been verified by qualified WDNR personnel to have been caused by chemical contaminants for a period of five years.	In Progress
A fish health survey of resident benthic fish species such as white suckers finds incidences of tumors or other deformities at an incidence rate of less than 5 percent.	In Progress
OR, in cases where any tumors have been reported a comparison study of resident benthic fish (e.g., brown bullhead or white suckers) of comparable age and at maturity (3 years), or of fish species which have historically been associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.	In Progress

Status

In 2012, before management actions were taken to removed contaminated sediments, WDNR and the University of Wisconsin collected a baseline sample of 193 mature white suckers (between 3 and 28 years old) during the spring spawning run, primarily in the vicinity of Kiwanis Park in the lower Sheboygan River. Examination by personnel at USGS and WVU found that 8.3% of the fish had neoplastic liver tumors. The incidence of liver tumors exceeded the criteria of less than 5% specified in the BUI removal targets and exceeded the 3.5% incidence at a non-AOC site at the Kewaunee River (Blazer and Mazik, 2012; Blazer *et al.*, 2016).

In 2012-2013, over 300,000 cubic yards of PCB- and PAH-contaminated sediments were dredged from the lower Sheboygan River (WDNR, 2015a). In spring 2017, USGS and WVU collected 200 mature white suckers near Kiwanis Park to determine the effect of these improvements on tumor incidence. They found that 8.5% of the fish had liver tumors, which was not statistically different than in 2012 (Blazer *et al.*, 2016). The target of less than 5% was not met and the BUI was still impaired.

All but one year-class of fish collected during the 2017 study were born before and during sediment cleanup. Their tumors may result from exposure to contaminated sediments prior to the completion of dredging in 2013, or to contaminants suspended in the water by the dredging operations (Blazer *et al.,*

2019). Fish will be collected and examined again in 2021, when a higher proportion of fish will have recruited after cleanup was completed, to determine if the 5% tumor incidence target has been met.

For more information on these studies, see the 2019 final report in Appendix C.

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ A sample of 200 white suckers in 2017 found that the rate of neoplastic tumors was not statistically different than in 2012, confirming that the BUI remained impaired
- Fish tumors will be re-assessed in 2021.

Target	Status
Superfund and Resource Conservation and Recovery Act (RCRA) sediment and floodplain remedial actions have been implemented.	Complete
Studies conducted in the AOC indicate that the beneficial use should not be considered impaired; or	In progress
If studies conducted in the AOC determine that this use is impaired, then two approaches can be considered for removal:	
Approach 1 – Observational Data and Direct Measurements of Birds and Other Wildlife Evaluate observational data of bird and other animal deformities for a minimum of two successive monitoring cycles, in the indicator species identified in the initial studies as exhibiting deformities or reproductive problems. If deformity or reproductive problem rates are not statistically different from those at minimally impacted reference sites (at a 95% confidence interval), or no reproductive or deformity problems are identified during the two successive monitoring cycles, then the BUI can be removed. If the rates are statistically different from the reference site, it may indicate a source from either within or outside the AOC. Therefore, if the rates are statistically different or the data are insufficient for analysis, then Evaluate tissue contaminant levels in egg, young and/or adult wildlife. If contaminant levels are lower than the Lowest Observable Effect Level (LOEL) for that species for a particular contaminant and are not statistically different from those at minimally impacted reference sites (at a 95% confidence interval), the BUI can be removed.	In progress
Where data from direct observation of wildlife and wildlife tissue data are not available, the following approach should be used:	
Approach 2 – Fish Tissue Contaminant Levels as an Indicator of Deformities or Reproductive Problems If fish tissue concentrations of contaminants of concern identified in the AOC are at or lower than the LOEL known to cause reproductive or developmental problems in fish eating birds and mammals, the BUI can be removed, or If fish tissue concentrations of contaminants of concern identified in the AOC are not statistically different from those found in Lake Michigan (at 95% confidence interval), then the BUI can be removed. Fish of a size and species considered prey for the wildlife species under consideration must be used for the tissue data.	Not Complete

Rird o al Deformities

Status

Remedial actions at the Superfund sites were completed in 2013 and the Restrictions on Dredging Activities BUI was removed in 2015. To verify that contaminants such as PCBs, PAHs, and dioxins are no longer causing deformities or reproductive problems, USGS and WDNR have been monitoring contaminant levels and effects in tree swallows and American mink (Neovison vison), respectively, as

described in Approach 1 of the target. Tree swallows feed on flying insects, including those with a benthic life stage in which they are potentially exposed to sediment contaminants; in addition, they are common summer residents that readily use nest boxes so egg samples are easily taken. Mink are fisheating mammals that are sensitive to bioaccumulative chemicals (mink reproduction is known to be particularly sensitive to PCB exposures) and may be considered a "sentinel" species to indicate toxins in the aquatic food chain (Basu *et al.*, 2007; Blankenship *et al.*, 2008). Local trappers reported that, despite abundant habitat, few mink were trapped in the Sheboygan AOC, suggesting that contaminants may have been affecting survival and reproduction.

Tree swallow studies

From 2011-2014, USGS researchers measured contaminant concentrations in tree swallow eggs (Custer *et al.,* 2016) and nestlings (Custer *et al.,* 2017) at four sites in the Sheboygan River AOC. They compared tissue concentrations of contaminants to background levels at non-AOC sites, and to the levels that have been established to cause reproductive effects in tree swallows. They also compared the reproductive success, measured by the daily probability of egg failure or the number of eggs that failed to hatch at the AOC and non-AOC sites.

The average levels of PCBs in the tree swallow eggs were higher at the AOC sites (1.53-4.55 parts per million, [ppm]) than at non-AOC sites (0.32 ppm); however, reproductive effects do not occur until concentrations reach 20 ppm. Concentrations of dioxins/furans, pesticides, mercury, and other legacy contaminants were at background levels in eggs and nestlings at all the sites (Custer *et al.*, 2018; Appendix D). These results are inconclusive, and in consultation with the USFWS, WDNR is now considering other bird species which are more sensitive to PCBs, such as piscivorous birds (e.g., gulls or herons), which might better serve as indicators of reproductive effects (Bush *et al.*, 2020).

American mink studies

Efforts to collect enough mink samples to determine PCB levels have been ongoing since the completion of the contaminated sediment remediation projects. Live trapping efforts in 2014-2016 in areas where mink tracks were observed were unsuccessful. In 2017, WDNR revised the mink sampling strategy (Selle and Fischer, 2018). In 2018, WDNR conducted tracking surveys and deployed camera traps along the Sheboygan River in areas of likely habitat and prey availability and where mink tracks were previously observed. Body grip traps were then set for mink. That season two mink were trapped in the AOC and a roadkill specimen was collected in the control area along the Sheboygan River upstream of the AOC. Analysis by the Wisconsin State Lab of Hygiene (WSLH) determined that the two mink from the AOC had significantly higher total PCB hepatic tissue concentrations (0.956 ppm and 1.464 ppm) than the individual from the control area (0.031 ppm).

Trapping efforts continued unsuccessfully in 2019. However, WDNR was able to procure two mink specimens from a local trapper in the control area, and two roadkill specimens from 2013 (AOC) and 2015 (control area) that were still viable for tissue analysis. These samples were analyzed in 2018-2019. Preliminary indications from these data are that PCB concentrations in mink livers are higher within the

AOC than the control area. The average tissue concentration in the AOC, 1.60 ppm, is below the 2-ppm toxic threshold used to indicate potential adverse impacts but is high enough that potential effects cannot be ruled out (Strom, 2019). The strategy for 2020 is to increase sampling efforts, with the goal of obtaining at least 10 specimens to provide a robust sample size for analysis. WDNR will engage a local trapper and obtain a scientific collector's permit to trap mink out of season. If an insufficient sample size is obtained, a different indicator species may be chosen.

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ USGS published results from tree swallow studies in three technical journal articles in 2016, 2017, and 2018.
- ✓ The QAPP for mink sampling was updated for 2018 with a revised strategy.
- ✓ WDNR collected four mink in 2018-2019 and obtained hepatic tissue PCB concentrations.
- Mink collection efforts will increase in 2020, with a scientific collector's permit to hire a local trapper to trap mink out of season.
- WDNR will consult with USFWS regarding additional species that may be suitable for this BUI assessment.

Restrictions on Fish and Wildlife Consumption

Target	Status
Fish Consumption	
The Superfund PCB cleanup and Manufactured Gas Plant cleanup have been implemented.	Complete
All other known sources of bioaccumulative contaminants of concern (PCBs, mercury, pesticides, and PAHS) have been identified and controlled or eliminated.	Complete
Waters within the Sheboygan River AOC are no longer listed as impaired due to PCB fish consumption advisories in the most recent Impaired Waters (303(d)) list.	Not Complete
Wildlife Consumption	
The floodplain cleanup action that is part of the Superfund Cleanup is implemented.	Complete
All other known sources of bioaccumulative contaminants of concern (PCBs, mercury, pesticides, and PAHs) have been identified and controlled or eliminated.	Complete
Waters within the Sheboygan River AOC are no longer listed as impaired due to wildlife consumption advisories listed in the annual Wisconsin Migratory Bird Regulations.	Not Complete

Status

Currently, the Sheboygan River is listed as a 303(d) impaired water based on PCB contamination in fish tissue (WDNR, 2020a). The lower 14 miles are under a "do not eat" restriction for all fish species except brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*), which may be consumed once per week or once per month, depending on fish size and the age and sex of the consumer (i.e., children and women of childbearing age should consume less; WDNR 2020b). The third portion of the target for the fish consumption BUI is currently not met. Contaminant monitoring in fish tissue is planned in 2020-2021.

In 2011-2012, prior to completion of sediment remediation projects, WDNR and the U. S. Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS) sampled dabbling ducks, diving ducks, and Canada geese (*Branta canadensis*) from the AOC.

After a post-remediation recovery time, WDNR began reassessing waterfowl consumption advisories over a three-year period beginning in 2018. PCB levels in ducks decreased compared to 2011-2012: 27% of all ducks had PCB tissue concentrations sufficient to place them in the "do not eat" category (WDNR, 2016a) compared to 42% in 2012. Levels in diving ducks were higher than in dabbling ducks: 75% of diving ducks sampled in 2018-2019 had PCB levels restricting consumption to one meal per month, compared to 45% of dabbling ducks sampled in 2011-2012 (WDNR, 2016a).

Levels in geese were much lower than in ducks, and the 2018-2019 results were similar to those of 2011-2012: the highest level fell under the advisory of no more than one meal/month and 20% of geese had levels indicating unlimited consumption is allowed. After evaluating these results with a fish and wildlife toxicologist and considering feeding patterns, geese were removed from the list of waterfowl species to be sampled in 2020.

Lesser scaup (*Aythya affinis*) from the Sheboygan Harbor portion of the AOC remained under a "do not eat" restriction in 2019 (WDNR, 2019). The third portion of the target for the wildlife consumption BUI is currently not met. Waterfowl sampling will continue in 2020. The BUI status will be evaluated in 2022, following both the fish and waterfowl consumption advisory assessments.

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ PCB concentrations in waterfowl were assessed in 2018 and 2019.
- **PCB** monitoring in waterfowl (dabbling and diving ducks) will continue in 2020.
- **Contaminant monitoring in fish tissue is planned to occur in 2020-2021.**
- The BUI status will be evaluated in 2022.

Target	Status
Sources causing nutrient enrichment to the Outer Harbor and near shore waters are identified and controlled if nutrients are the main contributor to plankton population degradation; OR Sources of ambient water toxicity in the Outer Harbor and near shore waters are identified and controlled if toxicity is the main contributor to plankton population degradation.	Complete
Phytoplankton or zooplankton bioassays confirm no toxicity in ambient waters and the community structure is diverse and contains species indicative of clean water.	Complete
The phytoplankton and zooplankton communities within the site being evaluated are statistically similar to those of a reference site with similar habitat and minimal sediment contamination.	Complete

Degradation of Phytoplankton and Zooplankton Populations

Status

As part of their studies of the benthos and plankton at Wisconsin's Lake Michigan AOCs, USGS assessed the phytoplankton and zooplankton communities at a site at the mouth of the Sheboygan River in in the spring, summer, and fall of 2012 and 2014 (Scudder Eikenberry *et al.*, 2014; Scudder Eikenberry *et al.*, 2016). They compared mean density, species richness, and diversity of plankton to the mean values at two non-AOC comparison sites at the Manitowoc and Kewaunee Rivers as well as all six non-AOC sites combined. In 2019, they published a report interpreting their results (Scudder Eikenberry *et al.*, 2019; Appendix E). WDNR sampled water at the same Sheboygan River site in August 2016 and in May and August-October 2017, and WSLH tested it for toxic effects on phytoplankton growth and zooplankton growth and reproduction.

USGS found no differences in the phytoplankton community metrics between the Sheboygan site and the mean values from either the pair of comparison sites or all the non-AOC sites as a group (Scudder Eikenberry *et al.,* 2019). WSLH found no adverse effects on phytoplankton growth in four of the six bioassays. Slight reduction in phytoplankton growth occurred in summer 2016, and significant reduction in September 2017 (20% difference from laboratory control), but no effects were seen in October 2017 (Figure 2).



Figure 2. Effect of Sheboygan River water on phytoplankton growth.

The results of USGS' studies indicated that zooplankton diversity in 2014 was significantly lower at the Sheboygan River site than at the non-AOC comparison sites (Scudder Eikenberry *et al.*, 2016), so a follow-up study of zooplankton was conducted in 2016 (Olds *et al.*, 2017; Appendix F). Diversity was lower in 2016 than 2014 (but higher than in the pre-restoration study of 2012), and lower than at the non-AOC sites (Olds *et al.*, 2017). However, there were no significant differences between the zooplankton density and species number at the Sheboygan site and all the non-AOC sites as a group in

either 2012 or 2014. The fluctuations in mean yearly diversity can be attributed to the variation in zooplankton assemblages with year and season, and the sensitivity to invasive species and environmental conditions. Immature zebra mussels (*Dreissena polymorpha*), which were not found at the Kewaunee or Manitowoc comparison sites, were the dominant taxon at Sheboygan in fall 2014, and one of the dominant taxa in 2016 (Scudder Eikenberry *et al.*, 2019). Zebra mussels, a highly invasive species, are wide-spread throughout Lake Michigan and must be addressed lake-wide rather than through the local AOC program. The WSLH bioassays of the Sheboygan River water showed no chronic toxicity to zooplankton, except for a 15% reduction in reproduction compared to the lab control in August 2016 (Figure 3).

Based on the bioassay results and USGS' plankton community assessments, WDNR and technical experts determined that there are no ongoing toxicity effects to phyto- and zooplankton populations in the Sheboygan River and that plankton communities are similar at Sheboygan and in the non-AOC group. The third portion of the target for BUI removal has been met and the BUI will be proposed for removal in 2020.



Figure 3.Effect of Sheboygan River water on zooplankton reproduction.

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ The USGS report for the 2012 study, "Benthos and plankton for selected rivers and harbors along Wisconsin's Lake Michigan shoreline, 2012", is available at https://pubs.er.usgs.gov/publication/ds824.
- ✓ The USGS report for the 2014 study, "Benthos and plankton community data for selected rivers and harbors along the western Lake Michigan shoreline, 2014" is available at <u>https://pubs.er.usgs.gov/publication/ds1000</u>.
- ✓ Interpretive report "Benthos and Plankton of Western Lake Michigan Areas of Concern in Comparison to Non-Areas of Concern for Selected Rivers and Harbors, 2012 and 2014" is available at <u>https://pubs.er.usgs.gov/publication/sir20195051</u>).
- ✓ Interpretive report "An evaluation of the zooplankton community at the Sheboygan River Area of Concern and non-Area of Concern comparison sites in western Lake Michigan rivers and harbors in 2016" is available at <u>https://doi.org/10.3133/sir20175131</u>.
- ✓ WDNR did not list the Sheboygan River as impaired due to aquatic toxicity in the draft Impaired Waters 303(d) list submitted to USEPA in April 2020 (WDNR 2020c).
- The Degradation of Phytoplankton and Zooplankton Populations BUI will be proposed for removal in 2020.

Degradation of Benthos	
Target	Status
Known contaminant sources contributing to sediment contamination and degraded benthos have been identified and control measures implemented.	Complete
All remediation actions for contaminated sediments are completed and monitored according to the approved plan with consideration to using consensus-based sediment quality guidelines and equilibrium partitioning sediment benchmarks.	Complete
The benthic community within the site being evaluated is statistically similar to that of a reference site with similar habitat and minimal sediment contamination.	Complete

Status

As part of a study of the benthos and plankton in Wisconsin's four Lake Michigan AOCs, USGS assessed the benthic community at a site at the mouth of the Sheboygan River in 2012 and 2014 (Scudder Eikenberry *et al.*, 2014; Scudder Eikenberry *et al.*, 2016). Samples of the benthos were collected in spring, summer, and early fall, from the Sheboygan Harbor site and from two non-AOC comparison sites at the Manitowoc and Kewaunee Rivers. The metrics that were evaluated included: total density; number and diversity of taxa; and, the richness, density, and percentage of individuals in insect orders Ephemeroptera-Plecoptera-Trichoptera (EPT, mayflies, stoneflies, and caddisflies). The assessment also included a macroinvertebrate index of biotic integrity (IBI), a calculated metric that evaluates the community on a scale of 0-10 by considering not only the number of taxa but functional information about the organisms (for example, feeding guilds such as shredders, scrapers, and filterers) and their tolerance to environmental degradation.

In an interpretive report, USGS compared these results to the mean values at two non-AOC comparison sites at the Manitowoc and Kewaunee Rivers as well as all six non-AOC sites combined (Scudder Eikenberry *et al.*, 2019; Appendix E). None of the benthos metric results differed between the pre- and post-remediation samples, nor did the 2014 metric results differ between the AOC and non-AOC sites. The macroinvertebrate IBI improved from 2012 to 2014 (although the difference was not statistically significant), but still rated "very poor". As with the plankton study (see Degradation of Phytoplankton and Zooplankton Populations BUI section), the benthic macroinvertebrate assemblage differed in the AOC and non-AOC sites largely because zebra mussels were abundant in Sheboygan but not present at the comparison sites (Scudder Eikenberry *et al.*, 2019). Zebra mussels, a highly invasive species, are wide-spread throughout Lake Michigan and must be addressed lake-wide rather than through the local AOC program.

WDNR evaluated the macroinvertebrate community within the AOC at 15 wadeable and one nonwadeable sites in the Sheboygan River, Onion River, Willow Creek, and Weedens Creek. The nonwadeable site, SR01, corresponded to the river mouth site at which USGS carried out their studies. Macroinvertebrate communities were sampled in 2010-2011 before contaminated sediment remediation and habitat restoration (which included improvements in aquatic habitats such as increased water flows and sediment transport), and afterwards in 2014-2016. The same metrics were used as in the USGS study, but also included Hilsenhoff's biotic index (HBI, roughly equivalent to the proportion of organisms in a certain taxon, multiplied by that taxon's pollution tolerance score).

For the Sheboygan harbor site SR01, WDNR's studies corroborated those of USGS: the IBI scores for that site rated "poor" in all years (Masterson, 2018). The harbor is a highly modified environment with bulkhead walls, navigation channel dredging, and fine sediment deposition; therefore, a high-quality benthic community is likely unachievable in this part of the AOC.

For the wadeable stream sites, Masterson found that there were no significant differences between the macroinvertebrate communities before and after remediation/restoration, which may be due to annual variability at each site masking general improvements in the entire AOC, and the lack of replicate samples before the management actions were undertaken (Masterson, 2018; Appendix H). However, the average post-restoration macroinvertebrate IBIs were rated "Fair" to "Excellent", indicative of some response to restoration.

In 2016, USGS measured sediment concentrations of PCBs, PAHs, and heavy metals at three sites in the AOC. They conducted bioassays to assess sediment toxicity to aquatic organisms. Preliminary results suggest low toxicity, both in the AOC at non-AOC sites (Scudder Eikenberry *et al.*, 2017). A full report from USGS is expected. The BUI will be proposed for removal in 2020.

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ The USGS report for the 2012 study, "Benthos and plankton for selected rivers and harbors along Wisconsin's Lake Michigan shoreline, 2012", is available at https://pubs.er.usgs.gov/publication/ds824.
- ✓ The USGS report for the 2014 study, "Benthos and plankton community data for selected rivers and harbors along the western Lake Michigan shoreline, 2014" is available at <u>https://pubs.er.usgs.gov/publication/ds1000</u>.
- ✓ Interpretive report "Benthos and Plankton of Western Lake Michigan Areas of Concern in Comparison to Non-Areas of Concern for Selected Rivers and Harbors, 2012 and 2014" is available at <u>https://pubs.er.usgs.gov/publication/sir20195051</u>).
- **The Degradation of Benthos BUI will be proposed for removal in 2020.**

Restrictions on Dredging Activities	
Target	Status
All remediation actions for contaminated sediments are completed and monitored according to the approved remediation plans.	Complete
 A dredging alternatives plan is developed that includes an evaluation of the following: Restrictions that must remain in place to protect human health and the environment. Restrictions that must remain in place due to Superfund or RCRA requirements that are based upon state and federal law. Priority areas for navigational use. Priority areas where dredging is needed for other purposes (i.e., utilities) Costs associated with removing dredging restrictions in priority areas. Funding available to address removing dredging restrictions in priority areas. 	Complete

Status

A final removal package was sent to USEPA in July 2015 and with the concurrence of USEPA, the BUI was formally removed in August 2015. The final BUI removal document can be found on WDNR's Sheboygan River AOC web page under the <u>"Impairments" tab.</u> A summary of sediment removal projects can be found in Table 4 of the 2014 RAP Update (RAP Update; WDNR, 2014).

Management Actions

No further actions are necessary for this BUI.

oss of Fish and Wildlife Habitat	
Target	Status
A local fish and wildlife habitat management and restoration/rehabilitation plan has been developed for the entire AOC that accomplishes the following:	Complete
 ✓ Defines the causes of all habitat impairments within the AOC. ✓ Establishes site-specific habitat and population targets for fish and wildlife species within the AOC. ✓ Identifies primary and secondary habitat restoration goals, management activities, and projects that would adequately restore or rehabilitate fish and wildlife habitat within the Sheboygan River AOC. 	
All primary habitat restoration goals, management activities, and projects identified in the fish and wildlife management and restoration plan are implemented and modified as needed to ensure continual improvement.	Complete
Waters within the Sheboygan River AOC are not listed as impaired due to aquatic toxicity in the most recent Clean Water Act 303(d) and 305(b) Wisconsin Water Quality Report to Congress (submitted to USEPA every two years).	Complete

Status

The Fish and Wildlife Restoration Plan for the Sheboygan River AOC (WDNR, 2016b), developed by WDNR and the Sheboygan AOC Fish and Wildlife Technical Advisory Committee (TAC), fulfills the first portion of the target for this BUI. The plan defined the causes of habitat impairments, established site-specific habitat and population targets for fish and wildlife species, and identified habitat restoration goals, management activities, and projects that would adequately restore or rehabilitate fish and wildlife habitat within the AOC. Conditions that degraded the fish and wildlife habitat included: erosion, especially along shorelines and streambanks; sedimentation and loss of spawning habitat; vegetation removal and habitat fragmentation; urban impacts including pollutants and stormwater runoff; and non-native species coverage.

The restoration plan identified eight Tier One project conservation goal categories for restoration or improvement (WDNR, 2016a, b; GEI, 2019a):

- 1. Migratory bird stopover habitat
- 2. Shorebird stopover and breeding habitat
- 3. Resident breeding bird habitat
- 4. Warmwater fisheries community habitat
- 5. Herptile habitat
- 6. Riparian emergent wetlands
- 7. Riparian forested floodplains
- 8. Coldwater fisheries community habitat

Meeting the second target for this BUI, six Tier One habitat restoration projects were completed in 2012 (Figure 2):

- Kiwanis Park Shoreline Restoration (Goals 1-5)
- Taylor Drive and Indiana Avenue Riparian Area and Wetland Restoration (Goals 1-6)
- Wildwood Island Area Restoration (Goals 1-6)
- Shoreline Stabilization in Problem Areas (Goals 1-5)
- In-Stream Habitat Improvements (Rochester Park and Kohler Site) (Goal 4)
- Targeted Invasive Species Control (Goals 1-8)

A seventh project at the Schuchardt property was delayed due to property ownership changes. This 140acre property within the City of Sheboygan is considered an Area of Special Natural Resource Interest due to its diverse mix of natural communities, and its preservation was a high priority. Glacial Lakes Conservancy purchased the property with Natural Resources Damage Assessment (NRDA) funds, and it is now known as the Willow Creek Preserve. Restoration actions for the site are being planned and will address conservation goals 1-8 (USFWS, 2017; GEI, 2019a).

Management actions for the restoration projects addressed impairment sources such as pollution and stormwater and improved the physical structure and vegetative communities along shorelines and streambanks, in wetlands, and in upland areas. More than 4,900 feet of degraded shorelines were stabilized, and more than 5.5 acres of wetland created, within the Kiwanis Park, Taylor Drive/Indiana Avenue, and Wildwood Island project sites. Besides the removal of invasive species and installation of native vegetation in the riparian zones, improvements included large woody debris structures and bioengineered shoreline treatments. Over 2,000 feet of in-stream habitat improvements were made in the vicinity of Rochester Park in Sheboygan Falls and Village of Kohler property, including the installation of boulders and boulder-vane structures, woody structures, and tree-drops. Habitat structures for fish, birds, and bats, such as woody debris and nest boxes, were placed in appropriate areas (WDNR, 2016a, b; GEI, 2019a). Maintenance and monitoring of the projects continued into 2016 (WDNR, 2018).

Wildlife usage is often used as an indicator of habitat quality (Johnson, 2007). To provide baseline information on the habitat conditions and the status of fish and wildlife populations, extensive assessments were conducted throughout the AOC in 2011-2012, as sediment remediation projects neared completion and before habitat restoration began. Pre-restoration studies included invasive plant species surveys and mapping, wildlife assessments, and a Rapid Ecological Assessment focusing on rare species and high-quality natural communities (WDNR Natural Heritage Inventory, 2012). After completion of the restoration projects, verification monitoring assessments were conducted for aquatic and terrestrial communities. Results of these pre- and post-restoration wildlife community surveys are detailed in the Degradation of Fish and Wildlife Populations section of this RAP.



Figure 4. Locations of the shoreline habitat and in-stream restoration projects to address Fish and Wildlife BUIs in the Sheboygan River AOC.

Habitat restoration assessments

In 2018, WDNR contracted GEI Consultants to evaluate each of the conservation goal categories for improvement at the restoration sites (WDNR, 2016b). GEI reviewed WDNR Remedial Action Plans, restoration design plans for the projects, previous habitat assessments and reports, and conducted on-the-ground habitat surveys to compare current and past conditions at the six project sites. Their 2018 habitat assessments included wetland delineations, Wetland Rapid Assessment Methods (WRAM), Floristic Quality Assessments, invasive species treatment assessment, and restoration site assessment. Where appropriate, general estimation of shoreline stability and observations of in-stream habitat improvements were included. To estimate wildlife usage of the restored sites, they reviewed WDNR preand post-restoration monitoring studies (GEI, 2019a). The results of the GEI assessments are detailed below.

• Prior to restoration, the wetlands at Kiwanis Park, Taylor Drive/Indiana Avenue, and Wildwood island consisted only of wet meadow and shrub carr, with some floodplain

forest and shallow marsh. The post-restoration WRAM evaluation at these three areas found that vegetative community types increased from two to seven, and included wet meadow, mesic prairie, floodplain and upland forest, and deep marsh. The coverage of the five target invasive species was significantly reduced, with only buckthorn in the forest area being higher than the <5% restoration goal. Post-restoration, the sites had "medium" or "high" scores for the wetland functions Human Uses, Floristic Integrity, Wildlife Habitat, Fish and Aquatic Life Habitat, Shoreline Protection, and Water Quality Protection (GEI, 2019a). Shoreline protection was improved at all sites, with shorelines armored with woody vegetation and native plants.

Conservation goal assessments

- The results of the assessments indicate that all site-specific Tier One Restoration project goals have been attained. Migratory bird stopover habitat (Conservation Goal 1) and resident breeding bird habitat (Conservation Goal 3) were substantially improved for all bird guilds by the removal of invasive species and establishment of diverse native plant communities, especially in riparian and wetland habitats which benefit both breeding and migrating birds. The planting of thousands of trees and shrubs to soften the transition from forest to grassland diversified the habitat structure and provided increased foraging and nesting opportunities. Installation of structures such as nest boxes and platforms provided additional nesting and roosting habitat (GEI, 2019a). The increase in wetland and riparian habitat (Conservation Goal 2), as did the installation of gravel bars and the creation of mudflats. The WRAM (GEI, 2019a) ranked the sites "medium" or "high" for wildlife habitat.
- Warmwater fisheries community habitat (Conservation Goal 4) was improved by the placement of boulders and woody debris to create backwater and rocky areas. These structures stabilized shorelines, provided cover, and increased water flows and sediment transport. The installed gravel bars also provided fish foraging and spawning habitat, and tree-drops provided shaded areas as well as floating vegetation habitat. The modifying of stormwater outfalls helped reduce sedimentation and improve water quality (GEI, 2019a). Post-restoration, stream habitat assessments by Masterson rated all wadeable sites "fair" to "excellent" (2018). Fish assemblage surveys found a relatively healthy community based on numbers and species diversity (Motl, 2016; Appendix I).
- Herptile habitat (Conservation Goal 5) was improved by the expansion and improvement of wetlands and naturalized shorelines, including the creation of shallow depressions and improvement of an ephemeral pond. Large woody debris added in streams and in upland and woodland habitats provided cover and basking areas, and a snake hibernaculum was created at the Taylor Drive/Indiana Avenue site. GEI's post-

restoration herptile assessments indicate that the community is generally equivalent to that measured before restoration in 2011 (GEI, 2019a).

- The expansion and enhancement of wetlands, improvement of hydrologic connections to the river, and the improvement of stormwater outlets met the Riparian emergent wetland habitat goal (Conservation Goal 6). The wetland delineations showed an increase in wetland area, and the WRAM evaluation showed increased numbers of communities and coverage and diversity of native plants (GEI, 2019).
- Over 12 acres of riparian forest (Conservation Goal 7) were improved throughout the restoration sites. Restoration actions included removal of invasive vegetation, placement of woody debris, and establishment of diverse natural communities through the planting of trees, shrubs, and native plants (GEI, 2019a).
- Coldwater fisheries community habitat (Conservation Goal 8) improvements resulted from invasive species control throughout the AOC, as well as WDNR's trout stream and wetland restoration projects along the Onion River. Conservation of the Shuchardt property as Willow Creek Preserve and restoration projects along its coldwater stream will also address this goal.

Water column toxicity

WDNR sampled the water in the Sheboygan River in summer 2016, and in spring, summer and fall 2017 (six samples total) and tested it for toxic effects on *Selanastrum* (phytoplankton) growth and *Ceriodaphnia* (zooplankton) reproduction. Bioassays by WSLH showed no chronic toxicity to zooplankton, except for a 15% reduction in mean number of neonates (offspring) in August 2016 compared to the lab control. There were no effects on phytoplankton growth in four of six assays. Slight reduction in phytoplankton growth occurred in August 2016, and significant inhibition in September 2017 (20% difference from laboratory control), but no effects were seen in October 2017. Using this information in conjunction with sediment remediation information, WDNR did not list the lower 14 miles of the Sheboygan River as being impaired due to aquatic toxicity on the 2020 draft 303(d) list (Beranak, 2019; WDNR 2020a, b). When the list is approved, the third portion of the target for BUI removal will be met.

Management Actions

 ✓ Seven habitat projects have been completed and the last year of maintenance and monitoring took place in 2018 (herptile habitat; GEI, 2018).

Additional Actions

GEI Consultants conducted a detailed habitat assessment and published their report in 2019.

- Based on the results of water column toxicity tests, aquatic toxicity is not contributing to the 303(d) impaired waters listing of the Sheboygan River.
- This BUI will be proposed for removal in 2021.

Degradation of Fish and Wildlife Populations

Target	Status							
Approved remedial actions (Superfund and RCRA) for contaminated sediment and floodplains have been fully implemented; and								
 A local fish and wildlife management and restoration plan has been developed for the entire AOC that: Defines the causes of all population impairments within the AOC. Establishes site specific local population targets for native indicator fish and wildlife species within the AOC. Identifies all fish and wildlife population restoration programs/activities within the AOC and establishes a mechanism to assure coordination among all these programs/activities including identification of lead and coordinative agencies. Establishes a time table, funding mechanism, and lead agency responsibility for all fish and wildlife population restoration activities needed with the AOC. 	Complete							
The programs necessary to accomplish the recommendations of the fish and wildlife Complete management and restoration plan are implemented.								
Populations of native indicator fish/wildlife species are statistically similar to populations in reference sites with similar habitat, but little to no contamination.	Complete							

Status

The Fish and Wildlife Populations BUI is tied to the Fish and Wildlife Habitat BUI, in that improvements in habitat should result in greater wildlife usage of the sites. The first and second portions of the target for this BUI removal are met by the Fish and Wildlife Restoration Plan and the restoration actions described in the Loss of Fish and Wildlife Habitat section. To meet the third portion of the target, WDNR conducted pre- and post-restoration wildlife assessments in 2011-2012 and in 2014-2016, respectively, to determine the wildlife response to habitat improvements.

Fish community surveys

WDNR collected representative fish assemblage samples in 2011 and 2014-2016 from 17 sites in the lower 14-miles of the Sheboygan River and in its tributaries. Data from three additional sites in the Onion River from 2009-2010 were included in the analysis. Fish counts, measurements, weights and species were used to calculate an IBI specific for fish as an indicator of assemblage health and water quality (Lyons, 2006). At sites where at least 16 fish were caught, smallmouth bass (*Micropterus dolomieu*) Catch Per Unit effort (CPU) and Relative Stock Density (RSD) were calculated as an indicator of whether a population was meeting its potential for the habitat type (Motl, 2016; Appendix I).

Results from the Onion River, Willow Creek, and Weedens Creek were positive overall. In the Onion River (six sampling sites) and Willow Creek (three sampling sites) the IBIs ranged from "fair" to "excellent" in all years. One site in the Onion River had an "exceptional" CPU. Two sites were sampled in Weedens Creek; the IBI in the downstream segment improved from "fair" to "excellent" from 2014-2016, while the upstream site had a "poor" average IBI that was likely due to intermittent flows including a dry year in 2014 (Motl, 2016).

At the nine sites in the Sheboygan River, habitat and IBI values, as well as smallmouth bass catch rates, were better in the upstream, wadeable sections, with the three-year average IBI rated "fair" or "good". The same sites in 2011 had "good" or "excellent" ratings, but direct comparison is difficult because there was only one sample replicate before restoration. Overall, fish populations in the Sheboygan River were relatively healthy and resembled those at sites with comparable habitat but no contamination (Motl, 2016).

Bird surveys

Breeding birds were surveyed in 2011 (37 locations) and again in 2016 (38 locations) at the habitat restoration sites and nearby areas. In 2016, Baughman observed 987 birds and 77 species compared to 808 individuals and 70 species in 2011. The higher abundance and species richness were attributed to "additional areas and habitats" (Baughman, 2016).

During the WRAM evaluation site visits conducted in August and October 2018, GEI Consultants directly observed 51 bird species at the Taylor Drive/Indiana Avenue area. Reliable data from the online database eBird exist for 68 more species (including 52 species of migrant birds), and 11 additional species could potentially breed there based on available habitat. In Kiwanis Park, they observed 48 bird species, eBird data exist for 4 more species (migrants), and 17 additional breeding species could potentially use the site based on available habitat. At Wildwood Island, they observed 52 bird species, reliable eBird data exist for 35 more (28 migrants), and 14 additional breeding species could potentially use the site based on available habitat (GEI, 2019a). The breeding bird population will likely increase as the restoration plantings mature; migrating birds, which use early-successional vegetation for stopover habitat, will benefit even more from the softened forest-prairie transition, although there will be annual variations.

Mammal surveys

Two acoustic surveys for bats along the Sheboygan River in 2016 detected an average of 24.9 bat passes per detector-hour, compared to 14.7 in 2010-2011. All the Wisconsin resident bats were found except the Northern long-eared bat *(Myotis septentrionalis)*. The hoary bat *(Aeorestes cinereus)* and Eastern pipistrelle (*Perimyotis subflavus*) were detected for the first time in 2016. The little brown bat (*Myotis lucifugus*) was the most common species found during the 2010/2011 surveys (46.4% of bat passes), but in 2016 the big brown bat (*Eptesicus fuscus*) was the most common (82.7%), followed by little brown bat (7.4%). The decline in detections of little brown bat may be due to white-nose syndrome affecting the population of a hibernaculum within 50 miles of the Sheboygan AOC (Kaarakka, 2016).

American mink censuses were originally part of the verification monitoring studies for the Fish and Wildlife Populations BUI; however, the difficulty of capturing mink and the resulting low sample numbers make it an unsuitable indicator for population assessments. The mink's role as a mesopredator in the ecosystem, and its sensitivity to PCBs, makes it more suitable as a study species for the Bird and Animal Deformities and Reproductive Problems BUI.

Herptile surveys

In 2011, Dare Ecosystems conducted pre-restoration surveys for herptiles at 14 sites in the AOC. Survey sites included city parks and preserves, Kohler property, and city and state property including the three fish and wildlife habitat restoration projects at Kiwanis Park, Taylor Drive/Indiana Avenue, and Wildwood Island (Dare, 2011). In 2018, GEI Consultants repeated the surveys at the same sites, with the addition of Roy Sebald Sheboygan River Natural Area. The surveys comprised nocturnal frog call surveys, coverboard surveys for snakes and salamanders, and visual encounter surveys for snakes and turtles (GEI, 2018b; Appendix F).

Direct comparison of the 2018 and 2011 surveys was difficult due to several survey protocol differences, and the lack of species abundance data collected in 2011. However, the herptile community was comparable in both years: eleven herptile species were detected in 2011 and twelve in 2018. All species except snapping turtle *(Chelydra serpentina)* were found at more sites in 2018 than in 2011. GEI concluded that "WDNR has begun to achieve the objectives of increased usage of the survey areas by herptile species, in both number of species found and in population sizes of the herptile species found in comparison the 2011 survey" (GEI, 2019b).

Macroinvertebrate and aquatic macrophyte surveys

WDNR assessed benthic macroinvertebrate assemblages and stream habitat in 2010/2011 and again in 2014-2016, at 16 sites in the Sheboygan River and its tributaries. The invertebrates in the samples were identified and the following metrics calculated: the number of taxa, Shannon Diversity Index, the percentage individuals or genera in the family Chironomidae (non-biting midges), EPT, IBI, and HBI (see Degradation of Benthos section) (Masterson, 2018; Appendix H).

All stream habitat surveys on the wadable sites rated "Fair" to "Excellent". Wadeable streams less than 10 meters wide had habitat ranking "Fair to "Good". Sites on larger streams ranked "Fair" to "Excellent" for habitat. There were no significant differences in scores or rankings before and after contaminated sediment was removed and habitat restoration projects were implemented (Masterson, 2018).

Diversity and number of taxa were lower in Willow Creek and Weeden Creek than in the larger Onion and Sheboygan Rivers. The non-wadeable site SR01 at the mouth of the Sheboygan River had "Poor" macroinvertebrate IBI ratings and HBI scores both pre- and post- restoration, due to lack of habitat and dominance of fine sediment substrate. At all other sites in the Sheboygan River the mean

macroinvertebrate IBI scores after restoration were sufficiently high that the macroinvertebrate community is not considered impaired (WDNR, 2015; Masterson, 2018).

WDNR conducted aquatic plant surveys in 2011 and 2014-2016 at Wildwood Island to determine the potential to support annual Northern pike (*Esox Lucius*) spawning. The number of plant species, frequency of occurrence, and floristic quality were very low in all years, although they increased post-restoration. This is likely due to excessive stream flows, turbidity, foraging from common carp, and ice scour of the substrate in early spring. The area is a poor candidate for Northern pike spawning habitat (Masterson, 2018).

Mussel surveys

Dare Ecosystems conducted surveys for mussels at 14 sites in the Sheboygan River in 2011 and at seven sites in 2016 (Dare, 2012; Dare, 2017 [Appendix J]). The mussel community within the lower AOC restoration areas is moderately diverse and has varying abundance depending on the site. In 2011, Dare found seven species of live mussels at 13 sites, while 234 live individuals of eight species were found at five sites in 2016. The restoration sites at Taylor Drive and Esslingen Park had good populations of most of the observed species, and the abundance improved from 2011 to 2016. Populations may rebound over time as fish move these species to new areas of restored habitat in the river (Dare, 2017).

Management Actions

 ✓ All sources of contaminants have been identified and controlled or eliminated within the Sheboygan River AOC.

Additional Actions

- ✓ Fish and Wildlife Restoration Plan was finalized in early 2017.
- ✓ GEI Consultants conducted a detailed habitat assessment and published their report in 2019.
- Pre- and post-restoration assessments were conducted for fish, bird, mammal, herptile, macroinvertebrate, and mussel populations and the results indicate that populations are recovering.
- The Degradation of Fish and Wildlife Populations BUI will be proposed for removal in 2021.

Eutrophication or Undesirable Algae							
Target	Status						
In-river total phosphorus concentrations meet Wisconsin AOC target criteria with a 95% level of confidence; and	Complete						
There are no violations of the minimum dissolved oxygen concentrations established in NR 102 within the AOC due to excessive sediment deposition or algae growth; and	Complete						
The Wisconsin AOC target criteria will be considered to have been met when the sample population does not exceed nutrient targets or evidence indicates the lack of biological impairment (as determined by fish and macroinvertebrate Indicators of Biological Integrity, or IBIs).	Complete						

Status

A final removal package was sent to USEPA in September 2015 and with the concurrence of USEPA, the BUI was officially removed in November 2015. The final BUI removal document can be found on WDNR's Sheboygan River AOC web page under the <u>"Impairments" tab.</u>

Management Actions

No further actions are necessary for this BUI.

References

Basu, M., Scheuhammer, A. M., Bursian, S. J., Rouvinen-Watt, K., Elliott, J., and H. M. Chan. 2007. Mink as a sentinel species in environmental health. Environmental Research **103**, 130-144.

Beranak, A. 2019. Personal communication to Madeline Magee, November 20, 2019.

Blankenship, A. L., Kay, D. P., Zwiernik, M. J., Holem, R. R., Newsted, J. L., Hecker, M. and J. P. Giesey. 2008. Toxicity reference values for mink exposed to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) equivalents (TEQs). Ecotoxicology and Environmental Safety. **69**, 325-349.

Blazer, V. S. and P. Malik. 2012. Data Collection and Analysis to Address Bui 4 (Fish Tumors or Other Deformities) Within the Sheboygan Area of Concern. Final report submitted to Wisconsin Department of Natural Resources, December 2012.

Blazer, V. S., Walsh, H. L., Braham, R. P., Hahn, C. M., Mazik, P. and P. P. McIntyre. 2016. Tumours in white suckers from Lake Michigan tributaries: pathology and prevalence. Journal of Fish Diseases **40**, 1-17.

Blazer, V. S., Walsh, H. L., Braham, R. P., and P. M. Mazik. 2019. Assessment of Skin and Liver Neoplasms in White Sucker (Catostomus commersonii) Collected at the Sheboygan River Area of Concern, Wisconsin, in 2017. U.S. Geological Survey Open-File Report 2019–1014, 18 p., https://doi.org/10.3133/ofr20191014.

Bush, D., Armstrong, B., Bowman, S., and J. Bohr. 2020. Assessment of the Bird or Animal Deformities or Reproductive Problems Beneficial Use Impairment in Michigan's Great Lakes Areas of Concern 2020. Michigan Department of Environmental Quality. 50 pages.

Custer, C.M., Custer, T.W., Dummer, P.M., Goldberg, D., and J. C. Franson. 2016, Concentrations and spatial patterns of organic contaminants in tree swallow (Tachycineta bicolor) eggs at United States and Binational Great Lakes Areas of Concern, 2010–2015: Environmental Toxicology and Chemistry, **35** (12), 3071–3092.

Custer, T.W., Custer, C.M., Dummer, P.M., Goldberg, D., Franson, J.C., and R. A. Erickson. 2017a. Organic contamination in tree swallow (Tachycineta bicolor) nestlings at United States and binational Great Lakes Areas of Concern: Environmental Toxicology and Chemistry, **36**, (3), 735– 748.

Custer, C. M., and T. W. Custer. 2018.Synthesis of tree swallow (Tachycineta bicolor) data for Beneficial Use Impairment (BUI) assessment at Wisconsin Areas of Concern: U.S. Geological Survey Open-File Report 2018–1032, 8 p., https://doi.org/10.3133/ofr20181032.

Dare, J. 2011. 2011 Sheboygan River AOC Herptile Survey and Habitat Assessment. Conducted for the WDNR Bureau of Endangered Resources. 9 pages.

Dare, J. 2012. Qualitative Unionid Mussel Surveys and Habitat Assessment of the Sheboygan River AOC. Sheboygan County, Wisconsin. 18 pages.

Dare, J. M. 2017. Lower Sheboygan River restoration Area of Concern mussel inventory. Technical Report #17008DEM. 18 pages.

GEI Consultants, Inc. 2019a. Sheboygan River AOC Habitat Restoration Final Evaluation Report Sheboygan County, Wisconsin June 2019. 37 pages.

GEI Consultants, Inc. 2019b. Sheboygan River AOC 2018 Herptile Inventory Report. 25 pages.

Johnson, M. D. 2007. Measuring habitat quality: a review. Condor 109: 489-504.

Kaarakka, H. 2016. Bat inventory in the Sheboygan River Area of Concern. 8 pages.

Lyons, J. 2006. A Fish-Based Index of Biotic Integrity to Assess Intermittent Headwater Streams in Wisconsin, USA. Environmental Monitoring and Assessment **122**, 239-258.

Masterson, J. 2018. Verification monitoring of biological communities and physical habitat in select streams within the Sheboygan River Area of Concern 2014-2016. 34 pages.

Motl, T. 2016. Sheboygan River Area of Concern verification monitoring update, fish community. 7 pages.

Olds, H.T., Scudder Eikenberry, B.C., Burns, D.J., and A. H. Bell. 2017. An evaluation of the zooplankton community at the Sheboygan River Area of Concern and non-Area of Concern comparison sites in western Lake Michigan rivers and harbors in 2016: U.S. Geological Survey Scientific Investigations Report 2017–5131, 15 p., https://doi.org/10.3133/sir20175131.

Scudder Eikenberry, B.C., Bell, A.H., Burns, D.J., and H.A. Templar. 2014. Benthos and plankton for selected rivers and harbors along Wisconsin's Lake Michigan shoreline, 2012: U.S. Geological Survey Data Series 824, 30 p. plus 8 appendices, <u>http://dx.doi.org/10.3133/ds824</u>.

Scudder Eikenberry, B.C., Burns, D.J., Templar, H.A., Bell, A.H., and K.T. Mapel. 2016. Benthos and plankton community data for selected rivers and harbors along the western Lake Michigan shoreline, 2014: U.S. Geological Survey Data Series 1000, 29 p. plus 8 appendices, http://dx.doi.org/10.3133/ds1000.

Scudder Eikenberry, B.C., Besser, J.M., Dorman, R.A., and H.T. Olds. 2017. Sediment Toxicity Assessment in Two Wisconsin Areas of Concern and Selected Lake Michigan Tributaries. Poster presentation at the State of Lake Michigan Conference, Green Bay, WI. November 8, 2017.

Scudder Eikenberry, B.C., Olds, H.T., Burns, D.J., Bell, A.H., and J.L. Carter. 2019. Benthos and plankton of western Lake Michigan Areas of Concern in comparison to non-Areas of Concern for

selected rivers and harbors, 2012 and 2014: U.S. Geological Survey Scientific Investigations Report 2019–5051, 50 p., <u>https://doi.org/10.3133/sir20195051</u>

Selle, A. and A. Fischer. 2018. Quality Assurance Project Plan for Winter Tracking and Trapping Efforts related to American Mink (Neovison vison) in the Sheboygan River – Area of Concern.

Strom, S. 2019. Personal communication, September 5, 2019.

USFWS 2017. Sheboygan River and Harbor Natural Resource Damage Assessment Restoration Plan and Environmental Assessment. https://www.fws.gov/midwest/es/ec/nrda/SheboyganHarbor

Wisconsin Natural Heritage Inventory Program (NHI), 2012. Rapid ecological assessment for the Sheboygan River Area of Concern (Sheboygan County). PUBL ER-838 2012. 79 pages.

WDNR 2015a. Removal package, Restrictions on Dredging Activities BUI for the Sheboygan River Area of Concern.

https://dnr.wi.gov/topic/GreatLakes/documents/SheboyganDredgingRemoval.pdf.

WDNR 2015b. Wisconsin 2016 Consolidated Assessment and Listing Methodology (WisCALM) for CWA Section 303(d) and 305(b) Integrated Reporting. Guidance # 3200-2015-01.

WDNR 2016a. Quality Assurance Project Plan Revision of Section D. Evaluation Waterfowl Consumption in the AOC. BUI Decision Criteria. Grant #GL-00E00876. March 31. 2016.

WDNR 2016b. Fish and Wildlife Restoration Plan for the Sheboygan River Area of Concern. 76 pages.

WDNR 2018. Remedial Action Plan Update for the Sheboygan River Area of Concern. 19 pages.

WDNR 2019. 2019 Wisconsin Migratory Bird Regulations. 32 pages. https://dnr.wi.gov/topic/hunt/documents/WaterfowlRegulations.pdf.

WDNR 2020a. Draft 2020 Impaired Waters and Restoration Waters Lists. <u>https://dnr.wi.gov/topic/impairedwaters/</u>.

WDNR 2020b. Eating your catch – making healthy choices. Wisconsin DNR fish consumption advisory online query tool. <u>https://dnr.wi.gov/FCSExternalAdvQry/FishAdvisorySrch.aspx</u>.

WDNR 2020c. Wisconsin Impaired Water Report to Congress. https://dnr.wi.gov/topic/surfacewater/congress.html. List of Previous Remedial Action Plans, Updates, and other important historical documents:

2017 Remedial Action Plan Update for the Sheboygan River Area of Concern

2016 Remedial Action Plan Update for the Sheboygan River Area of Concern

2015 Remedial Action Plan Update for the Sheboygan River Area of Concern

2014 Remedial Action Plan Update for the Sheboygan River Area of Concern

2012 Remedial Action Plan Update for the Sheboygan River Area of Concern

2011 Stage 2 Remedial Action Plan for the Sheboygan River Area of Concern

2008 Delisting Targets for the Sheboygan River Area of Concern: Final Report

1995 Remedial Action Plan for the Sheboygan River Area of Concern

1989 Sheboygan River Remedial Action Plan Stage 1

Appendices

Appendix A – Acronyms

Appendix B – BUI Tracking Matrix

Appendix C – Assessment of Skin and Liver Neoplasms in White Sucker (*Catostomus commersonii*), (Blazer *et al.*, 2017)

Appendix D – Synthesis of Tree Swallow (*Tachycineta bicolor*) Data for Beneficial Use Impairment (BUI) Assessment at Wisconsin Areas of Concern, (Custer *et al.*, 2018)

Appendix E – Benthos and Plankton of Western Lake Michigan Areas of Concern in Comparison to Non-Areas of Concern for Selected Rivers and Harbors, (Scudder Eikenberry *et al.*, 2019)

Appendix F – An Evaluation of the Zooplankton Community at the Sheboygan River Area of Concern and Non-Area of Concern Comparison Sites in Western Lake Michigan Rivers and Harbors in 2016, (Olds *et al.*, 2017)

Appendix G – Sheboygan River AOC 2018 Herptile Inventory Report, (GEI Consultants, Inc., 2018)

Appendix H – Verification Monitoring of Biological Communities and Physical Habitat in Select Streams within the Sheboygan River Area of Concern 2014-2016, (Masterson 2018)

Appendix I – Fish Assemblage Surveys in Select Streams in the Sheboygan River Area of Concern 2014-2016, (Molt 2016)

Appendix J – Lower Sheboygan River Restoration Area of Concern Mussel Inventories, (Dare 2017)

Appendix A - List of Acronyms

AOC	Area of Concern
APHIS	Animal and Plant Health Inspection Service
BUI	Beneficial Use Impairment
CPU	Catch Per Unit Effort
EPT	Ephemeroptera, Plecoptera, and Tricoptera
НВІ	Hilsenhoff's Biotic Index
IBI	Index of Biotic Integrity
LOEL	Lowest Observable Effect Level
NHI	Natural Heritage Inventory
NRDA	Natural Resources Damages Assessment
РАН	Polycyclic aromatic hydrocarbon
ppm	Parts per million
РСВ	Polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
ТАС	Technical Advisory Committee
WRAM	Wetland Rapid Assessment Method
USDA	U. S. Department of Agriculture
USEPA	U. S. Environmental Protection Agency
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey
WDNR	Wisconsin Department of Natural Resources

- WSLH Wisconsin State Lab of Hygiene
- WVU West Virginia University

This page has been intentionally left blank.

Appendix B – BUI Tracking Matrix

Note that projects listed in the table below are the next clearly delineated action steps that have been identified by WDNR in collaboration with AOC partners and stakeholders to make progress toward delisting the AOC. This list does not necessarily reflect all actions that will ultimately be needed to remove impairments and will be updated as more information is collected and as actions are completed.

Sheboygan River BUI Tracking Matrix

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern	BUI 6, BUI 13	Fish and Wildlife	Assessment	COMPLETED	Completed	2013	2019	\$414,300.00	U.S. Environmental Protection Agency [GLRI]	USGS
Benthos & Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern	BUI 6, BUI 13	Fish and Wildlife	Assessment	COMPLETED	Completed	2011	2015	\$451,500.00	U.S. Environmental Protection Agency [GLRI]	USGS
Camp Marina Superfund Alternative Dredging	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 14	Sediment	Remediation	COMPLETED	Completed	2011	2011	\$10,000,000.00	Responsible Party [Non-GLRI]	USEPA
Camp Y-Koda Citizen-based Wildlife Monitoring	BUI 3	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	04/01/2015	02/01/2019	\$21,000.00	U.S. Environmental Protection Agency [GLRI]	
Dredging Technical Memo	BUI 7	Sediment	Remediation	COMPLETED	Completed	2012	2014	Unknown	Great Lakes Legacy Act [GLRI]	
Education and Outreach UW- Extension	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 8, BUI 13, BUI 14	Community Involvement	Education	COMPLETED	Completed	2011	2013	\$83,000.00	U.S. Environmental Protection Agency [GLRI]	UW-Ext
Evaluate Eutrophication BUI	BUI 8	Nonpoint	Assessment	COMPLETED	Completed	2013	2015	Unknown	Wisconsin Dept of Natural Resources [Non- GLRI]	WDNR

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Evaluation of Fish Tumors or Other Deformities	BUI 4	Fish and Wildlife	Assessment	COMPLETED	Completed	2011	2014	\$139,485.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Evaluation of Waterfowl Consumption Advisories within the AOC	BUI 1	Fish and Wildlife	Assessment	COMPLETED	Completed	2011	2013	\$66,437.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Exposure to PCBs of tree swallows nesting along the Sheboygan River, WI	BUI 3, BUI 5	Fish and Wildlife	Assessment	COMPLETED	Completed	2012	2015	\$18,920.00	U.S. Environmental Protection Agency [GLRI]	USGS
Fish & Wildlife Habitat Restoration and Management Plan	BUI 3, BUI 14	Fish and Wildlife	Assessment	COMPLETED	Completed	2012	2016	Unknown	Wisconsin Dept of Natural Resources [GLRI]	WDNR
Fish Contaminant Monitoring and Advisory Program	BUI 1	Fish and Wildlife	Verification Monitoring	Reporting	In Progress	2015		Unknown	Wisconsin Dept of Natural Resources [Non- GLRI]	WDNR
Fish Tumor Assessment	BUI 4	Fish and Wildlife	Verification Monitoring	Reporting	In Progress	08/01/2017	09/01/2019	\$74,106.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Habitat Restoration Assessment Post-Completion	BUI 14	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	01/01/2018	06/01/2019	\$98,600.00	U.S. Environmental Protection Agency [GLRI]	WDNR
In-Stream Habitat Improvements	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2012	\$144,083.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Kiwanis Park Shoreline Restoration	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2016	\$2,115,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Plankton BUI post- remediation follow-up monitoring in the Sheboygan River AOC	BUI 13	Fish and Wildlife	Verification Monitoring	Reporting	In Progress	2015	2019	\$41,000.00	U.S. Environmental Protection Agency [GLRI]	USGS
Raising Community and CAC Awareness through the "Explore and Restore the Sheboygan River" Initiative	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 8, BUI 13, BUI 14	Community Involvement	Education	COMPLETED	Completed	2011	2014	\$51,689.00	U.S. Environmental Protection Agency [GLRI]	
Schuchardt Conservation Plan	BUI 3, BUI 14	Fish and Wildlife	Assessment	COMPLETED	Completed	2011	2012	\$40,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Schuchardt Property Invasive Species Management Planning	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2012	\$85,000.00	U.S. Army Corps of Engineers [GLRI]	USACE
Sheboygan AOC Pathway to Delisting Habitat BUI's – Rapid Ecological Assessment	BUI 3, BUI 14	Fish and Wildlife	Assessment	COMPLETED	Completed	2010	2012	\$202,181.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Sheboygan Harbor Navigational Improvement Dredging	BUI 7	Sediment	Navigational Dredging	COMPLETED	Completed	2012	2012	\$20,797,000.00	U.S. Environmental Protection Agency [GLRI]	USEPA
Sheboygan River & Harbor Superfund Dredging-Lower River Dredging	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 14	Sediment	Remediation	COMPLETED	Completed	2011	2012	\$13,500,000.00	Responsible Party [Non-GLRI]	USEPA

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Sheboygan River & Harbor Superfund Dredging-Upper River Dredging	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 14	Sediment	Remediation	COMPLETED	Completed	2006	2007	\$9,000,000.00	Responsible Party [Non-GLRI]	USEPA
Sheboygan River AOC Plankton and Other BUI Data Assessment	BUI 1, BUI 5	Fish and Wildlife	Verification Monitoring	Planning	In Progress	09/01/2019	03/01/2021	\$50,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Sheboygan River AOC Plankton and Other BUI Data Assessment - Consumption	BUI 1	Fish and Wildlife	Verification Monitoring	Planning	In Progress	2019	2021	\$22,500.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Sheboygan River AOC Plankton and Other BUI Data Assessment - Deformities	BUI 5	Fish and Wildlife	Verification Monitoring	Planning	In Progress	2019		\$22,500.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Sheboygan River AOC Plankton and Other BUI Data Assessment - Phyto/Zooplankton	BUI 13	Fish and Wildlife	Verification Monitoring	Planning	In Progress	2019	2021	\$5,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Sheboygan River Great Lakes Legacy Act Project	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 14	Sediment	Remediation	COMPLETED	Completed	2011	2012	\$32,776,000.00	U.S. Environmental Protection Agency [GLRI]	USEPA
Shoreline Stabilization in Problem Areas	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2016	\$292,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Small Mammal Contaminant Monitoring in the Sheboygan River AOC	BUI 3, BUI 5	Fish and Wildlife	Assessment	COMPLETED	Completed	2011	2012	\$16,768.00	U.S. Environmental Protection Agency [GLRI]	WDNR

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Supporting & Developing A Sheboygan AOC Community Advisory Committee	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 7, BUI 8, BUI 13, BUI 14	Community Involvement	Capacity	COMPLETED	Completed	2011	2012	\$28,655.00	U.S. Environmental Protection Agency [GLRI]	SRBP
Targeted Invasive Species Control	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2016	\$132,500.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Taylor Drive & Indiana Ave Area Wetland Restoration	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2016	\$795,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Verification Monitoring - Benthic & aquatic community	BUI 3, BUI 14	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	2014	2018	\$27,882.00	U.S. Environmental Protection Agency [GLRI]	USGS
Verification Monitoring - Bird, bat, mussel, and herptiles study	BUI 3, BUI 14	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	2016	2018	\$50,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Verification Monitoring - Fish Community Assessment	BUI 3, BUI 14	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	2014	2017	\$120,000.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Verification Monitoring - Macroinvertebrates and Fish Habitat Assessment	BUI 3, BUI 14	Fish and Wildlife	Verification Monitoring	COMPLETED	Completed	2015	2017	\$27,882.00	U.S. Environmental Protection Agency [GLRI]	WDNR
Verification Monitoring - Mink Survey and Contaminant Monitoring	BUI 3, BUI 5	Fish and Wildlife	Verification Monitoring	Implementation	In Progress	2014	2020	\$127,500.00	U.S. Environmental Protection Agency [GLRI]	WDNR

Project Name	BUI Short List	Project Type	Project Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Verification Monitoring - Tree Swallows	BUI 3, BUI 5	Fish and Wildlife	Verification Monitoring	Reporting	In Progress	2015	2017	Unknown	U.S. Environmental Protection Agency [Non- GLRI]	USGS
Wildlife Consumption Assessment	BUI 1	Fish and Wildlife	Verification Monitoring	Implementation	In Progress	2017	2020	Unknown	U.S. Environmental Protection Agency [Non- GLRI]	WDNR
Wildwood Island Restoration	BUI 3, BUI 14	Fish and Wildlife	Restoration	COMPLETED	Completed	2011	2016	\$2,110,212.00	U.S. Environmental Protection Agency [GLRI]	WDNR

BUI Number Key

BUI #	BUI Name	BUI #	BUI Name
BUI 1	Restrictions on Fish and Wildlife Consumption	BUI 8	Eutrophication or Undesirable Algae or Excessive Loading of Sediments and Nutrients
BUI 2	Tainting of Fish and Wildlife Flavor	BUI 9	Restrictions on Drinking Water Consumption or Taste and Odor Problems
BUI 3	Degraded Fish and Wildlife Populations	BUI 10	Beach Closings and Body Contact Restrictions
BUI 4	Fish Tumors and Other Deformities	BUI 11	Degradation of Aesthetics
BUI 5	Bird or Animal Deformities or Reproductive Problems	BUI 12	Added Costs to Agriculture or Industry
BUI 6	Degradation of Benthos	BUI 13	Degradation of Phytoplankton and Zooplankton Populations
BUI 7	Restrictions on Dredging Activities	BUI 14	Loss of Fish and Wildlife Habitat

This page has been intentionally left blank.

Appendix C – Assessment of Skin and Liver Neoplasms in White Sucker (*Catostomus commersonii*)

51

This page has been intentionally left blank.

Appendix D – Synthesis of Tree Swallow (*Tachycineta bicolor*) Data for Beneficial Use Impairment (BUI) Assessment at Wisconsin Areas of Concern This page has been intentionally left blank.

Appendix E – Benthos and Plankton of Western Lake Michigan Areas of Concern in Comparison to Non-Areas of Concern for Selected Rivers and Harbors This page has been intentionally left blank.

Appendix F – An Evaluation of the Zooplankton Community at the Sheboygan River Area of Concern and Non-Area of Concern Comparison Sites in Western Lake Michigan Rivers and Harbors in 2016 This page has been intentionally left blank.

Appendix G – Sheboygan River AOC 2018 Herptile Inventory Report

This page has been intentionally left blank.

Appendix H – Verification Monitoring of Biological Communities and Physical Habitat in Select Streams within the Sheboygan River Area of Concern 2014-2016 This page has been intentionally left blank.

Appendix I – Fish Assemblage Surveys in Select Streams in the Sheboygan River Area of Concern 2014-2016

This page has been intentionally left blank.

Appendix J – Lower Sheboygan River Restoration Area of Concern Mussel Inventories