

**REMEDIAL ACTION PLAN UPDATE**  
**for the**  
**LOWER GREEN BAY AND FOX RIVER AREA OF CONCERN**

**December 2014**



**Wisconsin Department of Natural Resources**  
**Office of the Great Lakes**

DRAFT

**Remedial Action Plan Update  
for the  
Lower Green Bay and Fox River Area of Concern  
December 2014**

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**Comment [MO1]:** Those who provide written comments on the draft will also be acknowledged in this section.

**Cover photo:**

**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.

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## **EXECUTIVE SUMMARY**

The Area of Concern program has continued to evolve over the last 25 years. Over the past five years, the Great Lakes Restoration Initiative has provided Areas of Concern (AOCs) with many of the necessary resources to carry out assessments for BUIs, and has funded needed management actions to facilitate the removal of these impairments with the ultimate goal of delisting remaining AOCs. This initiative has been vital in moving the Area of Concern program forward.

Locally, in 2009, the final phase of the Lower Fox River PCB Cleanup project began, and is expected to conclude in 2017. While cleanup completion is a significant step for removal of several BUIs, BUI removal also depends on being able to meet BUI-specific criteria, or targets. The most current version of those targets can be found in this document. Over the next couple of years, DNR will be working with technical stakeholders on refining some of these targets to better defined endpoints so that once these endpoints are met, BUI removal can occur.

Changes from the 2013 RAP Update to this document are summarized below, in order to assist the reader in better understanding what occurred between 2013 and 2014.

### **Summary of Changes for Restrictions on Fish and Wildlife Consumption**

- WDNR successfully obtained GLRI funding to collect current data to update the waterfowl consumption advisory that has existed for the AOC since 1987, but not been reassessed since that time. Sampling commenced in spring of 2013 and is now anticipated to be completed in 2017.
- In 2014, approximately 543,000 cubic yards of material will be removed from the Lower Fox River as part of the PCB cleanup. The project is expected to conclude by 2018.

### **Summary of Changes for Tainting of Fish and Wildlife Flavor**

- DNR will review data from an assessment that was conducted in 2013 and 2014, and will make a recommendation in early 2015 about whether any additional data or assessment is needed prior to recommending changes to the status of the BUI.

### **Summary of Changes for Degradation of Fish and Wildlife Populations**

- EPA funded a fish and wildlife populations/habitat assessment and project planning is underway.

### **Summary of Changes for Fish Tumors or Other Deformities**

- DNR is planning to conduct a fish tumor assessment beginning in 2018, dependent upon completion of the Lower Fox River PCB Cleanup.
- Contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site was conducted in August of 2014. In 2003, the upland portion of the site was remediated, and vapor intrusion, groundwater, and surface water are currently being monitored. In-water cleanup of PAH- and heavy metal-contaminated sediments will be completed, but a final cleanup schedule is pending.

### **Summary of Changes for Bird or Animal Deformities or Reproduction Problems**

- In 2015, DNR will work with partners to develop an assessment strategy for this impairment.
- DNR also plans to fund analysis of previous years' tree swallow data collected by USGS so that hatching effects can be determined at sites within the AOC (Ashwaubomay Park, Bay Beach, and Little Tail Point).

### **Summary of Changes for Degradation of Benthos**

- As of Oct. 1, 2014, results from the 2012 benthos data that USGS collected from the AOC and several other Lake Michigan sites (including other AOC sites and non-AOC sites) were

not available. Results should be available in early 2015 and will be included in that RAP Update.

- USGS performed additional sampling in 2014 for benthos and plankton.
- In 2014, approximately 543,000 cubic yards of material will be removed from the Lower Fox River as part of the PCB cleanup. The project is expected to conclude by 2018.
- Contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site was conducted in August of 2014. In 2003, the upland portion of the site was remediated, and vapor intrusion, groundwater, and surface water are currently being monitored. In-water cleanup of PAH- and heavy metal-contaminated sediments will be completed, but a final cleanup schedule is pending.

#### **Summary of Changes for Restrictions on Dredging**

- In 2014, approximately 543,000 cubic yards of material will be removed from the Lower Fox River as part of the PCB cleanup. The project is expected to conclude by 2018.
- Contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site was conducted in August of 2014. In 2003, the upland portion of the site was remediated, and vapor intrusion, groundwater, and surface water are currently being monitored. In-water cleanup of PAH- and heavy metal-contaminated sediments will be completed, but a final cleanup schedule is pending.

#### **Summary of Changes for Eutrophication or Undesirable Algae**

- No change reported for 2014.

#### **Summary of Changes for Restrictions on Drinking Water Consumption, or Taste and Odor Problems**

- No change reported for 2014.

#### **Summary of Changes for Beach Closings**

- In 2012, Bay-Lake Regional Planning Commission received an Urban Waters grant to monitor water quality at the beach and develop a restoration plan for the beach. The grant project was completed in 2014. As part of the project, a restoration plan for the beach was developed for the beach. The cost estimate to restore Bay Beach so that it can be once again usable is \$700,000.
- According to initial monitoring results for Bay Beach, both *E. coli* and microcystin-LR (a toxin produced by cyanobacteria) levels appear to meet state recreation water quality standards. However, it is likely that recreational water quality standards at the other swimming areas in the AOC are not being met because of high levels of cyanobacteria.

#### **Summary of Changes for Degraded Aesthetics**

- In 2014, volunteers continued aesthetics monitoring.
- In late 2014/early 2015, DNR will consult with technical stakeholders regarding its 2015 revision of the volunteer monitoring program. The revision will allow DNR to incorporate lessons learned from previous years and enhance consistency between the two AOCs that are implementing the program..

#### **Summary of Changes for Degraded Phytoplankton and Zooplankton Populations**

- As of Oct. 1, 2014, results from the 2012 plankton data that USGS collected from the AOC and several other Lake Michigan sites (including other AOC sites and non-AOC sites) were not available. Results should be available in early 2015 and will be included in that RAP Update.
- USGS performed additional sampling in 2014 for benthos and plankton.

#### **Summary of Changes for Loss of Fish and Wildlife Habitat**

- EPA funded a fish and wildlife populations/habitat assessment and project planning is underway.

**Next Steps**

For 2015, the Lower Fox River AOC Coordinator will be focused on developing BUI-focused assessment strategies for the AOC. DNR will engage partners and seek their input on these plans. The main priorities for 2015 will be the Degradation of Aesthetics BUI, Bird and Animal Deformities and Reproduction Problems, Tainting of Fish and Wildlife Flavor, Loss of Fish and Wildlife Habitat, and Degraded Fish and Wildlife Populations BUIs.

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Appendix A Lower Green Bay and Fox River BUI Tracking Matrix

Appendix B Fish and Wildlife Objectives

**List of Acronyms**

AOC	Area of Concern
BUI	Beneficial Use Impairment
cfu/100mL	Colony forming units per 100 milliliters
FY	Fiscal year
GBMSD	Green Bay Metropolitan Sewerage District / NEW Water
GLRI	Great Lakes Restoration Initiative
LLBdM	Little Lake Butte des Morts
µg/L	Micrograms per liter
mg/L	Milligrams per liter
NRCS	Natural Resources Conservation Service
PCB	Polychlorinated biphenyl
ppm	Part per million
RAP	Remedial Action Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WDNR	Wisconsin Department of Natural Resources
WHO	World Health Organization
WisCALM	Wisconsin Consolidated Assessment and Listing Methodology

## **DEFINITIONS**

### **Area of Concern (AOC)**

Defined by Annex 2 of the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement as “geographic areas that fail to meet the general or specific objectives of the Agreement where such failure has caused or is likely to cause impairment of beneficial use of the area’s ability to support aquatic life.” These areas are the “most contaminated” areas of the Great Lakes, and the goal of the AOC program is to bring these areas to a point at which they are not environmentally degraded more than other comparable areas of the Great Lakes. When that point has been reached, the AOC can be removed from the list of AOCs, or “delisted.”

### **Beneficial Use Impairment (BUI)**

A “beneficial use” is any way that a water body can improve the quality of life for humans or for fish and wildlife (for example, providing fish that are safe to eat). If the beneficial use is unavailable due to environmental problems (for example if it is unsafe to eat the fish because of contamination) then that use is impaired. The International Joint Commission provided a list of 14 possible beneficial use impairments in the 1987 Great Lakes Water Quality Agreement amendment.

### **Delisting Target**

Specific goals and objectives established for beneficial use impairments, with measurable indicators to track progress and determine when BUI removal can occur.

### ***Escherichia coli (E. coli)***

A bacterium commonly found in natural bodies of water that serves as an indicator of the possible presence of other health risks in the water, such as bacteria, viruses, and other organisms.

### **Microcystins**

A class of toxins produced by freshwater cyanobacteria (also known as “blue-green algae”). These chemicals include microcystin-LR, which is the most common type. Microcystins can be produced in large quantities during algal blooms, and can cause adverse reactions in humans and animals that come in contact with the toxin.

### **Remedial Action Plan (RAP)**

According to the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement, a RAP is a document that provides “a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern...” RAPs were required by the 1987 Protocol to be submitted to the International Joint Commission at three stages:

- Stage 1: Problem definition
- Stage 2: When remedial and regulatory measures are selected
- Stage 3: When monitoring indicates that identified beneficial uses have been restored

Note that a renegotiated Great Lakes Water Quality Agreement was signed in 2012 by the U.S. and Canada which removed the “stage” terminology from the AOC Annex, and simply requires Remedial Action Plans to be “developed, periodically updated, and implemented for each AOC.”

### **Total Maximum Daily Load (TMDL)**

A TMDL is the amount of a pollutant a waterbody can receive and still meet water quality standards. It can be thought of as a pollution “budget” for a water body or watershed that establishes the pollutant reduction needed from each pollutant source to meet water quality goals.

**PURPOSE STATEMENT**

The purpose of this document is to serve as a Remedial Action Plan update. 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 beneficial use impairments and causes;
2. Criteria for the restoration of beneficial uses that take into account local conditions and 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.

This Remedial Action Plan Update was prepared by the Wisconsin Department of Natural Resources in consultation with its partners and is intended to be a concise summary of beneficial use impairment status and specific actions that will be important for reaching the delisting targets. "Actions" may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. It is also a tool for documenting and communicating progress to agency partners and technical stakeholders. The Remedial Action Plan is typically updated annually to incorporate new information that becomes available over the course of the year.

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## **INTRODUCTION**

Areas of Concern (AOCs) are severely degraded geographic areas within the Great Lakes. The areas – 43 within the Great Lakes region – were designated as AOCs primarily due to contamination of river and harbor sediments by toxic pollutants (sometimes referred to as “legacy” pollutants due to the historical industrial development that often was the source of the pollution). Cleaning up these severely degraded areas is a first step toward restoring the chemical, physical, and biological integrity of the lakes as required by the Great Lakes Water Quality Agreement. When the areas have been cleaned up to the point where they are not more degraded than other, comparable non-AOC areas, they are “delisted” as AOCs; they are then considered to be part of the Lakewide Management Plan (LaMP) program, a “whole lake” program that is also set forth in the Agreement. The Agreement provides the framework for the U.S. and Canada to work together to restore the chemical, physical, and biological integrity of the lakes.

The Lower Green Bay and Fox River AOC is one of five AOCs in Wisconsin. This AOC spans seven miles of the Lower Fox River (downstream from the De Pere Dam to the mouth) and 22 square miles of southern Green Bay (from the Fox River mouth to a line drawn between Long Tail Point and Point au Sable, Figure 1). The relatively small geographic area officially recognized as the AOC is the location where cumulative impacts from the much larger Fox-Wolf watershed are manifested and the environment is most severely impaired.

The Lower Green Bay Remedial Action Plan (RAP; WDNR, 1988) and RAP Update (WDNR, 1993) provide extensive descriptions of the historic and environmental setting of the AOC, the original environmental problems that led to designation of this area as an AOC, and the sources of those problems as they were characterized at the time. These plans also include goals, objectives, and strategies to address these problems and restore the Lower Bay and Fox River. These plans are available on DNR’s website: <http://dnr.wi.gov/topic/greatlakes/greenbay.html>.

At the time of the first RAP, the major environmental problems in the Lower Bay and Fox River that led to AOC designation were caused by sources that can be divided into four broad categories:

- Toxic Substances: Polychlorinated biphenyls (PCBs), historically discharged by mills during the manufacture and recycling of carbonless copy paper, were of primary concern although the RAP mentions several chemicals including 20 that were on the U.S. Environmental Protection Agency’s (USEPA’s) priority pollutant list at that time.
- Point Source and Runoff Pollution: Phosphorus and sediment discharges from municipalities and industries lining the Fox River corridor and nonpoint sources in the Lower Fox Watershed.
- Physical Habitat Alterations: including wetland filling and draining, shoreline erosion and filling.
- Other: water level fluctuations and non-native invasive species.

More complete descriptions of these causes can be found in the 2013 RAP Update.

These sources of impairment led to designation of eleven of the possible fourteen beneficial use impairments (BUIs) as applicable to this AOC. Additionally, two of the fourteen beneficial use impairments were listed as “suspected,” meaning that they were likely to be a problem but data were lacking or inconclusive.

The original RAP (WDNR, 1988) and RAP Update (WDNR, 1993) contained goals and objectives for restoring beneficial uses in the AOC. In the twenty-five years since these were first developed, local, state, and federal partners made significant progress toward addressing the causes of impairments.

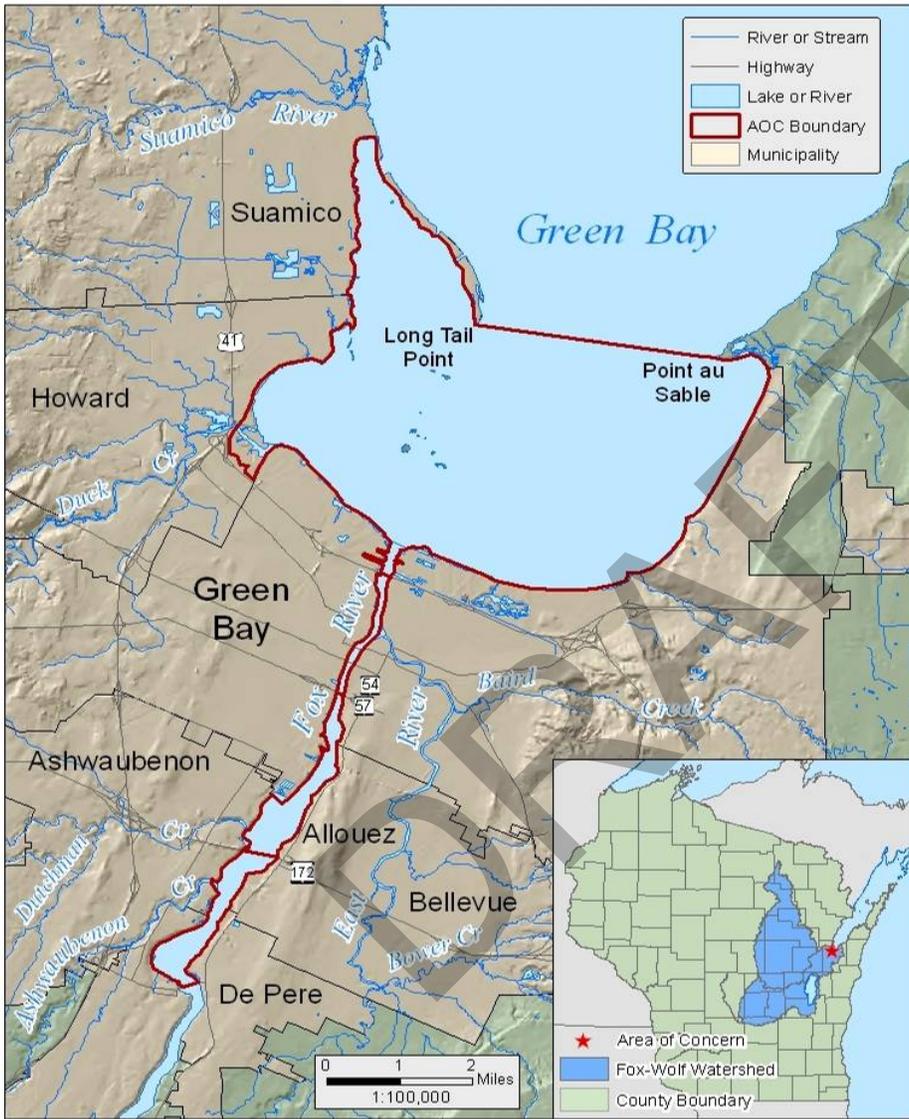
However, no beneficial use impairments have been removed and the Lower Green Bay and Fox River still remain an Area of Concern. In an effort to recognize progress towards meeting RAP goals, USEPA requested that states generate “Delisting Targets” for each BUI. The targets clearly define when impairments are to be considered sufficiently addressed so that they can be removed from the AOC. The Wisconsin Department of Natural Resources (WDNR) worked with local stakeholders in early 2009 to develop the targets for the Lower Green Bay and Fox River AOC (WDNR, 2009). In some cases, those targets have been modified or updated as needed in subsequent RAP Updates. The annual RAP Updates provide the most current version of the target, summarize the current status of the BUIs, and identify actions needed to reach the delisting targets. Public participation is part of the AOC process and is discussed in the overview below.

#### Stakeholder Engagement

WDNR is working on developing a multi-AOC community engagement strategy for 2015. Discussions with the citizen advisory committee (CAC) are currently taking place that will influence what kind of outreach is done over the next year. During the next calendar year, WDNR’s primary focus will be to work with technical stakeholders to develop or refine BUI-specific assessment strategies. The impairments WDNR will intensively focus on for 2015 will be Degradation of Aesthetics, Tainting of Fish and Wildlife Flavor, Loss of Fish and Wildlife Habitat, and Degraded Fish and Wildlife Populations.

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**Figure 1.** The boundaries of the Lower Green Bay and Fox River Area of Concern



**Table 1.** Current Status of Beneficial Use Impairments in the Lower Green Bay and Fox River AOC (Refer to Appendix A for more detail)

Beneficial Use Impairment	Beneficial Use Remains Impaired	Summary Status
Restrictions on fish and wildlife consumption	Yes	Wildlife consumption assessment is in progress. Sampling is scheduled to occur 2013-2015. Fish consumption advisories for PCBs specific to the AOC will be addressed by the Lower Fox River PCB Cleanup project.
Tainting of fish and wildlife flavor	Suspected	WDNR conducted an angler survey in 2013-2014 to assess this BUI. Additional information is being sought from the Hmong community to ensure diverse perspectives are represented in the assessment. Data analysis will occur in 2015.
Degradation of fish and wildlife populations	Yes	No one discrete project will be sufficient to address the complex needs of this BUI. Also currently depends on completion of on-going Lower Fox River PCB Cleanup and TMDL implementation. WDNR secured GLRI funding for 2015-2016 to assess habitat and populations in the AOC.
Fish tumors or other deformities	Suspected	BUI will be assessed following WDNR criteria after Lower Fox River PCB Cleanup is complete (expected 2017).
Bird or animal deformities or reproduction problems	Yes	BUI removal depends on completion of contaminated sediment remediation. The next step will be to develop an assessment strategy in 2015.
Degradation of benthos	Yes	The 2012 and 2014 USGS benthos study will provide baseline information for assessing the status of this BUI. In 2014, one Fox River site was resampled, and new sites were added in Lower Green Bay in order to assess that portion of the AOC.
Restrictions on dredging activities	Yes	This use will remain impaired until the on-going Lower Fox River PCB Cleanup project has been completed and the Institutional Control Implementation and Assurance Plan (ICIAP) is in place and fully implemented.
Eutrophication or undesirable algae	Yes	A TMDL report for total phosphorus and total suspended solids in the Lower Fox Watershed was approved by USEPA in 2012. The report identifies reductions needed to meet water quality standards. A WDNR TMDL Project Manager who was hired in October 2012 worked with local stakeholders on TMDL implementation planning in 2013. The TMDL Implementation Plan will be completed in 2015.
Restrictions on drinking water consumption, or taste and odor problems	Yes	WDNR will consult with local stakeholders and technical experts to see whether any additional information is necessary to assess the status of this BUI.
Beach closings	Yes	Beach program monitoring at locations used by the public for recreation indicate <i>E. coli</i> levels are good overall. However, cyanobacteria are present in the AOC, possibly at levels that may pose a risk to human health. Bay-Lake Regional Planning Commission is currently performing <i>E. Coli</i> and microcystin toxin monitoring for the purpose of writing a Restoration Action Plan for Bay Beach. WDNR will work with stakeholders to evaluate existing data to determine BUI status and determine future monitoring needs for this impairment.
Degradation of aesthetics	Yes	WDNR initiated a pilot volunteer monitoring program in 2011. This program will continue until enough data has been obtained to assess the impairment. Results will be used to identify the current status and determine if further management actions related to this impairment are needed.

**Comment [MO2]:** This appendix is not available for the draft for public comment. If you are interested in seeing it, please contact Megan O'Shea directly.

Degradation of phytoplankton and zooplankton populations	Yes	The 2012 and 2014 USGS phytoplankton and zooplankton study will provide baseline information for assessing the status of this impairment and determining if additional information is needed.
Loss of fish and wildlife habitat	Yes	No one discrete project will be sufficient to address the complex needs of this BUI. Key projects that address this impairment include Cat Island Chain and Point au Sable habitat restoration projects. WDNR secured GLRI funding for 2015-2016 to assess habitat and populations in the AOC.

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**Table 2.** 2014 Stakeholder Engagement

**Comment [M03]:** Table will be revised for final version of document.

**Information/Education/Outreach Activities**  
**To keep the local community of residents, businesses, and tourists updated on and supportive of projects, and aware of needed actions/cooperation**

Media	Target Audience	Messages	Implementer(s)	Collaborators	Funded by	Year(s)

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**BENEFICIAL USE IMPAIRMENT UPDATES**

The following pages summarize the current status of each Beneficial Use Impairment using the format below. An explanation of each section is provided after the heading. In 2014, DNR added a section called “target rationale” to the Beneficial Use Impairment Updates for each impairment. This section will supplant the “notes” section that was in the previous years’ updates.

Target	Status
The most recent version of the Lower Green Bay and Fox River AOC delisting targets based on the delisting targets produced in 2009 (WDNR, 2009), or with subsequent modifications made during previous RAP Updates are listed here as separate target components on each row to clearly show status of each part of the target.	May be: - “Complete” - “In progress” - “Action needed” - “Unknown” - “Assessment in progress” (data collection occurring in years listed in parentheses) - “TBD” (to be determined)

**Target rationale**

This section may address or provide one or more of the following:

- Relevant background and explanation related to the target and any applicable modifications.
- If applicable, an explanation of why the updates or clarifications were necessary for the 2009 target updates.
- Potential concerns WDNR has about the target, particularly if the target is not specific enough to define a measurable endpoint for the BUI

Please note that the original 2009 delisting targets can be found in the document *Lower Green Bay and Fox River Area of Concern delisting targets* (WDNR, 2009).

**Rationale for listing**

The section briefly summarizes the reason the BUI was known or suspected at the time of listing. If sources contributing to the impairment have been identified since listing, those are included in this section as well.

**Summary of key remedial actions since the 2013 RAP Update and current status**

“Key remedial actions” are those that directly contributed to the current status of the BUI. A table may be included as an appendix to capture a detailed list of past projects. The narrative here explains and leads to the “Next action needed”.

**Next action(s) needed**

1. This section is a narrative listing of assessments, and on-the-ground projects, that are clearly delineated and directly address the specific BUI.
2. Plans for verifying achievement of delisting targets are listed here if known.

**Issues (challenges, risks) affecting progress on this BUI**

This section lists project contingencies (i.e., one thing has to happen before another can occur), funding obstacles, and any other considerations that could affect the timeline for removal.

**RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION**

Target	Status
The Fox River Contaminated Sediment Remediation has been completed and meets the target established in the plan (Surface Area Weighted Concentration of 0.25 ppm or that determined acceptable by the agencies for completion of the PCB remedial action)	In progress
Fish and wildlife consumption advisories are the same or lower than those in the associated Great Lake or appropriate control site.	Assessment in progress

**Target rationale**

Contaminated sediments are the primary contributor of PCBs to fish and wildlife within the AOC. An effective source control and remediation program is therefore necessary in order to meet delisting goals. Post-remedial actions and taking appropriate source control measures and evaluation monitoring must be conducted to determine the state of recovery for this impairment. Please note that for this impairment, PCBs are the contaminant of concern; there are no additional fish consumption advisories in the AOC for mercury or other chemical contaminants (i.e., beyond the state-wide fish consumption advice that applies for mercury). Please refer to WDNR's *Choose wisely: A health guide for eating fish in Wisconsin* (WDNR, 2014a) document for more information about current fish consumption advisories.

A waterfowl consumption advisory has also been in effect in the AOC since 1987. The most current information can be found on page 26 of the *2014 Wisconsin migratory bird regulations* (WDNR, 2014b).

**Rationale for listing**

This impairment was originally identified because of the presence of persistent, bioaccumulative, and toxic substances, primarily PCBs, in sediments that resulted in consumption advisories for certain species of fish and waterfowl specifically in AOC waters. At the time the RAP was developed concerns were also noted about the presence of more than 100 chemicals including 20 then listed on USEPA's priority list of pollutants that pose a risk to the environment and human health (Allen et al., 1987).

**Summary of key remedial actions since the 2013 RAP Update and current status**

Sources of PCB discharges to the river have been largely eliminated and completion of the on-going Lower Fox River PCB Cleanup will address PCBs remaining in sediments along with mercury and other potentially toxic chemicals. The long-term goal of the cleanup project is to protect human health by removing fish consumption advisories as quickly as possible, although it may take years before this occurs.

In 2014, the Lower Fox River PCB Cleanup project continued. As of Oct. 24, 2014, project milestones were:

- 506,693 cubic yards of material removed
- 312,171 tons of material were sent to the landfill
- 140 acres were sand covered
- 55 acres were rock capped

The WDNR received funding to reassess the waterfowl consumption advisory for the AOC to determine if the existing advisory is still warranted. Sampling began in spring of 2013 and will continue through at least 2015. A final report with update consumption advice is scheduled for 2016. In conjunction with this project, a new method for determining waterfowl consumption advice is being developed in Wisconsin.

This new advice methodology will shift advisories from being species-specific to those based on feeding niche (Sean Strom, 2014, personal communication).

**Next action(s) needed**

1. Waterfowl Consumption Advisory Update: Complete 3-year waterfowl consumption advisory evaluation to determine if the existing advisory is still warranted (final report expected 2017).
2. Complete the Lower Fox River PCB Cleanup project (currently expected to be completed in 2018).
3. Complete fish tissue monitoring as required by Lower Fox River PCB Cleanup project long term monitoring plan.
4. Complete fish consumption advisory analysis as required by WDNR and Wis. Dept. of Health Services (WDHS) procedures. Data from the sediment remediation project can be used for this process, but additional monitoring may be necessary for updating the consumption advisory.

**Issues (challenges, risks) affecting progress on this BUI**

- Removal of this impairment depends on completion of the Lower Fox River PCB Cleanup project. Any delay in the sediment remediation will also delay removal of this impairment.
- Time may be needed for the fish and wildlife contaminant levels to decline after completion of the PCB cleanup.

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TAINTING OF FISH AND WILDLIFE FLAVOR

Target	Status
No target was developed in 2009, as this is a suspected impairment. In 2015, a target will be developed.	Assessment in progress

**Target rationale**

Not applicable at this time.

**Rationale for listing**

This impairment was briefly mentioned in the 1993 RAP Update as suspected based on 1) occasional angler reports of problems with fish taste and odor and 2) the potential for components in industrial and municipal effluents (resin acids, chlorophenols) to cause off-flavors in fish (WDNR, 1993).

**Summary of remedial actions since the 2013 RAP Update and current status**

The current status is unknown as WDNR does not routinely collect reports about problems with fish taste.

In order to determine whether this impairment currently exists in the AOC, WDNR conducted an angler survey in 2013 and 2014. The majority of the surveys were distributed in conjunction with WDNR's annual creel survey, which is conducted to estimate fishing effort, catch, and harvest rates using angler counts and interviews. The creel clerk handed out survey forms with pre-addressed, postage-paid envelopes to anglers she encountered during her regular creel surveys. In addition, a few surveys were distributed by other means, such as via the Green Bay Area Great Lakes Sport Fishermen, during the Green Bay Tall Ship Festival, and to the Hmong Center of Green Bay. The AOC angler survey asked anglers a variety of questions about fishing in the AOC, including whether they ate fish from the AOC; whether they noticed a difference in the taste and odor of fish caught in the AOC versus other locations; and if they didn't eat fish from the AOC, why they did not. The survey also asked some questions related to the fish consumption advisory and the aesthetics/beauty of the area.

**Next action(s) needed**

Before DNR analyzes the results of the survey, we will work with interested stakeholders in 2015 to determine quantitative targets and measures for this impairment. The results of that work will be included in the 2015 RAP Update.

**Issues (challenges, risks) affecting progress on this BUI**

Some anglers simply will not eat any fish from the AOC; however, this is not expected to have a substantial deleterious impact on conducting the survey and assessing the status of the impairment.

**DEGRADATION OF FISH & WILDLIFE POPULATIONS**

Target	Status
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native fish species (including walleye, northern pike, yellow perch, lake sturgeon, Great Lakes spotted muskellunge, and centrarchids) in abundances sufficient to provide ecological function in the fish community	Partially complete (walleye); more assessment needed
Populations of traditionally harvested fish species are capable of supporting some level of exploitation	Partially complete (walleye); more assessment needed
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native furbearers (including mink, muskrats, and otter), amphibians (including spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs, bullfrogs, and salamanders), reptiles (including snapping and painted turtles), terns (common and Forster's), migratory diving ducks, dabbling ducks, marsh nesting birds and island-dependent colonial nesting birds in abundances sufficient to provide ecological function	Assessment needed
Populations of traditionally harvested wildlife species are capable of supporting some level of exploitation	Assessment needed
Invasive species (lamprey, carp, gobies, white perch, and others) expansion is minimized and controlled as needed to protect native species within the AOC and upstream	In progress
Contaminant levels in forage fish populations do not impair the reproductive success of fish-eating birds and wildlife (including predatory fish) and meet the criteria established in Annex 1 of the 1978 Great Lakes Water Quality Agreement as amended by Protocol in 1987, specifically "the concentration of total polychlorinated biphenyls in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of birds and animals which consume fish"	Assessment needed
The AOC supports fish and wildlife populations at levels consistent with extant fish and wildlife management plan objectives. Specifically, the following objectives should be met unless extant management plans have updated criteria (specific objectives identified in past RAP documents are listed in Appendix B)	Partially complete; more assessment needed

**Target rationale**

In Green Bay, there is a strong desire among stakeholders to use an ecosystem approach. At the time that targets were developed, narrative goals were crafted with the intention of allowing experts to use their best judgment to determine when the targets had been met. A rather lengthy list of objectives for fish and wildlife were developed as part of this process (see Appendix B).

WDNR intends to revisit these objectives in the upcoming year or two and work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the remedial goals of the Area of Concern program.

**Rationale for listing**

The major causes of degraded fish and wildlife populations in the AOC listed in the original Remedial Action Plan (WDNR, 1988) and Update (WDNR, 1993) include the following:

- Changes in habitat due to wetland filling, hardened shorelines, and development associated with urban and industrial areas

- Impact from exotic species of fish (alewife, sea lamprey, rainbow smelt, gobies, white perch, and carp) and vegetative invasive species
- Toxic chemicals – suspected impacts of toxics on other wildlife (mink, bald eagle, osprey, otter, terns nesting in unsuitable locations such as Renard Island)
- Unbalanced fish community with low abundance and diversity of top predators (northern pike) and native forage fish (spot tail shiner)
- Waterfowl – lack of preferred foods (invertebrates, submerged aquatic plants)
- Periods of low dissolved oxygen caused by hypereutrophication
- Loss of habitat, including reduced submerged aquatic vegetation due to poor light transmissivity through turbid waters and reduced hydrologic connections between the Bay and coastal wetlands.

#### **Summary of remedial actions since the 2013 RAP Update and current status**

In 2014, the Lower Fox River PCB Cleanup project continued. As of Oct. 24, 2014, project milestones were:

- 506,693 cubic yards of material removed
- 312,171 tons of material were sent to the landfill
- 140 acres were sand covered
- 55 acres were rock capped

In 2014, DNR funded a trapper survey for the AOC. Results from this survey were mixed, and the recommendations from the final report included obtaining baseline abundance data and conducting habitat assessments in the AOC for mink, otter, and muskrats (Dhuey et al, 2014).

WDNR secured GLRI funds for a fish and wildlife populations and habitat assessment for the AOC that is scheduled to occur 2015-2016.

#### **Next action(s) needed**

1. Obtain baseline abundance data and conduct habitat assessments in the AOC for mink, otter, and muskrats as part of the AOC fish and wildlife habitat and populations assessment.
2. Begin the AOC fish and wildlife habitat and populations assessment.
3. Work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the Area of Concern program.
4. Complete the Lower Fox River PCB Cleanup (currently expected to be complete by 2018).

#### **Issues (challenges, risks) affecting progress on this BUI**

We will need to determine discrete management actions and identify specific, targeted assessments that are needed to assess and address this impairment.

FISH TUMORS OR OTHER DEFORMITIES

Target	Status
No target was developed in 2009, as this is a suspected impairment. In 2015, a target will be developed.	Assessment needed

**Target rationale**

Not applicable at this time. Note that DNR has developed criteria for this impairment to determine whether it is impaired and will assess the BUI when appropriate.

**Rationale for listing**

This BUI was listed as suspected due to the presence of persistent, bioaccumulative, and toxic substances, primarily PCBs, in Lower Fox River sediments thought to induce external and liver tumors in fish. At the time the original RAP (WDNR, 1988) and the first RAP Update (WDNR, 1993) were developed there was not enough evidence of tumors or other deformities in fish collected from the AOC to definitively list this BUI. Baumann et al. (1991) only identified 1 hepatocellular neoplasm in 40 walleye and no liver neoplasms in brown and black bullheads collected from the Fox River. It was then recognized that only a small number of fish (10 per location) were taken at random for histopathology and that “a larger study would be required to determine a frequency of neoplasms or cellular alteration with confidence” (Baumann et al., 1991).

**Summary of remedial actions since the 2013 RAP Update and current status**

Although the Lower Fox River PCB Cleanup project is important to the AOC overall, the current understanding is that contaminant-related liver tumors of interest for this BUI (defined more specifically by the IJC listing criteria as neoplastic or preneoplastic liver tumors in bullhead or suckers) are associated with PAH exposure, typically not PCB exposure (Rafferty et al, 2009).

Because these tumors are more closely associated with PAH exposure, cleaning up any sites in the AOC that contain elevated concentrations of PAHs is necessary to removing this impairment. There is a known PAH-contaminated site in the AOC, the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site. In August of 2014, the Integrys Group completed contaminated sediment sampling at the site that will be used to inform remedial actions. A cleanup schedule is pending and should be available for the 2015 RAP Update.

**Next action(s) needed**

1. Completion of the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site cleanup.
2. BUI Assessment following WDNR criteria after the Lower Fox River PCB Cleanup is complete. The earliest that a BUI assessment could be initiated is 2018 based upon the anticipated completion date of that project.

**Issues (challenges, risks) affecting progress on this BUI**

The assessment will be conducted once the PCB cleanup project is completed. Funding will need to be secured to complete the assessment.



potential habitat, existed to suggest mink and river otter were impacted by contaminants in the AOC (Allen et al., 1987).

**Summary of remedial actions since the 2013 RAP Update and current status**

In 2014, the Lower Fox River PCB Cleanup project continued. As of Oct. 24, 2014, project milestones were:

- 506,693 cubic yards of material removed
- 312,171 tons of material were sent to the landfill
- 140 acres were sand covered
- 55 acres were rock capped

In 2014, DNR funded a trapper survey for the AOC. Results from this survey were mixed, and the recommendations from the final report included obtaining baseline abundance data and conducting habitat assessments in the AOC for mink, otter, and muskrats (Dhuey et al., 2014).

**Next action(s) needed**

1. Develop an assessment strategy for this BUI: WDNR will work with stakeholders and experts to identify appropriate species, metrics, sampling methods, timing, locations, and a lead entity to collect sufficient data to demonstrate whether or not this BUI is still impaired.
2. Completion of the Lower Fox River PCB Cleanup (expected by 2018).

**Issues (challenges, risks) affecting progress on this BUI**

The Lower Fox Contaminated Sediment Remediation project long term monitoring plan does not include bird or wildlife monitoring.

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DEGRADATION OF BENTHOS

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved plan and have met their remedial action goal.	In progress
The benthic community IBI within the site being evaluated is statistically similar to a reference site with similar habitat and minimal sediment contamination.	Assessment in progress (2012 and 2014)
Burrowing mayfly ( <i>Hexagenia</i> ) populations return to the AOC in stable annual abundances between 100-400 nymphs/m <sup>2</sup> (measured as a 3-year running average) or as otherwise indicative of adequate levels of dissolved oxygen in overlying waters and uncontaminated surficial sediments in Lake Michigan.	In progress
Sediment toxicity (due to ammonia, PCB, or dissolved oxygen) is not present at levels that are acute or chronically toxic (as defined by relevant, field validated, bioassays with appropriate quality assurance/quality controls) to the benthic community.	Assessment needed
Native benthic communities adequately support the trophic levels that depend upon them.	Assessment needed

**Target rationale**

The 2009 target reflects the interest of stakeholders in seeing contaminated sediment remediation (contaminated sediments have impacts on benthic communities). It also reflects a desire among some stakeholders to have mayfly populations, which were historically in the area, return.

**Rationale for listing**

This impairment was originally identified based on studies indicating low species diversity, low numbers of individuals, and a benthic community dominated by oligochaetes and chironomids in the AOC (WDNR, 1993). A burrowing mayfly, *Hexagenia*, was not collected from Green Bay since 1955 and its return was suggested to be a key indicator of macroinvertebrate recovery in Green Bay (Ball et al., 1985). Tests of sediment pore water toxicity from the Lower Fox River determined that ammonia was toxic to a variety of aquatic organisms and possibly the result of not only direct inputs from point sources but also enrichment of the system by various nutrients (Ankley et al., 1990).

**Summary of key remedial actions since the 2013 RAP Update and current status**

In 2014, the Lower Fox River PCB Cleanup project continued. As of Oct. 24, 2014, project milestones were:

- 506,693 cubic yards of material removed
- 312,171 tons of material were sent to the landfill
- 140 acres were sand covered
- 55 acres were rock capped

In August of 2014, the Integrys Group completed contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative site that will be used to inform remedial actions. A cleanup schedule is pending and should be available for the 2015 RAP Update.

Additionally, USGS sampled the AOC for benthos and plankton in 2012 and again in 2014. DNR expects the 2012 results to be available sometime in late 2014 or early 2015 and will include the results in next year's RAP Update.

In 2014, the University of Wisconsin-Milwaukee received a grant from Sustain our Great Lakes to re-establish mayfly populations in the Bay. During 2014, 180 million *Hexagenia limbata* (known as “giant mayflies”) eggs were placed in five locations in the Bay. Approximately 29 million were placed in the AOC adjacent to Long Tail Point (back in the bay), and 29 million in the Little Tail Point bay. Additionally, another 29 million were placed in the middle of the bay between Long Tail Point and Point au Sable. In 2015 the sites will be surveyed to determine hatching and early life stage survival.

**Next action(s) needed**

1. Determine quantitative criteria for BUI removal.
2. Evaluate the results of the 2012 and 2014 USGS benthos assessment.
3. Complete the contaminated sediment cleanups.

**Issues (challenges, risks) affecting progress on this BUI**

Developing quantitative criteria for BUI removal will require specific technical expertise; however, USGS can provide technical support in proposing such thresholds.

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**RESTRICTIONS ON DREDGING ACTIVITIES**

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved remediation plans, the remedial action goals have been achieved, and institutional controls have been implemented.	In progress

**Target rationale**

The completion of the contaminated sediment cleanups (both the PCB cleanup and the WPS Former Manufactured Gas Plant site) is the driving force behind being able to remove this impairment. This delisting target is not intended to create specific measures that would restrict agency decision-making and will not be used as the basis for cleanup levels for contaminated sites or for regulatory enforcement.

**Rationale for listing**

This impairment was originally identified due to the presence of toxic substances in sediments that prevented unrestricted dredging and sediment disposal in the AOC. At that time concerns were noted about the presence of more than 100 chemicals including 20 then listed on USEPA's priority list of pollutants that pose a risk to the environment and human health (Allen et al., 1987). Emphasis has been placed on PCBs in the sediments since the remedy to address PCB exposure effectively addresses the other compounds as well.

**Summary of key remedial actions since the 2013 RAP Update and current status**

In 2014, the Lower Fox River PCB Cleanup project continued. As of Oct. 24, 2014, project milestones were:

- 506,693 cubic yards of material removed
- 312,171 tons of material were sent to the landfill
- 140 acres were sand covered
- 55 acres were rock capped

In August of 2014, the Integrys Group completed contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative site that will be used to inform remedial actions. A cleanup schedule is pending and should be available for the 2015 RAP Update.

**Next action(s) needed**

Complete the contaminated sediment cleanups.

**Issues (challenges, risks) affecting progress on this BUI**

Removal of this impairment depends on completion of the two contaminated sediment projects. Any delay in these projects also delays removal of this impairment.

**EUTROPHICATION OR UNDESIRABLE ALGAE**

Target	Status
Total phosphorus and total suspended solids concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and US EPA approved Total Maximum Daily Load. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
There are no violations of the minimum dissolved oxygen concentrations established in Wisconsin Administrative Code Chapter NR 102 within the AOC due to excessive sediment deposition or algae growth.	Action needed
No waterbodies within the AOC are included on the 303(d) list of impaired waters due to nutrients or blue-green algae in the most recent Wisconsin Impaired Waters list.	Action needed
<p>Cyanobacteria will be evaluated using the following methodology:</p> <ul style="list-style-type: none"> <li>• 90% of the geometric means of at least 5 monthly samples (collected between May 1 and September 30<sup>th</sup> in at least 2 years) of phytoplankton samples from waterbodies in the AOC contain less than 100,000 cyanobacterial cells/mL or less than 20 µg/L of microcystin-LR.</li> <li>• Less than 50 - 60% of the relative biomass of phytoplankton is cyanobacteria when total phosphorus at the mouth of the Lower Fox River reaches the TMDL target of 100 µg/L (0.1 mg/L)</li> </ul>	<p>Assessment needed</p> <p>Assessment needed</p>

**Target rationale**

In 2009, at the time the targets were set, there was a desire to have total phosphorus and cyanobacteria (“blue-green algae”) evaluated in accordance with Wisconsin’s Monitoring Strategy and most recent Consolidated Assessment and Listing Methodology (WisCALM) document available at <http://dnr.wi.gov/topic/surfacewater/assessments.html>. This document is used to make impaired waters determinations as part of the Clean Water Act.

In 2013, the Lower Green Bay and Fox River AOC Social Uses Workgroup decided to change the original targets for cyanobacteria and microcystin-LR from 20,000 cells/mL and 1 microgram per liter (µg/L) to 100,000 cells/mL and 20 µg/L, respectively, because the original targets were deemed to be too stringent (they were based on a drinking water standard). The new targets align with the World Health Organization’s threshold for high risk of adverse health impacts in recreational waters (World Health Organization, 2003).

If total phosphorus levels at the mouth of the Lower Fox reach the TMDL target but the percentage of cyanobacteria in phytoplankton does not decrease as expected, the applicability of the last target component will be evaluated and other factors examined (for example: nitrogen concentrations).

The Lower Green Bay and Fox River AOC Social Uses Workgroup decided in 2012 to add the numerical targets from the approved TMDL for total phosphorus and total suspended solids to the first portion of the delisting target.

**Rationale for listing**

The original listing of eutrophication or undesirable algae was based on historically elevated phosphorus levels that resulted in hypereutrophic (overly productive) conditions, excessive algal blooms in the AOC, and low dissolved oxygen concentrations in the Lower Bay (WDNR, 1993). These algal blooms contributed to decreased water clarity in the AOC that restricted the growth of underwater plants. More recently, since the invasion of zebra mussels, these blooms are increasingly dominated by potentially toxic cyanobacteria (De Stasio et al., 2008; De Stasio et al., 2014). Cyanobacterial blooms are considered undesirable as they are a less preferred food source for zooplankton and fish and contribute to ammonia toxicity and depleted oxygen in sediments when decomposed by bacteria (WDNR, 1993). These blooms also have the potential to produce toxins that are potentially harmful to humans, pets, and livestock.

**Summary of remedial actions since the 2013 RAP Update and current status**

Implementation of the Lower Fox TMDLs is on-going. Beginning in 2012, WDNR began re-issuance of WPDES permits, with effluent limits consistent with the TMDL waste load allocations, to point sources (industrial and municipal) within the Lower Fox basin. In 2013, WDNR initiated drafting of the Municipal Separate Storm Sewer System (MS4) Permit in accordance with the TMDL waste load allocations. The MS4 Permit is expected to be re-issued to applicable municipalities (regulated urban stormwater) in 2014. The four counties (Brown, Calumet, Outagamie, and Winnebago) located within the basin, the Oneida Nation, and NRCS continue to plan, design, and implement conservation projects and practices to address agricultural/rural nonpoint runoff within the basin.

Development of the TMDL implementation plan is progressing, but the schedule has been pushed back, and now it is expected to be completed in 2015.

Outagamie County Land and Water Conservation is preparing a nine element plan for the Plum and Kankapot sub-watersheds, which are the two highest load-contributing sub-watersheds in the basin.

NEW Water (GBMSD) continues to pursue an Adaptive Management pilot project in the Silver Creek watershed.

In 2014, WDNR also funded a project that would determine what kind of impact the sediment removal from the PCB cleanup would have in reducing internal loading of nutrients in the AOC. That project is expected to be completed in 2015.

**Next action(s) needed**

1. **TMDL Implementation Planning:** The Lower Fox River TMDL approved by USEPA calls for the development of detailed implementation plans to meet the reductions specified in the TMDL. "The next step following approval of the TMDL is to develop an implementation plan (or multiple implementation plans – one for each sub-basin) that specifically describes how the TMDL goals will be achieved. The implementation planning process may develop strategies to most effectively utilize existing federal, state, and county-based programs to achieve wasteload and load allocations outlined in the TMDL. Details of the implementation plan may include project goals, actions, costs, timelines, reporting requirements, and evaluation criteria" (Cadmus Group, 2012). A WDNR TMDL Project Manager was hired in October 2012 to assist with planning and implementation of the TMDL. The TMDL Implementation Plan(s) is expected to be completed in 2015.
2. Complete actions identified in the detailed implementation plan.

3. Complete Great Lakes Commission and USDA-NRCS Lower Fox Watershed phosphorus credit trading program (Fox P trade project) to establish a pilot program in the watershed. The goal is to establish a framework with credit trading to begin in 2016.
4. Determine if conditions meet the water quality targets established in the TMDL following the evaluation criteria outlined during the TMDL implementation planning.

**Issues (challenges, risks) affecting progress on this BUI**

- Even though “this TMDL will be implemented through enforcement of existing regulations, financial incentives, and various local, state, tribal, and federal water pollution control programs” (Cadmus Group, 2012), significant challenges exist to meet the substantial reductions identified for total phosphorus at the mouth of the Lower Fox River. “Development of a TMDL implementation plan will require a continued collaborative effort that utilizes the funding and technical expertise of various agencies and private organizations” (Cadmus Group, 2012).
- Success of the Lower Fox TMDL depends on success of the TMDLs for the Upper Fox and Wolf, which empty into Lake Winnebago, which discharges to the lower Fox River.

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**RESTRICTIONS ON DRINKING WATER CONSUMPTION, OR TASTE AND ODOR PROBLEMS**

<b>Target</b>	<b>Status</b>
Densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances do not exceed human health standards, objectives, or guidelines.	Assessment needed
Taste and odor problems are not present.	Assessment needed
Treatment and costs needed to make raw water suitable for drinking is the standard treatment used in comparable portions of the Great Lakes which are not degraded, specifically disinfection, coagulation, sedimentation, and filtration.	Assessment needed

**Target rationale**

This target refers to treated drinking water supplies, not the raw source water. WDNR's standards for drinking water in Wisconsin Administrative Code Ch. NR 809 apply after treatment and are evaluated based on samples collected at the point of distribution to the public water supply. WDNR has not yet defined criteria to determine the cost threshold above which this BUI should be considered impaired.

**Rationale for Listing**

The original listing of restrictions on drinking water as an impaired use was based upon the "unknown risks of toxic substances to human health" and the "health risks of exposure to the multitude of chemicals suspected" to exist in the AOC (Allen et al., 1987). Additional concerns were raised about potential taste and odor problems and high cost of water treatment related to removal of suspended solids, bacteria, and viruses from the water (Allen et al., 1987). An earlier comprehensive water study for Brown County had concluded that Lake Michigan was a preferable water supply over the Fox River or Green Bay because of water quality considerations (Donohue and Associates, 1976). Other factors favoring Lake Michigan as a water supply included the potential for accidental discharges from industries along the Fox River, the long distance from shore to reach an adequate depth for an intake in Green Bay, and potential high operating costs in a treatment plant related to algal growth impacting filtration and taste/odor problems (Donohue and Associates, 1976).

**Summary of remedial actions since the 2013 RAP Update and current status**

The 2013 RAP Update summarizes information about why local communities are using Lake Michigan as their water supply.

The first two sections of the 2009 Target listed above refer to treated drinking water supplies of communities adjacent to the AOC, not raw source water. The third section of the 2009 Target applies to the treatment and costs necessary to make raw water suitable for drinking and might be considered to apply to AOC waters. The status of this impairment is unknown.

**Next action(s) needed**

Determine what, if any, assessments are necessary for this impairment. To do this, clear questions relevant to the BUI must first be articulated.

**Issues (challenges, risks) affecting progress on this BUI**

Assessment of this impairment is challenging because surface waters in the AOC are not currently used as a drinking water supply.

**BEACH CLOSINGS**

Target	Status
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail, are open for 95% of the swimming season (between Memorial day and Labor Day) for any 5 year period based on Wisconsin Coastal Beach monitoring protocols for <i>E. coli</i> monitoring	Assessment of data needed
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail meet the blue-green algae target for 95% of the swimming season (geometric means of phytoplankton samples contain less than 100,000 cyanobacterial cells/ml or less than 20 µg/L of microcystin-LR based on at least 5 monthly samples over at least 2 years)	Assessment needed (2011 study indicates possible impairment)
No waterbodies within the AOC are included on the list of impaired waters due to pathogen contamination or blue-green algae in the most recent Wisconsin Impaired Waters list	Complete (assessment of blue-green algae data needed)

**Target rationale**

There was an interest among stakeholders to include Bay Beach, even though the beach has not been a functional public beach for decades. The target is also closely tied with the impaired waters water quality criteria and World Health Organization guidelines.

**Rationale for listing**

The AOC was historically used for recreational activities, including swimming at Bay Beach on the southern shore of Green Bay near the mouth of the Fox River. Bay Beach closed in 1938 due to excessive bacterial contamination and since that time sedimentation between Renard Island and the beach has reduced the area available for recreational activities (WDNR, 1993).

**Summary of remedial actions since the 2013 RAP Update and current status**

The swimming beach at Bay Beach has remained closed since 1938, and there are no similar public beaches in the AOC. However, much of the Fox River and Bay is used for swimming, wading, tubing, jet skiing, water skiing and other water sports. Two locations in and adjacent to the AOC—Communiversity Park and Long Tail Point—are commonly used for swimming and other water-based recreation and are monitored by the Brown County Health Department following Wisconsin Beach Monitoring Program protocols (Figure 2, protocols available online at <http://dnr.wi.gov/topic/beaches/monitoring.html>). Long Tail Point samples have typically been collected on the north side of Long Tail Point at two locations just outside the AOC boundary, but are considered here because of their immediate proximity to the AOC. Unfortunately, federal cuts to beach monitoring meant that no beaches or swimming areas were monitored for *E. coli*. Based on past data, however, it is likely that the targets related to pathogens are being met for the AOC; however, based on visual observations, it is unlikely that guidelines and recreational standards related to cyanobacteria and cyanotoxins are being met.

There has been a recent initiative to bring Bay Beach back as a public swimming beach. Toward that end, the Bay-Lake Regional Planning Commission received a USEPA Urban Waters Grant in 2012 to conduct two years of *E. coli* and other water quality monitoring at Bay Beach to identify sources of pollution and develop a restoration action plan. The Commission worked in partnership with the NEW Wilderness Alliance and the City of Green Bay to use sampling and routine and annual sanitary surveys conducted by UW-Oshkosh to develop a restoration action plan for Bay Beach that includes engineered redesign recommendations with the goal of making Bay Beach swimmable. The initial sampling plan did not include cyanobacteria or microcystin, but weekly microcystin sampling was added in 2013. This project

will provide valuable information on the current status of Bay Beach and what it would take to make it a safe swimming beach once again. Based on the data collected as part of the project, it is feasible that Bay Beach could be restored and that the current water quality that exists in that location would not pose a threat to human health (i.e., monitoring indicates that state standards and guidelines for recreation are being met). To implement the restoration plan, \$700,000 would be needed to restore the beach, as it hasn't been used as a public beach in over 75 years.

**Next action(s) needed**

1. Determine whether additional data is needed for assessing the targets.
2. Determine whether the current target is being met by analyzing recent data from Bay Beach, Long Tail, and Communiversity Park.

**Issues (challenges, risks) affecting progress on this BUI**

Cyanobacterial cell counts and microcystin data are not routinely collected in many locations, so obtaining existing data may not be possible, and additional sampling may be needed. Furthermore, federal funding cuts to the Beaches Environmental Assessment and Coastal Health (BEACH) Act mean that more recent pathogen indicator data for beaches and popular swimming areas in the AOC is no longer being collected on a regular basis.

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**Figure 2.** Recreation areas in the Lower Green Bay and Fox River AOC

DEGRADATION OF AESTHETICS

Target	Status
Total phosphorus and total suspended solid concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and US EPA approved Total Maximum Daily Load (TMDL). The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
Monitoring data within the AOC and/or surveys for any five year period indicates that water bodies in the AOC do not exhibit unacceptable levels of the following properties in quantities which interfere with the Water Quality Standards for Surface Waters: (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (b) Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state or impair use.	Assessment in Progress (initiated 2011)

**Target rationale**

During the time that the 2009 targets were developed, the first target component was included because of previous RAP documents' statements about the impact of degraded water quality on the visual appearance of the water. It was thought that by meeting the TMDL water quality goals, the visual quality of the water would no longer be degraded.

The second component refers to NR 102.04 of the Wisconsin Administrative Code regarding objectionable properties.

**Rationale for Listing**

This impairment was originally identified based on the appearance of the AOC's water. WDNR (1993) listed large total suspended solids loads, algal blooms (and occasional odor from decaying algae), and turbidity from wave action as the primary causes of this impairment.

Public perception of the AOC was measured in 1990 using a telephone survey of Brown County residents (Baba et al., 1990). The average ranking of water quality in the Lower Bay near the mouth of the Fox River was 4.1 on a scale of 1 (worst possible) to 10 (best possible). Although this survey did not ask specific questions about aesthetics, responses suggested that people perceived the water quality to be below what would be desirable for boating and swimming.

**Summary of remedial actions since the 2013 RAP Update and current status**

In 2014, WDNR took on an intensive revision of the volunteer aesthetics monitoring program. The program is utilized in two different Areas of Concern in the state, and there is a desire to have consistency between the two programs. Before the review, the programs were similar, but did not use the same data sheet, quality assurance project plan, or BUI decision thresholds.

Some work remains to complete the revision of the program, and WDNR intends to consult with interested stakeholders early in 2015 to get their input on the proposed changes to the program.

**Next action(s) needed**

Continue aesthetics volunteer monitoring\_WDNR will continue to refine and expand the program in 2015 and is seeking ways to engage more people in taking the survey.

**Issues (challenges, risks) affecting progress on this BUI**

Although volunteer monitoring is cost effective, it is not without costs. WDNR will need to continue to provide support for this project to assess the results. Additional funding may be necessary, pending the survey results, to implement necessary management actions that would need to occur in order to address the impairment.

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DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS

Target	Status
<p>Plankton and zooplankton structure and function do not significantly diverge from unimpaired reference conditions with comparable physical and chemical characteristics, recognizing the uncontrollable impact of invasive species. The following specific objectives should also be met:</p> <ul style="list-style-type: none"> <li>– Sources contributing to nutrient enrichment are identified and controlled; and</li> <li>– AOC total phosphorus concentrations consistently meet water quality standards and/or water quality targets of a State and US EPA approved TMDL; and</li> <li>– In lower Green Bay, the amount of energy from phytoplankton and zooplankton that reaches the open water food chain has increased, and the amount of energy reaching the bottom sediments has decreased. (In other words, the carbon transfer efficiency of the phytoplankton and zooplankton levels of the food chain in lower Green Bay is increased such that the amount of energy channeled into the detrital food chain is decreased and the amount of energy channeled into the pelagic food chain is increased). This is expected to occur when phosphorus levels and the corresponding percentage of blue-green algae in the phytoplankton are reduced.</li> </ul>	<p>Assessment in progress for first part of target (2012 and 2014)</p>
<p>Phytoplankton or zooplankton bioassays confirm no significant toxicity in ambient waters in the AOC.</p>	<p>Unknown</p>

**Target rationale**

The targets were chosen to address changes in the plankton communities that have occurred in the area primarily because of the issues with high phosphorus levels and associated hypereutrophication.

It should be noted that the state of Wisconsin does not have methodology for assessing plankton toxicity, and other AOCs in the state whose delisting targets originally included similar language (notably, the Milwaukee Estuary AOC) have since eliminated that component of the target for this impairment.

**Rationale for listing**

This impairment was originally identified because excessive nutrients altered both phytoplankton and zooplankton populations in the AOC (WDNR, 1993). Community changes noted included dominance of cyanobacteria in phytoplankton populations, smaller zooplankton with low grazing effectiveness, and a large portion of primary production reaching bottom sediments rather than passing into the pelagic food web (WDNR, 1993).

**Summary of remedial actions since the 2013 RAP Update and current status**

Additionally, USGS sampled the AOC for benthos and plankton in 2012 and again in 2014. DNR expects the 2012 results to be available sometime in late 2014 or early 2015 and will include the results in next year's RAP Update.

**Next action(s) needed**

Determine the status of the impairment and verify whether the benthic community in the AOC is impacted. If it is, work to identify specific management actions that are needed.

**Issues (challenges, risks) affecting progress on this BUI**

The large size of the watershed and its characteristics are likely impacting this BUI. There should be some considerations of what is appropriate to do as part of the remedial goals of the AOC program.

LOSS OF FISH & WILDLIFE HABITAT

Target	Status
Fish and wildlife management goals are achievable as a result of the physical, chemical, and biological integrity of the AOC waters, including wetlands.	Action Needed
A balance of diverse habitat types exists within the AOC that supports all life stage requirements of fish and wildlife populations including: 1. Multiple wetland types (for example: submerged aquatic vegetation, emergent vegetation, sedge meadows, forested & shrub) that adequately represent historic wetland types 2. Quality fish spawning habitats 3. Islands for colonial nesting birds, amphibians, and furbearers 4. Intact migration corridors (both shoreline and water) 5. Unconsolidated beaches (for shorebirds) 6. Habitat for State or Federally listed species (special concern, threatened, or endangered)	Action Needed
The hydrologic connectivity between wetlands and the AOC is maintained and restored sufficiently to support fish spawning and allow for fish passage.	In progress
The Green Bay portion of the AOC contains water clarity and other conditions suitable for support of a diverse biological community, including a robust and sustainable area of submersed aquatic vegetation in shallow water areas.	Action Needed
The AOC contains a diversity of plants, an abundance of submersed aquatic vegetation, and sufficient invertebrates to provide adequate food supplies to support a diverse assemblage of migratory diving ducks (both mussel and vegetation feeding), fish, and other wildlife (including aquatic invertebrates, amphibians, and reptiles).	Action Needed
The AOC meets water quality standards and/or water quality targets of a State and US EPA approved TMDL. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action Needed
The AOC meets Wisconsin water quality criteria for dissolved oxygen and water temperature that are protective of fish and wildlife populations.	Action Needed
No waterbodies within the AOC are listed as impaired due to physical or water chemistry conditions in the most recent Wisconsin Impaired Waters List (303(d) List).	Action Needed

**Target rationale**

Stakeholders were concerned that water quality was negatively impacting the AOC in many areas, including fish and wildlife populations. There was also an interest in ensuring that contaminants were addressed (although it's not explicitly stated in the targets) and that a fish and wildlife plan would be developed for the AOC.

WDNR intends to revisit the targets for this BUI in the upcoming year or two and work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the remedial goals of the AOC program.

**Rationale for Listing**

The major causes of lost habitat in the AOC listed in the original Remedial Action Plan (WDNR, 1988) and Update (WDNR, 1993) include:

- Habitat destruction and fragmentation due to urban and industrial development, channelization, dredging and filling along the River corridor.

- Wetland losses from human activity and changing water levels and loss of hydrologic connectivity.
- Lack of submerged aquatic vegetation in the Duck Creek delta area of the Lower Bay because of turbid water, hypereutrophication, destruction of the Cat Island Chain of islands by high water and storms, and carp impact on underwater plants and littoral vegetation.
- Silt deposition and resuspension of sediments in the Lower Bay.
- Invasive vegetative species.

#### **Summary of remedial actions since the 2013 RAP Update and current status**

Construction of the Cat Island Chain restoration project is now underway. Beginning in June of 2012, Brown County began construction of a rock spine structure that will act as a wave barrier and provide the foundation for restoring the Cat Island Chain. The rock spine structure was completed in 2013. The wave barrier provides the base for constructing three islands which is being built from fine sands dredged from the outer navigation channel. The USACE began filling in the islands using clean dredged material from the maintenance of the Green Bay Harbor over the next thirty years. Filling of the islands began in 2014.

WDNR obtained funding for the AOC fish and wildlife habitat and populations assessment. That work is expected to commence sometime in late 2014.

In 2014, Ducks Unlimited and UW-Green Bay, with support from U.S. Fish and Wildlife Service and WDNR, initiated a project to begin a long-term effort to restore aquatic vegetation, primarily wild rice, wild celery, and hardstem bulrush, near the mouth of Duck Creek behind the newly-restored Cat Island Chain. The overall goal of the project is to successfully re-establish aquatic plant communities in the lowermost portion of Green Bay.

In 2014, UW-Green Bay began controlling invasive species (*Phragmites*, garlic mustard) at Point au Sable. Baseline hydrologic conditions were also documented, along with bird monitoring. During 2015, implementation of the major habitat restoration work at the coastal lagoon will occur, and preliminary work for a fish habitat restoration project, funded by the National Fish and Wildlife Foundation, will also begin.

#### **Next action(s) needed**

1. Complete AOC habitat and populations assessment and habitat restoration plan. This assessment will be used to assist in refining delisting targets, determining baseline conditions, and recommending specific actions needed to restore this impairment. It will also identify current and potentially restorable wetlands and rank them for several watershed functions, including wildlife value.
2. Continue Cat Island Chain Restoration Project.
3. Continue Point au Sable restoration project. Phase I was completed in 2013, and Phase II, funded through a Sustain Our Great Lakes grant, continued in 2014, with additional restoration work expected at the site in 2015.
4. Complete design for fish habitat restoration in the Fox River in De Pere. The Fox-Wisconsin Heritage Parkway recently received funding through the USFWS to create plans for fish spawning and rearing habitat in the Fox River near Voyageur Park in De Pere. The goals of the project are to collect data relevant to the biological, chemical, and physical attributes of instream habitat at, across, and downstream of Voyageur Park; fill in data gaps where necessary through field assessments; and use that data to create a design or plan for the restoration of fish spawning and rearing habitat post remediation that will be as "shovel-ready" as possible.

5. Continue to expand fish habitat connectivity around the AOC by removing fish barriers and replacing culverts. Some potential spawning areas are still cut off from the Bay. Use the results of the WDNR/TNC Green Bay coastal zone fish passage inventory (see <http://maps.tnc.org/coastalwetlandtool/>) to prioritize projects.

**Issues (challenges, risks) affecting progress on this BUI**

- Populations of certain species are mobile and not restricted to habitat simply within the AOC boundary. Therefore, some actions to address the habitat needs of local populations may need to occur in a broader area, beyond that of the AOC boundary.
- Maintenance of implemented projects for invasive species needs to be considered for restoration projects to ensure the projects' long-term success.

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**APPENDICES**

Appendix A – Lower Green Bay and Fox River BUI Tracking Matrix

Appendix B – Fish and Wildlife Objectives

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**Appendix A**

**Lower Green Bay and Fox River BUI Tracking Matrix**

Appendix A

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.

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**Lower Green Bay and Fox River BUI Tracking Matrix**

**Comment [MO4]:** Not available at this time. If you are interested in seeing this, please contact Megan O'Shea

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**Appendix B**

**Fish and Wildlife Objectives based on the 2009 Targets**

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#### Fish Objectives

- Average sport angler harvest over a 3-4 year period of 7,000 **walleyes** harvested annually and 150,000 **yellow perch** harvested annually
- Predator-prey biomass ratio of fish species in the AOC is 1:10 to 1:20
- Lower Fox River capable of supporting a **lake sturgeon** spawning population of a minimum of 750 mature adults (per Welsh et al., 2010).

#### Wildlife Objectives

- Presence of a diverse array of **colonial waterbirds** such as, but not limited to: great egrets, great blue herons, black-crowned night herons, double-crested cormorants, white pelicans, common terns, Forster's terns, black terns, herring gulls, and ring-billed gulls.
- Resident nesting **waterfowl** production in the Area of Concern of mallards, blue-winged teal, wood ducks, and Canada geese totals at least 1 young produced per acre of brood water.
- Migratory concentrations of **dabbling ducks** reach peak numbers of 5,000 in the Area of Concern.
- Bay habitat improves so that **diving duck** migratory populations increase on the West Shore of Green Bay. Divers should have access to ample submergent vegetation in addition to fingernail clams. A diverse assemblage of diving ducks should be present during migration. Diving duck use of the Bay from the Fox River to the Wisconsin border in Green Bay should reach 2,000,000 use days during fall migration and the species using the Bay should be a mixture of mussel feeding ducks and vegetation feeding ducks.
- A diverse assemblage of **marsh-nesting birds** should be present in suitable habitat in the Lower Bay. An aggregate total of 5 nesting pairs per acre of marsh habitat would indicate a healthy marsh bird community. Rails, grebes, herons, wrens, and blackbirds are some of the groups of birds which should be present.
- **Furbearers** in the AOC should recover to the point that otters and mink are present. Abundant muskrat populations should be present particularly when water conditions in the Lower Bay result in emergent marshes.
- A diverse assemblage of **anurans** including: wood frogs, spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs and bullfrogs.