

# Stage 2 Remedial Action Plan Muskegon Lake Area of Concern



Office of the Great Lakes  
Great Lakes Management Unit  
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Compiled by:

Stephanie Swart  
Muskegon Lake Area of Concern Coordinator  
Office of the Great Lakes  
Great Lakes Management Unit  
Michigan Department of Environmental Quality  
P.O. Box 30473  
Lansing, MI 48909  
Phone: 517-335-6721  
Fax: 517-335-4053  
Email: swarts@michigan.gov

#### Acknowledgements

The efforts to restore the Muskegon Lake Area of Concern are the work of many dedicated and caring individuals over more than two decades. The summary information presented here only touches the surface of the good work carried out by those who are dedicated to the restoration of the Muskegon Lake Area of Concern and its watershed.

Of special note is the work of the members of the Muskegon Lake Watershed Partnership, who have worked tirelessly to restore the place they call home.

It is a privilege to work with my colleagues in the Departments of Environmental Quality and Natural Resources and with our counterparts in the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service, and those who staff the federal and state agencies involved.

Thank you.

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# Muskegon Lake Area of Concern Stage 2 Remedial Action Plan

## ***Purpose of the Stage 2 Remedial Action Plan***

A Michigan Department of Environmental Quality (MDEQ) Stage 2 Remedial Action Plan (RAP) for each Area of Concern (AOC) is the primary tool for documenting and communicating restoration progress. The AOC-specific Stage 2 RAPs are meant to be brief, user-friendly documents that identify actions needed to restore Beneficial Use Impairments (BUIs) in each AOC. The Stage 2 RAPs are prepared by the MDEQ in consultation with the respective AOC Public Advisory Council (PAC) and the United States Environmental Protection Agency (USEPA), Great Lakes National Program Office (GLNPO).

Identifying specific actions necessary to remove a BUI is one component of the MDEQ's process for tracking AOC restoration, removing BUIs, and ultimately delisting AOCs. These processes and relevant restoration criteria are described in more detail in the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern (Guidance)* (MDEQ, 2008). Comprehensive background information on the AOC is provided in previous RAP documents, which are listed in the reference section of this publication.

## ***Disclaimer***

The Great Lakes Water Quality Agreement (GLWQA) is a non-regulatory agreement between the U.S. and Canada, and criteria developed under its auspices are non-regulatory in nature. The actions identified in this document as needed to achieve BUI restoration criteria are not subject to enforcement or regulatory actions by virtue of being listed in this document.

The actions identified in this Stage 2 RAP do not constitute a list of pre-approved 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 AOC. However, in many AOCs, further information is needed to determine all actions required to remove a BUI. Thus, the AOC-specific BUI Tracking Matrix is not necessarily comprehensive and will be updated to reflect additional actions that are needed.

## ***Introduction***

In 1987, amendments to the GLWQA were adopted by the federal governments of the United States and Canada. Annex 2 of the amendments listed 14 BUIs which are caused by a detrimental change in the chemical, physical, or biological integrity of the Great Lakes system (International Joint Commission (IJC), 1987). The Annex directed the two countries to identify AOCs that did not meet the objectives of the GLWQA. The RAPs addressing the BUIs were to be prepared for all 43 AOCs identified. The BUIs provided a framework for describing effects of the contamination, and a means for focusing remedial actions.

The Muskegon Lake AOC includes Muskegon Lake and portions of its tributaries, the Muskegon River, Ruddiman Creek, Ryerson Creek, Green Creek, Four Mile Creek, Little Bear Creek (including the unnamed tributary), and Bear Lake (Figure 1).

The 1987 Remedial Action Plan for the Muskegon Lake Area of Concern was written by the Michigan Department of Natural Resources (MDNR), 1987. It described problems known at the time and identified actions and studies needed to further define and remediate those problems.

However, the RAP was written before the 1987 amendments to the GLWQA that outlined new guidelines for RAPs were published. The guidelines included identifying which of 14 potential beneficial use impairments existed in the AOC. Seven years later, the 1994 RAP update reflected those requirements and identified nine BUIs in the Area of Concern. These included: restrictions on fish and wildlife consumption, degradation of benthos, restrictions on dredging activities, eutrophication or undesirable algae, restrictions on drinking water consumption or taste and odor problems, beach closings, degradation of aesthetics, degradation of fish and wildlife populations, and loss of fish and wildlife habitat (Public Sector Consultants, 1994).

The Muskegon Lake Watershed Partnership (Partnership), formerly the Muskegon Lake Public Advisory Council, has developed criteria for restoration of the following BUIs: Beach Closings, Degradation of Aesthetics, Degradation of Benthos, Eutrophication and Undesirable Algae, Loss of Fish and Wildlife Habitat, Degradation of Fish and Wildlife Populations, and Restrictions on Drinking Water. These criteria were approved by the MDEQ and determined to be functionally equivalent to the MDEQ's removal criteria in the *Guidance*. In some cases, the local criteria go above and beyond the *Guidance* and must be approved by the MDEQ. In those instances, the responsibility for planning, implementation, coordination, and funding for such activities rests with the Partnership, though the MDEQ may assist as resources allow. Further detail is provided as it applies to each BUI throughout this document. Additionally, the Partnership has accepted the *Guidance* restoration criteria for the Restrictions on Fish and Wildlife Consumption and Restrictions on Dredging Activities BUIs. Table 1 is a summary of the status of BUI assessments and removals from the Muskegon Lake AOC. The 'Assessment in 2011' column indicates those BUIs that will be reviewed for removal during the current year.

<b>Beneficial Use Impairment</b>	<b>Beneficial Use Remains Impaired</b>	<b>Assessment in 2011</b>	<b>BUI Removed</b>
Restrictions on Fish and Wildlife Consumption	x		
Degradation of Benthos	x		
Restrictions on Dredging Activities	x	x	
Eutrophication or Undesirable Algae	x		
Restrictions on Drinking Water Consumption or Taste and Odor Problems	x	x	
Beach Closings	x	x	
Degradation of Aesthetics	x	x	
Degradation of Fish and Wildlife Populations	x		
Loss of Fish and Wildlife Habitat	x		

## ***Restrictions on Fish and Wildlife Consumption***

### **Significance in the Muskegon Lake Area of Concern**

According to the 1987 RAP, contamination mainly due to mercury and polychlorinated biphenyls (PCBs) resulted in the Michigan Department of Community Health (MDCH) issuing fish consumption advisories for various sizes of carp and walleye (MDNR, 1987).

The Michigan Department of Community Health (MDCH), A Family Guide for Eating Michigan Fish recommends restricted consumption of carp, largemouth bass, smallmouth bass, pike, and walleye from Muskegon Lake and Bear Lake due to elevated levels in PCBs, Mercury, and Chlordane. Restricted consumption of larger carp, suckers and walleye is recommended for the Muskegon River downstream of the Croton Dam (MDCH, 2010). For the Ruddiman Creek Lagoon, MDCH advises on restricted consumption of carp and largemouth bass due to elevated levels of PCBs (2010).

### **Restoration Criteria**

The Partnership voted to adopt the state's criteria for restoring this beneficial use. The fish consumption advisory in Muskegon Lake is in some cases more stringent than for Lake Michigan. Therefore, fish contaminants will need to be assessed using either a comparison study or trend analysis.

### **Current Status and Actions to be Undertaken**

Although this beneficial use is currently impaired, restoration and post-remediation sampling activities in Ruddiman Creek have been completed. Remedial actions at the Muskegon Lake Division Street Outfall are underway and post-remediation monitoring will help assess this BUI. A fish tissue comparison study being conducted by Grand Valley State University, Annis Water Resources Institute, the MDEQ and the MDCH should allow for the re-assessment of this BUI in the near future. A technical committee will be convened when the MDEQ and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether or not to support a recommendation to formally remove this BUI.

## ***Degradation of Benthos***

### **Significance in the Muskegon Lake Area of Concern**

Degradation of Benthos was listed because of heavy metals and organic chemicals in the sediment and impacts to species diversity from the discharge of municipal sewage and storm water. The 1987 RAP identified Muskegon Lake, Ruddiman Creek, Ryerson Creek, the Division Street Outfall, Bear Lake, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Teledyne and North Branch at the mouth) as having degraded benthic communities (MDNR, 1987).

### **Restoration Criteria**

The MDEQ has approved local restoration criteria for this BUI as follows:

The Degradation of Benthos BUI will be considered restored when the Surface Water Assessment Section (SWAS) Procedure #51 yields a score for the benthic metrics which meets the standards for aquatic life in two successive monitoring cycles for Ruddiman Creek, Ryerson Creek, Little Bear Creek (including the unnamed tributary), and the Muskegon River (South Branch near Getty Street [Teledyne site] and North Branch at the mouth) and in cases where MDEQ procedures are not applicable and benthic degradation is caused by contaminated

sediments, this BUI will be considered restored when all remedial actions for known contaminated sediment sites with degraded benthos are completed (except for minor repairs required during operation and maintenance) and monitored according to the approved plan for the sites. Contaminated sediment sites identified as Great Lakes Legacy Act (GLLA) projects in the Muskegon Lake AOC are the Division Street Outfall, Ruddiman Creek, and Ryerson Creek. In addition, average benthic macroinvertebrate populations in Muskegon Lake and Bear Lake should reflect the following conditions:

<b>Muskegon Lake Indicator</b>	<b>Target</b>
Sediment Toxicity	Amphipod Survival > 60%
<i>Hexagenia</i>	Present in river mouth littoral zone
% Oligochaeta	< 75%
Chironomidae (#/m <sup>2</sup> )	> 500
Diversity (Shannon Weaver)	> 1.5
<b>Bear Lake Indicator</b>	<b>Target</b>
% Oligochaeta	Decreasing Trend from 1972
% Chironomidae	Increasing Trend from 1972

For Muskegon Lake, compliance with the sediment toxicity indicator will be determined by review of pre and post remediation toxicity and benthic diversity invertebrate data for Ruddiman Creek, Ryerson Creek, and the Division Street Outfall. Compliance with the indicators for Muskegon Lake will be based on a benthic survey conducted at a group of the same stations sampled in 1999. If any station shows an indication of significant degradation (> ±3 standard deviations), the area will require resampling and analysis to determine the source of the problem. Compliance for Bear Lake targets will be determined by a comparison of the data sets from 1972 and 2007.

For the remaining tributary sites, compliance with SWAS Procedure #51 will be determined by two successive monitoring cycles that yield scores for benthic metrics which meets the standards for aquatic life in Ruddiman Creek (stream channel), Ryerson Creek, Little Bear Creek (including the unnamed tributary) and the Muskegon River (South Branch near Getty Street [Teledyne site] and North Branch at the mouth).

### **Current Status and Actions to be Undertaken**

Although significant improvement has been observed (Rediske *et al.*, 2009) and contaminated sediments from Ruddiman Creek have been removed, this beneficial use is currently impaired. A National Oceanic and Atmospheric Association (NOAA) Habitat Restoration grant will help restore benthos habitat by restoring woody structure in Ruddiman Creek pond and by removing mill debris along the south shoreline of Muskegon Lake. The MDEQ will complete monitoring to assess Ryerson Creek, the Muskegon River, and Little Bear Creek during the summer of 2011. Under the GLLA, the remediation of contaminated sediment from the Division Street Outfall will be completed by the MDEQ and the USEPA, and the USEPA will determine the extent of contaminated sediments in Muskegon Lake at the mouth of Ryerson Creek. Biota will be monitored in 2011 in accordance with the Ruddiman Creek Total Maximum Daily Load (TMDL). The Annis Water Resources Institute will do a second round of sampling at Muskegon Lake in 2013 (see Tracking Matrix page 14). Additional sampling in Muskegon Lake and post remediation toxicity sampling in Muskegon Lake, completion of sediment cleanup at Ryerson Creek, and restoration activities at Ryerson Creek must take place before the BUI can be completely assessed. A technical committee will be convened when the MDEQ and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting

documentation to provide a decision on whether or not to support a recommendation to formally remove this BUI.

## ***Restrictions on Dredging Activities***

### **Significance in the Muskegon Lake Area of Concern**

This BUI was originally identified because of contaminated sediments in Muskegon Lake and its tributaries. The federal navigational channel maintenance was recognized as a challenge because of the cost associated with dredging contaminated sediments by the United States Army Corps of Engineers (USACE) (Muskegon Conservation District, 2002). The Partnership recognized the potential for dredging contaminated sediment at nearshore recreational and commercial sites as a concern.

### **Restoration Criteria**

The Partnership has voted to adopt the state's criteria for restoring this beneficial use. This beneficial use will be considered restored when either there have been no restrictions on routine commercial or recreational navigational channel dredging by the USACE, based on the most recent dredging cycle data available; or, in cases where dredging restrictions exist, a comparison of sediment contaminant data from the commercial or recreational navigation channel (at the time of proposed dredging) in the AOC indicates that contaminant levels are not statistically different from other comparable, non-AOC commercial or recreational navigation channels.

### **Current Status and Actions to be Undertaken**

In the spring of 2011 the USACE dredged the navigational channel and used the spoils for beach nourishment. The dredge spoils have been used for beach nourishment since the 1980's and thereby meet the restoration criteria. A technical committee was convened and reviewed the results of all the monitoring data and other supporting documentation. Based on the sampling results from 2011, documentation for removal of this BUI has been submitted to EPA.

## ***Eutrophication or Undesirable Algae***

### **Significance in the Muskegon Lake Area of Concern**

At the time of AOC listing, the Eutrophication or Undesirable Algae BUI was not included. However, historical water quality degradation was mentioned in the 1987 RAP (MDNR, 1987). The BUI for the AOC was listed by the Partnership in 2002 because of concerns related to historical non point source pollution in the Muskegon Lake watershed and the water quality of Bear Lake (2002).

### **Restoration Criteria**

The Partnership developed and adopted a target for delisting the Eutrophication or Undesirable Algae BUI that exceeds the criteria contained in the State of Michigan *Guidance*. The local criteria were approved by the MDEQ.

This BUI will be considered restored when: (1) no waterbodies within the AOC are included on the list of impaired waters due to nutrients or excessive algal growths in the current Water Quality and Pollution Control in Michigan: Section 303(d) and 305(b) Integrated Report and (2) the following average annual concentrations/values are achieved in Muskegon Lake for two consecutive annual monitoring events:

Indicator	Target	Reasoning
Surface Total Phosphorus Concentration	30 µg/l	DNR Recommendation for the 1987 RAP <sup>1</sup>
Chlorophyll <i>a</i>	10 µg/l	USEPA <sup>2</sup>
Secchi Disk Depth	~ 2.0 m	Pentwater Lake as reference
Trophic Status Index	50-55	Pentwater Lake as reference

<sup>1</sup>A Total Phosphorus concentration of 30 µg/l (during spring and fall turnover) was recommended to maintain water quality at levels that will not produce nuisance algal blooms.

<sup>2</sup>A Chlorophyll *a* target of 10 µg/l (during the summer) was recommended to maintain water quality at levels that will not produce nuisance algal blooms.

The targets for Bear Lake will be consistent with the TMDL and the established local target criteria. The overall objective of the TMDL is to reduce total phosphorus loads to levels that are expected to achieve water quality standards, and specifically, reduce excessive algal growth and increase water transparency (MDEQ, 2008).

#### **Current Status and Actions to be Undertaken**

A Phosphorus TMDL was written for Bear Lake in 2008. This beneficial use is currently impaired due to a need for watershed improvements related to the Bear Lake TMDL. Steinman *et al.* has recorded improvements in Total Phosphorus, Chlorophyll *a*, and Secchi disk results in Muskegon Lake over time (2008). A NOAA Great Lakes Habitat Restoration Program grant will assist in the hydrologic reconnection of Bear Creek to Bear Lake within the Muskegon Lake AOC, by restoring wetlands. In addition, a Clean Water Act Section 319 grant will allow the evaluation of nonpoint sources of phosphorus to Bear Lake (see Tracking Matrix page 15). The Partnership will use the 2010 Integrated Report and additional data as the reference document to determine which waterbodies require restoration to meet the MDEQ *Guidance*. The actions underway will allow for an evaluation of the *Guidance* and Partnership's criteria, at which point a technical committee will be convened for a formal review and assessment of this BUI. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether or not to support a recommendation to remove this BUI.

### ***Restrictions on Drinking Water Consumption or Taste and Odor Problems***

#### **Significance in the Muskegon Lake Area of Concern**

This BUI was not originally identified in the 1987 RAP and was later added by the Partnership. According to the 2002 RAP update, this BUI was identified because of the public's dependence on groundwater for drinking water on the north side of the lake, associated contamination from abandoned and improperly capped oil wells, leaking underground storage tanks and two National Priority List Superfund sites (Muskegon Conservation District, 2002).

#### **Restoration Criteria**

In 2008, the Partnership proposed restoration criteria specific to a number of contaminated groundwater sites in the Muskegon Lake area. The MDEQ determined that the proposed criteria went beyond the scope of the AOC program, and therefore did not approve those criteria. The state criteria as set forth in the *Guidance* remain in effect while discussions on this topic continue between the MDEQ and the Partnership.

This beneficial use will be considered restored when monitoring data for two years indicates that public water supplies: meet the current and most stringent human health standards, objectives, or guidelines (at the point of distribution into the water system) for levels of disease-causing organisms, hazardous or toxic chemicals, or radioactive substances; and treatment needed to make raw water potable and palatable does not exceed standard methods in those supplies. In the event a public drinking water intake must be closed due to contamination of surface water, standard treatment methods are considered to have been exceeded.

#### **Current Status and Actions to be Undertaken**

This beneficial use is currently impaired. An extension of public water supply, originating from the City of Muskegon Water Filtration Plant, through the Northside Water System will allow for a reassessment of this BUI in 2011. A technical committee will be convened when the MDEQ and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether or not to support a recommendation to remove this BUI.

### ***Beach Closings***

#### **Significance in the Muskegon Lake Area of Concern**

Historically the Muskegon Lake AOC received direct discharge from residential, industrial and municipal waste which made the lake visibly unappealing. High levels of *E. coli* have been previously reported. Construction of the Muskegon County Wastewater Management System Metro Wastewater Treatment Plant largely addressed this situation. Still, “no contact” health advisories were periodically posted for the lake and its tributaries due to discharges of untreated industrial and municipal waste from failing lift station pumps and force main breaks. In 1999, 2001, and 2007, excessive quantities of raw sewage were discharged into Muskegon Lake due to the failure of the 66” force main that carries almost all of the county’s sewage 11 miles to the wastewater treatment plant. Millions of gallons of untreated sewage, 4 were discharged during these events and human contact advisories were posted.

#### **Restoration Criteria**

The Partnership voted to adopt a target and criteria for removing the Beach Closings BUI that are more restrictive than the State of Michigan *Guidance*. The MDEQ approved the criteria. In addition to the identification of the source(s) of pathogens and remediation on Ruddiman Creek, the criteria will require the elimination of contact advisories on Muskegon Lake due to sewage infrastructure failure.

The Beach Closings BUI will be considered restored when: (1) no waterbodies within the AOC are included on the list of impaired waters in the most recent *Water Quality and Pollution Control in Michigan: Section 303(d) and 305(b) Integrated Report* and (2) contact advisories have not been placed on Muskegon Lake due to sewage infrastructure failure for three consecutive years beginning in 2006. A TMDL for *E. coli* was approved in 2010 and Ruddiman Creek is part of the list of impaired waterbodies in the 2010 Integrated Report (MDNR, 2010).

#### **Current Status and Actions to be Undertaken**

Compliance with the first part of the target will be achieved when Ruddiman Creek is no longer included in the 303(d) list of impaired waters. Ruddiman Creek remains on that list, although a TMDL has been prepared. This beneficial use remains impaired due to a need for infrastructure improvements related to the Ruddiman Creek TMDL. In addition, an infrastructure failure occurred in 2010 near Ruddiman Creek, and the Partnership’s restoration criteria requires three years of zero contact advisories at Muskegon Lake. This BUI will be evaluated in 2011 by the

Partnership to determine the infrastructure improvement requirements at Ruddiman Creek and separately by a technical committee through a GLRI Statewide Assessment grant. The Partnership will work with the MDEQ to develop the monitoring and assessment program for Ruddiman Creek as part of the TMDL process. A technical committee will be convened when the MDEQ and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether to support a recommendation to remove this BUI.

## ***Degradation of Aesthetics***

### **Significance in the Muskegon Lake Area of Concern**

At the time of AOC listing, the Degradation of Aesthetics BUI was not identified as impaired. However, excessive shoreline filling was mentioned in the 1987 RAP (MDNR, 1987). The BUI was listed by the Partnership in 2002 because excessive amounts of metal scrap and concrete rubble were discarded along the shoreline and in the lake by historical industrial activity. These deposits impede the safe access and enjoyment of Muskegon Lake by the public and the ability to conduct shoreline habitat improvement efforts.

### **Restoration Criteria**

The Partnership developed and voted to adopt a target for delisting the Degradation of Aesthetics BUI that is functionally equivalent to the MDEQ *Guidance*. The target was approved by the MDEQ. The Partnership has identified priority restoration sites for the BUI that enhance public access and enjoyment of Muskegon Lake and are consistent with future habitat improvement projects and municipal planning. The target is presented below:

This BUI will be considered restored when monitoring data for two successive monitoring cycles indicates that Muskegon Lake AOC does not exhibit persistent, high levels of the following “unnatural physical properties” (as defined by Rule 323.1050 of the Michigan WQS) in quantities which interfere with the State’s designated uses for surface waters:

- turbidity
- color
- oil films
- floating solids
- foams
- settleable solids
- suspended solids
- deposits

Important public locations in Muskegon Lake where aesthetics are degraded include: Ruddiman Creek (including the Amoco property), Ryerson Creek, the former Grand Trunk Railroad Car Ferry Dock (southwest shore of Muskegon Lake extending into the lake on a man-made peninsula), Heritage Landing (southeast shore of Muskegon Lake), Michigan Steel Bay (south central shore of Muskegon Lake), and Bear Lake’s Fenner’s Ditch Bayou. Special emphasis will be placed on the removal and restoration of areas at the above locations where deposits of submerged rubble, and metallic debris impede the safe access and enjoyment of Muskegon Lake.

### **Current Status and Actions to be Undertaken**

This beneficial use is currently impaired. However, through a NOAA Habitat Restoration grant many of the aesthetically impaired locations on the south side of Muskegon Lake and in Ryerson Creek are being transformed. In addition, federal funding sources are being sought to assess the oil in Fenner’s Ditch a tributary to Bear Lake. Also, a 2011 MDEQ Statewide Assessment of the BUI will review progress in the degraded locations for further evaluation of the BUIs status and eventual removal. A technical committee will be convened when the MDEQ

and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether or not to support a recommendation to remove this BUI.

## ***Degradation of Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat***

### **Significance in the Muskegon Lake Area of Concern**

These BUIs were originally listed due to shoreline filling primarily due to private, municipal, and industrial development that eliminated wetlands and shallow water areas which served as prime fish and wildlife habitat (MDNR, 1987). Chemical contamination from industrial discharges and municipal storm water and the resulting impacts to benthos and other food sources also contributed to the extent of population and habitat degradation.

### **Restoration Criteria**

As listed in the Great Lakes Water Quality Agreement, the BUIs related to degraded fish and wildlife habitat and population are: Degradation of Fish and Wildlife Populations, and Loss of Fish and Wildlife Habitat. However, the Partnership chose to address these BUIs by separating the fish habitat and populations from the wildlife habitat and populations components. According to the *Guidance*, these two BUIs are considered together in recognition of the integral relationship between them. The Partnership has established quantitative restoration targets as criteria for removal of these BUIs.

With regard to fish habitat and population degradation, the MDEQ has approved use of an index of biological integrity (IBI), which takes several aspects of fish populations into account (indicator species, groups with similar feeding habits, and the number and composition of species, among others) and results in a scoring system that indicates relative ecosystem health. This approach is used commonly throughout the United States for water quality monitoring (Ruetz *et al.*, 2007).

The Partnership also developed and adopted restoration criteria for the loss of wildlife habitat and degradation of populations in consultation with the MDEQ, the Michigan Department of Natural Resources (MDNR) Fisheries, USEPA, United States Fish and Wildlife Service (USFWS), and a local team of experts for removal of this BUI. The finalized restoration plan contains the following components to address the *Guidance* and restoration criteria for the two BUIs:

- A short narrative on historical fish and wildlife habitat or population issues in the AOC
- A description of the impairment(s) and location for each aquatic habitat or population site(s) to address the issues that had been identified in the RAP Updates
- A locally derived restoration target for each impacted habitat or population site
- A list of all other ongoing habitat or population planning processes in the AOC
- A scope of work for restoring each impacted aquatic habitat or population site
- A component for reporting on habitat or population restoration implementation action(s) to the MDEQ.

Removal of these BUIs will be based on the achievement of the locally derived restoration targets and implementation of the steps listed above. Habitat values and populations need not be fully restored prior to delisting, as some may take many years to recover after activities are complete.

### **Current Status and Actions to be Undertaken**

Through recent NOAA American Recovery and Reinvestment and Great Lakes Habitat Restoration grants the Partnership has accomplished 50% of their habitat restoration goals (Evans, personal communication). This has been done in part by softening shoreline, removing fill, and creating open and emergent wetlands along the south side of Muskegon Lake. A second NOAA Habitat Restoration grant will allow for design of coastal emergent marsh and littoral zone habitats in Muskegon Lake and Bear Lake. Locally derived restoration targets for each impacted population site have been developed and are being implemented by the Partnership. The Partnership is working with Ducks Unlimited on a potential North American Wetlands Conservation Act grant to address restoration in the lower North Branch of the Muskegon River. These beneficial uses are currently impaired, but with funding from NOAA and current habitat restoration throughout the AOC it can be evaluated for removal in the near future. A technical committee will be convened when the MDEQ and the Partnership determine that this BUI is ready for a formal review and assessment. The technical committee will review the results of all remedial actions completed and other supporting documentation to provide a decision on whether or not to support a recommendation to remove these BUIs.

### ***Actions to Delist: Muskegon Lake AOC BUI Tracking Matrix***

The following BUI Tracking Matrix is intended as a simple way to track ongoing progress with the remedial activities identified as being necessary to remove each BUI, and subsequently to delist the AOC entirely. As progress is made, the matrix will be updated to reflect current conditions. Completed activities will remain in the matrix as it is updated, but updates will reflect completed status and completed BUI removals.

The matrix lists each BUI, indicates whether each BUI is scheduled for assessment in the current year, and lists the actions/tasks necessary to advance toward BUI removal. If a funding source has been identified, it is listed along with the targeted start and end dates for each action. Project leads are identified as appropriate, along with the targeted BUI removal date.

The matrix represents the AOC program's current best effort to assess activity in an AOC at the time the document was updated. The matrix does not necessarily commit the listed entities/individuals to any particular activity. Contracts, grant agreements, etc. are the documents governing commitments that have been or will be made.

The dates listed reflect the MDEQ's best estimate of project completion given currently available information. Work does not always proceed as planned, and the MDEQ recognizes that unforeseen circumstances can arise. The MDEQ is dedicated to facilitating the completion of each of the projects listed in the timeliest manner possible.

Acronyms used in the Muskegon Lake AOC BUI Tracking Matrix:

AOC – Area of Concern

AWRI – Annis Water Resources Institute

BMPs – Best Management Practices

BUI – Beneficial Use Impairment

CWA – Clean Water Act

MDEQ – Michigan Department of Environmental Quality

DU – Ducks Unlimited

USEPA – United States Environmental Protection Agency

GLRI – Great Lakes Research Initiative

GVSU – Grand Valley State University

MDCH – Michigan Department of Community Health

MLWP – Muskegon Lake Watershed Partnership

NOAA – National Oceanic and Atmospheric Association

OGS – Office of Geological Survey

TBD – To be determined

TMDL – Total Maximum Daily Load

WMRSDC – West Michigan Regional Shoreline Development Council

# Muskegon Lake AOC BUI Tracking Matrix

June 2, 2011

Area of Concern Name	Beneficial Use Impairment Name	Assessment in 2011? (Y/N)	Actions/Tasks Needed	Funding Source	Start Date	Targeted Completion Date	Project Lead	Targeted BUI Removal Date	Comments
Muskegon Lake	Restrictions on Fish and Wildlife Consumption	No	Fish tissue sampling by GVSU AWRI	GLRI State Capacity Monitoring	September 2011	January 2013	Swart (MDEQ), Rediske (AWRI)	October 2014	MDEQ contracting with AWRI
Muskegon Lake	Restrictions on Fish and Wildlife Consumption	No	Additional fish tissue sampling	TBD	June 2013	October 2013	MDEQ, MLWP, WMRSDC, AWRI	October 2014	
Muskegon Lake	Restrictions on Fish and Wildlife Consumption	No	MDCH evaluation of fish tissue in Muskegon Lake and Ruddiman Creek	GLRI	May 2013	October 2013	MDCH, MDEQ	October 2014	
Muskegon Lake	Restrictions on Fish and Wildlife Consumption	No	Remediation of sediments near the Division Street outfall and in Ruddiman Creek	Great Lakes Legacy Act	June 2011	January 2012	Tuchman (USEPA), MLWP, WMSRDC	October 2014	
Muskegon Lake	Degradation of Benthos	No	Monitoring on Ryerson, N.B. Muskegon, S.B. Muskegon, Little Bear, and Ruddiman needed	TBD	July 2011	December 2013	Swart (MDEQ), Walterhouse (MDEQ)	December 2015	
Muskegon Lake	Degradation of Benthos	No	Monitoring biota in accordance with Ruddiman Creek TMDL	TBD	June 2011	October 2012	Lipsey (MDEQ), GVSU AWRI	December 2015	
Muskegon Lake	Degradation of Benthos	No	Monitor benthos in Muskegon Lake	TBD	June 2013	January 2014	MLWP, Rediske (AWRI)	December 2015	
Muskegon Lake	Degradation of Benthos	No	Post remediation toxicity sampling in Muskegon Lake	TBD	June 2013	January 2014	USEPA	December 2015	

Area of Concern Name	Beneficial Use Impairment Name	Assessment in 2011? (Y/N)	Actions/Tasks Needed	Funding Source	Start Date	Targeted Completion Date	Project Lead	Targeted BUI Removal Date	Comments
Muskegon Lake	Restrictions on Dredging Activities	Yes	Evaluate dredge spoils in federal navigational channel, prepare and submit BUI removal documents	GLRI Statewide Assessment	August 2011	October 2012	Swart (MDEQ)	October 2012	
Muskegon Lake	Eutrophication or Undesirable Algae	No	Watershed improvements in Bear Lake in accordance with TMDL, implement updated 319 plan	CWA 319	2012	2014	MLWP	October 2017	
Muskegon Lake	Eutrophication or Undesirable Algae	No	Establish hydrologic reconnection between Bear Lake and Bear Creek	NOAA Habitat Restoration	May 2012	May 2014	MLWP, WMSRDC, NOAA	October 2017	
Muskegon Lake	Restrictions on Drinking Water Consumption or Taste and Odor Problems	Yes	MLWP will evaluate status of several sites and provide feedback to MDEQ	GLRI Support Grant	October 2011	October 2012	MLWP, WMSRDC, Swart (MDEQ)	December 2013	
Muskegon Lake	Restrictions on Drinking Water Consumption or Taste and Odor Problems	Yes	Convene a technical committee to address local concerns	TBD	June 2012	June 2013	MLWP, MDEQ, OGS, MDCH, USEPA	December 2013	
Muskegon Lake	Beach Closings	Yes	MLWP will evaluate status of several sites and provide feedback to MDEQ	GLRI PAC Support	October 2011	October 2012	MLWP, WMSRDC	December 2014	
Muskegon Lake	Beach Closings	Yes	Evaluate the designated use support status at Muskegon Lake related to the DEQ Integrated Report	GLRI Statewide Assessment grant	July 2011	January 2012	Aiello (MDEQ), Swart (MDEQ)	December 2014	

Area of Concern Name	Beneficial Use Impairment Name	Assessment in 2011? (Y/N)	Actions/Tasks Needed	Funding Source	Start Date	Targeted Completion Date	Project Lead	Targeted BUI Removal Date	Comments
Muskegon Lake	Beach Closings	Yes	Infrastructure improvements and evaluation of BMPs needed on Ruddiman Creek related to <i>E. coli</i> TMDL	TBD	TBD	TBD	City of Muskegon, MLWP, WMSRDC	December 2014	
Muskegon Lake	Beach Closings	Yes	Evaluate BMPs needed for Muskegon Lake MLWP criteria	TBD	TBD	TBD	MLWP, WMSRDC	December 2014	
Muskegon Lake	Degradation of Aesthetics	Yes	Assessment of listed aesthetically impaired sites, 2 rounds	GLRI Statewide Assessment	July 2011	September 2013	Riley (MDEQ), Swart (MDEQ)	November 2015	
Muskegon Lake	Degradation of Aesthetics	Yes	Completion of cleanup and restoration activities at Ruddiman, Ryerson, Heritage Landing, and MI Steel Bay	NOAA Habitat Restoration	2011	2012	MLWP, WMSRDC, NOAA	November 2015	
Muskegon Lake	Degradation of Aesthetics	Yes	Assessment of oil in Fenner's Ditch, tributary to Bear Lake	TBD	September 2011	September 2012	Berdinski (MDEQ)	November 2015	
Muskegon Lake	Degradation of Aesthetics	Yes	Implementation of Fenner's Ditch study	TBD	TBD	TBD	MDEQ, OGS	November 2015	
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Cleanup of mill debris at Muskegon Lake marine and shoreline restoration	NOAA Habitat Restoration	2012	2013	MLWP, Evans (WMSRDC), NOAA	2015	
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Hydrologic reconnection of wetlands on Bear Lake and N.B. Muskegon River, Willbrandt property	NOAA Habitat Restoration	2012	2014	MLWP, Evans (WMSRDC), NOAA	2015	

Area of Concern Name	Beneficial Use Impairment Name	Assessment in 2011? (Y/N)	Actions/Tasks Needed	Funding Source	Start Date	Targeted Completion Date	Project Lead	Targeted BUI Removal Date	Comments
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Restore Ryerson Creek wetland and adjacent lakeshore riparian habitat	NOAA Habitat Restoration	2012	2014	MLWP, Evans (WMSRDC), NOAA	2015	
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Restore Michigan Steel peninsula wetland	NOAA Habitat Restoration	2012	2014	MLWP, Evans (WMSRDC), NOAA	2015	
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Zephyr/Bosma property wetland restoration	TBD	TBD	TBD	MLWP, WMSRDC, DU	2015	
Muskegon Lake	Loss of Fish and Wildlife Habitat	No	Restoration at Ruddiman Creek	NOAA Habitat Restoration	2011	2012	MLWP, NOAA	2015	
Muskegon Lake	Degradation of Fish and Wildlife Populations	No	See Loss of Fish and Wildlife Habitat BUI					2015	

## ***Bibliography***

- Evans, K. 2011. West Michigan Shoreline Regional Development Council. Personal Communication.
- International Joint Commission (IJC), 1987. Revised Great Lakes Water Quality Agreement of 1978.
- Michigan Department of Community Health (MDCM), 2010. Michigan Fish Advisory: A Family Guide to Eating Michigan Fish. <http://www.michigan.gov/eatsafefish>
- Michigan Department of Environmental Quality (MDEQ), 2008. *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, revised. MI/DEQ/WB-06-001.
- Michigan Department of Environmental Quality (MDEQ), 2008. Remedial Action Plan Update for the Muskegon Lake Area of Concern. Aquatic Nuisance Control & Remedial Action Unit, Michigan Department of Environmental Quality (MDEQ), Lansing, Michigan.
- Michigan Department of Environmental Quality (MDEQ), 2008. Total Maximum Daily Load for Phosphorous for Bear Lake, Muskegon County. Water Bureau, Michigan Department of Environmental Quality (MDEQ), Lansing, Michigan.
- Michigan Department of Natural Resources (MDNR), 1987. Remedial Action Plan for the Muskegon Lake Area of Concern. Great Lakes and Environmental Assessment Section, Surface Water Quality Division, Michigan Department of Natural Resources (MDNR), Lansing, Michigan.
- Michigan Department of Natural Resources and Environment. 2010. Remedial Action Plan Update for the Muskegon Lake Area of Concern (draft). Office of the Great Lakes, Michigan Department of Natural Resources and Environment, Lansing, Michigan.
- Michigan Department of Natural Resources and Environment. 2010. Total Maximum Daily Load for *E. coli* for Ruddiman Creek Muskegon County. Water Bureau, Michigan Department of Natural Resources and Environment, Lansing, Michigan.
- Michigan Department of Natural Resources and Environment. 2010. Water Quality and Pollution Control in Michigan 2010 Sections 303(d), 305(b), and 314 Integrated Report. Water Bureau, Michigan Department of Natural Resources and Environment, Lansing, Michigan.
- Muskegon Conservation District. 2002. Muskegon Lake Community Action Plan Remedial Action Plan Update. Prepared for the Muskegon Lake Public Advisory Council and the Muskegon Lake Watershed Community.
- Muskegon Lake Watershed Partnership. 2010. Degraded Aesthetics Beneficial Use Impairment Restoration and Removal Strategy for the Muskegon Lake Area of Concern. Muskegon Lake Watershed Partnership, Muskegon, Michigan.
- Muskegon Lake Watershed Partnership Habitat Committee. 2008. Muskegon Lake Area of Concern Fish and Wildlife Habitat Restoration and Beneficial Use Impairment Removal Strategy. Muskegon Lake Watershed Partnership, Muskegon, Michigan.

- Muskegon Lake Watershed Partnership. 2007. A Guide to Restoration of Muskegon Lake Fish and Wildlife Habitat. Muskegon Lake Watershed Partnership, Muskegon Michigan and Muskegon River Watershed Assembly, Big Rapids, Michigan.
- Public Sector Consultants. 1994. Muskegon Lake Area of Concern Remedial Action Plan: 1994 Update. Prepared for the Michigan Department of Natural Resources (MDNR).
- Rediske, R.R., L.B. Nederveld, Y. Hong, K. Rieger, N.W. MacDonald, J.P. Dunn, and D.G. Uzarski. 2009. Assessment of Benthic Invertebrate Populations in the Muskegon Lake Area of Concern. Annis Water Resources Institute, Grand Valley State University, Muskegon, Michigan and Central Michigan University, Mt. Pleasant, Michigan.
- Ruetz III, C.R., D.G. Uzarski, D.M. Krueger, and E.S. Rutherford. 2007. Sampling a Littoral Fish Assemblage: Comparison of Small-Mesh Fyke Netting and Boat Electrofishing. *North American Journal of Fisheries Management* **27**: 825-831.
- Sims, J. 2009. Muskegon Lake Area of Concern Delisting Targets (draft). Aquatic Nuisance Control & Remedial Action Unit, Water Bureau, Michigan Department of Environmental Quality (MDEQ), Lansing, Michigan.
- Steinman, A.D., M. Ogdahl, R. Rediske, C.R. Ruetz III, B.A. Biddanda, and L. Nemeth. 2008. Current status and trends in Muskegon Lake, Michigan. *Journal of Great Lakes Research* **34**: 169-188