REGION 5
CHICAGO, IL 60604

October 31, 2024

Phil Argiroff, Acting Director
Water Resources Division
Michigan Department of Environment, Great Lakes, and Energy
525 W Allegan St.
P.O. Box 30028
Lansing, Michigan 48909-7528

Dear Mr. Argiroff:

Thank you for your October 16, 2024, request to remove the *Degradation of Benthos* Beneficial Use Impairment (BUI) from the Muskegon Lake Area of Concern (AOC). As you know, we share your desire to restore all the Great Lakes AOCs and to formally delist them.

Based upon a review of your submittal and supporting information, the U.S. Environmental Protection Agency (EPA) hereby approves your request to remove this BUI from the Muskegon Lake AOC. EPA will notify the International Joint Commission of this significant positive environmental change at this AOC.

We congratulate you and your staff as well as the many federal, state, and local partners who have been instrumental in achieving this environmental improvement. Removal of this last BUI will benefit not only the people who live and work in the AOC, but all the residents of Michigan and the Great Lakes basin as well.

We look forward to the continuation of this productive relationship with your agency and the Muskegon Lake Watershed Partnership Public Advisory Council as we work together to delist this AOC in the year to come. If you have any further questions, please contact me at (312) 886-0124 or your staff can contact Leah Medley at (312) 886-1307.

Sincerely,

Teresa Seidel, Director
Great Lakes National Program Office

cc: Gary Kohlhepp, EGLE
Melanie Foose, EGLE
Stephanie Swart, EGLE
Raj Bejankiwar, IJC

STATE OF MICHIGAN
DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY
LANSING

GRETCHEN WHITMER
GOVERNOR

PHILLIP D. ROOS
DIRECTOR

October 16, 2024

VIA EMAIL

Teresa Seidel, Director
Great Lakes National Program Office
United States Environmental Protection Agency, Region 5
77 West Jackson Boulevard (G-9J)
Chicago, Illinois 60604-3507

Dear Teresa Seidel:

The Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Water Resources Division (WRD) requests the concurrence of the United States Environmental Protection Agency's (USEPA) Great Lakes National Program Office (GLNPO) with the removal of the Degradation of Benthos Beneficial Use Impairment (BUI) from the Muskegon Lake Area of Concern (AOC). The WRD has assessed the status of the BUI in accordance with the *Guidance for Delisting Michigan's Great Lakes Areas of Concern* and recommends that the BUI be removed from the list of impairments in the Muskegon Lake AOC.

Attached please find documentation to support this recommendation, including the BUI removal recommendation prepared by WRD's technical staff. The Muskegon Lake Watershed Partnership passed a motion supporting this recommendation on August 21, 2024, which is included as Attachment D. This is the final BUI for the Muskegon Lake AOC.

We value our continuing partnership in the AOC Program and look forward to working with the GLNPO in the delisting of this AOC. If you would like further information concerning this request, please contact Stephanie Swart, Muskegon Lake AOC Coordinator, Great Lakes Management Unit, Great Lakes Watersheds Assessment, Restoration, and Management Section, WRD, at 517-331-3779; SwartS@Michigan.gov; or EGLE, P.O. Box 30458, Lansing, Michigan 48909-7958; or you may contact me.

Sincerely,

Phil Argiroff, Acting Director
Water Resources Division
517-284-5470

Attachments

cc/att: Andrea Schaller, USEPA, Region 5
Amy Pelka, USEPA, Region 5
Leah Medley, USEPA, Region 5
Mark Loomis, USEPA, Region 5
Gary Kohlhepp, EGLE
Melanie Foose, EGLE
Stephanie Swart, EGLE

Removal Recommendation
Degradation of Benthos Beneficial Use Impairment
Muskegon Lake Area of Concern

Issue

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division (WRD), Areas of Concern (AOC) Program, recommends removal of the Degradation of Benthos Beneficial Use Impairment (BUI) for the Muskegon Lake AOC. The recommendation is made with the support of the Muskegon Lake Watershed Partnership (MLWP), which serves as the Public Advisory Council for the AOC. This request is made in accordance with the process and criteria set forth in the *Guidance for Delisting Michigan's Great Lakes Areas of Concern* (Guidance) (Michigan Department of Natural Resources [MDNR], 2018) and the locally approved criteria.

Background

Muskegon Lake is a 4,150-acre drowned river mouth located in Muskegon County. 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 an unnamed tributary), and Bear Lake. Muskegon Lake was listed as an AOC primarily due to historic discharges of industrial process wastewater, municipal wastewater treatment plant effluent, combined storm sewer overflows, alterations of shoreline, excessive shoreline filling, and urban runoff. These discharges introduced elevated levels of polychlorinated biphenyls, heavy metals, nutrients, oils, and other contaminants into the AOC (MDNR, 1987).

This is the final outstanding BUI for the Muskegon Lake AOC. This document pertains only to the Degradation of Benthos BUI.

According to the 1987 Remedial Action Plan (RAP), the presence of heavy metals in the sediment and municipal sewage and storm water discharges impacted species diversity, resulting in impaired uses (MDNR). The 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).

Removal Criteria

In 2007, the Michigan Department of Environmental Quality ([MDEQ] now EGLE) accepted a locally developed target for the Degradation of Benthos BUI that is

functionally equivalent to the criteria outlined in the Guidance (MDNR, 2018; Attachment A). The target is outlined as such:

The Degradation of Benthos BUI will be considered restored when the Great Lakes Watersheds Assessment, Restoration, and Management Section (GLWARMS) Procedure 51 (EGLE, 2014) yields a score for the benthic metrics that 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) or in cases where EGLE 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 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:

Muskegon Lake Indicator	**Target**
Sediment Toxicity	Amphipod Survival > 60%
Hexagenia	Present in river mouth littoral zone
% Oligochaeta (#/m^2)	< 75%
Chironomidae (#/m^2)	> 500
Diversity (Shannon Weaver)	> 1.5

Bear Lake Indicator	**Target**
% 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 (Figure 1). 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.

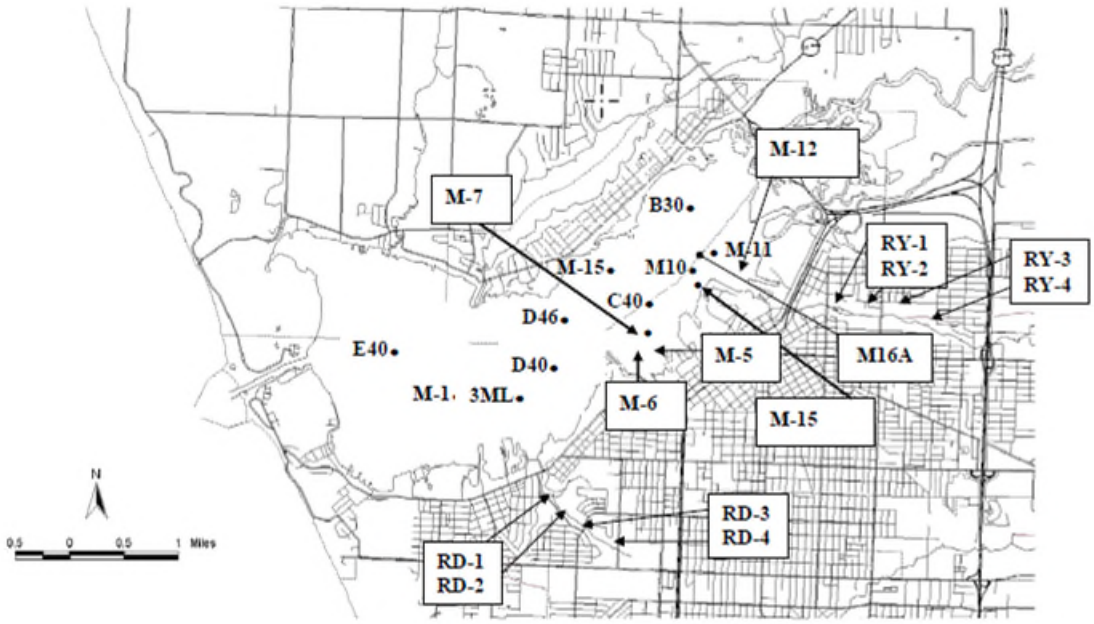

Figure 1. Locations selected for benthic macroinvertebrate monitoring in the Muskegon Lake AOC (Rediske et al., 2009).

Supporting Data and Analysis

Sediment Contamination Sites and Remedial Activities

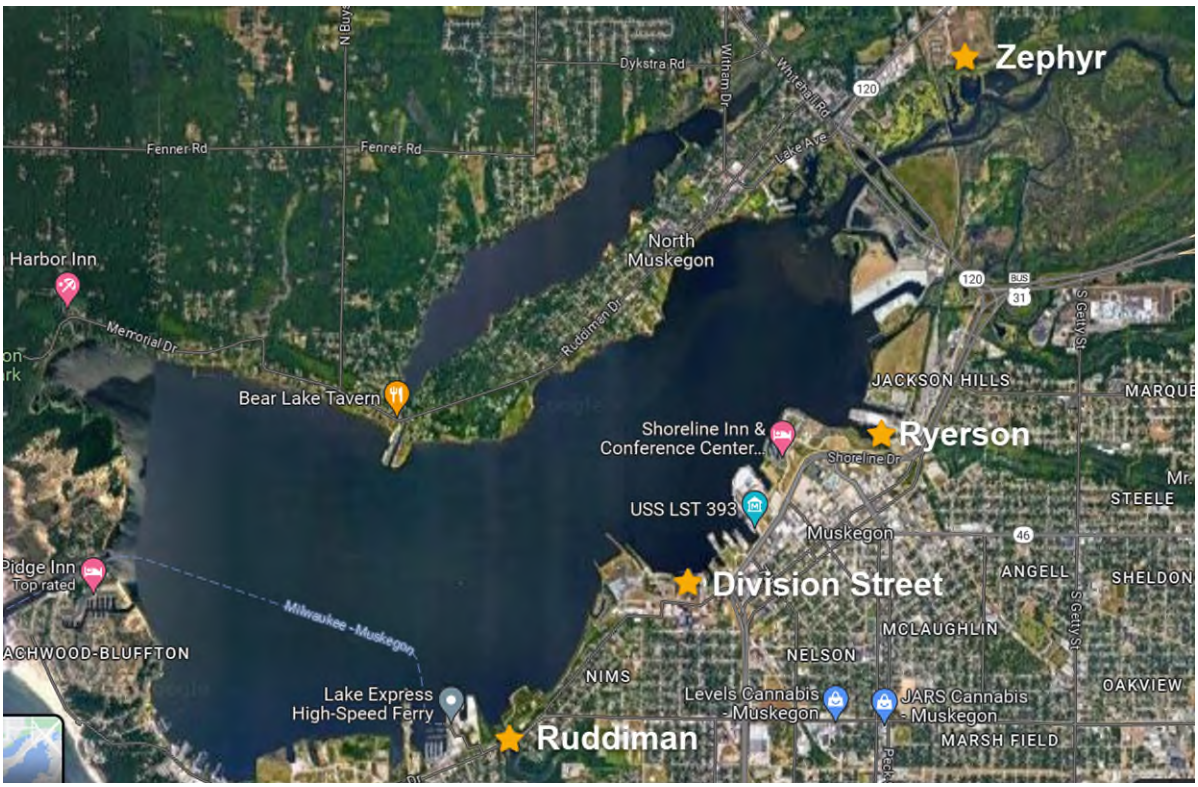

Figure 2. Sediment contamination site locations, represented by star icons.

Division Street Outfall

The Division Street outfall is a bay located on the southern shore of Muskegon Lake near Heritage Landing (Figure 2). Sediments at the site were contaminated with polyaromatic hydrocarbons (PAH), oil and grease, lead, and mercury as a result of former industry in the area (Lata-Kemron, 2013; Anchor, 2020). Forty-three thousand cubic yards of contaminated sediment in 13 acres was removed at the outfall. The area was covered by 6 to 12 inches of clean sand post-remediation in an area over 61 acres (Anchor, 2020). One foot of soil was removed along the shoreline north to the entrance of the outfall (Lata-Kemron, 2013). The shoreline was softened and planted with native species as part of the project.

Baseline total mercury concentrations ranged from 0.02 to 3.4 milligrams per kilogram (mg/kg) with post-remediation concentrations ranging from non-detect to 0.81 mg/kg, but all 18 samples were below the 1.0 mg/kg remedial goal (Anchor, 2020). Total PAH concentrations ranged from 1.0 to 40 mg/kg baseline with 88% meeting the goal below 48 mg/kg post-remediation. The area that did not meet the PAH goal had 4 to 7 inches of silt above the sand layer indicating new deposition (Anchor, 2020). In 28-day growth tests of *Hyalella azteca* results of the baseline and post-remedy both met the survival and growth acceptance criteria (Anchor, 2020). The total abundance of species was higher in the post-remedy samples compared to baseline results. All sampled locations showed an increase in the number of Chironomids in the post-remedy samples (Anchor, 2020).

Ruddiman Creek

Ruddiman Creek impacts consisted of foundry fill, slag, and concrete debris. The slag and concrete were removed from the shoreline and replaced with native plants. Historic discharges of industrial and municipal wastewater, sewer overflows, and urban runoff contributed to the degradation. Ruddiman lagoon forms where Ruddiman Creek crosses under Lakeshore Drive (Figure 2). The lagoon was filled with contaminated sediments and a blockage was created with concrete preventing fish passage during low water periods.

In 2006, 88,640 cubic yards of polychlorinated biphenyls, lead, chromium, and cadmium-contaminated sediments were dredged from Ruddiman Creek, and a sand cover was placed after removal. Additionally, restoration efforts removed the invasive species and created a native plant buffer and the concrete blockage was removed to allow for fish passage. The project was sampled pre-remediation to evaluate if contaminants would indicate sediment toxicity and contaminants were well above the Probable Effects Concentration. Because of the high levels of contaminants, conducting benthic toxicity testing was not advised since mortality and toxic impacts were already

anticipated. Sediment sampling post-remediation indicated that the site met remedial goals for sediment quality (Battelle, 2009).

Ryerson Creek Outfall

The mouth of Ryerson Creek is on the south shore of Muskegon Lake and includes an area of shallow and emergent wetland (Figure 2). Historical photographs indicate that the course of Ryerson Creek was altered during industrial development (Sevenson, 2020). Since the site was impacted by industry the sediments were contaminated with heavy metals and PAHs. Approximately 16,000 cubic yards of sediment were removed and clean fill was placed over the area. Invasive species removal and shoreline softening were included in the site remediation. The project was sampled pre-remediation to evaluate if contaminants would indicate sediment toxicity and had contaminants well above the Probable Effects Concentration. Because of the high levels of contaminants, conducting benthic toxicity testing was not advised since mortality and toxic impacts were already anticipated. Sediment sampling post-remediation indicated that the site met remedial goals for sediment quality (Sevenson, 2020).

Upstream, Ryerson Creek was impacted by a failed culvert, which caused a blockage. Much of the floodplain contained historical fill and invasive species. As part of a Habitat BUI project, the culvert was replaced and a portion of the creek daylighted. Invasive species were controlled along the corridor and numerous native grasses, wildflowers, shrubs, and trees were installed. A rain garden was added to filter storm water from the adjacent parking lots prior to entering the creek (Swart, 2023).

Zephyr Site

The Zephyr site is located along the northern branch of the Muskegon River (Figure 2). An oil refinery was located on the site that had a ditch to provide fire suppression to the operation. Over time over 700,000 gallons of oil was spilled. During use of the fire suppression, ditch water mixed with oil, ash, and smoke was returned to the wetlands below the bluff.

In 2018, 49,000 cubic yards of sediment contaminated with total petroleum hydrocarbons and heavy metals were removed from the site. After the sediments were removed the wetlands surrounding the ditch were restored. Although not part of the Benthos BUI target, the elimination of contaminated sediments from the wetlands near the north branch of the Muskegon River certainly benefitted the surrounding habitats.

Assessment of Target Achievement

The removal target for the Degradation of Benthos BUI is based on a review of Procedure 51 results for five streams in the AOC or, when not applicable, remediation of contaminated sediment sites, as well as benthic population results for Muskegon Lake

and Bear Lake (EGLE, 2014). The three sites (Division Street Outfall, Ruddiman Creek, and Ryerson Creek) that were listed in the BUI removal criteria with contaminated sediments have been remediated and monitored according to approved plans.

Muskegon Riverine Benthos Results

Benthic communities across the Muskegon Lake AOC vary, but most have improved over time, especially with the extensive habitat restoration work and nonpoint source control measures (Swart, 2023). Sites included for review are the portions of Ryerson Creek and Ruddiman Creek applicable to Procedure 51 as well as Little Bear Creek and the Muskegon River (North and South Branches). The areas of Ryerson and Ruddiman Creeks not applicable to Procedure 51 have met the BUI criteria due to contaminated sediment removal.

Because the Muskegon River and Ryerson Creek operate more like wetland systems, a wetland monitoring method rather than Procedure 51 was employed to obtain applicable results (EGLE, 2014; Cooper, 2022; 2023). Procedure 51 is used in streams and rivers that can be safely waded (EGLE, 2014). This procedure evaluates macroinvertebrate communities based on several characteristics and combines all results into a one-number score that ranges from +9 to -9 (Table 1). Using the Procedure 51 score, the macroinvertebrate community is rated as excellent, acceptable, or poor. Habitat is rated as excellent, good, marginal, or poor based on measures that describe the habitat in the stream and along the banks of the stream. Habitat scores are used to help better understand what might influence the macroinvertebrate scores.

Table 1. EGLE Procedure 51 macroinvertebrate and habitat scoring and rating system.

Macroinvertebrate Score	Macroinvertebrate Rating	Habitat Score	Habitat Rating
5 to 9	Excellent	> 154	Excellent
-4 to 4	Acceptable	105 to 154	Good
-5 to -9	Poor	56 to 104	Marginal
		<56	Poor

Comparing invertebrate responses over time using the two methodologies (Procedure 51 and wetland) should be done with caution, given that we do not know for certain whether differences are due to actual recovery or the different methods. Descriptions of the methodologies used for Procedure 51 and the wetland systems can be found respectively in Attachments B and C.

Little Bear Creek

Little Bear Creek and the unnamed tributary were indicated as severely degraded in the 1987 RAP (MDNR). The unnamed tributary was described as having a strong chemical odor and containing bacterial/fungal slime growths on the stream substrate. The

degraded conditions were from the discharge of chemical production wastes and contaminated groundwater from the Ott/Story/Cordova Chemical Company. The facility was listed as a Superfund site in 1989 and a combination of waste removal and groundwater treatment programs were initiated (United States Environmental Protection Agency [USEPA], 2024). Approximately 14,000 cubic yards of contaminated soil were removed from the site from 1992-2008. Purge wells were installed to intercept groundwater and the former production area was declared cleaned up in 2002.

Benthic macroinvertebrate surveys using Procedure 51 were conducted in 2006, 2011, 2016, and 2021 (Michigan Department of Natural Resources and Environment [MDNRE], 2010; MDEQ, 2012a; EGLE, 2024). In 2006, the macroinvertebrate community was rated acceptable, with notations of a flashy hydrologic regime and mowing to the stream edge (MDNRE, 2010). Scores during the 2011 sampling event were acceptable with a good habitat rating (MDEQ, 2012a). Sampling in 2016 indicated that macroinvertebrates in Little Bear Creek were also acceptable (EGLE, 2024). Monitoring in 2021 found the greatest diversity of macroinvertebrates including the highest number of stonefly taxa (EGLE, 2024). Since 2006, the macroinvertebrate community in Little Bear Creek has remained acceptable, but there have been improvements in substrate, in-stream cover, and channel morphology (EGLE, 2024).

Muskegon River

Since this river is not wadeable and contains reaches not appropriate for Procedure 51 monitoring, surveys were conducted using a wetland monitoring methodology (Cooper, 2022). The Muskegon River was qualitatively assessed in 2011 and 2016 using a nonwadeable procedure and received good macroinvertebrate community scores (MDEQ, 2012a; EGLE, 2013; EGLE, 2024). Dr. Matthew Cooper with Grand Valley State University assessed the Muskegon River twice in two habitat zones during the summers of 2021 and 2023.

Macroinvertebrates were diverse in both zones with 19-29 genera per zone (Cooper, 2023). The assemblages were dominated by crustaceans, which is typical for drowned river mouth wetlands (Cooper et al., 2007; Cooper and Uzarski, 2016). The Index of Biotic Integrity scores fell in the “moderately impacted” range but were like the comparison sites at Pere Marquette and White Lake (Cooper, 2023). The results indicated a river dominated by taxa that are typical of healthy drowned river mouth wetlands, and compared to four reference wetlands, the benthic habitat quality is sufficient to support aquatic life (Cooper, 2023).

Ruddiman Creek

The Ruddiman Creek watershed drains 2,994 acres located primarily within the city of Muskegon and includes sections of the cities of Norton Shores, Muskegon Heights, and

Roosevelt Park. The watershed is heavily urbanized, and the creek was impacted by contaminated sediments (MDNR, 1987). Procedure 51 is not appropriate for a portion of Ruddiman Creek denoted on maps as “Ruddiman Lagoon” as it is deep and lentic. It was in this area that the contaminated sediment removal took place as noted in the previous section. Benthic macroinvertebrate surveys using Procedure 51 were conducted in 2009, 2011, and 2022 on appropriate areas of the creek (MDEQ, 2011; MDEQ, 2012b; EGLE, 2024).

The 2009 sampling event showed that the macroinvertebrate community scored acceptable and poor with indications of stream flashiness and large amounts of trash (MDEQ, 2011). Data from the 2011 sampling event provided that the macroinvertebrate community continued to be poor, with insects tolerant to environmental disturbance (MDEQ, 2012b). Sampling in 2022 confirmed the status of the macroinvertebrate community in Ruddiman Creek as poor. Ruddiman Creek is an ‘urban’ stream that experiences a significant amount of storm water flow. Similar streams within non-AOC high population areas experience the same results for macroinvertebrates, i.e., Carrier Creek (Eaton County), Bishop and Tonquish Creeks (Wayne County), and Malletts Creek (Washtenaw County) (Cooper, 2002; Goodwin, 2007; Wuycheck, 2004). In each case, the recommendation was the same as it is for Ruddiman Creek; reduce storm water flows and sediment input. Habitat restoration work as part of the AOC program in the vicinity as well as community support has reduced the amount of trash and runoff impacts to the stream over time and will continue to do so as part of the long-term planning for the area (Swart, 2023).

Ryerson Creek

The Ryerson Creek watershed covers 5,180 acres and includes major portions of the city of Muskegon, Muskegon Township, and Egelston Township (Rediske, 2015). The creek has been impacted by industrial sources and previous studies found low populations of pollution-tolerant macroinvertebrates (Wuycheck, 1989). Since portions of this creek contain significant reaches not appropriate for Procedure 51 monitoring, some surveys were conducted using a wetland monitoring methodology (Cooper, 2022).

Surveys of Ryerson Creek in 2011 and 2016, using the Procedure 51 methodology, found the creek macroinvertebrate community to be acceptable in some portions and poor in others (MDEQ, 2012a; EGLE, 2024). Some of the reasoning for the poor rating is due to the ‘urban’ nature of Ryerson Creek and the prevalence of storm water runoff. As noted in the Ryerson Outfall sediment paragraph, habitat restoration work in the highly-impacted areas now reduce and filter the storm water runoff.

Dr. Matthew Cooper with Grand Valley State University assessed Ryerson Creek twice in two habitat zones during the summers of 2021 and 2023. Macroinvertebrate

assemblages were quite diverse, having upwards of 30 genera. Crustaceans and mollusks made up a substantial portion of the sites, which is typical for drowned river mouth wetlands (Cooper, 2023; Cooper et al., 2007). The Index of Biotic Integrity score was “moderately impacted” and at one of the sites was in the “reference” category, indicating a diverse and well-functioning macroinvertebrate community at Ryerson Creek (Cooper, 2023). The reference wetlands were like the scores at Ryerson Creek.

Muskegon Lake and Bear Lake Benthos Results

Both Muskegon Lake and Bear Lake continue to improve because of the extensive habitat work and contaminated sediment removal. The data presented here are older since the first macroinvertebrate survey occurred in 1999. Remediation and restoration work occurred later in the tributaries and required additional time for habitat regrowth and stabilization. Data from 1972 showed that pollution tolerant oligochaete worms comprised 89% of the total benthic population, chironomid numbers were low (< 200/square meters [m^2]), and species diversity was only 0.68 on the Shannon Weaver Index (Evans, 1976). Macroinvertebrates in Muskegon Lake were collected in 2006 and compared to 1999 data as per the target (Rediske et al., 2009; Carter et al., 2006). The comparison indicated that restoration targets were achieved (Table 2). Annual mayfly hatches were reported in Muskegon confirming the presence of this species (Rediske, 2015).

Table 2. Summary of benthic macroinvertebrate data and restoration targets for Muskegon Lake.

Indicator	Target	1999	2006
Sediment Toxicity	Amphipod Survival >60%	<60% at Division Street Outfall	>60% in 2020 at Division Street Outfall (Anchor)
Hexagenia	Present in river mouth littoral zone	Yes	Yes
% Oligochaeta (#/m^2, w/o Zebra Mussels)	<75%	69	45
Chironomidae (#/m^2)	>500	677	1209
Diversity (Shannon Weaver Index)	>1.5	1.88	2.08

In Bear Lake, 2007 data were compared to 1972 data indicating that chironomid and oligochaete targets were met (Cadmus and Annis Water Resources Institute [AWRI], 2007). Compared to the 2007 data, the earlier conditions showed fewer organisms per m^2 with a dominance of oligochaetes and a lack of clams. Both the taxa richness and numbers have improved in Bear Lake (Rediske, 2015).

Additional macroinvertebrate samples were collected three times per year at six sites from 2004-2010 and compared to historic data (Nelson and Steinman, 2013). During the monitoring period, the dominant taxa was chironomids with oligochaetes the second most dominant. In comparison to the 1972 data, benthic community density increased ten-fold (Nelson and Steinman, 2013). The study showed overall recovery of the benthic invertebrate community structure, including increased densities of major taxonomic groups and decreases in the proportion of oligochaetes (Nelson and Steinman, 2013).

From 2018-2019 macroinvertebrate samples were collected in Muskegon Lake near two restored habitat sites and at one reference site (Orzechowski and Steinman, 2022). The most abundant taxa were *Gammarus* spp., *Echinogammarus* spp., Chironominae, and *Dreissena polymorpha.* Restoration sites had a higher mean macroinvertebrate density or diversity compared to the reference sites across all seasons and all macrophyte habitat types (Orzechowski and Steinman, 2022). The Muskegon Lake restoration sites differed from the reference site in that they were dominated by tolerant generalist species, likely because pollutant-sensitive macroinvertebrates were reduced after decades of environmental pollution (Orzechowski and Steinman, 2022). Although the taxa were more tolerant species, the results indicated that seven years after the conclusion of restoration activities those improvements were successful in establishing a robust community of invertebrates in the littoral zone of the lake (Orzechowski and Steinman, 2022).

Conclusion

The status of the Degradation of Benthos BUI was assessed by reviewing the data associated with the local targets and the work completed in the AOC. The benthos impairments in the Muskegon Lake AOC were largely the result of historical sediment contamination and wastewater runoff.

Based on the studies conducted in Muskegon Lake and Bear Lake as well as the extensive nonpoint source improvements, benthos in the Muskegon Lake AOC have improved, especially when compared to original observations (MDNR, 1987). Contaminated sediment removals took place at four sites and those sites meet remedial goals for sediment quality. Assessments in Muskegon Lake and Bear Lake indicate they meet target criteria for macroinvertebrates. Additionally, macroinvertebrate communities have improved in the tributaries and are either in an acceptable range or acting like other drowned river mouth wetlands. The tributaries remain impacted by storm water runoff, but these issues are no different than other non-AOC, urban streams with impacted biota. The Technical Team (EGLE, Grand Valley State University, and MLWP) for this BUI is confident the local BUI criteria is satisfied. EGLE's AOC Program staff recognize that the benthos impairment in the Muskegon Lake AOC is meeting the established local criteria.

Recommendation

EGLE recommends removal of the Degradation of Benthos BUI in the Muskegon Lake AOC.

The MLWP Technical Committee reviewed the documentation on July 10, 2024, then the removal recommendation was discussed with the MLWP at their regular meeting on August 6, 2024. The MLWP submitted a formal letter of support for removal of the BUI dated August 21, 2024 (Attachment D). This proposed action was public noticed for 14 days via EGLE's Environmental Calendar and posting to the GLIN-Announce listserv. A couple of written comments were received and addressed.

Prepared by: Stephanie Swart, Muskegon Lake AOC Coordinator
Great Lakes Management Unit
Great Lakes Watersheds Assessment, Restoration, and Management Section
Water Resources Division
Michigan Department of Environment, Great Lakes, and Energy
September 5, 2024

Attachments:

A – Target for the Delisting of the Degradation of Benthos Beneficial Use Impairment in the Muskegon Lake Area of Concern

B – EGLE, Water Resources Division, Great Lake Watershed Assessment, Restoration and Monitoring Section Procedure 51 Method

C – Dr. Matthew Cooper sampling methodology for Muskegon River and Ryerson Creek

D – MLWP letter of August 21, 2024, supporting BUI removal

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

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Attachment A

Target for the Delisting of the Degradation of Benthos Beneficial Use Impairment in the Muskegon Lake Area of Concern

Introduction

Muskegon Lake is a 16.8 square kilometer drowned river mouth lake located in western Michigan. The lake was listed as an Area of Concern (AOC) by the International Joint Commission in 1987 because of severe environmental impairments related to the historic discharge of municipal and industrial wastes. The Beneficial Use Impairment (BUI), Degradation of Benthos, was listed because of sediment toxicity related to heavy metals and organic chemicals and impacts to species diversity from the discharge of municipal sewage. Data from 1972 (Evans, 1976) showed that pollution tolerant oligochaete worms comprised 89 percent (%) of the total benthic population, chironomid numbers were low (< 200/square meters [m^2]), and species diversity was only 0.68 (Shannon Weaver Index). In 1974, the direct discharge of municipal and industrial wastewater to Muskegon Lake was eliminated by the construction of an advanced tertiary treatment facility. In addition, industrial pretreatment programs, hazardous waste site remediation projects, and numerous conservation and nonpoint source reduction efforts have resulted in large improvement in water quality. In 1999, Shannon Weaver diversity improved to 1.66, oligochaetes were reduced to 68% of the total population, and chironomid numbers increased to over 600/m^2 (Carter, 2002; Rediske et al., 2002).

Available Guidance

The International Joint Commission criteria for listing the Degradation of Benthos is provided below:

> "When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated, bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls."

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) provides the following guidance for delisting:

> "This BUI will be considered restored when:
> An assessment of benthic community, using either EGLE's Procedure 51 for wadeable streams or EGLE's pending rapid assessment procedure for nonwadeable rivers yields a score for the benthic metrics that meets the standards

for aquatic life in any two successive monitoring cycles (as defined in the two procedures).

OR, in cases where EGLE 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 site. Remedial actions and monitoring are conducted under authority of state and federal programs, such as Superfund, Resource Conservation and Recovery Act, Great Lakes Legacy Act, or Part 201 of Michigan's National Resources and Environmental Protection Act (NREPA) of 1994."

Delisting Target

EGLE provides two options for target development: using Procedure 51; and completing all necessary remedial actions. Procedure 51 is not applicable to lakes and while completing sediment remediation projects and individual sites is important, Muskegon Lake has been impacted on a system-wide basis by chemical and nutrient pollution. Because of the importance Muskegon Lake as a recreational resource and public concern related to sustaining the current trend of improving water quality, the Muskegon Lake Public Advisory Council voted to adopt a target for delisting the Degradation of Benthos BUI that exceeds the State of Michigan criteria. The Public Advisory Council also voted to apply the same standards initially to Bear Lake, recognizing that information concerning the benthic community was lacking and the target would need to be evaluated when data became available. The target is presented below:

This BUI will be considered restored when average benthic macroinvertebrate populations in Muskegon Lake and Bear Lake reflect the following conditions:

Indicator	Target
Sediment Toxicity	Amphipod Survival >60%
Hexagenia	Present in river mouth littoral zone
% Oligochaeta	< 75%
Chironomidae (#/m^2)	> 500
Diversity (Shannon Weaver)	> 1.5

For Muskegon Lake, compliance with the sediment toxicity indicator will be determined by review of pre- and post-remediation data for Ruddiman Creek, Ryerson Creek, and the Division Street Outfall. Compliance with the remaining indicators will be based on a benthic survey conducted at a group of the same stations sampled in 1999 (Figure 1).

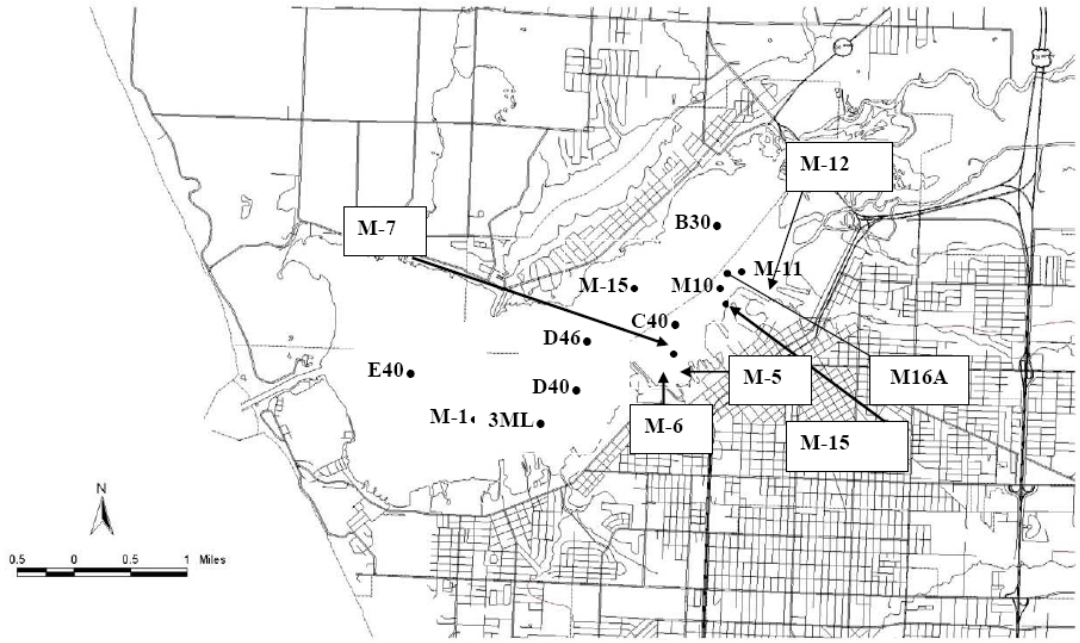

Figure 1. Muskegon Lake Benthos Sampling Locations.

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. The Public Advisory Council recognizes that data concerning the status of the benthic macroinvertebrate community and the presence of sediment toxicity are not available for Bear Lake. Based on the historic discharge from the Ott/Story/Cordova Superfund site and the presence of accelerated cultural eutrophication (as evident from inclusion of Bear Creek/Lake on the Michigan Section 303(d) list), the Public Advisory Council has established a priority to collect additional data on Bear Lake. Sampling locations for sediment toxicity and benthic invertebrates will be identified in the request for additional funding. The targets for Bear Lake are subject to change pending the collection and evaluation of new benthic community data and the development of a comprehensive restoration plan.

Funding Partners

Funding of the monitoring program for the delisting targets will be by the submission of grants and requests for assistance from the following sources:

- EGLE Clean Michigan Fund Local Monitoring Grants.
- EGLE, Great Lakes Watersheds Assessment, Restoration, and Management Section, 5-Year Basin Monitoring Program and Section 303(d) List Program (Total Maximum Daily Load).
- Great Lakes National Program Office.

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Attachment B

Michigan Department of Environment, Great Lakes, and Energy (EGLE),
Water Resources Division (WRD), Great Lakes Watersheds Assessment,
Restoration, and Management Section (GLWARMS)
Procedure 51 Method

The EGLE, GLWARMS, Procedure 51 establishes the process necessary to monitor the fish community, macroinvertebrate community, and habitat quality in wadeable rivers and streams in support of ambient water quality monitoring, National Pollutant Discharge Elimination System (NPDES) permit support, and other point and nonpoint source needs.

I. INTRODUCTION

The development and subsequent modification of these biological and habitat survey protocols was a result of the increasing demand for a more vigorous and standardized evaluation of Michigan's water resources. The GLWARMS implemented the revisions included in these protocols prior to the 2006 field season. These protocols can be used to assess the existing condition of Michigan's wadeable streams and rivers as well as detect spatial and temporal trends. Specifically, the GLWARMS uses these protocols to fulfill monitoring requests, assess known or potential Areas of Concern or where more information is needed, achieve assessment coverage of watersheds, provide information to support and evaluate the effectiveness of EGLE's protection programs (e.g., NPDES, nonpoint source, and site remediation), and make site-specific determinations of designated use support (per R 323.1100 of the Part 4 Rules, Water Quality Standards, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), as well as spatial and temporal designated use support determinations on statewide and watershed levels.

The biosurvey protocols consist of separate qualitative evaluations of the macroinvertebrate community, fish community, and habitat quality in wadeable lotic (flowing) streams or rivers. These evaluations may be conducted and applied independently or in combination. The biological integrity of a stream is based on the results of the fish and/or macroinvertebrate community evaluations.

The physical transition between wadeable and nonwadeable rivers is not distinct. On larger rivers, the determination of the ability to adequately sample should acknowledge the broad scale of habitat features and the potential difficulties with collecting biological and habitat information representative of the entire river reach rather than simply

consider the access location. The ability to safely wade the majority of the channel and adequately sample all available habitats should be considered in situations where the applicability of these protocols is questionable due to the size of the river. For large, nonwadeable rivers where it is determined that these protocols are inappropriate, the Quantitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (EGLE, 2013) should be used. Survey locations in the "Very Large" Valley Segment Ecological Classification stratum should be assessed using the protocols for nonwadeable rivers.

Certain studies or situations may require quantitative or alternate methods. The biosurvey protocols presented here do not preclude the use of alternate methods; however, the use of alternate methods is the exception.

II. PRINCIPLES OF FISH, MACROINVETEBRATE, AND HABITAT SURVEYS

Better stream quality is normally indicated by greater warmwater fish and macroinvertebrate diversity and abundance, as well as a more even distribution of individuals among taxa at one station compared with another. Conversely, poorer stream quality is indicated by lower diversity and abundance at one station when compared to another. Large-scale changes in stream quality over time may be recognized at a given station by repeated sampling and comparison of fish and macroinvertebrate data.

Fish and macroinvertebrate community composition generally reflect conditions present for an extended period of time prior to sampling. However, temporary events, such as decreases in dissolved oxygen concentrations or the presence of toxicants, may cause losses of sensitive taxa either by emigration or death. Similarly, an abundance of tolerant organisms may indicate persistent degraded stream quality. Changes in fish or macroinvertebrate community structure may also occur if trophic changes occur due to pollution or perturbation.

In these protocols, analyses of the warmwater fish and macroinvertebrate communities are made according to a set of measurements or "metrics." These metrics have been selected from those used in the United States Environmental Protection Agency’s (USEPA) Rapid Biological Assessment Protocols, Ohio Environmental Protection Agency's protocols, the state of Illinois' biological procedures, and those procedures developed specifically for Michigan and tested by EGLE. The individual metrics provide information on a variety of biological attributes and, when combined, intend to indicate overall changes in the fish and macroinvertebrate communities in response to various stream quality conditions. The accuracy of the protocols, however, depends on the selection and evaluation of excellent regional reference sites. These reference sites

were selected from streams within each of Michigan's ecoregions recognized as excellent in quality by biologists. These sites are the level against which all other field measured stream biological parameters are compared. Each ecoregion has several reference sites, spanning different stream widths. The glacial history of Michigan created 5 distinct ecoregions, separable by soil types, topography, and stratigraphy. The ecoregion approach provides a logical framework to use with these biological monitoring protocols when excellent sites are described within each ecoregion.

An excellent quality stream for the ecoregion would have most metrics rating similar to the reference sites. Poor quality streams would have most metrics rating substantially different than the reference sites. The use of these metrics creates a uniform and systematic evaluation for each station. This approach makes the results easily interpretable, since they are expressed relative to the reference sites.

Multiple metrics for coldwater fish communities are not included in this procedure. The coldwater fish community is evaluated for the presence of at least 50 fish, relative abundance of anomalies, and relative abundance of salmonids collected.

The habitat evaluation is also important in determining the nature and degree of abiotic constraints on the biological potential. This habitat evaluation is accomplished through stream characterization based on selected physical measurements and descriptive watershed features. Habitat metrics are used to assess a wide range of physical characteristics that are important to the optimum development and stability of biological communities. Ultimately, the metrics are used to rate overall habitat quality. The habitat metrics used in this protocol are based on the USEPA’s Rapid Bioassessment Protocols.

III. GENERAL SAMPLING CONSIDERATIONS

1. Sampling should occur between June 1 and September 30 during periods of stable discharge and at times of low or moderate flow. This sampling period helps to ensure consistency between sampling studies by reducing variability due to seasonality and flow fluctuations within years or between years.
2. For basin investigations or long-term studies, stations should be sampled during the same time frame to minimize seasonal variability in fish and macroinvertebrate distribution or abundance.
3. Maximum impact of a municipal or industrial discharge usually occurs during summer low stream flow and maximum temperature conditions. Dilution is minimal for pollutants during low flow conditions, while elevated stream temperatures and productivity produce maximum fluctuations in diurnal oxygen concentrations. High

temperatures also increase fish and macroinvertebrate metabolic rates, which may amplify toxics effects.

4. Consideration must be given to the sampling sequence to ensure the least disruption of the communities to be sampled. Sampling should generally occur in the following order: fish, macroinvertebrates, and habitat.
5. Record all data on the Stream Survey Cards, and include a sketch of the station location to assist future sampling. A considerable amount of the data on the survey card is optional and used for informational purposes to assist the biologist with site description. Shaded areas on the card must be filled out for later entry into the biosurvey database. The following channel modifications should be noted by checking the appropriate box(es) on the survey card:

    - None - natural stream channel, no evidence of modifications.
    - Dredged - stream channel has been excavated (widened, deepened, straightened), evidence of dredge spoils along stream banks.
    - Canopy removal - woody riparian vegetation has been removed from 1 or both banks either by physical removal or with the use of defoliant sprays.
    - Snagging - removal of logs, deadfalls, and other large woody debris from the stream channel.
    - Impounded - station is located either directly upstream of an impoundment or directly downstream of a dam.
    - Relocated - stream channel has been completely rerouted from the original channel usually to follow a roadway, railway, or has been redirected for industrial purposes (e.g., mill race) or has been rerouted to another watershed.
    - Bank stabilization - this includes engineered cattle access points or the stream bank has been armored with rip-rap, sheet piling, revetments, etc.
    - Habitat improvement - identified by the presence of artificial banks (lunker structures), wing deflectors, half-logs, rock dams, etc.

The presence of attached algae, aquatic macrophytes, or bacterial slimes should also be noted. Although the determination of nuisance conditions will be left to the biologists' professional judgment, the following examples are provided as guidance for identifying nuisance conditions: (1) *Cladophora* spp. and/or *Rhizoclonium* spp. greater than 10 inches long and covering greater than 25% of a riffle; (2) Rooted macrophytes present at densities that would impair the designated uses of the water body; and (3) The presence of bacterial slimes.

Attachment C

Dr. Matthew Cooper Sampling Methodology for Muskegon River and Ryerson Creek

Macroinvertebrate samples were collected at NW-4 and the Ryerson Creek wetland on July 13, 2021, and August 3, 2023. Sampling protocols followed Great Lakes Coastal Wetland Monitoring Program (GLCWMP) methodology, which is detailed in the program's Quality Assurance Project Plan and Standard Operating Procedures (https://www.greatlakeswetlands.org/Sampling-protocols). Briefly, 3 replicate samples were collected from 2 different mono-dominant vegetation zones at each site. Specimens were collected using a semi-quantitative method using 0.5 millimeter mesh dip nets to sweep vegetation. Net contents were then placed into white plastic trays and macroinvertebrates were picked from the trays for 30 minutes or until 150 organisms per sample were collected. Samples were then returned to the laboratory for identification to lowest-operational-taxonomic-unit, which was genus for most groups. Sample processing (taxonomy) was conducted at the Wetland Ecology Lab at Central Michigan University, which processes hundreds of coastal wetland macroinvertebrate samples annually as part of the GLCWMP.

Data were analyzed and Index of Biological Integrity (IBI) scores calculated according to Uzarski et al. (2017) and the GLCWMP Standard Operating Procedures (https://www.greatlakeswetlands.org/Sampling-protocols). However, because calibrated IBI metrics are not currently available for the vegetation types encountered at these two Muskegon Lake Areas of Concern (AOC) wetlands, IBI metrics were calculated based on formulae and thresholds typically used in dense *Schoenoplectus* habitats in Lakes Michigan and Huron. Because these metrics were originally calibrated for a different habitat type, four regional reference wetlands were selected to compare the Muskegon Lake wetlands against using the same metric calculations and scoring schema. Reference wetlands included the Pere Marquette River, Pentwater River, White River, and Duck Lake drowned river mouth wetlands. These four non-AOC wetlands provide context for the Muskegon Lake AOC results. The same set of metrics and scoring thresholds were applied to the reference wetlands as were applied to the NW-4 and Ryerson Creek sites.

Data for reference sites were acquired from the GLCWMP database (https://www.greatlakeswetlands.org/Home.vbhtml). Data from the Pere Marquette River were collected in 2019, data from Duck Lake were collected in 2020, and data from the Pentwater River and White River were collected in 2021. Reference data from 2022 and 2023 were not yet available in the GLCWMP database at the time of analysis.

Attachment D

316 Morris Ave., Suite 340 – Muskegon, MI 49440
Website: www.muskegonlake.org

August 21, 2024

Ms. Stephanie Swart
Great Lakes Management Unit
Water Resources Division
Michigan Department of Environment, Great Lakes, and Energy
Lansing, Michigan

Dear Ms. Swart,

The Muskegon Lake Watershed Partnership (MLWP), as the Public Advisory Council (PAC) for the Muskegon Lake Area of Concern (AOC), has reviewed the attached, Michigan Department of Environment, Great Lakes, and Energy (EGLE) Degradation of Benthos BUI Removal Document during our August 6, 2024, meeting.

A draft document was reviewed by the Technical Committee and emailed to the MLWP's voting members prior to the August meeting. Following the August meeting, minor adjustments were made then reviewed and approved by the MLWP chairs.

The MLWP (Muskegon Lake PAC) is pleased to provide this letter in support of EGLE's recommendation to remove the Degradation of Benthos BUI. We look forward to the 30-day public notice via the EGLE Calendar and postings to the Mich-RAP listserv.
Sincerely,

Dennis Kirksey, Chair
Muskegon Lake Watershed Partnership

CC: Mark Loomis, U.S. EPA GLNPO
Fallon Chabala, PAC Support Staff, WMSRD