WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENTS E-U

[Attachments A-D were submitted with WaterLegacy's July 31, 2023 Comments on these MPCA Procedures and Framework]

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT E

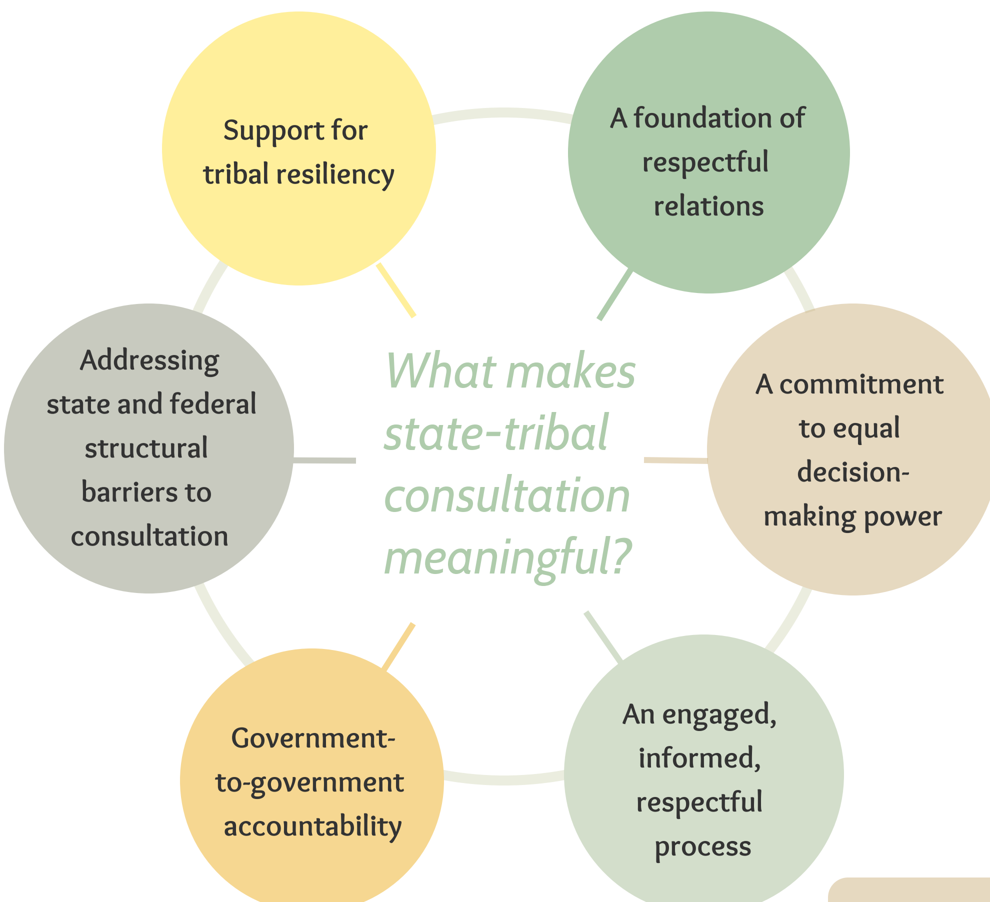
(University of Minnesota, Tribal Consultation Fact Sheet, 2020)

2020

What makes state-tribal consultation meaningful?

Insights gained from interviews with tribal and state leaders

Manoomin (Ojibwe), psiŋ (Dakota), wild rice (English) or *Zizania palustris* (Latin/scientific) is an aquatic grass with significant cultural and spiritual value to tribal nations in the Great Lakes region. To the Ojibwe people, it is a sacred food, medicine, and gift from the Creator. Because Manoomin is highly sensitive to environmental stressors, the Minnesota Pollution Control Agency (MPCA) established the 10mg/L wild rice sulfate standard in 1973. The standard went unenforced for years until the U.S. Environmental Protection Agency (EPA) mandated the state to begin enforcing it in 2011. From 2011-2017, the MPCA led a rule-making process to review and amend the wild rice sulfate standard. This process included researching wild rice, engaging a wild rice advisory task force, consulting with tribes, hosting public hearings, and issuing a new equation-based rule which was ultimately disapproved by the Chief Administrative Law Judge. In 2018, University of Minnesota and tribal researchers collaborated to interview four MPCA consultation participants and seven tribal participants–representing the Minnesota Chippewa Tribe, Grand Portage, Lac du Flambeau, and Fond du Lac bands of Lake Superior Chippewa–regarding their views on the sulfate standard consultation process. Insights gained from the interviews are intended to improve consultation practices and support more equitable and racially just, government-to-government environmental decision-making.



What is tribal consultation?

As sovereign nations, federally recognized American Indian and Alaska Native tribal nations maintain government-to-government relations with the U.S. federal and individual state governments as defined in treaties and the U.S. Constitution. Consultation between U.S. government agencies and tribal nations is required for all issues within tribal jurisdictions or with tribal implications, including natural resources management in ceded territories. In Minnesota, Governors Dayton and Walz have each established a consultation requirement for state agencies via Executive Orders in 2013 and 2019, respectively. Thus state policies that impact Manoomin and Manoomin waters, such as the sulfate pollution standard for wild rice, require co-regulation and consultation between state agencies and tribal nations.

> *"I think consultation requires listening and certainly at least incorporating some of what's heard in a consultation. Otherwise it's not meaningful." —Tribal staff member*

A foundation of respectful relations

- Recognition of inherent tribal sovereignty
- Understanding and respect for different relationships with Manoomin
- Understanding and respect for different management philosophies
- Recognition of historic and ongoing harms to local Indigenous peoples, including systematic and institutionalized racism
- Commitment to repairing and building trust
- Training for state agency staff on intercultural and tribal governance
- Opportunities for state and tribal staff to build authentic relationships outside the formal consultation space

A commitment to equal decision-making power

- Avoiding a superficial "check-the-box" approach
- Engaged listening, even when there are conflicting views
- Exchanging information and perspectives on equal footing
- Using tribal knowledge, resources, and research in decision-making

> *"It's astounding to me that these tribal elders and ricers come to these meetings and speak to state officials about wild rice . . . and then just have nothing come of that is just the ultimate disrespect." —Tribal staff member*

An engaged, informed, respectful process

- Engaging with tribes immediately in the consultation process
- Sending staff who have thorough understanding of the relevant issues, including legal, technical, cultural, and traditional ecological knowledge [TEK]
- Committing to open, respectful communication and behavior
- Preparing fair and flexible agendas that allow for inclusive information exchange and opportunities for conversation
- Maximizing location, timing, and technological access for all invited participants
- Including tribally hosted meetings
- Creating and sharing clear documentation, including thorough meeting notes and written statements of intentions
- Ensuring deliberate followup when there are misunderstandings

> *"I think we have a better appreciation for the technical knowledge —whether it's tribal ecological knowledge or Western science, but being practiced by tribal members . . . I think we're more ready to build time into the process for that." —MPCA staff member*

Support for tribal resiliency

- Continuing to foster tribal staff who are well-versed in the issues
- Continuing to adapt strategies that bring successes within the existing system
- Preparing to repeatedly stand up for tribal sovereignty
- Continuing to show tribal solidarity and band together across tribes

> *It's up to us as tribal leaders to be there to speak for [our tribal members] . . . Not only that, but it all comes down to standing up and speaking for that Manoomin." —Tribal staff member*

Addressing structural barriers

- The Clean Water Act and sulfate rulemaking mandate have narrow and restrictive regulatory structures.
- The scientific approach used in lawmaking is traditionally narrow, and excludes TEK integration.
- State interpretations of treaty and federal law are inconsistent.
- Sulfate pollution is a politicized issue subject to industry influence.

> *"It wouldn't have been possible to have a broader rule at that time or to entertain that more holistic protection, because we didn't know how to do it . . . the Clean Water Act isn't structured that way . . . It's structured for figuring out how much protection is needed to protect a specific use." —MPCA staff member*

> *". . . there's no accountability. There's no recourse . . . at least on the federal side [it's] written in law . . . in the Constitution of the United States itself that treaties are the supreme law of the land. And that's probably one of our biggest, greatest tools . . . If we're doing things with the federal government, there's a tool to hold them accountable, and when we do these types of things with state governments there isn't." —Tribal staff member*

Government-to-government accountability

- Meaningful accountability mechanisms for the state
- Tribal liaisons within state and federal agencies who are empowered and included in consultations
- Clear government-to-government channels of communications with the appropriate level of decision-makers committed to the process
- Clear commitment of U.S. and state leadership to mutually beneficial tribal relations

This study was conducted as part of the Kawe Gidaa-Naanaagadawendaamin Manoomin (First We Must Consider Manoomin/Psiŋ) project. The partnerships created through this project are among its most important outcomes. We would like to acknowledge our project collaborators and partners: Mark Bellcourt (White Earth Nation), retired UMN; Jeremy Bloomquist, St. Croix Chippewa Indians of Wisconsin Environmental Services; Perry Bunting, Mille Lacs Band of Ojibwe DNR; Trinaty Caldwell (Menominee), UW-Oshkosh student; Eric Chapman (Lac du Flambeau Ojibwe Nation); LeAnn Charwood (Leech Lake Band of Ojibwe), Leech Lake Tribal College student; Jamie Colvin (Seminole Nation of Oklahoma), Haskell Indian Nations University student; Diana Dalbotten, UMN; Mae Davenport, UMN; Peter David, Great Lakes Indian Fish & Wildlife Commission; Karen Diver (Fond du Lac), University of Arizona; Mike Dockry (Citizen Potawatomi Nation), UMN; Bree Duever, UMN; McKaylee Duquain (Menominee), UMN student; Joe Graveen (Lac du Flambeau Band of Lake Superior Chippewa Indians), Wi. Lac du Flambeau wildrice cultural enhancement program; Emily Green, UMN; Katherine Hagsten (Leech Lake Band of Ojibwe); Kari Hedin, Fond du Lac Resource Management Division; Susannah Howard (Citizen Potawatomi Nation), Smith College student; Riley Howes (Fond du Lac), Brown University student; Tom Howes (Fond du Lac Band of Lake Superior Chippewa); John D. Johnson Sr. (Lac du Flambeau); Anna Kadrie, UMN student; Shannon Kesner (Fond du Lac); Hannah Jo King, UMN student; Erik Kojola, UMN; Roger LaBine (Lac Vieux Desert Band of Lake Superior Chippewa); Dan Larkin, UMN; Laura Matson, UMN; Gabby Menomin (Forest County Potawatomi), UMN student; Melonee Montano (Red Cliff Band), Great Lakes Indian Fish and Wildlife Commission; Seth Moore, Grand Portage Band of Lake Superior Chippewa; Brena Mullen (Fond du Lac), Bemidji State University student; Amy Myrbo, St. Croix Watershed Research Station, Science Museum of MN; Gene-Hua Crystal Ng, UMN; Michael Northbird (Minnesota Chippewa Tribe); Maddy Nyblade, UMN student; Patrick O'Hara, UMN student; Jaren Peplinski, UMN student; Meghan Porter, Great Lakes Inter-Tribal Council, Inc.; Richard Robinson (Leech Lake Band of Ojibwe); Cara Santelli, UMN; Riley Schmitter (Chickasaw Nation), UMN student; Nancy Schuldt, Fond du Lac Resource Management Division; Robert Shimek (White Earth Nation); Allison Smart (Sault Ste Marie Tribe of Chippewa Indians), Little River Band of Ottawa Indians; Wally Storbakken (Leech Lake Band of Ojibwe), Leech Lake Band of Ojibwe; Donovan Strong (Bois Forte); Ed Swain, retired Minnesota Pollution Control Agency; Josh Torgeson, UMN student; Darren Vogt, 1854 Treaty Authority; Alex Waheed, UMN student; Lilah White (Mille Lacs), UMN student.
Funding: University of Minnesota Grand Challenges Research Program

https://manoominpsin.umn.edu/wp-content/uploads/2020/08/Manoomin-Fact-Sheet-Spread.pdf

UNIVERSITY OF MINNESOTA

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT F

(MPCA Strategy to Address Indirect Effects of Elevated Sulfate on Methylmercury Production and Phosphorus Availability, Oct. 19, 2006)

MPCA Strategy to Address Indirect Effects of Elevated Sulfate on Methylmercury Production and Phosphorus Availability

Summary: Although there is evidence that elevated sulfate loading can increase methylmercury production and phosphorus mobilization, it is premature to develop specific sulfate concentration limits or other regulatory responses based on these effects. The deleterious effects of sulfate may be restricted to certain areas of the state, certain background sulfate concentrations, or other environmental controlling factors. These factors will be explored in a multi-year data collection effort combined with ongoing data analysis. It is anticipated that sensitive areas of the state will be identified and appropriate controls on sulfate discharges will be developed if necessary. The primary focus of the strategy is to pursue research to further understand impacts from sulfate on methylmercury production and phosphorus mobilization and to use the research to guide the future need for additional requirements or controls in environmental review and NPDES permits. This strategy was approved by the MPCA Risk Managers on August 28, 2006 and the MPCA WQ Policy Forum on October 19, 2006.

Problem Statement: Research indicates a correlation between sulfate loading and methylmercury (MeHg) production and phosphorus (P) mobilization under certain conditions. Many waters of the state are impaired as a result of MeHg in fish tissues and excess nutrients. MPCA staff need to better understand the relationship between sulfate concentration and MeHg production/P mobilization so that appropriate responses, if necessary, can be developed. Sulfate is a common constituent in domestic and industrial wastewaters. Additional information is needed so that the MPCA can develop a permitting strategy for existing, expanding and new domestic and industrial process wastewater discharges. The strategy must reflect varying MeHg production and P availability under differing environmental conditions.

MPCA Actions to Monitor & Evaluate Sulfate Impacts

MPCA staff will evaluate the following hypotheses over three to five years.

1) Elevated sulfate discharge into low-sulfate receiving waters significantly increases MeHg concentrations (as percent of total mercury) and P concentrations.
2) Elevated sulfate discharge into high-sulfate receiving waters has no significant effect on MeHg concentrations (as percent of total mercury) and P concentrations.
3) Elevated sulfate discharge into low-sulfate waters has greater effect on P concentrations when the iron to P ratio is low in the sediments of the receiving water.

Environmental Analysis and Outcomes Division will coordinate the following activities to evaluate the above hypotheses and support eventual changes in the environmental review and permitting practices:

1) Continued research at Wetland 6 in the Marcell Experimental Forest north of Grand Rapids;
2) Milestone Monitoring – permanently add sulfate, TOC, total mercury, and MeHg to the MPCA's ambient water quality monitoring sites; (In FY07 Milestones did include THg, MeHg, sulfate, and TOC, through use of the Mercury Trends allotment).

3) Continue to track and participate in the research of national / international work groups;
4) Compile and map existing surface water sulfate concentration data in Minnesota;
5) Compile and map existing effluent sulfate concentration data in Minnesota;
6) Compile and map existing stormwater sulfate concentration data in Minnesota (if few data have been collected, consider obtaining representative data);
7) Fish Consumption Advisory Monitoring - Work with DNR and MDH to collect fish for mercury analysis of fish tissue at a subset of sites where environmental data is being collected on water or sediments;
8) Implement the Environmental Review and NPDES Permitting actions (below) Regional, Municipal and Industrial Divisions will lead as appropriate; and
9) Compile data from the above activities and complete an evaluation of the hypotheses.

Environmental Review and NPDES Permitting

While research shows a relationship between sulfate concentration and MeHg production/P mobilization, there is currently insufficient information to reach firm conclusions on whether specific point source (non-stormwater) discharges containing sulfate may impact water quality or cause/contribute to water quality impairments. The following information will guide the development of programmatic direction and procedures to address sulfate discharges. This approach includes 1) further characterization of the problem, 2) development of interim permitting and environmental review procedures, 3) research of sulfate impacts from point source dischargers, and 4) annual incorporation of new knowledge into the permitting and environmental review procedures. Prior to development of the interim procedures, NPDES permit writers and environmental review staff will need to manage projects on a case-by-case basis. They will use the current knowledge (as outlined below and in Appendix A) and work with the program supervisor and Ed Swain to assess and respond to the environmental risk from sulfate discharges.

Environmental Review

If a new or expanding domestic or industrial process wastewater discharge triggers environmental review for a wastewater-related threshold (not a non-wastewater related threshold) or if wet air controls that contribute sulfate to a wastewater stream are proposed the impact from sulfate must be evaluated in the environmental review document. The environmental review should include available data on projected effluent design flow rate, sulfate concentration, and sulfate load as well as best estimates of receiving water flow rate (7Q10 and other statistics) and concentrations of sulfate, mercury, MeHg, iron, ortho-P, total P, and, as a measure of organic matter in the water, TOC and/or DOC. If receiving water flow was measured concurrently with water sampling, flow data should also be included. The environmental review must also include available data on the organic matter, mercury, iron, and P content of the sediments of receiving waters and lakes or impoundments downstream. It is understood that available data may be limited. To the extent possible, qualitative discussion of downstream conditions and mitigative options should also be included.

NPDES Permitting

If a new, expanding or existing domestic or industrial wastewater discharge for "high risk" situations is encountered, 1) the need for effluent and/or receiving water monitoring for sulfate, mercury, MeHg, iron, ortho-P and/or total P should be considered; and 2) if research or other information supports a likely impact from sulfate in a specific situation an evaluation of the treatment technologies and pollution prevention opportunities should be included with the permit application. Existing discharges will be addressed at the time of reissuance. A guidance for project proposers and NPDES permit writers will be developed by June 2007 to explain the procedures for addressing sulfate discharges. In the interim, permit writers will work with the program supervisor and Ed Swain to assess and respond to the environmental risk from sulfate discharges.

Currently, high-risk situations may include:

- Discharge of elevated sulfate concentrations into high-organic aquatic environments (e.g., wetlands that drain to fisheries, lakes with organic sediment, rivers with slow-moving back waters, ponds where rising water might inundate vegetation).
- Discharge of elevated sulfate into low-sulfate waters (< 40 ppm or so) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria (SRB).
- Discharge of elevated sulfate into streams with fluctuating water levels and bordering wetlands. Rising water levels would introduce sulfate into the high-organic wetland matrix, followed by falling water levels that hydraulically deliver elevated MeHg and/or phosphate to the stream.
- Discharge of elevated sulfate to waters that flow to a lake or impoundment downstream that may thermally stratify even temporarily in the summer or be cut off from the atmosphere from ice cover in the winter. Either stratification or ice cover can produce anoxic water, in which sulfate can be converted to sulfide, potentially enhancing both mercury methylation and phosphate release.

Conditions that decrease the risk that elevated sulfate loading may enhance mercury methylation:

- Discharge of elevated sulfate to waters with high background sulfate (>100 ppm or so), including downstream waters.
- Discharge of elevated sulfate to highly oxygenated, turbulent waters with low-organic sediment and no adjacent riparian or lacustrine wetlands, and none downstream.

Research Impacts of Sulfate from Domestic and Industrial Process Wastewater Discharges

MPCA staff will pursue funding to study specific impacts from domestic and industrial process wastewater discharges of sulfate on MeHg production and P availability in receiving waters. The study (or series of smaller studies) will include site-specific evaluations at facilities representing the various high risk situations identified in "Environmental Review and NPDES Permitting" above. This work may include effluent and receiving water monitoring for sulfate, mercury, MeHg, iron, ortho-P, total P, and supporting parameters that may reveal biogeochemical mechanisms, such as DOC, pH, oxygen, nitrate, and potassium. The work will include an evaluation of the data to determine whether domestic and industrial process wastewater discharges are impacting receiving waters during any time of the year with a particular focus on the summer months. Some of the study work may need to be contracted out to a research entity (i.e. UMD, NRRI, U of M St. Anthony, U of Toronto). Funding sources may include Legislative Initiative, CW Legacy Act, GLNPO, salary savings, or other related project savings.

Action Items / Resource Needs

1) Risk Managers need to select an EAO Division representative to coordinate the overall Sulfate Strategy **by August 28, 2006**. Action Complete: Marvin Hora will be overall coordinator.

2) Sulfate Strategy Coordinator (Marvin Hora) will work with the appropriate managers to recommend staff team members to develop guidance documents described in the Environmental Review and NPDES Permitting action items below **by September 25, 2006**. Recommendation: Team should include Ed Swain, Jeff Stollenwerk, Deb Lindlief, Dana Vanderbosch, Bruce Wilson and a GIS specialist (see MPCA Actions 4 & 5 above).

3) Water Policy Team reviews and approves the Sulfate Strategy including staff assignments **by October 31, 2006**. Jeff Stollenwerk will coordinate.

4) EAO staff should develop funding requests, detailed plans and funding applications, RFPs and conduct study oversight necessary to complete research on impacts of sulfate from domestic and industrial process wastewater discharges. **Ed Swain - Ongoing.**

5) The Sulfate ER/NPDES Permitting staff team (from item 2 above) further defines and characterizes high-risk situations/criteria and develops interim procedures for environmental review and NPDES permitting activities. This action should be completed **by February 28, 2007**. Estimated time commitment – 40 to 80 hours for each team member.

6) The Sulfate ER/NPDES Permitting staff team (from item 2 above) develops brief guidance for project proposers and MPCA staff that provides background on the sulfate issue and factors that will need to be evaluated as part of the environmental review and/or permit process. Guidance should also address permitting projects that do not require environmental review. The team should develop procedure documents that will be included in the program manual for the environmental review and the NPDES Permit Writers' Manual. This document will provide background on the sulfate issue and issues that will need to be evaluated as part of the environmental review and/or permit process. These actions should be completed and presented to the WQ Policy Forum for review and approval **by June 29, 2007**. Estimated time commitment – 30 to 40 hours for each team member.

7) If necessary, revise the Illuminated EAW document and NPDES permit application to include background on the sulfate issue and issues that will need to be evaluated as part of the environmental review and NPDES permitting. These actions should be completed **by July 31, 2007.** ER Staff, Permit Staff and EAO staff – 10 hours each.

8) Complete technical review of environmental review submittals and NPDES permit applications. Develop responses to comments on specific projects. **Timeline is project-specific.** Environmental Review, Municipal/Industrial engineers and permit writers lead, and EAO staff support – workload could vary greatly.

9) Review research findings and if necessary incorporate into permitting and environmental review procedures. Sulfate ER/NPDES Permitting staff team (from item 2 above) 10 to 20 hours – **Annually.**

10) Provide technical assistance to permit writers regarding high-risk case-specific monitoring requirements and information protocols for targeted facilities or facility types. – EAO staff **as needed** – 40 to 80 hours per year.

11) Update agency managers on policy development needs, including needs to revise the sulfate standard - Strategy Coordinator **– Annually.**

Attachment A

MPCA Strategy
to Address Indirect Effects of Elevated Sulfate on
Methylmercury Production and Phosphorus Availability

Technical Background

Sulfur naturally cycles in aquatic systems between sulfate and sulfide, depending on multiple factors, including oxygen availability, hydrologic fluctuations, and organic matter degradation. Sulfate is a relatively inert chemical species, but its conversion to sulfide has a number of undesirable indirect effects that this strategy ultimately seeks to minimize. Under certain as-yet undefined environmental conditions, additional sulfate may enhance MeHg production and the availability of P for algal growth. The mechanisms associated with enhanced MeHg production and P availability are different, but are both associated with the tendency during decay of organic matter for natural bacteria to convert sulfate to sulfide after oxygen is depleted. This group of bacteria is called sulfate-reducing bacteria (SRB).

The initial tasks of the strategy involve collecting and interpreting data so that defensible quantitative permitting limits on sulfate discharge can be established. For instance, aquatic systems that are naturally elevated in sulfate due to local geological sources may not be sensitive to moderate increases in sulfate concentration. Other environmental attributes may make some systems more or less sensitive to added sulfate, including existence of wetlands and background dissolved iron concentrations.

Elevated sulfate can enhance MeHg production because SRBs are known to convert inorganic mercury (which is widely available due to atmospheric pollution) to MeHg, the only form that accumulates in fish. When the availability of sulfate controls the activity of SRBs, then additional sulfate may cause additional fish contamination. Recent research (Jeremiason et al. 2006) has documented increased MeHg production through increased sulfate concentrations in a wetland environment. SRBs produce MeHg when certain environmental factors coincide: low oxygen and adequate levels of bioavailable inorganic mercury, sulfate, and decaying organic matter. High organic matter can, of course, cause low oxygen because other bacteria will consume available oxygen in the first phases of organic matter degradation. SRBs are most active in aquatic systems because water decreases atmospheric oxygen availability and maintains a moist environment in which bacteria can thrive. SRB production of MeHg can be constrained by low mercury, low sulfate, low organic matter, or high oxygen. There is also a hypothesis that continued production of sulfide by SRBs can produce negative feedback by reducing mercury availability through the formation of sulfide-mercury chemical bonds. However, it is not clear how to model such negative feedback, and the production of sulfide is not necessarily permanent, as sulfide can oxidize back to sulfate. So, at this point, trying to maintain high sulfide does not seem like a viable strategy. However, data collection will provide empirical information on this hypothesis.

Elevated sulfate can enhance P availability because of an indirect effect of sulfide production. When aquatic systems become anoxic (common in both hypolimnia and wetlands) there is a tendency for enhanced P release from sediment to the water. While anoxic, iron oxides become soluble, which causes the dissolution of phosphate that had co-precipitated with the iron during an oxygenated phase. The phosphate will largely re-precipitate with the iron when the water is oxygenated, unless the iron to phosphate ratio is too low. During anoxia, sulfide may be produced, which has the unfortunate ability to form a precipitate with the dissolved iron—unfortunate because elevated levels of sulfide can decrease the amount of iron that is available to co-precipitate the P. If the P is not precipitated upon oxygenation (either turnover of a lake or hydraulic movement in a wetland), then the additional P will likely stimulate algal growth above the historical range for that waterbody (Caraco et al. 1993).

Both of these indirect effects of elevated sulfate are difficult to model in a quantitative manner. One impediment is that the conversion to sulfide may be downstream from the site of sulfate discharge because the required combination of low oxygen and elevated organic matter may not occur immediately below the discharge. Sulfate conversion may occur when water flows laterally into adjacent wetlands or when the water reaches an impoundment or lake deep enough to have a hypolimnion. Enhanced loading of P and MeHg would occur when the anoxic water mixes back into surface water. This mixing would occur in a lake when the hypolimnion mixes with the epilimnion, and in rivers with lateral wetlands during a falling hydrograph.

Sulfate comes from a variety of sources. Generally, natural background sources result from marine rock and glacial till containing some marine rock such as limestone or shale. Surface water and ground water in the granitic Canadian Shield area is expected to have relatively low sulfate concentrations while waters in other parts of the state are expected to have relatively higher sulfate concentrations. Anthropogenic sources include air deposition (typically less than 1 mg/l) and domestic and industrial wastewater discharges. Wastewater sulfate concentrations can be elevated above surface water concentrations simply because of use of high-sulfate groundwater. In addition, sulfate may be elevated in wastewater by concentration through evaporation, capture of sulfur compounds by air pollution control equipment, or various industrial processes (e.g. lime addition in taconite production).

It is important to minimize the effect of sulfate on MeHg and P because Minnesota's water quality is threatened by these chemicals state-wide. Federal NPDES permitting regulations prohibit the authorization of wastewater discharges that may cause or contribute to water quality impairments. Numerous water bodies in the state are listed as impaired because the MeHg concentrations in fish tissues make the fish unsuitable for frequent human consumption. Similarly, numerous water bodies are impaired because of excess P concentrations.

Treatment technologies for sulfate removal from wastewaters are limited. Reverse osmosis and evaporation are energy intensive and generally considered infeasible. A new treatment technology, submerged packed bed, has shown potential but there is an unevaluated risk of MeHg production within the treatment system. Land application or rapid infiltration basins may be effective but must be evaluated on a case-by-case basis.

While research indicates a strong correlation between sulfate loading and MeHg production in a sulfate-poor wetland, the factors that control MeHg production and P release in other surface waters are not documented. The research results do not, however, tell us how aquatic systems higher in sulfate react to increased sulfate loading. We have not reached a sufficient level of confidence with our understanding of the controlling factors such that firm effluent limitations based on these phenomena can be established. Therefore, a permitting strategy will need regulatory and study/monitoring components to reflect our varying levels of understanding of MeHg production under differing environmental scenarios. MeHg study and control is further complicated by the lack of a standard EPA analytical method and limited commercial laboratories that are prepared to conduct MeHg analyses. EPA has developed Draft Method 1630 (January 2001) for MeHg analyses. The draft method can be found at:

http://www.epa.gov/nerleerd/108Complete.pdf#search=%22mercury%20method%20methyl%20 1630%20site%3Aepa.gov%22
and
http://www.brooksrand.com/FileLib/1630.pdf

MPCA staff have used Frontier Geosciences in Seattle, WA for recent analyses. It is anticipated that the MDH lab, and possibly other labs in Minnesota, would gear-up to run Draft Method 1630 if demand for this work increased.

Notes: [since this note does not seem to be referred to anywhere, perhaps it should be moved up into the text.—otherwise, it is not contributing to the appendix]

1) As a general rule, the order of depletion of electron acceptors during bacterial metabolism in aquatic systems is O_2, NO_3, Fe_2O_3, MnO_2, then SO_4. SRBs are known to produce MeHg and it is thought that iron-reducing bacteria may also methylate mercury under certain conditions. In any given environmental setting, it is not easy to determine which bacteria are dominating degradation of organic matter. To achieve an understanding of biogeochemical mechanisms of the effects of elevated sulfate, it may be desirable to measure a number of parameters, including sulfate, total mercury, MeHg, iron, ortho-P, total P, and supporting parameters such as DOC, pH, oxygen, nitrate, and potassium (for an example of the utility of measuring this suite of parameters, see Balogh et al. 2004). For instance, elevated nitrate or oxidized iron could negate the effect of elevated sulfate because the bacterial community likely finds it energetically advantageous to consume either of those two chemicals as electron acceptors before consuming sulfate. Without information on nitrate and iron, the effect of elevated sulfate may appear to be inexplicably unpredictable. Potassium data may be useful in a different way—elevated potassium can be an indicator of a hydraulic source area in decaying organic matter such as a wetland. When potassium is correlated over time with DOC, MeHg, and P, then the weight of evidence tends toward wetlands as the source area for all of the materials.

Literature Cited:

Balogh, S.J., Y. Nollet, and E.B. Swain. 2004. Redox Chemistry in Minnesota Streams during Episodes of Increased Methylmercury Discharge. Environmental Science & Technology. 38:4921-4927.

Caraco, N.F., J. J. Cole, and G. E. Likens. Sulfate control of phosphorus availability in lakes. Hydrobiologia. 253:275-280.

Jeremiason et al. 2006. Sulfate addition increases methylmercury production in an experimental wetland. Environmental Science & Technology. 40:3800-3806.

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT G

(Jeremiason *et al*., Sulfate Addition Increases Methylmercury Production in an Experimental Wetland, 2006)

Environ. Sci. Technol. **2006**, *40,* 3800−3806

Sulfate Addition Increases Methylmercury Production in an Experimental Wetland

JEFF D. JEREMIASON,*,† DANIEL R. ENGSTROM,‡ EDWARD B. SWAIN,§ EDWARD A. NATER,|| BRIAN M. JOHNSON,⊥ JAMES E. ALMENDINGER,‡ BRUCE A. MONSON,§ AND RANDY K. KOLKA#

Department of Chemistry, Gustavus Adolphus College, Saint Peter, Minnesota 56082, St. Croix Watershed Research Station, Science Museum of Minnesota, Marine on St. Croix, Minnesota 55047, Minnesota Pollution Control Agency, St. Paul, Minnesota, 55155, Department of Soil, Water, and Climate, University of Minnesota, St. Paul, Minnesota, 55108, Department of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, Minnesota, 55108, and North Central Forest Experiment Station, United States Forest Service, Grand Rapids, Minnesota 55744

Atmospheric mercury is the dominant Hg source to fish in northern Minnesota and elsewhere. However, atmospherically derived Hg must be methylated prior to accumulating in fish. Sulfate-reducing bacteria are thought to be the primary methylators of Hg in the environment. Previous laboratory and field mesocosm studies have demonstrated an increase in methylmercury (MeHg) levels in sediment and peatland porewaters following additions of sulfate. In the current ecosystem-scale study, sulfate was added to half of an experimental wetland at the Marcell Experimental Forest located in northeastern Minnesota, increasing annual sulfate load by approximately four times relative to the control half of the wetland. Sulfate was added on four separate occasions during 2002 and delivered via a sprinkler system constructed on the southeast half (1.0 ha) of the S6 experimental wetland. MeHg levels were monitored in porewater and in outflow from the wetland. Prior to the first sulfate addition, MeHg concentrations (filtered, 0.7 μm) were not statistically different between the control (0.47 $\pm$ 0.10 ng L^{-1}, $n = 12$; mean $\pm$ one standard error) and experimental 0.52 $\pm$ 0.05 ng L^{-1}, $n = 18$) halves. Following the first addition in May 2002, MeHg porewater concentrations increased to 1.63 $\pm$ 0.27 ng L^{-1} two weeks after the addition, a 3-fold increase. Subsequent additions in July and September 2002 did not raise porewater MeHg, but the applied sulfate was not observed in porewaters 24 h after addition. MeHg concentrations in outflow from the wetland also increased leading to an estimated 2.4× increase of MeHg flux from the wetland. Our results demonstrate enhanced methylation and increased MeHg concentrations within the wetland and in outflow from the wetland suggesting that decreasing sulfate deposition rates would lower MeHg export from wetlands.

* Corresponding author e-mail: jjeremia@gac.edu.
† Gustavus Adolphus College.
‡ St. Croix Watershed Research Station.
§ Minnesota Pollution Control Agency.
|| Department of Soil, Water, and Climate, University of Minnesota.
⊥ Department of Ecology, Evolution, and Behavior, University of Minnesota.
North Central Forest Experiment Station.

Introduction

Efforts to reduce mercury (Hg) emissions in Minnesota and throughout the rest of the world assume change in atmospheric deposition of Hg will ultimately result in a proportional change of methylmercury (MeHg) concentrations in fish, all other things being constant. Accordingly, it is thought that fish now have mercury concentrations that are 3−4 times greater than natural (preindustrial) levels, because there is strong evidence that atmospheric Hg deposition is currently 3−4 times greater than natural rates (*1*−*6*). However, the proportion of Hg that is methylated and bioaccumulated in fish may not have been constant in some aquatic systems over that time period. Higher than expected Hg concentrations in fish may be the result of increased sulfate deposition to sulfate-poor ecosystems, where sulfate availability controls the activity of the bacteria that methylate Hg. A comparison of museum fish from the 1930s collected from low alkalinity lakes in northern Minnesota and fish collected from the same lakes in the 1980s indicated a 10-fold increase in Hg concentrations (*7*), consistent with the sulfate-enhancement hypothesis.

Hg methylation in natural systems is primarily by sulfate-reducing bacteria in sediments (*8*−*11*) and in wetlands (*12*−*16*), but has also been observed in floating macrophytes and periphyton (*17*). Wetlands, being a major source of MeHg to waters where fish exist (*18*−*21*), represent a critical link between atmospheric Hg deposition and accumulation of MeHg in aquatic food chains. The objective of this study is to determine if enhanced sulfate loads elevate MeHg levels in a sub-boreal *Sphagnum*/conifer wetland. Previous studies conducted in the laboratory and in field microcosms demonstrate a link between increased sulfate reduction rates and enhanced Hg methylation (*8, 12*). In this study, we artificially increased sulfate loads to an experimental wetland to examine the impact of increased sulfate deposition on Hg methylation at the watershed scale.

Material and Methods

Site Description. The United States Department of Agriculture Forest Service Marcell Experimental Forest (MEF; Figure 1) is an 890 ha tract of land located 40 km north of Grand Rapids, Minnesota (47°32′N, 93°28′W). The experimental site, wetland S6, is one of seven small watersheds that have been used for long-term study of forest hydrology and Hg cycling at the MEF (*22*−*26*). Climatic and hydrologic data have been collected continuously at monitoring stations since 1959. Two peatland/upland forest watersheds have been instrumented and studied in detail, including hydrology (*27, 28*), nutrient cycling and behavior (*29, 30*), and release of organic carbon and acidity (*31*). A National Atmospheric Deposition Program (NADP) site has been operating at Marcell since 1978 and the first Mercury Deposition Network (MDN) station began operation at the MEF in 1992 (*32, 33*). Hydrologic monitoring and other related research continues at the MEF.

The landscape of the MEF is typical of morainic landscapes in the western Great Lakes region. The S6 watershed contains an elongate 2.0 ha mature black spruce (*Picea mariana*) and

10.1021/es0524144 CCC: $33.50
© 2006 American Chemical Society
Published on Web 05/10/2006

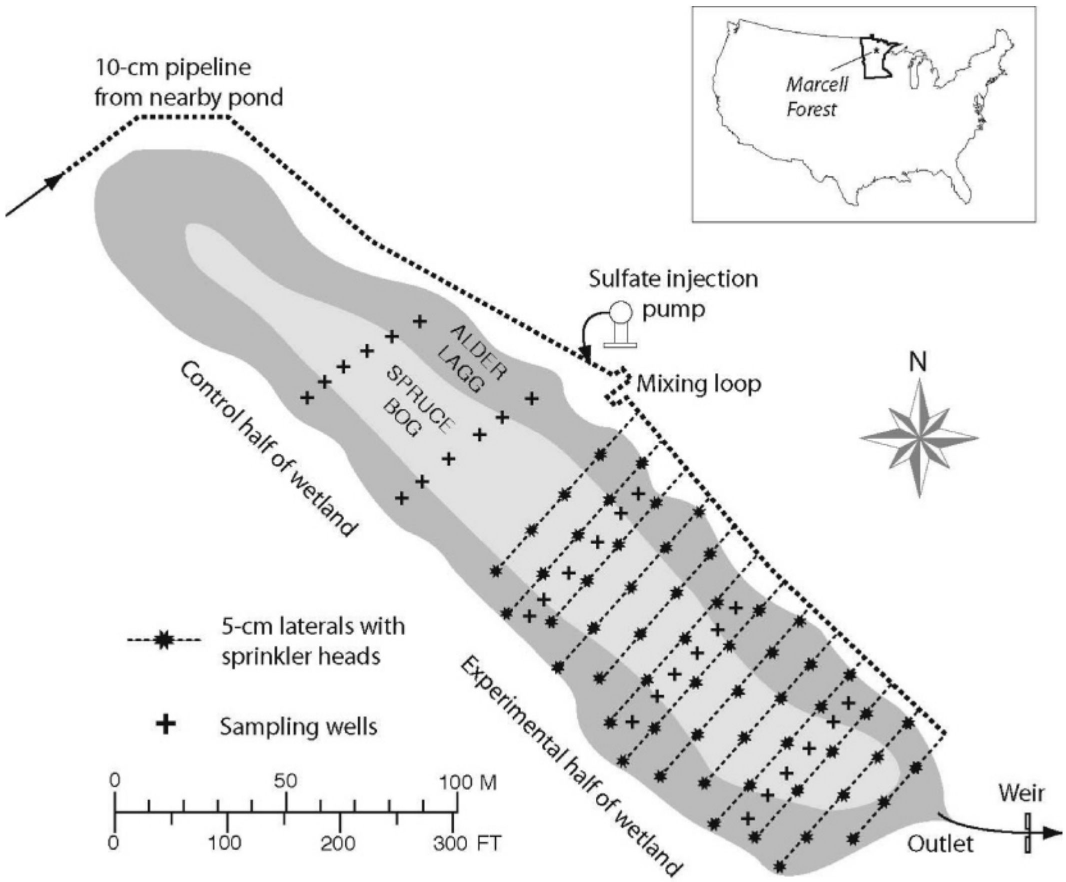


FIGURE 1. The S6 wetland in the Marcell Experimental Forest, northern Minnesota. The irrigation system consists of ~360 m of 10-cm diameter PVC pipe running adjacent to the north side of the S6 wetland. From this main line, thirteen 5-cm diameter laterals, spaced 14 m apart, extend across the experimental half of the wetland. Adjustable sprinkler heads spaced at 16-m intervals along each lateral operate with a spray radius of approximately 8−9 m and rotate on 0.6-m vertical risers. Wells for sampling peat pore waters are arrayed along five transects, each consisting of two lagg wells, two bog wells, and two "transition" wells between the bog and the lagg.

tamarack (*Larix laricina*) wetland. The S6 wetland (Figure 1) is characterized by an alder (*Alnus rugosa*) lagg (a zone of higher pH at the contact with mineral-soil uplands) encircling the slightly raised spruce/*Sphagnum* bog. Outflow from the S6 watershed (pH = 4.9 ± 0.7) has been monitored with a 120° V-notch weir since 1964 (*34*). The 6.9 ha upland was clear-cut in 1980 to convert the upland from predominantly aspen (*Populus tremula*) to white spruce (*Picea glauca*) and red pine (*Pinus resinosa*).

Sulfate Additions. Sulfate was added to the experimental half of the S6 wetland in five simulated rainfall events (6−10 mm) from November 2001 through October 2002 by means of a PVC irrigation system (*35*) constructed in 2001 (Figure 1). The system consists of ~360 m of 10-cm diameter PVC pipe running adjacent to the north side of the wetland. From this main line, thirteen 5-cm diameter laterals, spaced 14 m apart, extend across the experimental half of the wetland. Adjustable sprinkler heads spaced at 16 m intervals along each lateral operate with a spray radius of approximately 8−9 m and rotate on 0.6 m risers. Valves installed on each lateral allowed flow rates to be maintained to operate sprinkler heads at the desired radius. The PVC pipes were glued together at most joints, but flexible hosing at several joints allows for temperature contraction and expansion. Source water for the system was drawn from a dilute (conductivity ~10 μS cm^{-1}), low mercury (<1 ng L^{-1}), rain-fed pond, and a concentrated sodium sulfate solution was injected into the main line resulting in sulfate concentrations in the irrigation water of ~200 mg L^{-1}. A mixing loop after the injection point ensured a homogeneous sulfate solution. When the desired amount of sulfate had been added, a 1-mm rainfall equivalent cleared the lines and "washed" the sulfate off plant surfaces and into the peat porewaters. The 2002 sulfate load delivered by the irrigation system was 32 kg ha^{-1}, equivalent to approximately four times current annual atmospheric deposition and similar to atmospheric sulfate deposition in the northeastern United States (*32, 33*). The sulfate load was seasonally distributed based on historical sulfate deposition rates. Lithium bromide was used as a hydrologic tracer, but it appears to be nonconservative, and was not as useful as hoped.

Field Sampling. Filtered water samples were collected from 30 peat wells 1 day prior to, and 1, 3, 5, 7, 14, 28, and 56 days following, each sulfate addition. The wells were situated along 5 transects designated as experimental (ET1, ET2, and ET3) or control (CT2 and CT3). Each transect consisted of 6 wells: 2 lagg wells (one each in the N and S laggs), 2 bog wells, and 2 transition wells. The bog wells were located in the raised black spruce area of the wetland, the lagg wells were in the alder lagg, and the transition wells were located between the lagg and raised bog portions of the wetland. Unfiltered samples were collected at the S6 and nearby S7a outlet weirs every two weeks and whenever peat well sampling occurred. All mercury samples were collected in acid-cleaned 125 mL Teflon bottles using established protocols (*24*). Peat wells were designed to integrate peat porewater from the surface of the water table down to about 25 cm and by design collected porewater from depths corresponding to greatest hydraulic conductivity. Peat wells consisted of acid-cleaned 5-cm diameter PVC pipes cut to a length of 45 cm and driven approximately 35 cm into the peat. Approximately 40 holes (0.65-cm diameter) were drilled into the wells to allow porewater to flow freely. A 2.5-cm diameter, finely slotted, acid-cleaned PVC Geoprobe screen, capped on the bottom, was inserted into each well and wells were capped between samplings. Samples were drawn from inside the Geoprobe screen with a hand pump and filtered through 0.7 μm ashed glass fiber filters. Field duplicates and blanks constituted approximately 20% of all samples collected. Experimental results from the November 2001 and October 2002 additions are not presented in this paper because many of the sample wells froze shortly after sulfate additions. Outflows from sampled watersheds were measured at 120° V-notch weirs with individually calibrated stage–discharge relations and hourly stage readings (S7a) or a continuous strip-chart recorder (S6).

Laboratory Methods. Accepted clean methods were utilized throughout the collection and analysis of mercury and methylmercury samples. Samples analyzed for total mercury were first oxidized with 0.2 N bromine monochloride, neutralized with hydroxylamine, and then analyzed using the stannous chloride/cold vapor atomic fluorescence spectroscopic (CVAFS) method (*24, 36*). Analysis of MeHg was performed using the aqueous distillation/CVAFS method (*37, 38*). Briefly, following distillation, water samples were ethylated with sodium tetraethylborate, purged with nitrogen and collected on Tenax TA (Alltech 60–80 mesh) traps. Hg species were thermally desorbed from the Tenax in an argon stream and separated on an OV-1 chromatographic column, converted to elemental mercury in a pyrolytic column, and analyzed on a Tekran 2400 CVAFS. Lab duplicates and performance standards were routinely analyzed as part of the quality assurance plan. Sulfate and other anions were measured by ion chromatography (Dionex ICS 2000), while cations were measured with ICP-MS (Thermalelectric PQ ExCell).

Results and Discussion

Porewater MeHg Concentrations. Dramatic increases in porewater MeHg concentrations were observed following the May 22, 2002 sulfate addition (Figure 2a). One day prior to the addition (Day −1), MeHg levels in the peat porewaters were not significantly different ($p = 0.62$) in the control (0.47 ± 0.10 ng L^{-1}, $n = 12$; mean ± one standard error) versus the experimental (0.52 ± 0.05 ng L^{-1}, $n = 18$) half of the wetland (Figure 2a). In the period between the May and July additions, MeHg porewater levels in the experimental half increased and remained elevated, while the control half exhibited no statistically significant change relative to Day −1. All MeHg concentrations in the experimental half were statistically higher than those of Day −1 at $p < 0.05$ except for Day 56 ($p = 0.13$). Porewater MeHg levels in the experimental half were also higher than the control half at $p < 0.05$ except for Day 1 ($p = 0.06$), demonstrating that the sulfate addition elevated MeHg levels after the May addition and, relative to the control half, maintained them for an extended period of time. Total Hg levels were similar between the experimental and control halves at this time; however, the fraction of total Hg occurring as MeHg increased after the May sulfate addition and remained elevated (Figure 2b). In addition, other water chemistry parameters (cations, anions, pH, and DOC) unimpacted by the sulfate addition behaved similarly between the experimental and control halves.

Changes in MeHg levels in the experimental half were inversely related to sulfate concentration in the peat porewaters in the first four sampling dates following the May addition (Figure 2a). Sulfate levels were undetectable at Day −1 in both the control and experimental halves. Following the May addition the average sulfate concentration increased to 1.09 ± 0.33 mg L^{-1} ($n = 18$) at Day 1 in the experimental half of the wetland and remained undetectable in the control half. As the sulfate reducing bacteria utilized the added sulfate, levels began to drop gradually, until sulfate was undetectable again on June 5 (Day 14) and porewater MeHg concentrations were at a local maximum, 1.63 ± 0.27 ng L^{-1} ($n = 18$). Following June 5 and prior to the July addition, sulfate levels across the wetland were detectable, but lower in the control half, although not statistically ($p > 0.05$). The average sulfate concentration in the control during 2002 was 0.02 ± 0.01 mg L^{-1}.

MeHg levels decreased after the June 5 maximum, but not back to the pre-addition levels. Net methylation (methylation − demethylation) was apparently enhanced in the experimental half of the wetland by the addition of sulfate. Two possible mechanisms for sustaining the elevated MeHg concentrations include the creation of a larger biologically available sulfur pool (*14, 39, 40*) or an increase in sulfate-reducing bacteria that methylate mercury.

The current study employed a large number of sampling wells collecting depth-integrated porewaters dispersed over a large area (2.0 ha). The large scale and experimental design makes it difficult to compare to other studies. However, similar studies done at smaller scales and at specific depth intervals were conducted in the Experimental Lakes Area (ELA), Canada (*12*) and in Degero Stomyr in northern Sweden (*14*). In the current study, MeHg porewater concentrations increased by a factor of 3 (from 0.52 ± 0.05 ng L^{-1} to 1.63 ± 0.27 ng L^{-1}) two weeks after a 4× increase in sulfate load (Figure 2a). Branfireun et al. (*12*) reported MeHg increases of up to 10× following a 20× increase in sulfate load to an experimental mesocosm (0.16 m^2) in a poor fen peatland at ELA. A 2× increase in sulfate load at the ELA study site resulted in a 3–4-fold increase in MeHg levels (*12*). The ELA study was conducted over 5 days and in most cases MeHg in the porewaters returned to pre-addition levels. The study in Sweden (*14*) examined MeHg in porewaters from sedge peatland microcosms (4 m^2) dosed with sulfate for three years. A MeHg increase of approximately 5× was reported in the mesocosm receiving an ~7× increase in sulfate load.

Rain events influence MeHg levels in S6 not only by supplying sulfate, nutrients, and mercury, but also by transporting added sulfate within the wetland or flushing it from the wetland. The first rainfall after the spring addition—12 mm on May 28 and 17 mm on May 29—was not substantial enough to flush the added sulfate from the wetland. Indeed, the estimated sulfate load transported from the wetland was only 0.36 kg from May 21–June 5 compared to the added sulfate of 14.3 kg. An extremely large rain event (208 mm) occurred on June 22–24, preceded by a smaller event (36 mm) on June 18–19, resulting in record flows from S6 (Figure 3b). The amount of sulfate transported from the wetland at this time was 4.3 kg, still a relatively small amount compared to what was added. Despite this extreme hydrologic event, MeHg in the porewaters of the experimental half of the wetland exceeded those in the controls.

Contrary to expectations from the May sulfate application, MeHg concentrations did not increase in peat porewaters following the July and initially after the September sulfate additions (Figure 2). Moreover, there was no observed increase in porewater sulfate in the experimental peat wells, even 1 day after the applications. However, MeHg concentrations remained elevated in the experimental half relative to the control until late September. The most likely explanation for this seasonal contrast is temperature, which plays a key role in controlling sulfate reduction and methylation/demethylation rates. At the time of the May addition peat temperatures (as measured at the nearby S2 wetland, 0.4 km away), were still quite cool (4.5 °C at 5 cm), the bog having thawed only weeks before, and the added sulfate persisted for two weeks and changes in MeHg were observed. Peat temperatures increased slowly to above 16 °C by the time of the July addition and were still at 15 °C for the third addition

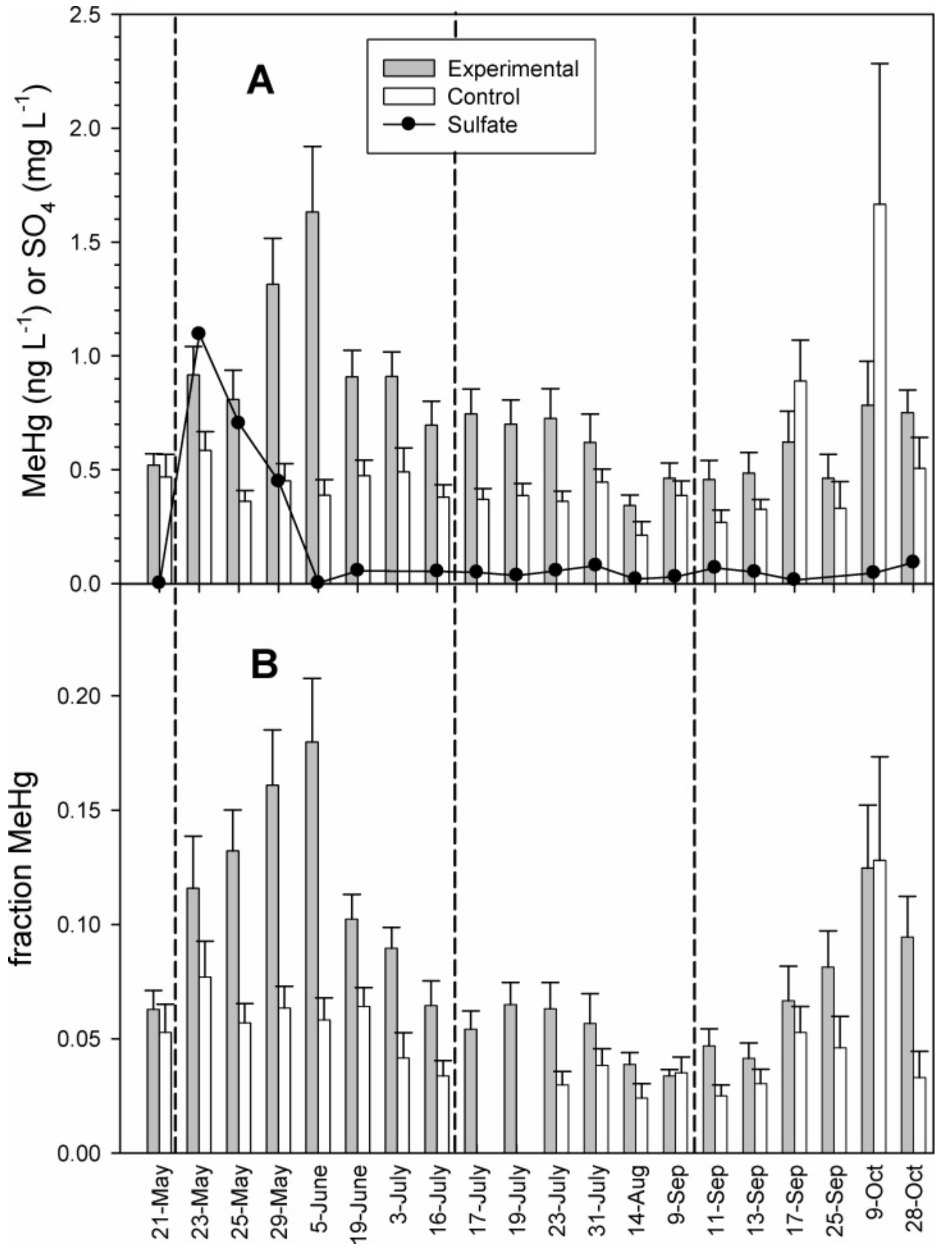


FIGURE 2. (A) MeHg concentrations (±1 standard error) in pore waters from control and experimental peat wells and sulfate concentrations in experimental peat wells only; sulfate was generally below detection (<0.01 mg L^{-1}) in the control wells. Each dotted line represents a sulfate application. (B) The fraction of total Hg existing as MeHg in control and experimental peat wells.

in early September. The warm late-summer peat temperatures likely led to very high sulfate reduction rates such that much of the added sulfate may have been consumed within 24 h (the first sampling day) following the July and September applications. Some of the sulfate may have also been entrained in the more abundant vegetation during the summer additions.

A subsequent decrease in peat temperature and outflow in late September/early October coincided with more variable MeHg concentrations and the control half actually exceeding MeHg levels in the experimental half on a few days, but these differences are not statistically significant (Figure 2). Currently, we cannot explain these observations, but they appear independent of the sulfate addition. The limited MeHg results from after the October 2002 addition (not presented because of extensive well freeze-up) were also highly variable and may be related to decreases in temperature. A few of these samples had MeHg concentrations exceeding 10 ng L^{-1}, however they could not be independently verified by additional late season field collections. Decreased temperatures might have contributed to the increase in MeHg concentrations, but other factors including Hg deposition through litterfall or possibly organic matter oxidation owing to late-season water-level fluctuations could have played a role. Litterfall, which begins in mid-September, is an important component of the total Hg flux to the Marcell wetlands, contributing nearly twice the Hg delivered by wet deposition alone (*41, 42*). Water level in the wetland was decreasing at this time creating relatively stagnant conditions. Flow from S6 decreased substantially in September 2002 with only a few small rain events (Figure 3b). With the decline in water level, labile organic matter in the surface peat may have been oxidized releasing bound mercury as well as sulfate to the dissolved phase.

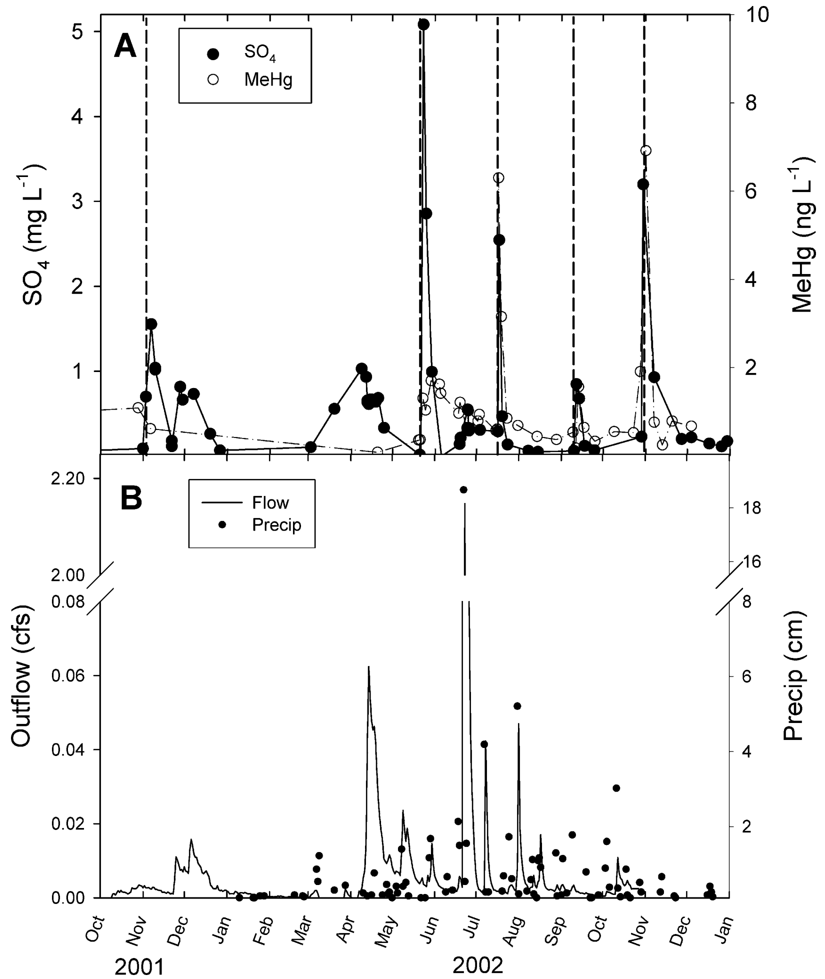


FIGURE 3. (A) MeHg and sulfate concentrations in the outflow from the S6 wetland. (B) Hydrologic outflow and precipitation events at S6. Flows were measured by chart recorder at the S6 weir (in operation since 1964), and precipitation was measured with a rain gauge located near the west end of the S6 wetland.

MeHg Export from S6. MeHg and sulfate concentrations increased at the S6 weir following each sulfate addition (Figure 3a), although the timing of the increases varied over the course of the experiment. Elevated concentrations observed at the weir after the July and September additions are in contrast to the peat wells where increases in sulfate or MeHg were not observed (but MeHg remained elevated relative to the control). Higher sulfate concentrations persisted at the weir following the May and late October additions, consistent with the peat well trends. A small pool impounded behind the weir likely contributed to these trends. Although sulfate was not added directly to the pool, some sulfate flowed into it within hours of each addition, increasing sulfate concentrations. Sulfate levels at the weir then declined over time as the pool was flushed by additional sulfate-depleted water from the wetland. For example, in May the flushing rate, k_f, of the weir pool was 1.37 d^{-1}, (k_f = flow/volume). The observed first-order loss of sulfate from the pool, k_{obs} (0.27 d^{-1}), from Day 1 to Day 7 was significantly less than k_f indicating a substantial flow of sulfate from the wetland to the weir pool. Sulfate levels in the peat porewaters were elevated at this time (Figure 3). In contrast, pool flushing rates following the July (0.48 d^{-1}) and September (0.33 d^{-1}) additions, were similar to k_{obs} for July (0.59 d^{-1}) and September (0.37 d^{-1}) suggesting that a pulse of sulfate was introduced to the weir pool within hours after these additions and then simply flushed out. Presumably due to high sulfate reduction rates or the sulfate never reaching the water table, sulfate in peat porewaters was insignificant during July and September and thus outflow of sulfate from the wetland to the pool was insignificant at this time. Water chemistry samples were not taken frequently enough following the October 2002 addition to calculate k_{obs} accurately.

MeHg trends at the weir closely track those for sulfate (Figure 3a). Following the May addition, MeHg concentration gradually increased at the weir, similar to the peat porewaters (Figure 2). The concentrations at the weir and in the peat porewaters were also similar at this time indicating that the peat porewaters were supplying the MeHg flowing over the weir. However, following the July and September additions, MeHg concentrations at the weir spiked immediately after each addition and the weir concentrations exceeded peat porewater concentrations. It is not clear if these spikes were due to high levels of MeHg flowing from the wetland or MeHg formation in the weir pool itself. However, based on the flushing rate of the pool, it appears that the dominant loss process for sulfate was flushing and that sulfate reduction in the weir pool was negligible.

Empirically modeled MeHg export from S6 without sulfate addition was compared to measured MeHg export in 2002. The observed daily MeHg export exceeded the predicted MeHg export during periods immediately following sulfate additions. To model MeHg export from S6 in the absence of sulfate additions, data from 2001 (prior to the 2002 sulfate additions to S6) showed a strong correlation between flows at the S6 weir and a nearby wetland weir, S7a (r^2 = 0.71).

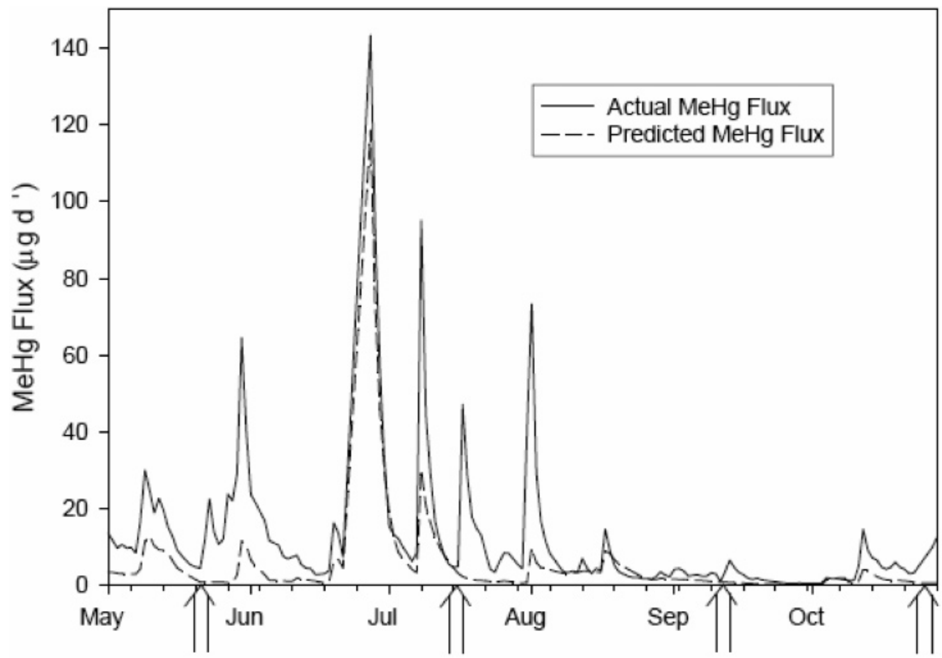


FIGURE 4. Actual and predicted fluxes of MeHg from the S6 wetland for 2002. The predicted flux is that which would have occurred in the absence of sulfate addition and is based on a correlation of 2001 (pretreatment) MeHg fluxes from S6 with those from a nearby reference wetland, S7a (see text). Arrows indicate experimental sulfate applications.

Furthermore, MeHg export from S7a was correlated to MeHg export from S6 in 2001

$$\log \mathrm{Flux}_{S6} = 1.23 \times \log \mathrm{Flux}_{S7a} - 1.62 \; (r^2 = 0.77 \text{ in } 2001) \quad (1)$$

where Flux_{S6} (μg d^{-1}) is the measured MeHg flux out of wetland S6 and Flux_{S7a} (μg d^{-1}) is the measured flux out of wetland S7a. Flux_{S6} and Flux_{S7a} are daily fluxes determined from average daily flows measured at the weirs and MeHg concentrations interpolated between sampling dates (see Supporting Information). In 2001, the weirs were sampled biweekly and in 2002 additional samples were collected from the weir at S6 corresponding to each porewater sampling date. Using eq 1, the MeHg flux for May though October 2002 that would have come from S6 in the absence of sulfate addition was estimated and compared to the actual flux (Figure 4). Excluding the high flow values from the June 22−24 storm event and the unusually high MeHg concentration observed the day after the October 2002 addition (including these values yields an even greater enhancement), the MeHg flux observed in 2002 (1780 μg MeHg) was more than two times greater (144%) than would have occurred without sulfate addition (730 μg MeHg).

In this study, enhanced MeHg concentrations were observed in the experimental peat porewaters and in the flow from the S6 wetland following sulfate addition. Enhanced MeHg concentrations were not observed in peat porewaters following the July and September additions, but the added sulfate did not increase porewater sulfate concentrations due to either rapid sulfate utilization or entrainment in overlying vegetation. Not all MeHg and sulfate trends observed can be readily explained in this initial year of sulfate addition, but sulfate addition enhanced MeHg concentrations in most cases, despite the fact that our addition of sulfur was negligible relative to the sulfur pool in the upper 30 cm of peat. At no point in the study were there any indications that the sulfate load decreased methylation as has been observed in the past in lake enclosures (*43*). The most likely explanation for these observations is that biologically available sulfur is a limiting factor in this system for the methylating bacteria. The addition of the limiting factor, sulfate, increased MeHg levels and may have increased the biologically active sulfur pool in S6. One possible implication of this study is that historic increases in atmospheric sulfate deposition (now on the decline) may have enhanced contemporary MeHg production and export from wetlands, contributing to widespread mercury contamination of aquatic food chains. It follows that decreases in sulfate deposition could result in less export of MeHg from wetlands and possibly result in lower MeHg levels in fish.

Acknowledgments

This research was funded by the U.S. EPA Science to Achieve Results (STAR) Program, Grant R827630. We gratefully acknowledge the assistance of Deacon Kyllander and Art Elling of the U.S. Forest Service for assistance with sample collection and weir-flow monitoring. We thank Daniel Helwig for experimental design assistance, planning, and support. We also thank the Minnesota Department of Natural Resources for equipment usage and those who helped construct the irrigation system: Neal Hines, Kelly O'Hara, Paul Hoff, Howard Markus, and Harold Wiegner.

Supporting Information Available

Additional plots and further information on methods related to eq 1 and Figure 4 used to estimate enhanced export of MeHg from the S6 wetland. This material is available free of charge via the Internet at http://pubs.acs.org.

Literature Cited

(1) Engstrom, D. R.; Swain, E. B. Recent declines in atmospheric mercury deposition in the Upper Midwest. *Environ. Sci. Technol.* **1997**, *31*, 960−967.
(2) Swain, E. B.; Engstrom, D. R.; Brigham, M. E.; Henning, T. A.; Brezonik, P. L. Increasing rates of atmospheric mercury deposition in midcontinental North America. *Science* **1992**, *257*, 784−787.
(3) Benoit, J. M.; Fitzgerald, W. F.; Damman, A. W. H. The biogeochemistry of an ombrotrophic bog: Evaluation of use as an archive of atmospheric mercury deposition. *Environ. Res.* **1998**, *78*, 118−133.
(4) Schuster, P. F.; Krabbenhoft, D. P.; Naftz, D. L.; Cecil, L. D.; Olson, M. L.; Dewild, J. F.; Susong, D. D.; Green, J. R.; Abbott,

M. L. Atmospheric mercury deposition during the last 270 years: A glacial ice core record of natural and anthropogenic sources. *Environ. Sci. Technol.* **2002**, *36*, 2303−2310.
(5) Lamborg, C. H.; Fitzgerald, W. F.; O'Donnell, J.; Torgersen, T. A non-steady-state compartmental model of global-scale mercury biogeochemistry with interhemispheric atmospheric gradients. *Geochim. Cosmochim. Acta* **2002**, *66*, 1105−1118.
(6) Lamborg, C. H.; Fitzgerald, W. F.; Damman, A. W. H.; Benoit, J. M.; Balcom, P. H.; Engstrom, D. R. Modern and historic atmospheric mercury fluxes in both hemispheres: global and regional mercury cycling implications. *Global Biogeochem. Cycles* **2002**, *16*, 1104.
(7) Swain, E. B.; Helwig, D. D. Mercury in fish from northeastern Minnesota lakes: historical trends, environmental correlates, and potential sources. *J. Minn. Acad. Sci.* **1989**, *55*, 103−109.
(8) Gilmour, C.; Henry, E.; Mitchell, R. Sulfate stimulation of mercury methylation in freshwater sediments. *Environ. Sci. Technol.* **1992**, *26*, 2281−2287.
(9) King, J. K.; Saunders, F. M.; Lee, R. F.; Jahnke, R. A. Coupling mercury methylation rates to sulfate reduction rates in marine sediments. *Environ. Toxicol. Chem.* **1999**, *18*, 1362−1369.
(10) Warner, K. A.; Roden, E. E.; Bonzongo, J. C. Microbial mercury transformation in anoxic freshwater sediments under iron-reducing and other electron-accepting conditions. *Environ. Sci. Technol.* **2003**, *37*, 2159−2165.
(11) Hammerschmidt, C. R.; Fitzgerald, W. F. Geochemical controls on the production and distribution of methylmercury in near-shore marine sediments. *Environ. Sci. Technol.* **2004**, *38*, 1487−1495.
(12) Branfireun, B. A.; Roulet, N. T.; Kelly, C. A.; Rudd, J. W. M. In situ sulphate stimulation of mercury methylation in a boreal peatland: toward a link between acid rain and methylmercury contamination in remote environments. *Global Biogeochem. Cycles* **1999**, *13*, 743−750.
(13) Heyes, A.; Moore, T. R.; Rudd, J. W. M.; Dugoua, J. J. Methyl mercury in pristine and impounded boreal peatlands, experimental Lakes Area, Ontario. *Can. J. Fish. Aquat. Sci.* **2000**, *57*, 2211−2222.
(14) Branfireun, B. A.; Bishop, K.; Roulet, N. T.; Granberg, G.; Nilsson, M. Mercury cycling in boreal ecosystems: The long-term effect of acid rain constituents on peatland pore water methylmercury concentrations. *Geophys. Res. Lett.* **2001**, *28*, 1227−1230.
(15) King, J. K.; Harmon, S. M.; Fu, T. T.; Gladden, J. B. Mercury removal, methylmercury formation, and sulfate-reducing bacteria profiles in wetland mesocosms. *Chemosphere* **2002**, *46*, 859−870.
(16) Harmon, S. M.; King, J. K.; Gladden, J. B.; Chandler, G. T.; Newman, L. A. Methylmercury formation in a wetland mesocosm amended with sulfate. *Environ. Sci. Technol.* **2004**, *38*, 650−656.
(17) Mauro, J. B. N.; Guimaraes, J. R. D.; Hintelmann, H.; Watras, C. J.; Haack, E. A.; Coelho-Souza, S. A. Mercury methylation in macrophytes, periphyton, and water − comparative studies with stable and radio-mercury additions. *Anal. Bioanal. Chem.* **2002**, *374*, 983−989.
(18) St. Louis, V.; Rudd, J.; Kelly, C.; Beaty, K.; Bloom, N.; Flett, R. Importance of wetlands as sources of methylmercury to boreal forest ecosystems. *Can. J. Fish. Aquat. Sci.* **1994**, *51*, 1065−1076.
(19) St. Louis, V.; Rudd, J.; Kelly, C.; Beaty, K.; Flett, R.; Roulet, N. T. Production and loss of methylmercury and loss of total mercury from boreal forest catchments containing different types of wetlands. *Environ. Sci. Technol.* **1996**, *30*, 2719−2729.
(20) Krabbenhoft, D.; Benoit, J.; Babiarz, C.; Hurley, J.; Andren, A. Mercury Cycling in the Allequash Creek Watershed, Northern Wisconsin. *Water Air Soil Pollut.* **1995**, *80*, 425−433.
(21) Hurley, J. P.; Benoit, J. M.; Babiarz, C. L.; Shafer, M. M.; Andren, A. W.; Sullivan, J. R.; Hammond, R.; Webb, D. A. Influences of watershed characteristics on mercury levels in Wisconsin rivers. *Environ. Sci. Technol.* **1995**, *29*, 1867−1875.
(22) Kolka, R. K.; Grigal, D. F.; Nater, E. A.; Verry, E. S. Hydrologic cycling of mercury and organic carbon in a forested upland-bog watershed. *Soil Sci. Soc. Am. J.* **2001**, *65*, 897−905.
(23) Grigal, D. F.; Kolka, R. K.; Fleck, J. A.; Nater, E. A. Mercury budget of an upland-peatland watershed. *Biogeochemistry* **2000**, *50*, 95−109.
(24) Kolka, R. K.; Nater, E. A.; Grigal, D. F.; Verry, E. S. Atmospheric inputs of mercury and organic carbon into a forested upland bog watershed. *Water Air Soil Pollut.* **1999**, *113*, 273−294.
(25) Kolka, R. K.; Grigal, D. F.; Verry, E. S.; Nater, E. A. Mercury and organic carbon relationships in streams draining forested upland peatland watersheds. *J. Environ. Qual.* **1999**, *28*, 766−775.
(26) Fleck, J. A.; Grigal, D. F.; Nater, E. A. Mercury uptake by trees: An observational experiment. *Water Air Soil Pollut.* **1999**, *115*, 513−523.
(27) Boelter, D. H.; Verry, E. S. *Peatland and Water in the Northern Lake States*; U.S. Department of Agriculture: St. Paul, MN, 1977.
(28) Nichols, D. S.; Brown, J. M. Evaporation from a sphagnum moss surface. *J. Hydrol.* **1980**, *48*, 289−302.
(29) Verry, E. S.; Timmons, D. R. Waterborne nutrient flow through an upland-peatland watershed in Minnesota. *Ecology* **1982**, *63*, 1456−1467.
(30) Grigal, D. F. Elemental dynamics in forested bogs in northern Minnesota. *Can. J. Bot.* **1991**, *69*, 539−546.
(31) Urban, N. R.; Bayley, S. E.; Eisenreich, S. J. Export of dissolved organic carbon and acidity from peatlands. *Water Resour. Res.* **1989**, *25*, 1619−1628.
(32) Mercury Deposition Network. http://nadp.sws.uiuc.edu/mdn/.
(33) National Atmospheric Deposition Network. http://nadp.sws.uiuc.edu.
(34) Nichols, D. S.; Verry, E. S. Stream flow and ground water recharge from small forested watersheds in north central Minnesota. *J. Hydrol.* **1991**, *245*, 89−103.
(35) Beaty, K. G. *An Irrigation System and Hydrological Network for a Wetland Acidification Project*; Canada Department of Fisheries and Oceans: Ottawa, ON, 1987.
(36) Bloom, N.; Fitzgerald, W. Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold-vapour atomic fluorescence detection. *Anal. Chim. Acta* **1988**, *208*, 151−161.
(37) Bloom, N. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas chromatography with cold vapour atomic fluorescence detection. *Can. J. Fish. Aquat. Sci.* **1989**, *46*, 1131−1140.
(38) Horvat, M.; Bloom, N.; Liang, L. Comparison of distillation with other current isolation methods for the determination of methyl mercury compounds in low level environmental samples. 1. Sediments. *Anal. Chim. Acta* **1993**, *281*, 135−152.
(39) Gilmour, C.; Riedel, G.; Ederington, M.; Bell, J.; Benoit, J.; Gill, G.; Stordal, M. Methylmercury concentrations and production rates across a trophic gradient in the northern Everglades. *Biogeochemistry* **1998**, *40*, 327−345.
(40) Benoit, J. M.; Gilmour, C. C.; Mason, R. P.; Heyes, A. Sulfide controls on mercury speciation and bioavailability in sediment pore waters. *Environ. Sci. Technol.* **1999**, *33*, 951−957.
(41) St. Louis, V. L.; Rudd, J. W. M.; Kelly, C. A.; Hall, B. D.; Rolfhus, K. R.; Scott, K. J.; Lindberg, S. E.; Dong, W. Importance of the forest canopy to fluxes of methyl mercury and total mercury to boreal ecosystems. *Environ. Sci. Technol.* **2001**, *35*, 3089−3098.
(42) Balogh, S. J.; Huang, Y. B.; Offerman, H. J.; Meyer, M. L.; Johnson, D. K. Episodes of elevated methylmercury concentrations in prairie streams. *Environ. Sci. Technol.* **2002**, *36*, 1665−1670.
(43) Winfrey, M. R.; Rudd, J. W. M. Environmental factors affecting the formation of methylmercury in low pH lakes. *Environ. Toxicol. Chem.* **1990**, *9*, 853−869.

Received for review November 30, 2005. Revised manuscript received March 29, 2006. Accepted April 6, 2006.

ES0524144

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT H

(MPCA Impaired Waters List for Mercury in the Water Column and Mercury in Fish Tissue, 2022)

MPCA Section 303(d) Impaired Waters List (2022)
Mercury Impairments

Water body name	Water body description	Water body type	Year added to List	Basin	AUID	Use Class	County	HUC 8	Watershed name	Partial tribal designation	Affected designated use	Pollutant or stressor
Cedar River	Rose Cr to Woodbury Cr	Stream	1998	Cedar River	07080201-501	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Roberts Cr to Upper Austin Dam	Stream	1998	Cedar River	07080201-502	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Headwaters to Roberts Cr	Stream	1998	Cedar River	07080201-503	2Bg	Dodge	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Upper Austin Dam to Wolf Cr	Stream	1998	Cedar River	07080201-511	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Wolf Cr to Lower Austin Dam	Stream	1998	Cedar River	07080201-512	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Lower Austin Dam to Dobbins Cr	Stream	1998	Cedar River	07080201-513	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Dobbins Cr to Turtle Cr	Stream	1998	Cedar River	07080201-514	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Turtle Cr to Rose Cr	Stream	1998	Cedar River	07080201-515	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Cedar River	Woodbury Cr to MN/IA border	Stream	1998	Cedar River	07080201-516	2Bg	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
East Side	Lake or Reservoir	Lake	1998	Cedar River	50-0002-00	2B	Mower	07080201	Cedar River		Aquatic Consumption	Mercury in fish tissue
Fountain (East Bay)	Lake or Reservoir	Lake	2012	Cedar River	24-0018-01	2B	Freeborn	07080202	Shell Rock River		Aquatic Consumption	Mercury in fish tissue
Fountain (North Bay)	Lake or Reservoir	Lake	2012	Cedar River	24-0018-03	2B	Freeborn	07080202	Shell Rock River		Aquatic Consumption	Mercury in fish tissue
Fountain (West Bay)	Lake or Reservoir	Lake	2012	Cedar River	24-0018-02	2B	Freeborn	07080202	Shell Rock River		Aquatic Consumption	Mercury in fish tissue
Pickeral	Lake or Reservoir	Lake	2016	Cedar River	24-0025-00	2B	Freeborn	07080202	Shell Rock River		Aquatic Consumption	Mercury in fish tissue
Shell Rock River	Albert Lea Lk to Goose Cr	Stream	2022	Cedar River	07080202-501	2Bg	Freeborn	07080202	Shell Rock River		Aquatic Consumption	Mercury in fish tissue
Des Moines River	Jackson Dam to JD 66	Stream	2016	Des Moines River	07100001-541	2Bg	Jackson	07100001	Des Moines River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Des Moines River	JD 66 to MN/IA border	Stream	2016	Des Moines River	07100002-501	2Bg	Jackson	07100002	Lower Des Moines River		Aquatic Consumption	Mercury in fish tissue
Alder	Lake or Reservoir	Lake	1998	Lake Superior	16-0114-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Alton	Lake or Reservoir	Lake	1998	Lake Superior	16-0622-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Aspen	Lake or Reservoir	Lake	1998	Lake Superior	16-0204-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Balsam	Lake or Reservoir	Lake	2002	Lake Superior	38-0245-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Barker	Lake or Reservoir	Lake	1998	Lake Superior	16-0358-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	2002	Lake Superior	69-0553-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Bassett	Lake or Reservoir	Lake	1998	Lake Superior	69-0041-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Bearskin	Lake or Reservoir	Lake	1998	Lake Superior	16-0228-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Beauty	Lake or Reservoir	Lake	1998	Lake Superior	31-0028-00	2B	Itasca	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Benson	Lake or Reservoir	Lake	1998	Lake Superior	38-0018-00	1B, 2A	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Bouder	Lake or Reservoir	Lake	2010	Lake Superior	16-0383-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Boulder	Lake or Reservoir	Lake	1998	Lake Superior	69-0373-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Brule	Lake or Reservoir	Lake	1998	Lake Superior	16-0348-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Cadotte	Lake or Reservoir	Lake	1998	Lake Superior	69-0114-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Caribou	Lake or Reservoir	Lake	1998	Lake Superior	16-0360-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Caribou	Lake or Reservoir	Lake	2010	Lake Superior	69-0489-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Carrot	Lake or Reservoir	Lake	1998	Lake Superior	16-0071-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Cascade	Lake or Reservoir	Lake	1998	Lake Superior	16-0346-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Chester	Lake or Reservoir	Lake	1998	Lake Superior	16-0033-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Christine	Lake or Reservoir	Lake	1998	Lake Superior	16-0373-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Chub	Lake or Reservoir	Lake	2010	Lake Superior	09-0008-00	2B	Carlton	04010301	Nemadji River		Aquatic Consumption	Mercury in fish tissue
Clara	Lake or Reservoir	Lake	1998	Lake Superior	16-0365-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Clearwater	Lake or Reservoir	Lake	1998	Lake Superior	16-0139-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Coe	Lake or Reservoir	Lake	2010	Lake Superior	69-0562-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Crescent	Lake or Reservoir	Lake	1998	Lake Superior	16-0454-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Crocodile	Lake or Reservoir	Lake	1998	Lake Superior	16-0119-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
CROOKED (EAST BAY)	Lake or Reservoir	Lake	1998	Lake Superior	38-0024-01	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
CROOKED (WEST BAY)	Lake or Reservoir	Lake	1998	Lake Superior	38-0024-02	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Dam Five	Lake or Reservoir	Lake	1998	Lake Superior	38-0053-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Deep	Lake or Reservoir	Lake	2002	Lake Superior	69-0666-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Deer Yard	Lake or Reservoir	Lake	1998	Lake Superior	16-0253-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Delay	Lake or Reservoir	Lake	2010	Lake Superior	38-0415-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Devil Track	Lake or Reservoir	Lake	1998	Lake Superior	16-0143-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Devil Track	Lake or Reservoir	Lake	1998	Lake Superior	16-0143-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Dinham	Lake or Reservoir	Lake	2012	Lake Superior	69-0544-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Divide	Lake or Reservoir	Lake	2020	Lake Superior	38-0256-00	1B, 2A	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Duncan	Lake or Reservoir	Lake	2004	Lake Superior	16-0232-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Dunn	Lake or Reservoir	Lake	1998	Lake Superior	16-0245-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Dyers	Lake or Reservoir	Lake	2002	Lake Superior	16-0634-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue

East	Lake or Reservoir	Lake	2002	Lake Superior	38-0020-00	1B, 2A	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
East Bearskin	Lake or Reservoir	Lake	1998	Lake Superior	16-0146-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
East Pike	Lake or Reservoir	Lake	1998	Lake Superior	16-0042-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Elbow	Lake or Reservoir	Lake	1998	Lake Superior	16-0096-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Elbow	Lake or Reservoir	Lake	1998	Lake Superior	16-0096-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
ELBOW (MAIN BASIN)	Lake or Reservoir	Lake	1998	Lake Superior	16-0805-01	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
ELBOW (NORTH BAY)	Lake or Reservoir	Lake	1998	Lake Superior	16-0805-02	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Embarrass River	Embarrass Lk thru Esquagama Lk	Stream	2016	Lake Superior	04010201-A99	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Embarrass River	Esquagama Lk to St Louis R	Stream	2016	Lake Superior	04010201-B00	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Embarrass River	Esquagama Lk to St Louis R	Stream	2016	Lake Superior	04010201-B00	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in water column
Esther	Lake or Reservoir	Lake	1998	Lake Superior	16-0023-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Finger	Lake or Reservoir	Lake	1998	Lake Superior	16-0646-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Fish Lk Flowage(East Bay)	Lake or Reservoir	Lake	2002	Lake Superior	69-0491-02	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Fish Lk Flowage(Main Bay)	Lake or Reservoir	Lake	2002	Lake Superior	69-0491-01	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Flour	Lake or Reservoir	Lake	1998	Lake Superior	16-0147-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Four Mile	Lake or Reservoir	Lake	1998	Lake Superior	16-0639-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Gilbert Pit	Lake or Reservoir	Lake	1998	Lake Superior	69-1306-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Goldeneye	Lake or Reservoir	Lake	2016	Lake Superior	38-0029-00	1B, 2A	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Golf Course Pond	Lake or Reservoir	Lake	1998	Lake Superior	69-1345-00	1B, 2Bd	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Greenwood	Lake or Reservoir	Lake	1998	Lake Superior	16-0077-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Greenwood	Lake or Reservoir	Lake	1998	Lake Superior	16-0077-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Gust	Lake or Reservoir	Lake	1998	Lake Superior	16-0380-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Half Moon	Lake or Reservoir	Lake	2014	Lake Superior	69-0657-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Hare	Lake or Reservoir	Lake	2014	Lake Superior	38-0026-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Homer	Lake or Reservoir	Lake	1998	Lake Superior	16-0406-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Homer	Lake or Reservoir	Lake	1998	Lake Superior	16-0406-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Hungry Jack	Lake or Reservoir	Lake	1998	Lake Superior	16-0227-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Jim	Lake or Reservoir	Lake	1998	Lake Superior	16-0135-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
John	Lake or Reservoir	Lake	1998	Lake Superior	16-0035-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Johnson	Lake or Reservoir	Lake	2002	Lake Superior	38-0242-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Katherine	Lake or Reservoir	Lake	1998	Lake Superior	38-0538-00	2B	Lake	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Kelly	Lake or Reservoir	Lake	1998	Lake Superior	69-0901-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Kelso	Lake or Reservoir	Lake	2010	Lake Superior	16-0706-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Kemo	Lake or Reservoir	Lake	1998	Lake Superior	16-0188-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Kinogami	Lake or Reservoir	Lake	2006	Lake Superior	16-0378-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Lax	Lake or Reservoir	Lake	2010	Lake Superior	38-0406-00	2B	Lake	04010102	Lake Superior - South		Aquatic Consumption	Mercury in fish tissue
Leora	Lake or Reservoir	Lake	2002	Lake Superior	69-0521-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Lester River	Headwaters to T52 R14W S14, south line	Stream	2014	Lake Superior	04010102-548	2Bg	St. Louis	04010102	Lake Superior - South		Aquatic Consumption	Mercury in fish tissue
Lester River	T52 R14W S23, north line to Lk Superior	Stream	2014	Lake Superior	04010102-549	1B, 2Ag	St. Louis	04010102	Lake Superior - South		Aquatic Consumption	Mercury in fish tissue
Lester River	T52 R14W S23, north line to Lk Superior	Stream	1998	Lake Superior	04010102-549	1B, 2Ag	St. Louis	04010102	Lake Superior - South		Aquatic Consumption	Mercury in water column
Lichen	Lake or Reservoir	Lake	1998	Lake Superior	16-0382-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Linwood	Lake or Reservoir	Lake	1998	Lake Superior	69-0248-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Little Alden	Lake or Reservoir	Lake	2004	Lake Superior	69-0130-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Little John	Lake or Reservoir	Lake	2012	Lake Superior	16-0026-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Little Trout	Lake or Reservoir	Lake	2006	Lake Superior	16-0170-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Little Wilson	Lake or Reservoir	Lake	1998	Lake Superior	38-0051-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Longyear (North)	Lake or Reservoir	Lake	1998	Lake Superior	69-0857-01	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Longyear (South)	Lake or Reservoir	Lake	1998	Lake Superior	69-0857-02	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Lost	Lake or Reservoir	Lake	2002	Lake Superior	69-0556-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Lupus	Lake or Reservoir	Lake	2002	Lake Superior	38-0038-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Mark	Lake or Reservoir	Lake	1998	Lake Superior	16-0250-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Mashkenode	Lake or Reservoir	Lake	2004	Lake Superior	69-0725-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
McDonald	Lake or Reservoir	Lake	1998	Lake Superior	16-0235-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
McDonald	Lake or Reservoir	Lake	1998	Lake Superior	16-0235-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Moore	Lake or Reservoir	Lake	1998	Lake Superior	16-0489-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Moose	Lake or Reservoir	Lake	1998	Lake Superior	16-0043-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Moosehorn	Lake or Reservoir	Lake	1998	Lake Superior	16-0015-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Murphy	Lake or Reservoir	Lake	1998	Lake Superior	69-0646-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue

Nemadji Creek	Headwaters to Nemadji R	Stream	2014	Lake Superior	04010301-545	1B, 2Ag	Carlton	04010301	Nemadji River		Aquatic Consumption	Mercury in fish tissue
Nemadji River	Headwaters (Maheu Lk 58-0033-00) to T45 R17W S4, north line	Stream	2014	Lake Superior	04010301-556	2Bg	Pine	04010301	Nemadji River		Aquatic Consumption	Mercury in fish tissue
Nemadji River	T46 R17W S33, south line to Unnamed cr	Stream	2014	Lake Superior	04010301-757	1B, 2Bdg	Carlton	04010301	Nemadji River		Aquatic Consumption	Mercury in fish tissue
Nemadji River	Unnamed cr to MN/WI border	Stream	2014	Lake Superior	04010301-758	1B, 2Ag	Carlton	04010301	Nemadji River		Aquatic Consumption	Mercury in fish tissue
Nicado	Lake or Reservoir	Lake	2012	Lake Superior	38-0230-00	2B	Lake	04010102	Lake Superior - South		Aquatic Consumption	Mercury in fish tissue
Nichols	Lake or Reservoir	Lake	2020	Lake Superior	69-0627-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Ninemile	Lake or Reservoir	Lake	1998	Lake Superior	38-0033-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Nipisiquit	Lake or Reservoir	Lake	2002	Lake Superior	38-0232-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
North Fowl	Lake or Reservoir	Lake	2002	Lake Superior	16-0036-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
North Twin	Lake or Reservoir	Lake	1998	Lake Superior	69-0419-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Northern Light	Lake or Reservoir	Lake	1998	Lake Superior	16-0089-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Northern Light	Lake or Reservoir	Lake	1998	Lake Superior	16-0089-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Pequaywan	Lake or Reservoir	Lake	1998	Lake Superior	69-0011-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Pike	Lake or Reservoir	Lake	1998	Lake Superior	16-0252-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Pike	Lake or Reservoir	Lake	2002	Lake Superior	69-0490-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Pine	Lake or Reservoir	Lake	2002	Lake Superior	16-0041-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Pine	Lake or Reservoir	Lake	1998	Lake Superior	16-0194-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Pine	Lake or Reservoir	Lake	1998	Lake Superior	69-0001-00	2B	Lake	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Pit	Lake or Reservoir	Lake	1998	Lake Superior	16-0155-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Pleasant	Lake or Reservoir	Lake	2006	Lake Superior	69-0655-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Poplar	Lake or Reservoir	Lake	1998	Lake Superior	16-0239-00	1C, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Salo	Lake or Reservoir	Lake	1998	Lake Superior	69-0036-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Sawbill	Lake or Reservoir	Lake	1998	Lake Superior	16-0496-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Sawbill	Lake or Reservoir	Lake	1998	Lake Superior	16-0496-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Seven Beaver	Lake or Reservoir	Lake	1998	Lake Superior	69-0002-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Silver	Lake or Reservoir	Lake	1998	Lake Superior	69-0662-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Six Mile	Lake or Reservoir	Lake	1998	Lake Superior	69-0840-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
South Fowl	Lake or Reservoir	Lake	1998	Lake Superior	16-0034-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
St. Mary's	Lake or Reservoir	Lake	2014	Lake Superior	69-0651-00	1C, 2Bd	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Swamp	Lake or Reservoir	Lake	1998	Lake Superior	16-0215-00	1B, 2Bd	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Swamper	Lake or Reservoir	Lake	1998	Lake Superior	16-0128-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Tait	Lake or Reservoir	Lake	1998	Lake Superior	16-0384-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Tetagouche	Lake or Reservoir	Lake	2002	Lake Superior	38-0231-00	2B	Lake	04010102	Lake Superior - South		Aquatic Consumption	Mercury in fish tissue
Thrasher	Lake or Reservoir	Lake	1998	Lake Superior	16-0192-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Thrush	Lake or Reservoir	Lake	1998	Lake Superior	16-0191-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Thunderbird	Lake or Reservoir	Lake	1998	Lake Superior	38-0031-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Tom	Lake or Reservoir	Lake	1998	Lake Superior	16-0019-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in water column
Tom	Lake or Reservoir	Lake	1998	Lake Superior	16-0019-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Toohey	Lake or Reservoir	Lake	1998	Lake Superior	16-0645-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Trout	Lake or Reservoir	Lake	1998	Lake Superior	16-0049-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Two Island	Lake or Reservoir	Lake	1998	Lake Superior	16-0156-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Virginia	Lake or Reservoir	Lake	1998	Lake Superior	69-0663-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Wampus	Lake or Reservoir	Lake	1998	Lake Superior	16-0196-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
West Pike	Lake or Reservoir	Lake	1998	Lake Superior	16-0086-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
West Two Rivers Reservoir	Lake or Reservoir	Lake	1998	Lake Superior	69-0994-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
White Pine	Lake or Reservoir	Lake	2002	Lake Superior	16-0369-00	2B	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Whiteface River	Paleface R to St Louis R	Stream	2016	Lake Superior	04010201-509	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in water column
Whiteface River	Paleface R to St Louis R	Stream	2002	Lake Superior	04010201-509	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Whiteface River	Bug Cr to Paleface R	Stream	2002	Lake Superior	04010201-528	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Whiteface River	Whiteface Reservoir to Palo Cr	Stream	2002	Lake Superior	04010201-B01	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Whiteface River	Palo Cr to Bug Cr	Stream	2002	Lake Superior	04010201-B63	2Bg	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Whitefish	Lake or Reservoir	Lake	1998	Lake Superior	38-0060-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Whitewater	Lake or Reservoir	Lake	1998	Lake Superior	69-0376-00	2B	St. Louis	04010201	St. Louis River		Aquatic Consumption	Mercury in fish tissue
Wild Rice	Lake or Reservoir	Lake	1998	Lake Superior	69-0371-00	2B	St. Louis	04010202	Cloquet River		Aquatic Consumption	Mercury in fish tissue
Wilson	Lake or Reservoir	Lake	1998	Lake Superior	38-0047-00	2B	Lake	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Winchell	Lake or Reservoir	Lake	1998	Lake Superior	16-0354-00	1B, 2A	Cook	04010101	Lake Superior - North		Aquatic Consumption	Mercury in fish tissue
Amelia	Lake or Reservoir	Lake	2010	Minnesota River	61-0064-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Andrew	Lake or Reservoir	Lake	1998	Minnesota River	34-0206-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue

Ann	Lake or Reservoir	Lake	2002	Minnesota River	10-0012-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Artichoke	Lake or Reservoir	Lake	1998	Minnesota River	06-0002-00	2B	Big Stone	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Barrett	Lake or Reservoir	Lake	1998	Minnesota River	26-0095-00	2B	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	1998	Minnesota River	22-0074-00	2B	Faribault	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Benton	Lake or Reservoir	Lake	1998	Minnesota River	41-0043-00	2B	Lincoln	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Big Stone	Lake or Reservoir	Lake	2006	Minnesota River	06-0152-00	2B	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Big Twin	Lake or Reservoir	Lake	2002	Minnesota River	46-0133-00	2B	Martin	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blackhawk	Lake or Reservoir	Lake	2006	Minnesota River	19-0059-00	2B	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Le Sueur R to Minnesota R	Stream	2002	Minnesota River	07020009-501	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Le Sueur R to Minnesota R	Stream	2002	Minnesota River	07020009-501	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in water column
Blue Earth River	W Br Blue Earth R to Coon Cr	Stream	1998	Minnesota River	07020009-504	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Willow Cr to Watonwan R	Stream	1998	Minnesota River	07020009-507	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	E Br Blue Earth R to South Cr	Stream	1998	Minnesota River	07020009-508	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Rapidan Dam to Le Sueur R	Stream	2002	Minnesota River	07020009-509	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in water column
Blue Earth River	Rapidan Dam to Le Sueur R	Stream	2002	Minnesota River	07020009-509	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Watonwan R to Rapidan Dam	Stream	1998	Minnesota River	07020009-510	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Center Cr to Elm Cr	Stream	1998	Minnesota River	07020009-514	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Elm Cr to Willow Cr	Stream	1998	Minnesota River	07020009-515	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	South Cr to Center Cr	Stream	1998	Minnesota River	07020009-516	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Coon Cr to Badger Cr	Stream	2004	Minnesota River	07020009-518	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Blue Earth River	Badger Cr to E Br Blue Earth R	Stream	1998	Minnesota River	07020009-565	2Bg	Faribault	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Bryant	Lake or Reservoir	Lake	2002	Minnesota River	27-0067-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Bush	Lake or Reservoir	Lake	1998	Minnesota River	27-0047-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Camp	Lake or Reservoir	Lake	2012	Minnesota River	76-0072-00	2B	Swift	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Cedar	Lake or Reservoir	Lake	1998	Minnesota River	70-0091-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Chippewa	Lake or Reservoir	Lake	1998	Minnesota River	21-0145-00	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Watson Sag to Minnesota R	Stream	2002	Minnesota River	07020005-501	2Bg	Chippewa	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Dry Weather Cr to Watson Sag	Stream	2002	Minnesota River	07020005-502	2Bg	Chippewa	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Stowe Lk to Little Chippewa R	Stream	2002	Minnesota River	07020005-503	2Bg	Grant	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Little Chippewa R to Unnamed cr	Stream	2002	Minnesota River	07020005-504	2Bg	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Unnamed cr to E Br Chippewa R	Stream	2002	Minnesota River	07020005-505	2Bg	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	E Br Chippewa R to Shakopee Cr	Stream	2002	Minnesota River	07020005-506	2Bg	Swift	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Shakopee Cr to Cottonwood Cr	Stream	2002	Minnesota River	07020005-507	2Bg	Swift	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Chippewa River	Cottonwood Cr to Dry Weather Cr	Stream	2002	Minnesota River	07020005-508	2Bg	Chippewa	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Christina	Lake or Reservoir	Lake	2002	Minnesota River	21-0375-00	2B	Douglas	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Cleary	Lake or Reservoir	Lake	1998	Minnesota River	70-0022-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	JD 30 to Minnesota R	Stream	1998	Minnesota River	07020008-501	2Bg	Brown	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Headwaters to Meadow Cr	Stream	1998	Minnesota River	07020008-502	2Bg	Lyon	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Meadow Cr to Plum Cr	Stream	1998	Minnesota River	07020008-503	2Bg	Redwood	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Plum Cr to Dutch Charley Cr	Stream	1998	Minnesota River	07020008-504	2Bg	Redwood	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Dutch Charley Cr to Dry Cr	Stream	1998	Minnesota River	07020008-505	2Bg	Redwood	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Dry Cr to Mound Cr	Stream	1998	Minnesota River	07020008-506	2Bg	Redwood	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Mound Cr to Coal Mine Cr	Stream	1998	Minnesota River	07020008-507	2Bg	Brown	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Coal Mine Cr to Sleepy Eye Cr	Stream	1998	Minnesota River	07020008-508	2Bg	Brown	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Cottonwood River	Sleepy Eye Cr to JD 30	Stream	1998	Minnesota River	07020008-509	2Bg	Brown	07020008	Cottonwood River		Aquatic Consumption	Mercury in fish tissue
Dead Coon (Main Lake)	Lake or Reservoir	Lake	1998	Minnesota River	41-0021-01	2B	Lincoln	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Del Clark	Lake or Reservoir	Lake	2004	Minnesota River	87-0180-00	2B	Yellow Medicine	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Duck	Lake or Reservoir	Lake	2012	Minnesota River	07-0053-00	2B	Blue Earth	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Eagle	Lake or Reservoir	Lake	1998	Minnesota River	34-0171-00	2B	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
East Solomon	Lake or Reservoir	Lake	2012	Minnesota River	34-0246-00	2B	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Fish (Bullhead Bay)	Lake or Reservoir	Lake	2002	Minnesota River	32-0018-02	2B	Cottonwood	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Fish (Main Lake)	Lake or Reservoir	Lake	2002	Minnesota River	32-0018-03	2B	Cottonwood	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Florida	Lake or Reservoir	Lake	1998	Minnesota River	34-0217-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Games	Lake or Reservoir	Lake	2012	Minnesota River	34-0224-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Gilchrist	Lake or Reservoir	Lake	2014	Minnesota River	61-0072-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Hattie	Lake or Reservoir	Lake	2014	Minnesota River	75-0200-00	2B	Stevens	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	T119 R35W S19, north line to T118 R37W S31, south line	Stream	2006	Minnesota River	07020004-508	7	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Limited Resource Value	Mercury in fish tissue
Hawk Creek	T117 R37W S6, north line to Chetomba Cr	Stream	2006	Minnesota River	07020004-510	2Bg	Chippewa	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue

Hawk Creek	Unnamed cr to Unnamed cr	Stream	2006	Minnesota River	07020004-568	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	Unnamed cr to Unnamed cr	Stream	2006	Minnesota River	07020004-569	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	Unnamed cr to Spring Cr	Stream	2006	Minnesota River	07020004-570	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	Spring Cr to Minnesota R	Stream	2006	Minnesota River	07020004-587	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	Chetomba Cr to Unnamed cr	Stream	2006	Minnesota River	07020004-591	2Bg	Chippewa	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hawk Creek	Headwaters (Foot Lk 34-0181-00) to T119 R35W S18, south line	Stream	2006	Minnesota River	07020004-627	2Bg	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Hendricks	Lake or Reservoir	Lake	1998	Minnesota River	41-0110-00	2B	Lincoln	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Hiniker Pond	Lake or Reservoir	Lake	1998	Minnesota River	07-0147-00	2B	Blue Earth	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Hydes	Lake or Reservoir	Lake	2004	Minnesota River	10-0088-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Independence	Lake or Reservoir	Lake	2018	Minnesota River	32-0017-00	2B	Jackson	07020009	Blue Earth River		Aquatic Consumption	Mercury in fish tissue
Johanna	Lake or Reservoir	Lake	2018	Minnesota River	61-0006-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Lac Lavon	Lake or Reservoir	Lake	1998	Minnesota River	19-0446-00	2B	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Lac Qui Parle (NW Bay)	Lake or Reservoir	Lake	1998	Minnesota River	37-0046-02	2B	Chippewa	07020001	Minnesota River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lac Qui Parle (SE Bay)	Lake or Reservoir	Lake	1998	Minnesota River	37-0046-01	2B	Chippewa	07020001	Minnesota River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lac qui Parle River, West Branch	Unnamed cr to Unnamed ditch	Stream	2010	Minnesota River	07020003-512	2Bg	Lac Qui Parle	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Lac qui Parle River, West Branch	Florida Cr to Unnamed cr	Stream	2010	Minnesota River	07020003-515	2Bg	Lac Qui Parle	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Lac qui Parle River, West Branch	Lost Cr to Florida Cr	Stream	2010	Minnesota River	07020003-516	2Bg	Lac Qui Parle	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Lac qui Parle River, West Branch	MN/SD border to Lost Cr	Stream	2010	Minnesota River	07020003-519	2Bg	Lac Qui Parle	07020003	Lac Qui Parle River		Aquatic Consumption	Mercury in fish tissue
Lady Slipper	Lake or Reservoir	Lake	2006	Minnesota River	42-0020-00	2B	Lyon	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	Maple R to Blue Earth R	Stream	2022	Minnesota River	07020011-501	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	Maple R to Blue Earth R	Stream	2002	Minnesota River	07020011-501	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in water column
Le Sueur River	Cobb R to Maple R	Stream	2022	Minnesota River	07020011-506	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	CD 6 to Cobb R	Stream	2022	Minnesota River	07020011-507	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	Boot Cr to CD 6	Stream	2022	Minnesota River	07020011-620	2Bg	Waseca	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	Headwaters to Freeborn/Steele County border	Stream	2022	Minnesota River	07020011-664	2Bg	Freeborn	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Le Sueur River	Freeborn/Steele County border to Boot Cr	Stream	2022	Minnesota River	07020011-665	2Bg	Waseca	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	1998	Minnesota River	34-0192-00	2B	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Loon	Lake or Reservoir	Lake	1998	Minnesota River	07-0096-00	2B	Blue Earth	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Lotus	Lake or Reservoir	Lake	2002	Minnesota River	10-0006-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Lower Prior	Lake or Reservoir	Lake	2002	Minnesota River	70-0026-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Lucy	Lake or Reservoir	Lake	2002	Minnesota River	10-0007-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Lura	Lake or Reservoir	Lake	2002	Minnesota River	07-0079-00	2B	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Madison	Lake or Reservoir	Lake	1998	Minnesota River	07-0044-00	2B	Blue Earth	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Maple	Lake or Reservoir	Lake	1998	Minnesota River	21-0079-00	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Marsh	Lake or Reservoir	Lake	1998	Minnesota River	06-0001-00	2B	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Consumption	Mercury in fish tissue
McMahon	Lake or Reservoir	Lake	2012	Minnesota River	70-0050-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Big Stone Lk to Marsh Lk Dam	Stream	1998	Minnesota River	07020001-552	1C, 2Bdg	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Lac qui Parle dam to Granite Falls Dam	Stream	1998	Minnesota River	07020004-747	1C, 2Bdg	Chippewa	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Granite Falls Dam to Yellow Medicine R	Stream	1998	Minnesota River	07020004-748	2Bg	Yellow Medicine	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Yellow Medicine R to Echo Cr	Stream	1998	Minnesota River	07020004-749	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Echo Cr to Beaver Cr	Stream	1998	Minnesota River	07020004-750	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Beaver Cr to Little Rock Cr	Stream	1998	Minnesota River	07020007-720	2Bg	Brown	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Little Rock Cr to Cottonwood R	Stream	1998	Minnesota River	07020007-721	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Cottonwood R to Blue Earth R	Stream	1998	Minnesota River	07020007-722	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in water column
Minnesota River	Cottonwood R to Blue Earth R	Stream	1998	Minnesota River	07020007-722	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Blue Earth R to Cherry Cr	Stream	2002	Minnesota River	07020007-723	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in water column
Minnesota River	Blue Earth R to Cherry Cr	Stream	1998	Minnesota River	07020007-723	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Minnesota River	RM 22 to Mississippi R	Stream	1998	Minnesota River	07020012-505	2Bg	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	RM 22 to Mississippi R	Stream	1998	Minnesota River	07020012-505	2Bg	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in water column
Minnesota River	Carver Cr to RM 22	Stream	1998	Minnesota River	07020012-506	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in water column
Minnesota River	Carver Cr to RM 22	Stream	1998	Minnesota River	07020012-506	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Cherry Cr to High Island Cr	Stream	1998	Minnesota River	07020012-799	2Bg	Le Sueur	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Minnesota River	Cherry Cr to High Island Cr	Stream	1998	Minnesota River	07020012-799	2Bg	Le Sueur	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in water column
Minnesota River	High Island Cr to Carver Cr	Stream	1998	Minnesota River	07020012-800	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in water column
Minnesota River	High Island Cr to Carver Cr	Stream	1998	Minnesota River	07020012-800	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Minnewaska	Lake or Reservoir	Lake	1998	Minnesota River	61-0130-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Moon	Lake or Reservoir	Lake	2014	Minnesota River	21-0226-00	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Mountain	Lake or Reservoir	Lake	1998	Minnesota River	17-0003-00	2B	Cottonwood	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue

Murphy	Lake or Reservoir	Lake	2008	Minnesota River	70-0010-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
North Oscar	Lake or Reservoir	Lake	2012	Minnesota River	21-0257-01	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
North Turtle	Lake or Reservoir	Lake	2008	Minnesota River	56-0379-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Northwest Bay	Lake or Reservoir	Lake	2002	Minnesota River	32-0018-01	2B	Cottonwood	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Norway (Northwest)	Lake or Reservoir	Lake	1998	Minnesota River	34-0251-01	2B	Kandiyohi	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Norway (Southern)	Lake or Reservoir	Lake	1998	Minnesota River	34-0251-02	2B	Kandiyohi	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
O'Dowd	Lake or Reservoir	Lake	1998	Minnesota River	70-0095-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Oliver (east portion)	Lake or Reservoir	Lake	2002	Minnesota River	76-0146-01	2B	Swift	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Oliver (west portion)	Lake or Reservoir	Lake	2002	Minnesota River	76-0146-02	2B	Swift	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Orchard	Lake or Reservoir	Lake	1998	Minnesota River	19-0031-00	2B	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Page	Lake or Reservoir	Lake	2014	Minnesota River	75-0019-00	2B	Stevens	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Pelican	Lake or Reservoir	Lake	1998	Minnesota River	26-0002-00	2B	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Perch	Lake or Reservoir	Lake	2002	Minnesota River	41-0067-00	2B	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Perkins	Lake or Reservoir	Lake	2014	Minnesota River	75-0075-00	2B	Stevens	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre	Lake or Reservoir	Lake	2006	Minnesota River	26-0097-00	2B	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Muddy (Mud) Cr to Minnesota R (Marsh Lk)	Stream	2006	Minnesota River	07020002-501	2Bg	Swift	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Pelican Cr to Pomme de Terre Lk	Stream	2006	Minnesota River	07020002-504	2Bg	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Tenmile Lk to Pelican Cr	Stream	2006	Minnesota River	07020002-505	2Bg	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Stalker Lk to Tenmile Lk	Stream	2006	Minnesota River	07020002-514	2Bg	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	North Pomme de Terre Lk to Middle Pomme de Terre Lk	Stream	2006	Minnesota River	07020002-558	2Bg	Stevens	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Middle Pomme de Terre Lk to Perkins Lk	Stream	2006	Minnesota River	07020002-560	2Bg	Stevens	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Perkins Lk to Muddy (Mud) Cr	Stream	2006	Minnesota River	07020002-562	2Bg	Stevens	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Barrett Lk to North Pomme de Terre Lk	Stream	2006	Minnesota River	07020002-563	2Bg	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Pomme de Terre River	Pomme de Terre Lk to Barrett Lk	Stream	2006	Minnesota River	07020002-565	2Bg	Grant	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Red Rock	Lake or Reservoir	Lake	2012	Minnesota River	21-0291-00	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Red Rock	Lake or Reservoir	Lake	2002	Minnesota River	27-0076-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Redwood	Lake or Reservoir	Lake	1998	Minnesota River	64-0058-00	2B	Redwood	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Ramsey Cr to Minnesota R	Stream	1998	Minnesota River	07020006-501	2Bg	Redwood	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	T111 R42W S33, west line to Threemile Cr	Stream	1998	Minnesota River	07020006-502	2Bg	Lyon	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Threemile Cr to Clear Cr	Stream	1998	Minnesota River	07020006-503	2Bg	Redwood	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Headwaters to Coon Cr	Stream	1998	Minnesota River	07020006-505	2Bg	Lyon	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Dam to Ramsey Cr	Stream	1998	Minnesota River	07020006-508	2Bg	Redwood	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Clear Cr to Redwood Lk	Stream	1998	Minnesota River	07020006-509	2Bg	Redwood	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	Coon Cr to T110 R42W S20, north line	Stream	1998	Minnesota River	07020006-510	2Bg	Lyon	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Redwood River	T110 R42W S17, south line to T111 R42W S32, east line	Stream	1998	Minnesota River	07020006-513	1B, 2Ag	Lyon	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Reeds	Lake or Reservoir	Lake	2012	Minnesota River	81-0055-00	2B	Waseca	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Reitz	Lake or Reservoir	Lake	2008	Minnesota River	10-0052-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Reno	Lake or Reservoir	Lake	2012	Minnesota River	61-0078-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	2002	Minnesota River	27-0071-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Rush River	S Br Rush R to Minnesota R	Stream	2016	Minnesota River	07020012-521	2Bg	Sibley	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Scandinavian	Lake or Reservoir	Lake	1998	Minnesota River	61-0041-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Schneider	Lake or Reservoir	Lake	2008	Minnesota River	70-0120-02	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
School Grove	Lake or Reservoir	Lake	2020	Minnesota River	42-0002-00	2B	Lyon	07020006	Redwood River		Aquatic Consumption	Mercury in fish tissue
Sewell	Lake or Reservoir	Lake	2006	Minnesota River	56-0408-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Shaokatan	Lake or Reservoir	Lake	1998	Minnesota River	41-0089-00	2B	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Signalness	Lake or Reservoir	Lake	1998	Minnesota River	61-0149-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Smetana	Lake or Reservoir	Lake	2008	Minnesota River	27-0073-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Snelling	Lake or Reservoir	Lake	1998	Minnesota River	27-0001-00	2B	Hennepin	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
South Oscar	Lake or Reservoir	Lake	2012	Minnesota River	21-0257-02	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Spitzer	Lake or Reservoir	Lake	2010	Minnesota River	56-0160-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Spring	Lake or Reservoir	Lake	1998	Minnesota River	70-0054-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
St. Olaf	Lake or Reservoir	Lake	2018	Minnesota River	81-0003-00	2B	Waseca	07020011	Le Sueur River		Aquatic Consumption	Mercury in fish tissue
Stalker	Lake or Reservoir	Lake	2002	Minnesota River	56-0437-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Susan	Lake or Reservoir	Lake	1998	Minnesota River	10-0013-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Swan	Lake or Reservoir	Lake	2008	Minnesota River	56-0781-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Ten Mile	Lake or Reservoir	Lake	2002	Minnesota River	56-0613-00	2B	Otter Tail	07020002	Pomme de Terre River		Aquatic Consumption	Mercury in fish tissue
Thole	Lake or Reservoir	Lake	2008	Minnesota River	70-0120-01	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Unnamed	Lake or Reservoir	Lake	2008	Minnesota River	19-0136-00	2B	Dakota	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue

Upper Prior	Lake or Reservoir	Lake	2002	Minnesota River	70-0072-00	2B	Scott	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Villard	Lake or Reservoir	Lake	2010	Minnesota River	61-0067-00	2B	Pope	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Waconia	Lake or Reservoir	Lake	1998	Minnesota River	10-0059-00	2B	Carver	07020012	Lower Minnesota River		Aquatic Consumption	Mercury in fish tissue
Washington	Lake or Reservoir	Lake	1998	Minnesota River	40-0117-00	2B	Le Sueur	07020007	Minnesota River - Mankato		Aquatic Consumption	Mercury in fish tissue
Watonwan River	Perch Cr to Blue Earth R	Stream	2016	Minnesota River	07020010-501	2Bg	Blue Earth	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	Perch Cr to Blue Earth R	Stream	2002	Minnesota River	07020010-501	2Bg	Blue Earth	07020010	Watonwan River		Aquatic Consumption	Mercury in water column
Watonwan River	S Fk Watonwan R to Perch Cr	Stream	2016	Minnesota River	07020010-510	2Bg	Watonwan	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	Butterfield Cr to S Fk Watonwan R	Stream	2016	Minnesota River	07020010-511	2Bg	Watonwan	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	N Fk Watonwan R to T107 R32W S13, east line	Stream	2016	Minnesota River	07020010-562	2Bg	Watonwan	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	T107 R31W S18, west line to Butterfield Cr	Stream	2016	Minnesota River	07020010-563	2Bg	Watonwan	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	Headwaters to T107 R33W S33, east line	Stream	2016	Minnesota River	07020010-566	2Bg	Cottonwood	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Watonwan River	T107 R33W S34, west line to N Fk Watonwan R	Stream	2016	Minnesota River	07020010-567	2Bm	Watonwan	07020010	Watonwan River		Aquatic Consumption	Mercury in fish tissue
Whiskey	Lake or Reservoir	Lake	2002	Minnesota River	21-0216-00	2B	Douglas	07020005	Chippewa River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	Spring Cr to Minnesota R	Stream	2012	Minnesota River	07020004-502	2Bg	Yellow Medicine	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	S Br Yellow Medicine R to Spring Cr	Stream	2012	Minnesota River	07020004-513	2Bg	Yellow Medicine	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	Mud Cr to S Br Yellow Medicine R	Stream	2012	Minnesota River	07020004-541	2Bg	Lyon	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	Headwaters to -96.265 44.459	Stream	2012	Minnesota River	07020004-782	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	-96.265 44.459 to -96.247 44.505	Stream	2012	Minnesota River	07020004-783	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River	-96.247 44.505 to Mud Cr	Stream	2012	Minnesota River	07020004-784	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River, North Branch	CD 8 to Yellow Medicine R	Stream	2012	Minnesota River	07020004-542	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River, South Branch (County Ditch 35)	Headwaters to -96.231 44.412	Stream	2012	Minnesota River	07020004-762	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River, South Branch (County Ditch 35)	-96.231 44.412 to T111 R45W S12, north line	Stream	2012	Minnesota River	07020004-763	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River, South Branch (County Ditch 35)	T111 R45W S1, south line to -96.156 44.448	Stream	2012	Minnesota River	07020004-764	2Bg	Lincoln	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Yellow Medicine River, South Branch (County Ditch 35)	-96.156 44.448 to Yellow Medicine R	Stream	2012	Minnesota River	07020004-765	2Bg	Lyon	07020004	Minnesota River - Yellow Medicine River		Aquatic Consumption	Mercury in fish tissue
Little Spirit	Lake or Reservoir	Lake	2010	Missouri River	32-0024-00	2B	Jackson	10230003	Little Sioux River		Aquatic Consumption	Mercury in fish tissue
Adams	Lake or Reservoir	Lake	1998	Rainy River	38-0153-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Armstrong	Lake or Reservoir	Lake	2002	Rainy River	69-0278-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Ash	Lake or Reservoir	Lake	1998	Rainy River	69-0864-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Auto	Lake or Reservoir	Lake	2002	Rainy River	69-0731-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	2010	Rainy River	31-0316-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	2002	Rainy River	69-0063-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	2016	Rainy River	69-0446-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Basswood	Lake or Reservoir	Lake	1998	Rainy River	38-0645-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Basswood River	Basswood Lk to Crooked Lk	Stream	1998	Rainy River	09030001-505	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bearhead	Lake or Reservoir	Lake	1998	Rainy River	69-0254-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bello	Lake or Reservoir	Lake	2010	Rainy River	31-0726-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Big	Lake or Reservoir	Lake	1998	Rainy River	69-0190-00	1C, 2Bd	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Big Fork River	Bear R to Rainy R	Stream	2012	Rainy River	09030006-501	2Bg	Koochiching	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Big Fork River	Sturgeon R to Bear R	Stream	2012	Rainy River	09030006-502	2Bg	Koochiching	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Big Fork River	Reilly Bk to Sturgeon R	Stream	1998	Rainy River	09030006-503	2Bg	Koochiching	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Big Fork River	Deer Cr to Caldwell Bk	Stream	1998	Rainy River	09030006-504	2Bg	Koochiching	09030006	Big Fork River	Bois Forte	Aquatic Consumption	Mercury in fish tissue
Big Fork River	Moose Bk to Coon Cr	Stream	1998	Rainy River	09030006-505	2Bg	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Big Fork River	Coon Cr to Deer Cr	Stream	1998	Rainy River	09030006-506	2Bg	Itasca	09030006	Big Fork River	Bois Forte	Aquatic Consumption	Mercury in fish tissue
Big Fork River	Caldwell Bk to Reilly Bk	Stream	1998	Rainy River	09030006-507	2Bg	Koochiching	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Birch	Lake or Reservoir	Lake	1998	Rainy River	38-0532-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Black Duck	Lake or Reservoir	Lake	2002	Rainy River	69-0842-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bog	Lake or Reservoir	Lake	2012	Rainy River	38-0443-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Border waters	Saganaga Lk to Basswood Lk	Stream	1998	Rainy River	09030001-503	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Border waters	Namakan Lk to Rainy Lk	Stream	1998	Rainy River	09030001-812	2Bg	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bottle River and Iron Lake	Crooked Lk to Lac La Croix	Stream	1998	Rainy River	09030001-507	1B, 2Bdg	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Browns	Lake or Reservoir	Lake	1998	Rainy River	38-0780-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Caribou	Lake or Reservoir	Lake	1998	Rainy River	31-0620-00	1B, 2A	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Cedar	Lake or Reservoir	Lake	1998	Rainy River	38-0810-00	1C, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	2002	Rainy River	38-0722-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	1998	Rainy River	69-0799-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Coffee	Lake or Reservoir	Lake	1998	Rainy River	38-0064-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue

Cook	Lake or Reservoir	Lake	2018	Rainy River	38-0004-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Crooked	Lake or Reservoir	Lake	1998	Rainy River	16-0723-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Crooked	Lake or Reservoir	Lake	1998	Rainy River	38-0817-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Cruiser	Lake or Reservoir	Lake	1998	Rainy River	69-0832-00	1B, 2A	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Deer	Lake or Reservoir	Lake	1998	Rainy River	31-0334-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Disappointment	Lake or Reservoir	Lake	1998	Rainy River	38-0488-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Dumbbell	Lake or Reservoir	Lake	1998	Rainy River	38-0393-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Eagles Nest #3	Lake or Reservoir	Lake	1998	Rainy River	69-0285-03	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Eagles Nest No. Four	Lake or Reservoir	Lake	2010	Rainy River	69-0218-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
East Chub	Lake or Reservoir	Lake	1998	Rainy River	38-0674-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
East Twin	Lake or Reservoir	Lake	1998	Rainy River	69-0163-01	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
East Vermilion	Lake or Reservoir	Lake	1998	Rainy River	69-0378-01	1C, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Eighteen	Lake or Reservoir	Lake	1998	Rainy River	38-0432-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Ek	Lake or Reservoir	Lake	1998	Rainy River	69-0843-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Elephant	Lake or Reservoir	Lake	1998	Rainy River	69-0810-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Ester	Lake or Reservoir	Lake	2020	Rainy River	38-0207-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Extortion	Lake or Reservoir	Lake	2002	Rainy River	16-0450-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Fat	Lake or Reservoir	Lake	1998	Rainy River	69-0481-00	1B, 2A	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Fishmouth	Lake or Reservoir	Lake	2002	Rainy River	69-0834-00	2B	St. Louis	09030003	Rainy River - Rainy Lake		Aquatic Consumption	Mercury in fish tissue
Flash	Lake or Reservoir	Lake	1998	Rainy River	38-0630-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Flat Horn	Lake or Reservoir	Lake	1998	Rainy River	38-0568-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Four	Lake or Reservoir	Lake	2020	Rainy River	38-0528-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Fourteen	Lake or Reservoir	Lake	1998	Rainy River	69-0793-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Fraser	Lake or Reservoir	Lake	1998	Rainy River	38-0372-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Frost	Lake or Reservoir	Lake	1998	Rainy River	16-0571-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Gabimichigami	Lake or Reservoir	Lake	1998	Rainy River	16-0811-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Gillis	Lake or Reservoir	Lake	1998	Rainy River	16-0753-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Grass	Lake or Reservoir	Lake	1998	Rainy River	38-0635-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Grave	Lake or Reservoir	Lake	2016	Rainy River	31-0624-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Greenstone	Lake or Reservoir	Lake	1998	Rainy River	38-0718-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Harriet	Lake or Reservoir	Lake	1998	Rainy River	38-0048-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Highlife	Lake or Reservoir	Lake	1998	Rainy River	38-0673-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Hobo	Lake or Reservoir	Lake	2004	Rainy River	69-0062-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Ima	Lake or Reservoir	Lake	2002	Rainy River	38-0400-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Iron	Lake or Reservoir	Lake	2002	Rainy River	16-0328-00	2B	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Isabella	Lake or Reservoir	Lake	1998	Rainy River	38-0396-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Island	Lake or Reservoir	Lake	2002	Rainy River	31-0913-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Jack	Lake or Reservoir	Lake	2002	Rainy River	38-0441-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Jasper	Lake or Reservoir	Lake	1998	Rainy River	16-0768-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Jeanette	Lake or Reservoir	Lake	1998	Rainy River	69-0456-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Johnson	Lake or Reservoir	Lake	1998	Rainy River	69-0117-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Joseph	Lake or Reservoir	Lake	2014	Rainy River	69-0157-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Jouppi	Lake or Reservoir	Lake	2010	Rainy River	38-0909-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kabetogama	Lake or Reservoir	Lake	1998	Rainy River	69-0845-00	1B, 2Bd	Koochiching	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kabustasa	Lake or Reservoir	Lake	2002	Rainy River	69-0679-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Kawishiwi	Lake or Reservoir	Lake	1998	Rainy River	38-0080-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kawishiwi River	South Kawishiwi R to Farm Lk	Stream	2002	Rainy River	09030001-512	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kawishiwi River	Headwaters (Kawishiwi Lk 38-0080-00) to Kawasachong Lk	Stream	2002	Rainy River	09030001-988	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kawishiwi River	Kawasachong Lk to Lk Polly	Stream	2002	Rainy River	09030001-990	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Kawishiwi River	Lk Polly to South Kawishiwi R	Stream	2002	Rainy River	09030001-992	1B, 2Bdg	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Knife	Lake or Reservoir	Lake	1998	Rainy River	38-0404-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lake of the Woods (Main)	Lake or Reservoir	Lake	1998	Rainy River	39-0002-01	1B, 2Bd	Lake of the Woods	09030009	Lake of the Woods		Aquatic Consumption	Mercury in fish tissue
LAKE OF THE WOODS(4 MI BAY)	Lake or Reservoir	Lake	1998	Rainy River	39-0002-02	1B, 2Bd	Lake of the Woods	09030009	Lake of the Woods		Aquatic Consumption	Mercury in fish tissue
Leander	Lake or Reservoir	Lake	1998	Rainy River	69-0796-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Bear	Lake or Reservoir	Lake	1998	Rainy River	31-0156-00	2B	Itasca	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Beaver Bk to Rainy R	Stream	1998	Rainy River	09030005-501	2Bg	Koochiching	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Headwaters to Rice R	Stream	1998	Rainy River	09030005-502	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue

Little Fork River	Rice R to Beaver Cr	Stream	1998	Rainy River	09030005-503	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Beaver Cr to Sturgeon R	Stream	1998	Rainy River	09030005-504	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Sturgeon R to Willow R	Stream	1998	Rainy River	09030005-505	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Willow R to Valley R	Stream	1998	Rainy River	09030005-506	2Bg	Koochiching	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Valley R to Prairie Cr	Stream	1998	Rainy River	09030005-507	2Bg	Koochiching	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Prairie Cr to Nett Lake R	Stream	1998	Rainy River	09030005-508	2Bg	Koochiching	09030005	Little Fork River	Bois Forte	Aquatic Consumption	Mercury in fish tissue
Little Fork River	Nett Lake R to Cross R	Stream	1998	Rainy River	09030005-509	2Bg	Koochiching	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Fork River	Cross R to Beaver Bk	Stream	1998	Rainy River	09030005-510	2Bg	Koochiching	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Little Iron	Lake or Reservoir	Lake	2002	Rainy River	16-0355-00	2B	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Johnson	Lake or Reservoir	Lake	1998	Rainy River	69-0760-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Knife	Lake or Reservoir	Lake	1998	Rainy River	38-0229-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Long	Lake or Reservoir	Lake	1998	Rainy River	69-0066-00	1C, 2Bd	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Saganaga	Lake or Reservoir	Lake	1998	Rainy River	16-0809-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Trout	Lake or Reservoir	Lake	1998	Rainy River	69-0455-00	1B, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Little Trout	Lake or Reservoir	Lake	1998	Rainy River	69-0682-00	1B, 2A	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2002	Rainy River	69-0765-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
LONG (MAIN BASIN)	Lake or Reservoir	Lake	1998	Rainy River	69-0859-01	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
LONG (NORTH BASIN)	Lake or Reservoir	Lake	1998	Rainy River	69-0859-02	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Loon River and Little Vermilion Lk	Lac la Croix to Sand Point Lk	Stream	1998	Rainy River	09030001-509	1B, 2Bdg	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lost	Lake or Reservoir	Lake	2014	Rainy River	69-0581-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Low	Lake or Reservoir	Lake	1998	Rainy River	69-0070-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lower Pauness	Lake or Reservoir	Lake	2008	Rainy River	69-0464-00	1B, 2Bd	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Marion	Lake or Reservoir	Lake	1998	Rainy River	69-0755-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Mayhew	Lake or Reservoir	Lake	1998	Rainy River	16-0337-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Meditation	Lake or Reservoir	Lake	2002	Rainy River	16-0583-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Middle McDougal	Lake or Reservoir	Lake	2002	Rainy River	38-0658-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Middle Sturgeon	Lake or Reservoir	Lake	1998	Rainy River	69-0939-02	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Moose	Lake or Reservoir	Lake	1998	Rainy River	38-0644-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Moose	Lake or Reservoir	Lake	1998	Rainy River	69-0750-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Muckwa	Lake or Reservoir	Lake	1998	Rainy River	69-0159-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Mukooda	Lake or Reservoir	Lake	1998	Rainy River	69-0684-00	1B, 2A	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Myrtle	Lake or Reservoir	Lake	1998	Rainy River	69-0749-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Namakan Narrows	Sand Point Lk to Namakan Lk	Stream	1998	Rainy River	09030001-813	2Bg	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Newfound	Lake or Reservoir	Lake	1998	Rainy River	38-0619-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Newton	Lake or Reservoir	Lake	1998	Rainy River	38-0784-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
North	Lake or Reservoir	Lake	1998	Rainy River	16-0331-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
O'Leary	Lake or Reservoir	Lake	1998	Rainy River	69-0685-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Ogishkemuncie	Lake or Reservoir	Lake	2004	Rainy River	38-0180-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
One	Lake or Reservoir	Lake	1998	Rainy River	38-0605-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Oriniack	Lake or Reservoir	Lake	2006	Rainy River	69-0587-00	1B, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Parent	Lake or Reservoir	Lake	1998	Rainy River	38-0526-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Peary	Lake or Reservoir	Lake	1998	Rainy River	69-0833-00	2B	St. Louis	09030003	Rainy River - Rainy Lake		Aquatic Consumption	Mercury in fish tissue
Pelican	Lake or Reservoir	Lake	1998	Rainy River	69-0841-00	1C, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Perent	Lake or Reservoir	Lake	1998	Rainy River	38-0220-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Pfeiffer	Lake or Reservoir	Lake	2002	Rainy River	69-0671-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	2002	Rainy River	38-0741-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Picket	Lake or Reservoir	Lake	2004	Rainy River	69-0591-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Pike	Lake or Reservoir	Lake	1998	Rainy River	38-0670-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Pike Bay	Lake or Reservoir	Lake	1998	Rainy River	69-0378-03	1C, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Quadga	Lake or Reservoir	Lake	1998	Rainy River	38-0596-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Quill	Lake or Reservoir	Lake	2006	Rainy River	69-0871-00	2B	St. Louis	09030003	Rainy River - Rainy Lake		Aquatic Consumption	Mercury in fish tissue
Rainy River	Rainy Lk to International Falls Dam	Stream	1998	Rainy River	09030008-539	1B, 2Bdg	Koochiching	09030008	Lower Rainy River		Aquatic Consumption	Mercury in fish tissue
Rainy River	International Falls Dam to Little Fork R	Stream	1998	Rainy River	09030008-540	1C, 2Bdg	Koochiching	09030008	Lower Rainy River		Aquatic Consumption	Mercury in fish tissue
Rainy River	Little Fork R to Rapid R	Stream	1998	Rainy River	09030008-559	1C, 2Bdg	Koochiching	09030008	Lower Rainy River		Aquatic Consumption	Mercury in fish tissue
Rainy River	Rapid R to RR bridge in Baudette	Stream	1998	Rainy River	09030008-560	1C, 2Bdg	Lake of the Woods	09030008	Lower Rainy River		Aquatic Consumption	Mercury in fish tissue
Rainy River	RR bridge in Baudette to Lake of the Woods	Stream	1998	Rainy River	09030008-561	2Bg	Lake of the Woods	09030008	Lower Rainy River		Aquatic Consumption	Mercury in fish tissue
Ramshead	Lake or Reservoir	Lake	1998	Rainy River	69-0339-00	1B, 2Bd	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue

Red Rock	Lake or Reservoir	Lake	1998	Rainy River	16-0793-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Redskin	Lake or Reservoir	Lake	2010	Rainy River	38-0440-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	1998	Rainy River	16-0606-00	2B	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Saganaga	Lake or Reservoir	Lake	1998	Rainy River	16-0633-00	1B, 2A	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Sand	Lake or Reservoir	Lake	2002	Rainy River	69-0736-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Section 29	Lake or Reservoir	Lake	1998	Rainy River	38-0292-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Section Twelve	Lake or Reservoir	Lake	2002	Rainy River	38-0714-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Shagawa	Lake or Reservoir	Lake	1998	Rainy River	69-0069-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Shell	Lake or Reservoir	Lake	2018	Rainy River	69-0461-00	1B, 2Bd	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Side	Lake or Reservoir	Lake	2010	Rainy River	69-0933-00	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Silver Island	Lake or Reservoir	Lake	1998	Rainy River	38-0219-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Snowbank	Lake or Reservoir	Lake	1998	Rainy River	38-0529-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Square	Lake or Reservoir	Lake	1998	Rainy River	38-0074-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Sturgeon	Lake or Reservoir	Lake	1998	Rainy River	69-0939-01	2B	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Sturgeon River	Bear R to Little Fork R	Stream	2004	Rainy River	09030005-514	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Sturgeon River	E Br Sturgeon R to Dark R	Stream	2004	Rainy River	09030005-523	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Sturgeon River	Dark R to Bear R	Stream	2004	Rainy River	09030005-524	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Sturgeon River	Headwaters (Little Sturgeon Lk 69-1290-00) to E Br Sturgeon R	Stream	2004	Rainy River	09030005-527	2Bg	St. Louis	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Surprise	Lake or Reservoir	Lake	2002	Rainy River	38-0550-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Susan	Lake or Reservoir	Lake	1998	Rainy River	69-0741-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
T	Lake or Reservoir	Lake	1998	Rainy River	38-0066-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Takucmich	Lake or Reservoir	Lake	2002	Rainy River	69-0369-00	1B, 2A	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Tee	Lake or Reservoir	Lake	2002	Rainy River	69-0083-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Teufer	Lake or Reservoir	Lake	2012	Rainy River	36-0019-00	2B	Koochiching	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Thistledew	Lake or Reservoir	Lake	2012	Rainy River	31-0158-00	2B	Itasca	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
Thomas	Lake or Reservoir	Lake	1998	Rainy River	38-0351-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Triangle	Lake or Reservoir	Lake	1998	Rainy River	38-0715-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Trout	Lake or Reservoir	Lake	1998	Rainy River	69-0498-00	1B, 2A	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Turtle	Lake or Reservoir	Lake	1998	Rainy River	31-0725-00	2B	Itasca	09030006	Big Fork River		Aquatic Consumption	Mercury in fish tissue
Two	Lake or Reservoir	Lake	1998	Rainy River	38-0608-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Two Deer	Lake or Reservoir	Lake	2014	Rainy River	38-0671-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Vera	Lake or Reservoir	Lake	1998	Rainy River	38-0491-00	1B, 2A	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Warroad River	W & E Br Warroad R to Lake of the Woods	Stream	2014	Rainy River	09030009-502	2Bg	Roseau	09030009	Lake of the Woods		Aquatic Consumption	Mercury in fish tissue
Warroad River, East Branch	Headwaters to Warroad R	Stream	2014	Rainy River	09030009-504	2Bg	Roseau	09030009	Lake of the Woods		Aquatic Consumption	Mercury in fish tissue
Warroad River, West Branch	Headwaters to Warroad R	Stream	2014	Rainy River	09030009-503	2Bg	Roseau	09030009	Lake of the Woods		Aquatic Consumption	Mercury in fish tissue
West Chub	Lake or Reservoir	Lake	1998	Rainy River	38-0675-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
West Pope	Lake or Reservoir	Lake	2002	Rainy River	16-0341-00	2B	Cook	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
West Robinson	Lake or Reservoir	Lake	2012	Rainy River	69-0217-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
West Sturgeon	Lake or Reservoir	Lake	1998	Rainy River	69-0939-03	2B	Itasca	09030005	Little Fork River		Aquatic Consumption	Mercury in fish tissue
West Twin	Lake or Reservoir	Lake	1998	Rainy River	69-0163-02	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
West Vermilion	Lake or Reservoir	Lake	1998	Rainy River	69-0378-02	1C, 2Bd	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Whisper	Lake or Reservoir	Lake	1998	Rainy River	69-0059-00	2B	St. Louis	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Winchester	Lake or Reservoir	Lake	2004	Rainy River	69-0690-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Wind	Lake or Reservoir	Lake	2014	Rainy River	38-0642-00	1B, 2Bd	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Wolf	Lake or Reservoir	Lake	1998	Rainy River	69-0582-00	2B	St. Louis	09030002	Vermilion River		Aquatic Consumption	Mercury in fish tissue
Wye	Lake or Reservoir	Lake	2012	Rainy River	38-0042-00	2B	Lake	09030001	Rainy River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Balm	Lake or Reservoir	Lake	2008	Red River of the North	04-0329-00	2B	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Big Cormorant	Lake or Reservoir	Lake	1998	Red River of the North	03-0576-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Big McDonald	Lake or Reservoir	Lake	2020	Red River of the North	56-0386-01	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Big Pine	Lake or Reservoir	Lake	1998	Red River of the North	56-0130-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Blackduck	Lake or Reservoir	Lake	1998	Red River of the North	04-0069-00	2B	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Blackduck River	Blackduck Lk to O'Brien Cr	Stream	2016	Red River of the North	09020302-510	2Bg	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Blackduck River	O'Brien Cr to South Cormorant R	Stream	2016	Red River of the North	09020302-511	2Bg	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Blackduck River	South Cormorant R to North Cormorant R	Stream	2016	Red River of the North	09020302-512	2Bg	Beltrami	09020302	Upper/Lower Red Lake	Red Lake	Aquatic Consumption	Mercury in fish tissue
Blackduck River	North Cormorant R to Lower Red Lk	Stream	2016	Red River of the North	09020302-513	2Bg	Beltrami	09020302	Upper/Lower Red Lake	Red Lake	Aquatic Consumption	Mercury in fish tissue
Blanche	Lake or Reservoir	Lake	2012	Red River of the North	56-0240-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Bois de Sioux River	Rabbit R to Otter Tail R	Stream	2012	Red River of the North	09020101-501	2Bg	Wilkin	09020101	Bois de Sioux River		Aquatic Consumption	Mercury in fish tissue
Bois de Sioux River	Mud Lk to Rabbit R	Stream	2012	Red River of the North	09020101-503	2Bg	Traverse	09020101	Bois de Sioux River		Aquatic Consumption	Mercury in fish tissue

Buchanan	Lake or Reservoir	Lake	2010	Red River of the North	56-0209-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Buffalo River	S Br Buffalo R to Red R	Stream	2012	Red River of the North	09020106-501	2Bg	Clay	09020106	Buffalo River		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	1998	Red River of the North	36-0011-00	2B	Koochiching	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Clearwater	Lake or Reservoir	Lake	1998	Red River of the North	04-0343-00	2B	Beltrami	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Lower Badger Cr to Red Lake R	Stream	1998	Red River of the North	09020305-501	2Bg	Red Lake	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Lost R to Beau Gerlot Cr	Stream	1998	Red River of the North	09020305-511	2Bg	Red Lake	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Headwaters to T148 R36W S36, east line	Stream	1998	Red River of the North	09020305-517	2Bg	Clearwater	09020305	Clearwater River	White Earth	Aquatic Consumption	Mercury in fish tissue
Clearwater River	Beau Gerlot Cr to Lower Badger Cr	Stream	2004	Red River of the North	09020305-519	2Bg	Red Lake	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Ruffy Bk to JD 1	Stream	1998	Red River of the North	09020305-647	2Bg	Clearwater	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	JD 1 to Lost R	Stream	1998	Red River of the North	09020305-648	2Bg	Red Lake	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Clearwater Lk to Unnamed cr	Stream	1998	Red River of the North	09020305-649	2Bg	Clearwater	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Unnamed cr to Ruffy Bk	Stream	1998	Red River of the North	09020305-650	2Bg	Clearwater	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	T148 R35W S31, west line to Unnamed cr	Stream	1998	Red River of the North	09020305-653	1B, 2Ag	Beltrami	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clearwater River	Unnamed cr to Clearwater Lk	Stream	1998	Red River of the North	09020305-654	1B, 2Ag	Beltrami	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Clitherall	Lake or Reservoir	Lake	1998	Red River of the North	56-0238-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Cotton	Lake or Reservoir	Lake	1998	Red River of the North	03-0286-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Dark	Lake or Reservoir	Lake	1998	Red River of the North	36-0014-00	2B	Koochiching	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Dead	Lake or Reservoir	Lake	1998	Red River of the North	56-0383-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Dellwater	Lake or Reservoir	Lake	2012	Red River of the North	04-0331-00	2B	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Detroit	Lake or Reservoir	Lake	1998	Red River of the North	03-0381-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
East Olaf	Lake or Reservoir	Lake	2002	Red River of the North	56-0950-02	2B	Otter Tail	09020106	Buffalo River		Aquatic Consumption	Mercury in fish tissue
East Spirit	Lake or Reservoir	Lake	2016	Red River of the North	56-0501-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
East Toqua	Lake or Reservoir	Lake	2004	Red River of the North	06-0138-00	2B	Big Stone	09020102	Mustinka River		Aquatic Consumption	Mercury in fish tissue
Floyd (south bay)	Lake or Reservoir	Lake	2002	Red River of the North	03-0387-02	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Hayes	Lake or Reservoir	Lake	1998	Red River of the North	68-0004-00	2B	Roseau	09020314	Roseau River		Aquatic Consumption	Mercury in fish tissue
Height of Land	Lake or Reservoir	Lake	2012	Red River of the North	03-0195-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Ida	Lake or Reservoir	Lake	1998	Red River of the North	03-0582-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Island	Lake or Reservoir	Lake	2010	Red River of the North	03-0153-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Jewett	Lake or Reservoir	Lake	2006	Red River of the North	56-0877-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Julia	Lake or Reservoir	Lake	1998	Red River of the North	04-0166-00	2B	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Leek	Lake or Reservoir	Lake	2016	Red River of the North	56-0532-02	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Little Cormorant	Lake or Reservoir	Lake	2020	Red River of the North	03-0506-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Little McDonald	Lake or Reservoir	Lake	1998	Red River of the North	56-0328-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Little Pine	Lake or Reservoir	Lake	2002	Red River of the North	56-0142-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Lomond	Lake or Reservoir	Lake	1998	Red River of the North	15-0081-00	2B	Clearwater	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2002	Red River of the North	56-0388-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Maple	Lake or Reservoir	Lake	1998	Red River of the North	60-0305-00	2B	Polk	09020305	Clearwater River		Aquatic Consumption	Mercury in fish tissue
Marion	Lake or Reservoir	Lake	2006	Red River of the North	56-0243-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Marsh River	Headwaters to Red R	Stream	2016	Red River of the North	09020107-503	2Bg	Norman	09020107	Red River of the North - Marsh River		Aquatic Consumption	Mercury in fish tissue
Minerva	Lake or Reservoir	Lake	1998	Red River of the North	15-0079-00	2B	Clearwater	09020108	Wild Rice River		Aquatic Consumption	Mercury in fish tissue
Mud	Lake or Reservoir	Lake	2002	Red River of the North	03-0387-01	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Murphy	Lake or Reservoir	Lake	2010	Red River of the North	56-0229-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Muskrat	Lake or Reservoir	Lake	1998	Red River of the North	03-0360-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
North Lida	Lake or Reservoir	Lake	1998	Red River of the North	56-0747-01	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Orwell	Lake or Reservoir	Lake	2008	Red River of the North	56-0945-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Otter Tail	Lake or Reservoir	Lake	2010	Red River of the North	56-0242-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Pebble	Lake or Reservoir	Lake	1998	Red River of the North	56-0829-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Pelican	Lake or Reservoir	Lake	1998	Red River of the North	56-0786-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	2020	Red River of the North	03-0287-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	1998	Red River of the North	56-0475-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Prairie	Lake or Reservoir	Lake	2004	Red River of the North	56-0915-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
RED (UPPER RED)	Lake or Reservoir	Lake	2002	Red River of the North	04-0035-01	2B	Beltrami	09020302	Upper/Lower Red Lake	Red Lake	Aquatic Consumption	Mercury in fish tissue
Red Lake River	Burnham Cr to Unnamed cr	Stream	1998	Red River of the North	09020303-501	1C, 2Bdg	Polk	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Black R to Gentilly R	Stream	1998	Red River of the North	09020303-502	1C, 2Bdg	Red Lake	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Unnamed cr to Red R	Stream	1998	Red River of the North	09020303-503	1C, 2Bdg	Polk	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	County Ditch 96 to Clearwater R	Stream	1998	Red River of the North	09020303-504	1C, 2Bdg	Red Lake	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	County Ditch 99 to Burnham Cr	Stream	1998	Red River of the North	09020303-506	1C, 2Bdg	Polk	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Thief R to Thief River Falls Dam	Stream	1998	Red River of the North	09020303-509	1C, 2Bdg	Pennington	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue

Red Lake River	Clearwater R to Cyr Cr	Stream	1998	Red River of the North	09020303-510	1C, 2Bdg	Red Lake	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Cyr Cr to Black R	Stream	1998	Red River of the North	09020303-511	1C, 2Bdg	Red Lake	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Gentilly R to County Ditch 99	Stream	1998	Red River of the North	09020303-512	1C, 2Bdg	Polk	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Thief River Falls Dam to County Ditch 96	Stream	1998	Red River of the North	09020303-513	1C, 2Bdg	Pennington	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	Clearwater/Pennington Co line to CD 39	Stream	1998	Red River of the North	09020303-561	1C, 2Bdg	Pennington	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Red Lake River	CD 39 to Thief R	Stream	1998	Red River of the North	09020303-562	1C, 2Bdg	Pennington	09020303	Red Lake River		Aquatic Consumption	Mercury in fish tissue
Rose	Lake or Reservoir	Lake	2012	Red River of the North	56-0360-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Rush	Lake or Reservoir	Lake	1998	Red River of the North	56-0141-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Sallie	Lake or Reservoir	Lake	2010	Red River of the North	03-0359-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Sandy	Lake or Reservoir	Lake	2006	Red River of the North	04-0124-00	2B	Beltrami	09020302	Upper/Lower Red Lake		Aquatic Consumption	Mercury in fish tissue
Star	Lake or Reservoir	Lake	1998	Red River of the North	56-0385-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Sybil	Lake or Reservoir	Lake	2008	Red River of the North	56-0387-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Thief River	Agassiz Pool to Red Lake R	Stream	2014	Red River of the North	09020304-501	2Bg	Marshall	09020304	Thief River		Aquatic Consumption	Mercury in fish tissue
Toad	Lake or Reservoir	Lake	1998	Red River of the North	03-0107-00	2B	Becker	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Traverse	Lake or Reservoir	Lake	1998	Red River of the North	78-0025-00	2B	Traverse	09020101	Bois de Sioux River		Aquatic Consumption	Mercury in fish tissue
Trowbridge	Lake or Reservoir	Lake	2016	Red River of the North	56-0532-01	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Union	Lake or Reservoir	Lake	2014	Red River of the North	60-0217-00	2B	Polk	09020301	Red River of the North - Sandhill River		Aquatic Consumption	Mercury in fish tissue
Unnamed	Lake or Reservoir	Lake	1998	Red River of the North	45-0119-00	2B	Marshall	09020311	Red River of the North - Tamarack River		Aquatic Consumption	Mercury in fish tissue
Walker	Lake or Reservoir	Lake	1998	Red River of the North	56-0310-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
Wall	Lake or Reservoir	Lake	1998	Red River of the North	56-0658-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
West Battle	Lake or Reservoir	Lake	2002	Red River of the North	56-0239-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
West Lost	Lake or Reservoir	Lake	2018	Red River of the North	56-0481-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Consumption	Mercury in fish tissue
West Olaf	Lake or Reservoir	Lake	2002	Red River of the North	56-0950-01	2B	Otter Tail	09020106	Buffalo River		Aquatic Consumption	Mercury in fish tissue
Ann	Lake or Reservoir	Lake	2018	St. Croix River	33-0040-00	2B	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Big Carnelian	Lake or Reservoir	Lake	1998	St. Croix River	82-0049-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Big Marine (Main Lake)	Lake or Reservoir	Lake	1998	St. Croix River	82-0052-04	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Big Pine	Lake or Reservoir	Lake	1998	St. Croix River	58-0138-00	2B	Aitkin	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Bone	Lake or Reservoir	Lake	1998	St. Croix River	82-0054-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Chisago (north portion)	Lake or Reservoir	Lake	2012	St. Croix River	13-0012-01	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Chisago (south portion)	Lake or Reservoir	Lake	2012	St. Croix River	13-0012-02	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Comfort	Lake or Reservoir	Lake	1998	St. Croix River	13-0053-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Coon	Lake or Reservoir	Lake	2006	St. Croix River	02-0042-00	2B	Anoka	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
DeMontreville	Lake or Reservoir	Lake	2020	St. Croix River	82-0101-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
East Rush	Lake or Reservoir	Lake	2002	St. Croix River	13-0069-01	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Elmo	Lake or Reservoir	Lake	1998	St. Croix River	82-0106-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Fish	Lake or Reservoir	Lake	1998	St. Croix River	13-0068-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Fish	Lake or Reservoir	Lake	1998	St. Croix River	33-0036-00	2B	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Green (Little Green)	Lake or Reservoir	Lake	2012	St. Croix River	13-0041-01	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
GREEN (MAIN BASIN)	Lake or Reservoir	Lake	2012	St. Croix River	13-0041-02	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Grindstone	Lake or Reservoir	Lake	2014	St. Croix River	58-0123-00	1B, 2A	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Island	Lake or Reservoir	Lake	2022	St. Croix River	58-0062-00	2B	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Knife	Lake or Reservoir	Lake	2014	St. Croix River	33-0028-00	2B	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Kroon	Lake or Reservoir	Lake	2020	St. Croix River	13-0013-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Lily	Lake or Reservoir	Lake	2002	St. Croix River	82-0023-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Linwood	Lake or Reservoir	Lake	2018	St. Croix River	02-0026-00	2B	Anoka	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Little	Lake or Reservoir	Lake	2010	St. Croix River	13-0033-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Little Carnelian	Lake or Reservoir	Lake	2002	St. Croix River	82-0014-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Little Hanging Horn	Lake or Reservoir	Lake	2002	St. Croix River	09-0035-00	2B	Carlton	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2002	St. Croix River	58-0107-00	2B	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Martin	Lake or Reservoir	Lake	2018	St. Croix River	02-0034-00	2B	Anoka	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
North Center Lake	Lake or Reservoir	Lake	2012	St. Croix River	13-0032-01	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
North Center Pond	Lake or Reservoir	Lake	2012	St. Croix River	13-0032-02	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Oak	Lake or Reservoir	Lake	2012	St. Croix River	58-0048-00	2B	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Park	Lake or Reservoir	Lake	2002	St. Croix River	09-0029-00	2B	Carlton	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Pokegama	Lake or Reservoir	Lake	2012	St. Croix River	58-0142-00	2B	Pine	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Sand	Lake or Reservoir	Lake	2014	St. Croix River	58-0081-00	2B	Carlton	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Snake River	Mud Cr to Mission Cr	Stream	1998	St. Croix River	07030004-503	2Bg	Pine	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Fish Lk outlet to Groundhouse R	Stream	1998	St. Croix River	07030004-505	2Bg	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue

Snake River	Chelsey Bk to Knife R	Stream	1998	St. Croix River	07030004-506	2Bg	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Headwaters to Hay Cr	Stream	1998	St. Croix River	07030004-508	2Bg	Aitkin	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Hay Cr to Chelsey Bk	Stream	1998	St. Croix River	07030004-523	2Bg	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Groundhouse R to Mud Cr	Stream	1998	St. Croix River	07030004-524	2Bg	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Knife R to Fish Lk outlet	Stream	1998	St. Croix River	07030004-525	2Bg	Kanabec	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Mission Cr to Cross Lk	Stream	1998	St. Croix River	07030004-586	2Bg	Pine	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
Snake River	Cross Lk to St Croix R	Stream	1998	St. Croix River	07030004-587	2Bg	Pine	07030004	Snake River - St. Croix Basin		Aquatic Consumption	Mercury in fish tissue
South Center	Lake or Reservoir	Lake	2010	St. Croix River	13-0027-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Square	Lake or Reservoir	Lake	2002	St. Croix River	82-0046-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
St. Croix	Lake or Reservoir	Lake	1998	St. Croix River	82-0001-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
St. Croix River	MN/WI border to Snake R	Stream	1998	St. Croix River	07030001-619	1B, 2Bdg	Pine	07030001	Upper St. Croix River		Aquatic Consumption	Mercury in fish tissue
St. Croix River	Snake R to Sunrise R	Stream	1998	St. Croix River	07030005-782	1B, 2Bdg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
St. Croix River	Sunrise R to Taylors Falls Dam	Stream	1998	St. Croix River	07030005-783	1B, 2Bdg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
St. Croix River	Taylors Falls Dam to Lk St Croix (82-0001-00)	Stream	1998	St. Croix River	07030005-784	1C, 2Bdg	Washington	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Sturgeon	Lake or Reservoir	Lake	1998	St. Croix River	58-0067-00	2B	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
Sunrise River	Kost Dam to N Br Sunrise R	Stream	2012	St. Croix River	07030005-542	2Bg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Sunrise River	N Br Sunrise R to St Croix R	Stream	2012	St. Croix River	07030005-543	2Bg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Sunrise River, North Branch	Headwaters to Keystone Ave	Stream	2012	St. Croix River	07030005-797	2Bg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Sunrise River, North Branch	Keystone Ave to Sunrise R	Stream	2012	St. Croix River	07030005-798	2Bg	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Tamarack	Lake or Reservoir	Lake	1998	St. Croix River	58-0024-00	2B	Pine	07030001	Upper St. Croix River		Aquatic Consumption	Mercury in fish tissue
Upper Pine	Lake or Reservoir	Lake	1998	St. Croix River	58-0130-00	2B	Pine	07030003	Kettle River		Aquatic Consumption	Mercury in fish tissue
West Rush	Lake or Reservoir	Lake	2002	St. Croix River	13-0069-02	2B	Chisago	07030005	Lower St. Croix River		Aquatic Consumption	Mercury in fish tissue
Byllesby	Lake or Reservoir	Lake	2010	Upper Mississippi River, Lower Portion	19-0006-00	2B	Dakota	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon	Lake or Reservoir	Lake	2012	Upper Mississippi River, Lower Portion	66-0008-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon River	Wolf Cr to Heath Cr	Stream	1998	Upper Mississippi River, Lower Portion	07040002-507	2Bg	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon River	Heath Cr to Northfield Dam	Stream	1998	Upper Mississippi River, Lower Portion	07040002-508	2Bg	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon River	Northfield Dam to Lk Byllesby inlet	Stream	1998	Upper Mississippi River, Lower Portion	07040002-509	2Bg	Dakota	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon River	Straight R to T110 R20W S19, SE1/4 line	Stream	1998	Upper Mississippi River, Lower Portion	07040002-581	2Bg	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cannon River	T110 R20W S19, NE1/4 line to Wolf Cr	Stream	1998	Upper Mississippi River, Lower Portion	07040002-582	2Bg	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Cedar	Lake or Reservoir	Lake	2010	Upper Mississippi River, Lower Portion	66-0052-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Circle	Lake or Reservoir	Lake	2010	Upper Mississippi River, Lower Portion	66-0027-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	81-0014-01	2B	Waseca	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Fox	Lake or Reservoir	Lake	2020	Upper Mississippi River, Lower Portion	66-0029-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Frances	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	40-0057-00	2B	Le Sueur	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
French	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	66-0038-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Gorman	Lake or Reservoir	Lake	2012	Upper Mississippi River, Lower Portion	40-0032-00	2B	Le Sueur	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Hunt	Lake or Reservoir	Lake	2004	Upper Mississippi River, Lower Portion	66-0047-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Loon	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	81-0015-00	2B	Waseca	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Lower Sakatah	Lake or Reservoir	Lake	2012	Upper Mississippi River, Lower Portion	66-0044-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
MARION (EAST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	19-0026-01	2B	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
MARION (MIDDLE BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	19-0026-02	2B	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
MARION (WEST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	19-0026-03	2B	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Mississippi River	St Croix R to Chippewa R (WI)	Stream	2004	Upper Mississippi River, Lower Portion	07040001-531	2Bg	Goodhue	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in water column
Mississippi River	St Croix R to Chippewa R (WI)	Stream	1998	Upper Mississippi River, Lower Portion	07040001-531	2Bg	Goodhue	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue

Mississippi River	Chippewa R (WI) to L & D #6	Stream	1998	Upper Mississippi River, Lower Portion	07040003-627	2Bg	Wabasha	07040003	Mississippi River - Winona		Aquatic Consumption	Mercury in fish tissue
Mississippi River	L & D #6 to Root R	Stream	1998	Upper Mississippi River, Lower Portion	07040006-515	2Bg	Winona	07040006	Mississippi River - La Crescent		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Root R to MN/IA border	Stream	1998	Upper Mississippi River, Lower Portion	07060001-509	2Bg	Houston	07060001	Mississippi River - Reno		Aquatic Consumption	Mercury in fish tissue
Root River	Thompson Cr to Mississippi R	Stream	2010	Upper Mississippi River, Lower Portion	07040008-501	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River	S Fk Root R to Thompson Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-502	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River	Money Cr to S Fk Root R	Stream	2010	Upper Mississippi River, Lower Portion	07040008-520	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River	Rush Cr to Money Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-522	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River	M Br Root R to Rush Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-527	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	Upper Bear Cr to N Br Root R	Stream	2002	Upper Mississippi River, Lower Portion	07040008-506	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	Trout Run Cr to S Br Root R	Stream	2004	Upper Mississippi River, Lower Portion	07040008-528	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	Rice Cr to Trout Run Cr	Stream	2004	Upper Mississippi River, Lower Portion	07040008-530	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	Lynch Cr to Rice Cr	Stream	2004	Upper Mississippi River, Lower Portion	07040008-532	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	N Br Root R to Lynch Cr	Stream	2004	Upper Mississippi River, Lower Portion	07040008-534	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	Bear Cr to T103 R12W S9, north line	Stream	2002	Upper Mississippi River, Lower Portion	07040008-B95	1B, 2Bdg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch	T103 R12W S4, south line to Upper Bear Cr	Stream	2002	Upper Mississippi River, Lower Portion	07040008-B96	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, Middle Branch (Deer Creek)	Spring Valley Cr to Bear Cr	Stream	2006	Upper Mississippi River, Lower Portion	07040008-545	1B, 2Bdg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	Beaver Cr to Root R	Stream	2010	Upper Mississippi River, Lower Portion	07040008-508	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	Riceford Cr to Beaver Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-509	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	Wisel Cr to T102 R8W S2, east line	Stream	2010	Upper Mississippi River, Lower Portion	07040008-510	1B, 2Ag	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	T102 R9W S26, west line to Wisel Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-511	1B, 2Ag	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	T102 R8W S1, west line to Riceford Cr	Stream	2010	Upper Mississippi River, Lower Portion	07040008-572	2Bg	Houston	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Root River, South Fork	Headwaters to T102 R9W S27, east line	Stream	2010	Upper Mississippi River, Lower Portion	07040008-573	2Bg	Fillmore	07040008	Root River		Aquatic Consumption	Mercury in fish tissue
Shields	Lake or Reservoir	Lake	2004	Upper Mississippi River, Lower Portion	66-0055-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Silver	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	55-0003-00	2B	Olmsted	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Tetonka	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	40-0031-00	2B	Le Sueur	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Upper Sakatah	Lake or Reservoir	Lake	2012	Upper Mississippi River, Lower Portion	40-0002-00	2B	Le Sueur	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
Vermillion River	Vermillion R/Vermillion Slough, Hastings Dam to Mississippi R	Stream	1998	Upper Mississippi River, Lower Portion	07040001-504	2Bg	Dakota	07040001	Mississippi River - Lake Pepin	Prairie Island	Aquatic Consumption	Mercury in fish tissue
Vermillion River	T114 R19W S30, south line to S Br Vermillion R	Stream	2012	Upper Mississippi River, Lower Portion	07040001-507	1B, 2Ag	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Vermillion River	Headwaters to T113 R20W S8, east line	Stream	2012	Upper Mississippi River, Lower Portion	07040001-516	2Bg	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Vermillion River	T113 R20W S9, west line to T114 R19W S31, north line	Stream	2012	Upper Mississippi River, Lower Portion	07040001-517	1B, 2Ag	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Vermillion River	S Br Vermillion R to T114 R18W S20, east line	Stream	2012	Upper Mississippi River, Lower Portion	07040001-691	1B, 2Ag	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Vermillion River	T114 R18W S21, west line to Hastings Dam	Stream	2012	Upper Mississippi River, Lower Portion	07040001-692	2Bg	Dakota	07040001	Mississippi River - Lake Pepin		Aquatic Consumption	Mercury in fish tissue
Wells	Lake or Reservoir	Lake	2012	Upper Mississippi River, Lower Portion	66-0010-00	2B	Rice	07040002	Cannon River		Aquatic Consumption	Mercury in fish tissue
West Indian Creek	T110 R11W S31, south line to Zumbro R	Stream	2008	Upper Mississippi River, Lower Portion	07040004-509	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
West Indian Creek	Headwaters to T109 R11W S28, north line	Stream	2008	Upper Mississippi River, Lower Portion	07040004-541	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue

West Indian Creek	T109 R11W S21, south line to T109 R11W S6, north line	Stream	2008	Upper Mississippi River, Lower Portion	07040004-542	1B, 2Ag	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Whitewater River	S Fk Whitewater R to Beaver Cr	Stream	1998	Upper Mississippi River, Lower Portion	07040003-537	1B, 2Ag	Winona	07040003	Mississippi River - Winona		Aquatic Consumption	Mercury in fish tissue
Whitewater River	Beaver Cr to T108 R10W S1, north line	Stream	1998	Upper Mississippi River, Lower Portion	07040003-538	1B, 2Ag	Winona	07040003	Mississippi River - Winona		Aquatic Consumption	Mercury in fish tissue
Whitewater River	T109 R10W S36, south line to Mississippi R	Stream	1998	Upper Mississippi River, Lower Portion	07040003-539	2Bg	Wabasha	07040003	Mississippi River - Winona		Aquatic Consumption	Mercury in fish tissue
Willow Reservoir 6A	Lake or Reservoir	Lake	2006	Upper Mississippi River, Lower Portion	55-0021-00	2B	Olmsted	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Zumbro	Lake or Reservoir	Lake	1998	Upper Mississippi River, Lower Portion	55-0004-00	2B	Olmsted	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Zumbro River	West Indian Cr to Mississippi R	Stream	1998	Upper Mississippi River, Lower Portion	07040004-501	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Zumbro River	Cold Cr to West Indian Cr	Stream	1998	Upper Mississippi River, Lower Portion	07040004-502	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Zumbro River	N Fk Zumbro R to Cold Cr	Stream	1998	Upper Mississippi River, Lower Portion	07040004-504	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Zumbro River	Zumbro Lk to N Fk Zumbro R	Stream	2006	Upper Mississippi River, Lower Portion	07040004-506	2Bg	Wabasha	07040004	Zumbro River		Aquatic Consumption	Mercury in fish tissue
Ada	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	11-0250-00	2B	Cass	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Adley	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	56-0031-00	2B	Otter Tail	07010107	Redeye River		Aquatic Consumption	Mercury in fish tissue
Agnes	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0053-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Aitkin	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	01-0040-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Alexander	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	49-0079-00	2B	Morrison	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Alstead Mine	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-06	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Andrew	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0085-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Ann	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0190-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Arco Mine	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-07	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Arvilla	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	47-0023-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Baby	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0283-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Bald Eagle	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0002-00	1C, 2Bd	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Ball Bluff	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	01-0046-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Bass	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	31-0576-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Battle Creek	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	82-0091-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0034-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Beaver	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	62-0016-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Beebe	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	86-0023-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Belle Taine	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0146-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Beltrami	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	04-0135-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bemidji (main lake)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	04-0130-02	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Bennett	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	62-0048-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Betty	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	47-0042-00	2B	Meeker	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Big	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	71-0082-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Big Bass (east basin)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	04-0132-02	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue

Big Bass (west basin)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	04-0132-01	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Big Birch (NE portion)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	77-0084-01	2B	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Big Birch (S portion)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	77-0084-02	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Big Fish	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0106-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Big Kandiyohi	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	34-0086-00	2B	Kandiyohi	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Big Portage (East Bay)	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	11-0308-02	2B	Cass	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Big Portage (West Bay)	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	11-0308-01	2B	Cass	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Big Sand	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0077-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Big Sand	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0185-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Big Sandy	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0062-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids	Mille Lacs	Aquatic Consumption	Mercury in fish tissue
Big Swan	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	47-0038-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Big Swan	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	77-0023-00	2B	Todd	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Big Trout	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	18-0315-00	1B, 2A	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Big Watab	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	73-0102-00	1B, 2A	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Black Hoof	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0117-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Blackwater	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	11-0274-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Blackwater	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	31-0561-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Blandin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0533-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Blind	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	01-0188-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Blueberry	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	80-0034-00	2B	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Borden	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	18-0020-00	2B	Crow Wing	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Boulder	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0162-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Briggs	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	71-0146-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Brownie	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0038-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Buck	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0069-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Buffalo	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0090-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Burgen	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0049-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Calhoun	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	34-0062-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Campbell	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	04-0196-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Carver	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	82-0166-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Cedar	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	49-0140-00	2B	Morrison	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Cedar	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0227-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Cedar Island (East Lk)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	73-0133-04	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Cedar Island (Koetter Lk)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	73-0133-03	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Cedar Island (Main Bay)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	73-0133-01	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue

Cedar Island (Mud Lk)	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	73-0133-02	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Cedar(Main Basin)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0209-01	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Cedar(N.E. Arm)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0209-02	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Cedar(West Bay)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0209-03	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Chase	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	31-0749-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Christmas	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0137-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0093-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	47-0095-00	2B	Meeker	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Clear	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	82-0163-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Clearwater	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0038-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Collinwood	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0293-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Como	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0055-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Crooked	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	02-0084-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Cross Lake Reservoir (Main Basin)	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	18-0312-01	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Cross Lake Reservoir (Southeast Bay)	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	18-0312-02	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Cross Lake Reservoir (Unnamed Bay)	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	18-0312-03	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Mill Cr to S Fk Crow R	Stream	2002	Upper Mississippi River, Upper Portion	07010204-503	2Bg	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Lk Koronis to M Fk Crow R	Stream	2002	Upper Mississippi River, Upper Portion	07010204-504	2Bg	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Jewitts Cr to Washington Cr	Stream	2002	Upper Mississippi River, Upper Portion	07010204-506	2Bg	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	M Fk Crow R to Jewitts Cr	Stream	2002	Upper Mississippi River, Upper Portion	07010204-507	2Bg	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Washington Cr to Meeker/Wright County line	Stream	2002	Upper Mississippi River, Upper Portion	07010204-555	2Bg	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Meeker/Wright County line to Mill Cr	Stream	2002	Upper Mississippi River, Upper Portion	07010204-556	2Bg	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Rice Lk to Lk Koronis	Stream	2006	Upper Mississippi River, Upper Portion	07010204-687	2Bg	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	Headwaters (Grove Lk 61-0023-00) to CD 32	Stream	2006	Upper Mississippi River, Upper Portion	07010204-763	2Bg	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, North Fork	CD 32 to Rice Lk	Stream	2006	Upper Mississippi River, Upper Portion	07010204-764	2Bg	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	Buffalo Cr to N Fk Crow R	Stream	1998	Upper Mississippi River, Upper Portion	07010205-508	2Bg	Carver	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	Hutchinson Dam to Bear Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010205-510	2Bg	McLeod	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	Bear Cr to Otter Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010205-511	2Bg	McLeod	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	Otter Cr to Buffalo Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010205-512	2Bg	Carver	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	Headwaters to 145th St	Stream	1998	Upper Mississippi River, Upper Portion	07010205-658	2Bm	Kandiyohi	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow River, South Fork	145th St to Hutchinson Dam	Stream	1998	Upper Mississippi River, Upper Portion	07010205-659	2Bg	Meeker	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Crow Wing	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0155-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Mosquito Cr to Long Prairie R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-508	2Bg	Morrison	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Swan Cr to Mosquito Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010106-509	2Bg	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Partridge R to Swan Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010106-510	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue

Crow Wing River	Leaf R to Partridge R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-511	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Farnham Cr to Leaf R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-512	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Beaver Cr to Farnham Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010106-513	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Cat R to Beaver Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010106-514	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Big Swamp Cr to Cat R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-515	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Shell R to Big Swamp Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010106-516	2Bg	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Headwaters (Eleventh Crow Wing Lk 29-0036-00) to Shell R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-523	2Bg	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crow Wing River	Long Prairie R to Mississippi R	Stream	1998	Upper Mississippi River, Upper Portion	07010106-721	2Bg	Morrison	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Crystal	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	11-0502-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Cutaway	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0429-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Dam	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0096-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Darling	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	21-0080-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Deer	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	04-0230-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Deer	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	31-0719-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Diamond	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	34-0044-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Dixon	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	31-0921-00	2B	Itasca	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Eagle	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	09-0057-00	2B	Carlton	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Eagle	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	10-0121-00	2B	Carver	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Eagle	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0111-01	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Eagle	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	29-0256-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
East Lake Sylvia	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0289-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
East Leaf	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	56-0116-02	2B	Otter Tail	07010107	Redeye River		Aquatic Consumption	Mercury in fish tissue
East Sarah	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0191-02	2B	Hennepin	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
East Twin	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	02-0133-00	2B	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
East Twin	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	18-0407-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
East Vadnais	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0038-01	1C, 2Bd	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Edward	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0305-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Eighth Crow Wing	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	29-0072-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Eleventh Crow Wing (East)	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0036-02	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Eleventh Crow Wing (Main)	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0036-01	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Elizabeth (Main Lake)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	34-0022-02	2B	Kandiyohi	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Elk	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	15-0010-00	2B	Clearwater	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Elk River	Mayhew Cr to Rice Cr	Stream	2002	Upper Mississippi River, Upper Portion	07010203-507	2Bg	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Elk River	Headwaters to Mayhew Cr	Stream	2002	Upper Mississippi River, Upper Portion	07010203-508	2Bg	Benton	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Elk River	Orono Lk to Mississippi R	Stream	2004	Upper Mississippi River, Upper Portion	07010203-525	2Bg	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue

Elk River	St Francis R to Orono Lk	Stream	2002	Upper Mississippi River, Upper Portion	07010203-548	2Bg	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Elk River	Elk Lk to St Francis R	Stream	2002	Upper Mississippi River, Upper Portion	07010203-579	2Bg	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Elk River	Rice Cr to Elk Lk	Stream	2002	Upper Mississippi River, Upper Portion	07010203-581	2Bg	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Elm Island	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0123-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Erie	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	47-0064-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Evergreen	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0227-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Farm Island	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0159-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Fifth Crow Wing	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	29-0092-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Fish	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	27-0118-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Fish	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	56-0066-00	2B	Otter Tail	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Fish Hook	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0242-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Forsythe	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	31-0560-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Fourth Crow Wing	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0078-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Francis	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0002-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
French	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	01-0104-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
French	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0273-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Garfield	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0061-00	2B	Hubbard	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Geneva	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	21-0052-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
George	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	02-0091-00	2B	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
George	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0216-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
George	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	34-0142-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Gervais	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0007-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Girl	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0174-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Golden	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	02-0045-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Grace	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0071-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Grand	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	73-0055-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Granite	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	86-0217-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Green	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	30-0136-00	2B	Isanti	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Grove	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	61-0023-00	2B	Pope	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Guile	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	31-0569-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Gull	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	04-0120-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Gull	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0305-00	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Gun	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0099-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Half Moon	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	27-0152-00	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Ham	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	02-0053-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue

Ham	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	29-0017-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Hammal	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0161-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Hanging Kettle	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0170-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Hardy	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	11-0209-00	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Hennepin	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0246-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Hickory	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	01-0179-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Hill (North Basin)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0142-01	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Hill (South Basin)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0142-02	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Hook	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	43-0073-00	2B	McLeod	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Horseshoe	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0157-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Horseshoe (East Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0251-01	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Horseshoe (West Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0251-02	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Howard	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0199-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Hubert	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	18-0375-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Ida	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0123-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Ida	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	86-0146-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Independence	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	27-0176-00	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
INGUADONA (N. BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0120-01	2B	Cass	07010102	Leech Lake River	Leech Lake	Aquatic Consumption	Mercury in fish tissue
INGUADONA (S. BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0120-02	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Irene	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	21-0076-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Irving	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	04-0140-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Island	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0254-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Island	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	31-0754-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Itasca	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	15-0016-00	2B	Clearwater	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
John	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0288-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Josephine	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0057-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Koronis (main lake)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0200-02	2B	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Kreigle	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	73-0097-00	2B	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Lake of the Isles	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0040-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Larue Pit	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	31-1326-01	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
LATOKA (NORTH BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0106-01	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
LATOKA (SOUTH BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0106-02	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Le Homme Dieu	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0056-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Leech (Ah-Gwah-Chin)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0203-03	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
LEECH (KABEKONA BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0203-02	2B	Cass	07010102	Leech Lake River	Leech Lake	Aquatic Consumption	Mercury in fish tissue

LEECH (MAIN BASIN)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0203-01	2B	Cass	07010102	Leech Lake River	Leech Lake	Aquatic Consumption	Mercury in fish tissue
LEECH (SHINGOBEE BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0203-04	2B	Cass	07010102	Leech Lake River	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Leech Lake River	Mud-Goose Lk Dam to Mississippi R	Stream	2014	Upper Mississippi River, Upper Portion	07010102-606	2Bg	Cass	07010102	Leech Lake River	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Little Bass	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	31-0575-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Birch	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	77-0089-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Little Boy	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0167-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Little Rock	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	05-0013-00	2B	Benton	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Little Swan	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	77-0034-00	2B	Todd	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Little Turtle	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	04-0155-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Little Waverly	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	86-0106-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
LOBSTER (EAST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0144-01	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
LOBSTER (WEST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0144-02	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Lone	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	01-0125-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0160-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0161-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	34-0066-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0026-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Long	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	73-0139-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Long (Main Bay)	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	31-0266-01	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Long Lost	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	15-0068-00	2B	Clearwater	07010106	Crow Wing River	White Earth	Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Fish Trap Cr to Crow Wing R	Stream	1998	Upper Mississippi River, Upper Portion	07010108-501	2Bg	Morrison	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Moran Cr to Fish Trap Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010108-502	2Bg	Todd	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Turtle Cr to Moran Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010108-503	2Bg	Todd	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Eagle Cr to Turtle Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010108-504	2Bg	Todd	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Spruce Cr to Eagle Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010108-505	2Bg	Todd	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	Headwaters (Lk Carlos 21-0057-00) to end of Wetland (CSAH 65)	Stream	1998	Upper Mississippi River, Upper Portion	07010108-534	2Bg	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Long Prairie River	End of Wetland (CSAH 65) to Spruce Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010108-535	2Bg	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Loon	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	11-0226-00	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Loon	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	31-0571-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Lost (North West Bay)	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	82-0134-01	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Lost (South East Bay)	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	82-0134-02	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Louise	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	21-0094-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Louise Mine	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-04	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Lower Bottle	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0180-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Lower Cullen	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	18-0403-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue

Lower Orono	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	71-0013-02	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Lower Panasa	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	31-0112-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Lower Prairie	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0384-01	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Lower Trelipe	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0129-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Lower Twin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0042-03	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Mahnomen Mine #1	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-01	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mahnomen Mine #2	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-02	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mahnomen Mine #3	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0440-03	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
MANTRAP (EAST BASIN)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0151-01	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
MANTRAP (HOME BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0151-05	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Mantrap (Middle Basin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0151-02	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
MANTRAP (MIRROR BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0151-03	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
MANTRAP (WEST ARM)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0151-04	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Maple	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	77-0181-00	2B	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Marion	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	43-0084-00	2B	McLeod	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Marquette	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	04-0142-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Mary	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0092-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Mary	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	77-0019-00	2B	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Mary	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	86-0156-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Mary	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	86-0193-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Mayhew	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	05-0007-00	2B	Benton	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
McCarron	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	62-0054-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Medicine	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0104-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Middle Twin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0042-02	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Midge	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0066-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Mille Lacs	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	48-0002-00	2B	Aitkin	07010207	Rum River	Mille Lacs	Aquatic Consumption	Mercury in fish tissue
Miltona	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0083-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Mink	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	86-0229-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Black Lake	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-06	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Carsons Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-03	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Crystal Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-10	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Emerald Lake	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-08	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Grays Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-01	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Halsteds Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-09	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Jennings Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-15	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue

Minnetonka-Lower Lake	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-02	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Maxwell Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-11	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-North Arm	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-13	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Seton Lake	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-07	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-St. Albans Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-04	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Stubbs Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-12	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-Upper Lake	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-05	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnetonka-West Arm	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0133-14	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnewashta	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	10-0009-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Minnewawa	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0033-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids	Mille Lacs	Aquatic Consumption	Mercury in fish tissue
Minnie-Belle	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0119-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Lk Winnibigoshish (11-0147-00) to Cohasset Dam	Stream	2010	Upper Mississippi River, Upper Portion	07010101-756	2Bg	Itasca	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Mississippi River	Cohasset Dam to Swan R	Stream	1998	Upper Mississippi River, Upper Portion	07010103-707	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Swan R to Willow R	Stream	1998	Upper Mississippi River, Upper Portion	07010103-708	2Bg	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Willow R to Pine R	Stream	1998	Upper Mississippi River, Upper Portion	07010104-655	2Bg	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Pine R to Crow Wing R	Stream	1998	Upper Mississippi River, Upper Portion	07010104-656	2Bg	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Crow Wing R to Crow Wing/Morrison County border	Stream	1998	Upper Mississippi River, Upper Portion	07010104-657	2Bg	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Crow Wing/Morrison County border to Swan R	Stream	1998	Upper Mississippi River, Upper Portion	07010104-658	1C, 2Bdg	Morrison	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Swan R to Sauk R	Stream	1998	Upper Mississippi River, Upper Portion	07010201-631	1C, 2Bdg	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Sauk R to Clearwater R	Stream	1998	Upper Mississippi River, Upper Portion	07010203-728	1C, 2Bdg	Stearns	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Clearwater R to Crow R	Stream	1998	Upper Mississippi River, Upper Portion	07010203-729	1C, 2Bdg	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Crow R to Upper St Anthony Falls	Stream	1998	Upper Mississippi River, Upper Portion	07010206-805	1C, 2Bdg	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Mississippi River	Upper St Anthony Falls to St Croix R	Stream	1998	Upper Mississippi River, Upper Portion	07010206-814	2Bg	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in water column
Mississippi River	Upper St Anthony Falls to St Croix R	Stream	1998	Upper Mississippi River, Upper Portion	07010206-814	2Bg	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Mitchell	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	71-0081-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Moose	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0722-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Movil	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	04-0152-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Mud	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0200-01	2B	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Nest	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	34-0154-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Nokay	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0104-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Nokomis	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0019-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
North Little Long	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	27-0179-01	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
North Long	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0372-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
North Long	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0067-01	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
North Whaletail	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	27-0184-01	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue

Oak	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	10-0093-00	2B	Carver	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Osakis	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	77-0215-00	2B	Douglas	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Otter	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	02-0003-00	1C, 2Bd	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Ox Hide	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0106-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Palmer	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	29-0087-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Pearl	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	73-0037-00	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Pelican	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0308-00	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Pelican	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	73-0118-00	2B	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Peltier	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	02-0004-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Phalen	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	62-0013-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0182-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	19-0079-00	2B	Dakota	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Pickerel	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0178-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Pike	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0111-02	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Pimushe	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	04-0032-00	2B	Beltrami	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Pine Mountain	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0411-00	2B	Cass	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Pine River	Little Pine R to Mississippi R	Stream	2016	Upper Mississippi River, Upper Portion	07010105-504	2Bg	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Plantagenet	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0156-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Plantation	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0439-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Platte	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	18-0088-00	2B	Crow Wing	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Platte River	Rice-Skunk Lakes Dam to Unnamed cr (above RR bridge)	Stream	2020	Upper Mississippi River, Upper Portion	07010201-546	2Bg	Morrison	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Pleasant	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	62-0046-00	1C, 2Bd	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Pleasant	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0251-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
POKEGAMA (MAIN BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0532-01	1B, 2A	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
POKEGAMA (WENDIGO)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0532-02	1B, 2A	Itasca	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Portage	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0050-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Portage	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	29-0250-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Portsmouth Mine	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0437-00	1B, 2A	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Potato	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0243-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Powderhorn	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	27-0014-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Prairie (main bay)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0384-02	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Prairie River	Prairie Lk to Mississippi R	Stream	2018	Upper Mississippi River, Upper Portion	07010103-508	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Prairie River	Headwaters to Day Bk	Stream	2018	Upper Mississippi River, Upper Portion	07010103-543	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Prairie River	Day Bk to Balsam Cr	Stream	2018	Upper Mississippi River, Upper Portion	07010103-759	2Be	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Prairie River	Balsam Cr to Prairie Lk	Stream	2018	Upper Mississippi River, Upper Portion	07010103-760	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue

Preston	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	65-0002-00	2B	Renville	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Pulaski (main bay)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0053-02	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Rabbit (East Portion)	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	18-0093-01	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Rabbit (West Portion)	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	18-0093-02	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Rabideau	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	04-0034-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Rebecca	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	19-0003-00	2B	Dakota	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Rebecca	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0192-00	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Red Sand	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0386-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Redeye River	Hay Cr to Leaf R	Stream	2014	Upper Mississippi River, Upper Portion	07010107-502	2Bg	Wadena	07010107	Redeye River		Aquatic Consumption	Mercury in fish tissue
Redeye River	Headwaters (Wolf Lk 03-0101-00) to Hay Cr	Stream	2014	Upper Mississippi River, Upper Portion	07010107-503	2Bg	Wadena	07010107	Redeye River		Aquatic Consumption	Mercury in fish tissue
Rice	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0145-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Rice	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0196-00	2B	Stearns	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Richardson	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0088-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Ripley (west portion)	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	47-0134-02	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Rock	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	01-0072-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	01-0023-00	2B	Aitkin	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	01-0137-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	01-0204-00	2B	Aitkin	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Round	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0373-00	2B	Crow Wing	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Rum River	Cedar Cr to Trott Bk	Stream	1998	Upper Mississippi River, Upper Portion	07010207-502	2Bg	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Seelye Bk to Cedar Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010207-503	2Bg	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Stanchfield Cr to Seelye Bk	Stream	1998	Upper Mississippi River, Upper Portion	07010207-504	2Bg	Isanti	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Lk Onamia to Tibbetts Bk	Stream	1998	Upper Mississippi River, Upper Portion	07010207-509	2Bg	Mille Lacs	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Tibbetts Bk to Bogus Bk	Stream	1998	Upper Mississippi River, Upper Portion	07010207-510	2Bg	Mille Lacs	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Bogus Bk to W Br Rum R	Stream	1998	Upper Mississippi River, Upper Portion	07010207-511	2Bg	Mille Lacs	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	W Br Rum R to Stanchfield Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010207-512	2Bg	Isanti	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Madison/Rice St in Anoka to Mississippi R	Stream	1998	Upper Mississippi River, Upper Portion	07010207-556	2Bg	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Anoka Dam to Madison/Rice St in Anoka	Stream	1998	Upper Mississippi River, Upper Portion	07010207-665	2Bg	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Rum River	Trott Bk to Anoka Dam	Stream	1998	Upper Mississippi River, Upper Portion	07010207-666	2Bg	Anoka	07010207	Rum River		Aquatic Consumption	Mercury in fish tissue
Ruth	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0212-00	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Sagatagan	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	73-0092-00	2B	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
SAUK (NORTH BAY)	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	77-0150-02	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk (Southwest Bay)	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	77-0150-01	2B	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Mill Cr to Mississippi R	Stream	1998	Upper Mississippi River, Upper Portion	07010202-501	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Adley Cr to Getchell Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010202-505	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue

Sauk River	Melrose Dam to Adley Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010202-506	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Sauk Lk to Melrose Dam	Stream	1998	Upper Mississippi River, Upper Portion	07010202-507	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Getchell Cr to State Hwy 23	Stream	1998	Upper Mississippi River, Upper Portion	07010202-508	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Knaus Lk to Cold Spring Dam	Stream	1998	Upper Mississippi River, Upper Portion	07010202-517	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Cold Spring Dam to Cold Spring WWTP	Stream	1998	Upper Mississippi River, Upper Portion	07010202-519	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Cold Spring WWTP to Mill Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010202-520	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	State Hwy 23 to Horseshoe Lk	Stream	1998	Upper Mississippi River, Upper Portion	07010202-557	2Bg	Stearns	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Headwaters (Lk Osakis 77-0215-00) to Guernsey Lk	Stream	1998	Upper Mississippi River, Upper Portion	07010202-667	2Bg	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Guernsey Lk to Little Sauk Lk	Stream	1998	Upper Mississippi River, Upper Portion	07010202-669	2Bg	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Little Sauk Lk to Juergens Lk	Stream	1998	Upper Mississippi River, Upper Portion	07010202-671	2Bg	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Sauk River	Juergens Lk to Sauk Lk	Stream	1998	Upper Mississippi River, Upper Portion	07010202-673	2Bg	Todd	07010202	Sauk River		Aquatic Consumption	Mercury in fish tissue
Schoolcraft	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0215-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Scrapper	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	31-0345-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Sebie	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0161-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Serpent	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0090-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Seventh Crow Wing	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0091-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Shallow	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	31-0084-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Shamineau	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	49-0127-00	2B	Morrison	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Shingobee	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0043-00	2B	Hubbard	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Silver	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	62-0083-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Silver	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0140-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Sissabagamah	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	01-0129-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Sixth Crow Wing	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0093-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Snail	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	62-0073-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
South Little Long	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	27-0179-02	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
South Long	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	18-0136-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
South Long	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0067-02	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
South Twin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	04-0053-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
South Whaletail	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	27-0184-02	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
SPIDER (EAST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0117-02	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
SPIDER (NE/SW BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	29-0117-01	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Spirit	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	01-0178-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Spring	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0032-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Spurzem	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	27-0149-00	2B	Hennepin	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Stahl's	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	43-0104-00	2B	McLeod	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue

Stocking	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	80-0037-00	2B	Wadena	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Stony	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	11-0371-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Straight	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	03-0010-00	2B	Becker	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Stump	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	04-0130-01	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Sucker	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	62-0028-00	1C, 2Bd	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Sugar	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0026-00	2B	Cass	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Sullivan	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	49-0016-00	2B	Morrison	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Sunset	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	01-0208-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
SWAN (MAIN BASIN)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0067-02	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
SWAN (WEST BAY)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0067-01	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Swan Lake Southwest Bay	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0067-03	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Swan River	Swan Lk to Trout Cr	Stream	1998	Upper Mississippi River, Upper Portion	07010103-753	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Swan River	Trout Cr to Mississippi R	Stream	1998	Upper Mississippi River, Upper Portion	07010103-754	2Bg	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Swenson	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	04-0085-00	2B	Beltrami	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Sylvan (Main Basin)	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	49-0036-01	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Sylvan (North Basin)	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	49-0036-02	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Sylvan (Northeast Bay)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0304-02	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Sylvan (Southwest Bay)	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0304-01	2B	Cass	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Third Crow Wing	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	29-0077-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Thunder	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	11-0062-00	2B	Cass	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Trillium	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	11-0270-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Trout	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0410-00	1B, 2A	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Turtle	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	04-0159-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Turtle River	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	04-0111-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Consumption	Mercury in fish tissue
Two Inlets	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	03-0017-00	2B	Becker	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Two Rivers	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	73-0138-00	2B	Stearns	07010201	Mississippi River - Sartell		Aquatic Consumption	Mercury in fish tissue
Union	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	86-0298-00	2B	Meeker	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Unnamed	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-1225-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Unnamed	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	62-0237-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Upper Bottle	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	29-0148-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Upper Dean	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	18-0170-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Upper Hay	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0412-00	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Upper Mission	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	18-0242-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Upper Orono	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	71-0013-01	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Consumption	Mercury in fish tissue
Upper Panasa	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0111-00	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue

Upper Prairie	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	31-0384-03	2B	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Upper South Long	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	18-0096-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Upper Twin	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0042-01	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Upper Twin	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	29-0157-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Victoria	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	21-0054-00	2B	Douglas	07010108	Long Prairie River		Aquatic Consumption	Mercury in fish tissue
Virginia	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	10-0015-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Wabana	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	31-0392-00	1B, 2A	Itasca	07010103	Mississippi River - Grand Rapids		Aquatic Consumption	Mercury in fish tissue
Wabedo (North East Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0171-01	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Wabedo (South West Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0171-02	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
Waboose	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	29-0098-00	2B	Hubbard	07010106	Crow Wing River		Aquatic Consumption	Mercury in fish tissue
Washburn	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	11-0059-00	2B	Cass	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Washington	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	47-0046-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Wassermann	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	10-0048-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Waukenabo	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0136-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Consumption	Mercury in fish tissue
Waverly	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	86-0114-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Weaver	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0117-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Webb	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	11-0311-00	2B	Cass	07010102	Leech Lake River		Aquatic Consumption	Mercury in fish tissue
West Fox	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	18-0297-00	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
West Lake Sylvia	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	86-0279-00	2B	Wright	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
West Leaf	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	56-0114-00	2B	Otter Tail	07010107	Redeye River		Aquatic Consumption	Mercury in fish tissue
West Sarah	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0191-01	2B	Hennepin	07010204	North Fork Crow River		Aquatic Consumption	Mercury in fish tissue
White Bear	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	82-0167-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Whitefish	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	18-0001-00	2B	Crow Wing	07010207	Rum River	Mille Lacs	Aquatic Consumption	Mercury in fish tissue
Whitefish	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	18-0310-00	2B	Crow Wing	07010105	Pine River		Aquatic Consumption	Mercury in fish tissue
Willie	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	47-0061-00	2B	Meeker	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Winsted	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	43-0012-00	2B	McLeod	07010205	South Fork Crow River		Aquatic Consumption	Mercury in fish tissue
Wirth	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	27-0037-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue
Wolf	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	04-0079-00	2B	Beltrami	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Consumption	Mercury in fish tissue
Zumbra-Sunny	Lake or Reservoir	Lake	1998	Upper Mississippi River, Upper Portion	10-0041-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Consumption	Mercury in fish tissue

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT I

(MPCA Impaired Waters List for Nutrients, 2022)

MPCA Section 303(d) Impaired Waters List (2022)
Nutrient Impairments

Water body name	Water body description	Water body type	Year added to List	Basin	AUID	Use Class	County	HUC 8	Watershed name	Partial tribal designation	Affected designated use	Pollutant or stressor
Elbow	Lake or Reservoir	Lake	2022	Lake Superior	69-0717-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Long	Lake or Reservoir	Lake	2012	Lake Superior	69-0495-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Manganika	Lake or Reservoir	Lake	2008	Lake Superior	69-0726-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Mashkenode	Lake or Reservoir	Lake	2022	Lake Superior	69-0725-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
McQuade	Lake or Reservoir	Lake	2012	Lake Superior	69-0775-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Mud Hen	Lake or Reservoir	Lake	2012	Lake Superior	69-0494-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Strand	Lake or Reservoir	Lake	2012	Lake Superior	69-0529-00	2B	St. Louis	04010201	St. Louis River		Aquatic Recreation	Nutrients
Altermatt	Lake or Reservoir	Lake	2020	Minnesota River	08-0054-00	2B	Brown	07020008	Cottonwood River		Aquatic Recreation	Nutrients
Amber	Lake or Reservoir	Lake	2006	Minnesota River	46-0034-00	1C, 2Bd	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Bachelor	Lake or Reservoir	Lake	2020	Minnesota River	08-0029-00	2B	Brown	07020008	Cottonwood River		Aquatic Recreation	Nutrients
Barrett	Lake or Reservoir	Lake	2020	Minnesota River	26-0095-00	2B	Grant	07020002	Pomme de Terre River		Aquatic Recreation	Nutrients
Bean	Lake or Reservoir	Lake	2010	Minnesota River	17-0054-00	2B	Cottonwood	07020008	Cottonwood River		Aquatic Recreation	Nutrients
Benton	Lake or Reservoir	Lake	2006	Minnesota River	41-0043-00	2B	Lincoln	07020006	Redwood River		Aquatic Recreation	Nutrients
Big Stone	Lake or Reservoir	Lake	2018	Minnesota River	06-0152-00	2B	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Recreation	Nutrients
Big Twin	Lake or Reservoir	Lake	2010	Minnesota River	46-0133-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Blue Earth River	Rapidan Dam to Le Sueur R	Stream	2016	Minnesota River	07020009-509	2Bg	Blue Earth	07020009	Blue Earth River		Aquatic Life	Nutrients
Boise	Lake or Reservoir	Lake	2020	Minnesota River	08-0096-00	2B	Brown	07020008	Cottonwood River		Aquatic Recreation	Nutrients
Budd	Lake or Reservoir	Lake	2006	Minnesota River	46-0030-00	1C, 2Bd	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Cedar	Lake or Reservoir	Lake	2020	Minnesota River	46-0121-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Chippewa River	Stowe Lk to Little Chippewa R	Stream	2022	Minnesota River	07020005-503	2Bg	Grant	07020005	Chippewa River		Aquatic Life	Nutrients
Clear	Lake or Reservoir	Lake	2020	Minnesota River	08-0011-00	2B	Brown	07020008	Cottonwood River		Aquatic Recreation	Nutrients
Clear	Lake or Reservoir	Lake	2020	Minnesota River	42-0055-00	2B	Lyon	07020006	Redwood River		Aquatic Recreation	Nutrients
Cobb River	Sueur R	Stream	2016	Minnesota River	07020011-556	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Life	Nutrients
Dead Coon (Main Lake)	Lake or Reservoir	Lake	2010	Minnesota River	41-0021-01	2B	Lincoln	07020006	Redwood River		Aquatic Recreation	Nutrients
Double (North Portion)	Lake or Reservoir	Lake	2010	Minnesota River	17-0056-01	2B	Cottonwood	07020008	Cottonwood River		Aquatic Recreation	Nutrients
East Chain	Lake or Reservoir	Lake	2020	Minnesota River	46-0010-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
East Sunburg	Lake or Reservoir	Lake	2022	Minnesota River	34-0336-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Recreation	Nutrients
Fish	Lake or Reservoir	Lake	2020	Minnesota River	46-0145-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Fox	Lake or Reservoir	Lake	2010	Minnesota River	46-0109-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
George	Lake or Reservoir	Lake	2006	Minnesota River	46-0024-00	1C, 2Bd	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Goose	Lake or Reservoir	Lake	2022	Minnesota River	61-0043-00	2B	Pope	07020005	Chippewa River		Aquatic Recreation	Nutrients
Goose	Lake or Reservoir	Lake	2010	Minnesota River	42-0093-00	2B	Lyon	07020006	Redwood River		Aquatic Recreation	Nutrients
Hall	Lake or Reservoir	Lake	2006	Minnesota River	46-0031-00	1C, 2Bd	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Ida	Lake or Reservoir	Lake	2020	Minnesota River	07-0090-00	2B	Blue Earth	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Iowa	Lake or Reservoir	Lake	2020	Minnesota River	46-0049-00	2B	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Island	Lake or Reservoir	Lake	2020	Minnesota River	42-0096-00	2B	Lyon	07020006	Redwood River		Aquatic Recreation	Nutrients
Lac Qui Parle (NW Bay)	Lake or Reservoir	Lake	2018	Minnesota River	37-0046-02	2B	Chippewa	07020001	Minnesota River - Headwaters		Aquatic Recreation	Nutrients
Lac Qui Parle (SE Bay)	Lake or Reservoir	Lake	2018	Minnesota River	37-0046-01	2B	Chippewa	07020001	Minnesota River - Headwaters		Aquatic Recreation	Nutrients
Le Sueur River	Maple R to Blue Earth R	Stream	2016	Minnesota River	07020011-501	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Life	Nutrients
Little Cobb River	Bull Run Cr to Cobb R	Stream	2016	Minnesota River	07020011-504	2Bg	Blue Earth	07020011	Le Sueur River		Aquatic Life	Nutrients
Long Tom	Lake or Reservoir	Lake	2018	Minnesota River	06-0029-00	2B	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Recreation	Nutrients
Middle	Lake or Reservoir	Lake	2012	Minnesota River	34-0208-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Recreation	Nutrients
Minnesota River	RM 22 to Mississippi R	Stream	2016	Minnesota River	07020012-505	2Bg	Dakota	07020012	Lower Minnesota River		Aquatic Life	Nutrients
Minnesota River	Carver Cr to RM 22	Stream	2016	Minnesota River	07020012-506	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Life	Nutrients
Minnesota River	Cherry Cr to High Island Cr	Stream	2016	Minnesota River	07020012-799	2Bg	Le Sueur	07020012	Lower Minnesota River		Aquatic Life	Nutrients
Minnesota River	High Island Cr to Carver Cr	Stream	2016	Minnesota River	07020012-800	2Bg	Scott	07020012	Lower Minnesota River		Aquatic Life	Nutrients
Minnesota River	Beaver Cr to Little Rock Cr	Stream	2018	Minnesota River	07020007-720	2Bg	Brown	07020007	Minnesota River - Mankato		Aquatic Life	Nutrients
Minnesota River	Little Rock Cr to Cottonwood R	Stream	2018	Minnesota River	07020007-721	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Life	Nutrients

Minnesota River	Cottonwood R to Blue Earth R	Stream	2016	Minnesota River	07020007-722	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Life	Nutrients
Minnesota River	Blue Earth R to Cherry Cr	Stream	2016	Minnesota River	07020007-723	2Bg	Nicollet	07020007	Minnesota River - Mankato		Aquatic Life	Nutrients
Minnesota River	Medicine R	Stream	2018	Minnesota River	07020004-748	2Bg	Yellow Medicine	07020004	Minnesota River - Yellow Medicine River		Aquatic Life	Nutrients
Minnesota River	Yellow Medicine R to Echo Cr	Stream	2018	Minnesota River	07020004-749	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Life	Nutrients
Minnesota River	Echo Cr to Beaver Cr	Stream	2016	Minnesota River	07020004-750	2Bg	Renville	07020004	Minnesota River - Yellow Medicine River		Aquatic Life	Nutrients
North Drywood	Lake or Reservoir	Lake	2020	Minnesota River	76-0169-00	2B	Swift	07020002	Pomme de Terre River		Aquatic Recreation	Nutrients
Redwood River	Ramsey Cr to Minnesota R	Stream	2016	Minnesota River	07020006-501	2Bg	Redwood	07020006	Redwood River		Aquatic Life	Nutrients
Rice	Lake or Reservoir	Lake	2020	Minnesota River	22-0007-00	2B	Faribault	07020009	Blue Earth River		Aquatic Recreation	Nutrients
Rock	Lake or Reservoir	Lake	2010	Minnesota River	42-0052-00	2B	Lyon	07020008	Cottonwood River		Aquatic Recreation	Nutrients
School Grove	Lake or Reservoir	Lake	2010	Minnesota River	42-0002-00	2B	Lyon	07020006	Redwood River		Aquatic Recreation	Nutrients
Sisseton	Lake or Reservoir	Lake	2006	Minnesota River	46-0025-00	1C, 2Bd	Martin	07020009	Blue Earth River		Aquatic Recreation	Nutrients
South Drywood	Lake or Reservoir	Lake	2020	Minnesota River	76-0149-00	2B	Swift	07020002	Pomme de Terre River		Aquatic Recreation	Nutrients
Steenerson	Lake or Reservoir	Lake	2012	Minnesota River	61-0095-00	2B	Pope	07020005	Chippewa River		Aquatic Recreation	Nutrients
Stowe	Lake or Reservoir	Lake	2022	Minnesota River	21-0264-00	2B	Douglas	07020005	Chippewa River		Aquatic Recreation	Nutrients
Sunburg	Lake or Reservoir	Lake	2022	Minnesota River	34-0359-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Recreation	Nutrients
Swenson	Lake or Reservoir	Lake	2022	Minnesota River	34-0321-00	2B	Kandiyohi	07020005	Chippewa River		Aquatic Recreation	Nutrients
Unnamed	Lake or Reservoir	Lake	2018	Minnesota River	06-0060-00	2B	Big Stone	07020001	Minnesota River - Headwaters		Aquatic Recreation	Nutrients
Unnamed creek	Unnamed cr to Artichoke Cr	Stream	2020	Minnesota River	07020002-566	2Bg	Big Stone	07020002	Pomme de Terre River		Aquatic Life	Nutrients
Venus	Lake or Reservoir	Lake	2022	Minnesota River	21-0305-00	2B	Douglas	07020005	Chippewa River		Aquatic Recreation	Nutrients
Willmar (main bay)	Lake or Reservoir	Lake	2018	Minnesota River	34-0180-01	2B	Kandiyohi	07020004	Minnesota River - Yellow Medicine River		Aquatic Recreation	Nutrients
Little Spirit	Lake or Reservoir	Lake	2004	Missouri River	32-0024-00	2B	Jackson	10230003	Little Sioux River		Aquatic Recreation	Nutrients
Split Rock Creek	Pipestone Cr to MN/SD border	Stream	2016	Missouri River	10170203-512	2Bg	Rock	10170203	Lower Big Sioux River		Aquatic Life	Nutrients
Little Spring	Lake or Reservoir	Lake	2014	Rainy River	31-0797-00	2B	Itasca	09030006	Big Fork River		Aquatic Recreation	Nutrients
Shallow Pond	Lake or Reservoir	Lake	2014	Rainy River	31-0910-00	2B	Itasca	09030006	Big Fork River		Aquatic Recreation	Nutrients
Alice	Lake or Reservoir	Lake	2022	Red River of the North	56-0867-00	2B	Otter Tail	09020103	Otter Tail River		Aquatic Recreation	Nutrients
Height of Land	Lake or Reservoir	Lake	2010	Red River of the North	03-0195-00	2B	Becker	09020103	Otter Tail River		Aquatic Recreation	Nutrients
Lee	Lake or Reservoir	Lake	2012	Red River of the North	14-0049-00	2B	Clay	09020106	Buffalo River		Aquatic Recreation	Nutrients
Mud	Lake or Reservoir	Lake	2014	Red River of the North	78-0024-00	2B	Traverse	09020101	Bois de Sioux River		Aquatic Recreation	Nutrients
Rockstad	Lake or Reservoir	Lake	2018	Red River of the North	15-0075-00	2B	Clearwater	09020108	Wild Rice River		Aquatic Recreation	Nutrients
Barker	Lake or Reservoir	Lake	2012	St. Croix River	82-0076-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Benz	Lake or Reservoir	Lake	2012	St. Croix River	82-0120-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Downs	Lake or Reservoir	Lake	2012	St. Croix River	82-0110-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Goose (South)	Lake or Reservoir	Lake	2012	St. Croix River	82-0113-02	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Long	Lake or Reservoir	Lake	2002	St. Croix River	82-0021-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Lynch	Lake or Reservoir	Lake	2010	St. Croix River	82-0042-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Mandall	Lake or Reservoir	Lake	2022	St. Croix River	13-0074-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
McDonald	Lake or Reservoir	Lake	2022	St. Croix River	82-0010-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Nielson	Lake or Reservoir	Lake	2022	St. Croix River	82-0055-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Rabour	Lake or Reservoir	Lake	2022	St. Croix River	13-0079-00	2B	Chisago	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Silver	Lake or Reservoir	Lake	2022	St. Croix River	62-0001-00	2B	Ramsey	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
South School Section	Lake or Reservoir	Lake	2002	St. Croix River	82-0151-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
St. Croix River	(82-0001-00)	Stream	2020	St. Croix River	07030005-784	1C, 2Bdg	Washington	07030005	Lower St. Croix River		Aquatic Life	Nutrients
Twin	Lake or Reservoir	Lake	2022	St. Croix River	30-0004-00	2B	Isanti	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Unnamed	Lake or Reservoir	Lake	2006	St. Croix River	82-0077-00	2B	Washington	07030005	Lower St. Croix River		Aquatic Recreation	Nutrients
Cannon River	Belle Cr to split near mouth	Stream	2016	Upper Mississippi River, Lower Portion	07040002-501	2Bg	Goodhue	07040002	Cannon River		Aquatic Life	Nutrients
Cannon River	Cannon Lk to Straight R	Stream	2016	Upper Mississippi River, Lower Portion	07040002-540	2Bg	Rice	07040002	Cannon River		Aquatic Life	Nutrients
Zumbro	Lake or Reservoir	Lake	2002	Upper Mississippi River, Lower Portion	55-0004-00	2B	Olmsted	07040004	Zumbro River		Aquatic Recreation	Nutrients
Zumbro River, Middle Fork, South Branch	75th St NW to M Fk Zumbro R	Stream	2016	Upper Mississippi River, Lower Portion	07040004-978	2Bg	Olmsted	07040004	Zumbro River		Aquatic Life	Nutrients

Agnes	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	21-0053-00	2B	Douglas	07010108	Long Prairie River		Aquatic Recreation	Nutrients
Alice	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0286-00	2B	Hubbard	07010101	Mississippi River - Headwaters		Aquatic Recreation	Nutrients
Black Oak	Lake or Reservoir	Lake	2022	Upper Mississippi River, Upper Portion	73-0241-00	2B	Stearns	07010202	Sauk River		Aquatic Recreation	Nutrients
Blind	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0188-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
Casey	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	18-0087-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
Church	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	10-0046-00	2B	Carver	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Colby	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	82-0094-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Crooked Lake Ditch	Unnamed cr to Fairfield Cr	Stream	2022	Upper Mississippi River, Upper Portion	07010202-637	2Bg	Douglas	07010202	Sauk River		Aquatic Life	Nutrients
Crow River	S Fk Crow R to Mississippi R	Stream	2016	Upper Mississippi River, Upper Portion	07010204-502	2Bg	Hennepin	07010204	North Fork Crow River		Aquatic Life	Nutrients
Crow River, North Fork	Mill Cr to S Fk Crow R	Stream	2016	Upper Mississippi River, Upper Portion	07010204-503	2Bg	Wright	07010204	North Fork Crow River		Aquatic Life	Nutrients
Crow River, South Fork	Buffalo Cr to N Fk Crow R	Stream	2016	Upper Mississippi River, Upper Portion	07010205-508	2Bg	Carver	07010205	South Fork Crow River		Aquatic Life	Nutrients
Crow River, South Fork	Hutchinson Dam to Bear Cr	Stream	2016	Upper Mississippi River, Upper Portion	07010205-510	2Bg	McLeod	07010205	South Fork Crow River		Aquatic Life	Nutrients
Crow River, South Fork	Bear Cr to Otter Cr	Stream	2016	Upper Mississippi River, Upper Portion	07010205-511	2Bg	McLeod	07010205	South Fork Crow River		Aquatic Life	Nutrients
Crow River, South Fork	Headwaters to 145th St	Stream	2016	Upper Mississippi River, Upper Portion	07010205-658	2Bm	Kandiyohi	07010205	South Fork Crow River		Aquatic Life	Nutrients
Crow River, South Fork	145th St to Hutchinson Dam	Stream	2016	Upper Mississippi River, Upper Portion	07010205-659	2Bg	Meeker	07010205	South Fork Crow River		Aquatic Life	Nutrients
Decker	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	31-0934-00	2B	Itasca	07010101	Mississippi River - Headwaters		Aquatic Recreation	Nutrients
Diann	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	71-0046-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Dixon	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	31-0921-00	2B	Itasca	07010101	Mississippi River - Headwaters	Leech Lake	Aquatic Recreation	Nutrients
Dog	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	86-0178-00	2B	Wright	07010204	North Fork Crow River		Aquatic Recreation	Nutrients
Eagle	Lake or Reservoir	Lake	2022	Upper Mississippi River, Upper Portion	71-0067-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Elk	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	71-0055-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Ellering	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	73-0244-00	2B	Stearns	07010202	Sauk River		Aquatic Recreation	Nutrients
Emily	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	18-0203-00	2B	Crow Wing	07010105	Pine River		Aquatic Recreation	Nutrients
Esquagamah	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0147-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
Fish	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	82-0137-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Fremont	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	71-0016-00	2B	Sherburne	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Goodners	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	73-0076-00	2B	Stearns	07010202	Sauk River		Aquatic Recreation	Nutrients
Grave	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	18-0110-00	2B	Crow Wing	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
Green Mountain	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	86-0063-00	2B	Wright	07010204	North Fork Crow River		Aquatic Recreation	Nutrients
Hart	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	29-0063-00	2B	Hubbard	07010102	Leech Lake River		Aquatic Recreation	Nutrients
Henry	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	21-0051-00	2B	Douglas	07010108	Long Prairie River		Aquatic Recreation	Nutrients

Hunters	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	86-0026-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Irene, Lake	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	27-0189-00	2B	Hennepin	07010205	South Fork Crow River		Aquatic Recreation	Nutrients
Jesse	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	34-0060-00	2B	Kandiyohi	07010204	North Fork Crow River		Aquatic Recreation	Nutrients
La	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	82-0097-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Larson	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	04-0154-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Recreation	Nutrients
Laura	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	27-0123-00	2B	Hennepin	07010204	North Fork Crow River		Aquatic Recreation	Nutrients
Little Mary (North Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	86-0139-02	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Little Mary (South Bay)	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	86-0139-01	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Little Stanchfield	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	30-0044-00	2B	Isanti	07010207	Rum River		Aquatic Recreation	Nutrients
Maria	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	73-0215-00	2B	Stearns	07010202	Sauk River		Aquatic Recreation	Nutrients
Markgrafs	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	82-0089-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Mill Creek	Buffalo Lk to N Fk Crow R	Stream	2016	Upper Mississippi River, Upper Portion	07010204-515	2Bg	Wright	07010204	North Fork Crow River		Aquatic Life	Nutrients
Millstone	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	86-0152-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Mitten	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	11-0114-00	2B	Cass	07010105	Pine River		Aquatic Recreation	Nutrients
Moose	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	04-0342-00	2B	Beltrami	07010101	Mississippi River - Headwaters		Aquatic Recreation	Nutrients
Northwood	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	27-0627-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Peavey	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	27-0138-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Pleasant	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	62-0046-00	1C, 2Bd	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Portage	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	01-0069-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
Powderhorn	Lake or Reservoir	Lake	2018	Upper Mississippi River, Upper Portion	27-0014-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Priebe	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	62-0036-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Sandy	Lake or Reservoir	Lake	2002	Upper Mississippi River, Upper Portion	02-0080-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Sauk River	Mill Cr to Mississippi R	Stream	2016	Upper Mississippi River, Upper Portion	07010202-501	2Bg	Stearns	07010202	Sauk River		Aquatic Life	Nutrients
Sauk River	Knaus Lk to Cold Spring Dam	Stream	2016	Upper Mississippi River, Upper Portion	07010202-517	2Bg	Stearns	07010202	Sauk River		Aquatic Life	Nutrients
School	Lake or Reservoir	Lake	2012	Upper Mississippi River, Upper Portion	86-0025-00	2B	Wright	07010203	Mississippi River - St. Cloud		Aquatic Recreation	Nutrients
Sixmile Creek	Mud Lk to Lk Minnetonka	Stream	2016	Upper Mississippi River, Upper Portion	07010206-551	2Bg	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Life	Nutrients
South	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	43-0014-00	2B	McLeod	07010205	South Fork Crow River		Aquatic Recreation	Nutrients
Tamarack	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	09-0067-00	2B	Carlton	07010103	Mississippi River - Grand Rapids		Aquatic Recreation	Nutrients
Tennyson	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	30-0113-00	2B	Isanti	07010207	Rum River		Aquatic Recreation	Nutrients
Twelve	Lake or Reservoir	Lake	2016	Upper Mississippi River, Upper Portion	49-0006-00	2B	Morrison	07010207	Rum River		Aquatic Recreation	Nutrients
Twin	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	27-0656-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients

Unnamed	Lake or Reservoir	Lake	2004	Upper Mississippi River, Upper Portion	02-0079-00	2B	Anoka	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Unnamed	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	27-0053-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Unnamed	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	62-0022-00	2B	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Unnamed	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	82-0087-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Unnamed creek	Woodland WMA wetland (86-0085-00) to N Fk Crow R	Stream	2016	Upper Mississippi River, Upper Portion	07010204-667	2Bg	Wright	07010204	North Fork Crow River		Aquatic Life	Nutrients
Unnamed creek (Regal Creek)	Unnamed cr to Crow R	Stream	2020	Upper Mississippi River, Upper Portion	07010204-542	2Bg	Wright	07010204	North Fork Crow River		Aquatic Life	Nutrients
Waukenabo	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	01-0136-00	2B	Aitkin	07010104	Mississippi River - Brainerd		Aquatic Recreation	Nutrients
West Vadnais	Lake or Reservoir	Lake	2014	Upper Mississippi River, Upper Portion	62-0038-02	1C, 2Bd	Ramsey	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
White Rock	Lake or Reservoir	Lake	2010	Upper Mississippi River, Upper Portion	82-0072-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Wilhelm	Lake or Reservoir	Lake	2022	Upper Mississippi River, Upper Portion	86-0020-00	2B	Wright	07010204	North Fork Crow River		Aquatic Recreation	Nutrients
Wilmes	Lake or Reservoir	Lake	2006	Upper Mississippi River, Upper Portion	82-0090-00	2B	Washington	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Windsor	Lake or Reservoir	Lake	2008	Upper Mississippi River, Upper Portion	27-0082-00	2B	Hennepin	07010206	Mississippi River - Twin Cities		Aquatic Recreation	Nutrients
Wolf	Lake or Reservoir	Lake	2020	Upper Mississippi River, Upper Portion	47-0016-00	2B	Meeker	07010204	North Fork Crow River		Aquatic Recreation	Nutrients

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT J

(Coleman-Wasik *et al*., Methylmercury Declines in a Boreal Peatland When Experimental Sulfate Deposition Decreases, 2012)

Environmental Science & Technology

Article

pubs.acs.org/est

Methylmercury Declines in a Boreal Peatland When Experimental Sulfate Deposition Decreases

Jill K. Coleman Wasik,*[†,‡] Carl P. J. Mitchell,[§] Daniel R. Engstrom,[‡] Edward B. Swain,[∥] Bruce A. Monson,[∥] Steven J. Balogh,[⊥] Jeffrey D. Jeremiason,[#] Brian A. Branfireun,[¶] Susan L. Eggert,[$] Randall K. Kolka,[$] and James E. Almendinger[‡]

[†]Water Resources Science Graduate Program, University of Minnesota, 173 McNeal Hall, 1985 Buford Avenue, St. Paul, Minnesota 55108, United States

[‡]St. Croix Watershed Research Station, Science Museum of Minnesota, 16910 152nd Street North, Marine on St. Croix, Minnesota 55047, United States

[§]Department of Physical and Environmental Sciences, University of Toronto—Scarborough, 1265 Military Trail, Toronto, Ontario, Canada M1C 1A4

[∥]Environmental Analysis and Outcomes, Minnesota Pollution Control Agency, 520 Lafayette Road, St. Paul, Minnesota 55155, United States

[⊥]Metropolitan Council Environmental Services, 2400 Childs Road, St. Paul, Minnesota 55106, United States

[#]Department of Chemistry, Gustavus Adolphus College, 800 West College Avenue, St. Peter, Minnesota 56082, United States

[¶]Department of Biology, Biological and Geological Sciences Building 3028, University of Western Ontario, London, Ontario, Canada N6A 5B7

[$]Northern Research Station, USDA Forest Service, 1831 Highway 169 East, Grand Rapids, Minnesota 55744, United States

Supporting Information

ABSTRACT: Between 2001 and 2008 we experimentally manipulated atmospheric sulfate-loading to a small boreal peatland and monitored the resulting short and long-term changes in methylmercury (MeHg) production. MeHg concentrations and %MeHg (fraction of total-Hg (Hg_T) present as MeHg) in the porewaters of the experimental treatment reached peak values within a week of sulfate addition and then declined as the added sulfate disappeared. MeHg increased cumulatively over time in the solid-phase peat, which acted as a sink for newly produced MeHg. In 2006 a "recovery" treatment was created by discontinuing sulfate addition to a portion of the experimentally treated section to assess how MeHg production might respond to decreased sulfate loads. Four years after sulfate additions ceased, MeHg concentrations and %MeHg had declined significantly from 2006 values in porewaters and peat, but remained elevated relative to control levels. Mosquito larvae collected from each treatment at the end of the experiment exhibited Hg_T concentrations reflective of MeHg levels in the peat and porewaters where they were collected. The proportional responses of invertebrate Hg_T to sulfate deposition rates demonstrate that further controls on sulfur emissions may represent an additional means of mitigating Hg contamination in fish and wildlife across low-sulfur landscapes.

Received: March 4, 2012
Revised: May 4, 2012
Accepted: May 11, 2012
Published: May 11, 2012

ACS Publications © 2012 American Chemical Society

■ INTRODUCTION

Atmospheric sulfate deposition increased dramatically with the advent of the industrial period, ultimately causing widespread ecosystem acidification, especially downwind of large population centers in North America and Europe.[1,2] Regulatory efforts aimed at controlling sulfur dioxide emissions were very successful at reducing sulfate deposition,[3−5] but ecosystems have responded variably depending on landscape and climatic factors.[6] Whereas most research in sulfate-impacted systems has focused on recovery from environmental acidification,[7,8] sulfate deposition is also of considerable consequence to the production of methylmercury (MeHg),[9] the predominant form of mercury that bioaccumulates in food webs.

Wetlands are a major linchpin in the coupled biogeochemical cycles of sulfur and mercury and serve two potential countervailing roles in ecosystem recovery from sulfate deposition. They are sites of active sulfate reduction and so provide an important sink for legacy sulfate leaching from upland soils toward downstream aquatic systems.[10] Wetlands are also important sites of mercury methylation in the landscape.[11] Augmented sulfate inputs can stimulate MeHg production in sulfur-limited systems due to the increased activity of sulfate-reducing bacteria (SRB), which are known mediators of the methylation process.[9,12−16] Therefore continued inputs of sulfate from uplands may prolong elevated MeHg production in, and export from, wetland systems.[17] Our understanding of how MeHg production in ecosystems responds to declining sulfate deposition, and the subsequent effects on mercury concentrations in biota, is limited to a handful of largely correlative studies in lakes.[18,19] We therefore lack an experimental basis for predicting the rate of ecosystem recovery, the factors that enhance or inhibit it, or the biogeochemical mechanisms involved.

To investigate the in situ response of net MeHg production as an ecosystem recovers from elevated sulfate deposition, we experimentally amended a peatland in northern Minnesota with sulfate for four years and then monitored the system over an equivalent period after sulfate additions ceased. Changes in porewater, peat, and biotic MeHg levels across treatments with differing sulfate depositional histories were used to (1) understand the impacts of increasing and decreasing sulfate deposition on net MeHg production within the peatland, (2) identify mechanisms that promote and inhibit recovery of systems previously impacted by elevated levels of sulfate deposition, and (3) connect changes in sulfate deposition to mercury levels in biota. The extended nature of this project provided an opportunity to study wetland recovery processes against a backdrop of variable climate and hydrology.

■ MATERIALS AND METHODS

Study Site. This study was performed in the S6 watershed of the Marcell Experimental Forest (MEF), a field-research facility of the Northern Research Station of the USDA Forest Service (Figure 1). The 2.0-ha S6 peatland has an overstory of mature black spruce (*Picea mariana*) and tamarack (*Larex laricina*) within a central bog area and is dominated by alder (*Alnus rugosa*) within its lagg margin.[20] The perched water table in the central bog is hydrologically isolated from the uplands and the lagg, creating a mineral-poor, ombrotrophic system ideal for experimental manipulation of atmospheric deposition.

Sulfate Additions. Long-term atmospheric deposition records from the National Atmospheric Deposition Program (NADP) site (MN-16) at MEF show that sulfate deposition

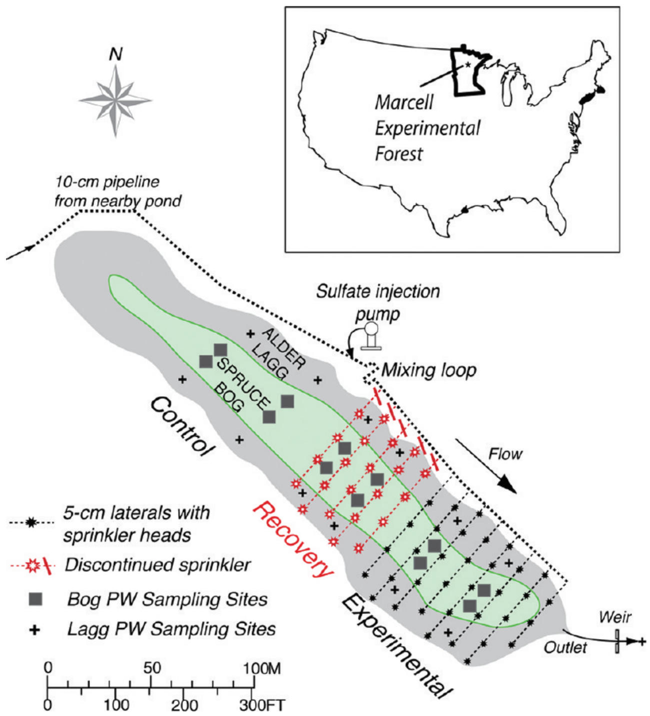


Figure 1. Schematic of the sulfate delivery system illustrating the experimental design within the S6 peatland. Porewater (PW) sampling sites in the bog (■) and lagg (+) were located along transects within each treatment. The first 5 lateral pipelines encompass the recovery treatment. See text for further details. The inset map shows the location of the Marcell Experimental Forest.

decreased by roughly 50%, from 11 kg ha^{-1} yr^{-1} in the early 1980s to approximately 5.5 kg ha^{-1} yr^{-1} in the mid-2000s (Supporting Information Figure S1).[21] Our experimental additions increased sulfate loading to 32 kg ha^{-1} yr^{-1}, or approximately 4× the average ambient 1990s deposition rate at MEF. This rate is representative of late 20th-century sulfate deposition across large areas of eastern North America, and thus provides an appropriate model for the effects of increasing sulfate deposition on MeHg production as well as the recovery processes that a sulfate-impacted peatland would experience as sulfate deposition declined.

The specific details of the initial experimental design and sulfate delivery system for this study were described previously by Jeremiason et al.[9] Briefly, in the summer of 2001 the peatland was divided into control and experimental sections, and a sulfate delivery system was constructed of PVC pipe across the down-gradient experimental half (Figure 1). Source water was pumped from a nearby, dilute pond (specific conductivity = 20 $\mu S\ cm^{-1}$), a concentrated sodium sulfate solution was injected into the 10-cm main pipeline just above the experimental treatment, and the sulfate-enriched solution was sprayed onto the peatland surface via sprinkler heads atop 1-m risers. Sulfate amendments began in the fall of 2001 and continued three times each year (spring, summer, and fall) through 2008. Each sulfate addition simulated approximately 6−8 mm of rainfall, which did not significantly alter the peatland water table. In the early spring of 2006 a recovery treatment was created by discontinuing sulfate addition to the up-gradient, one-third of the original experimental treatment (Figure 1).

Field Sampling. *Porewaters.* Two porewater sampling transects were established in the control and experimental treatments, with four 1-m^2 sample plots distributed evenly across the central bog area and lagg margins along each transect (Figure 1). To isolate the effect of atmospheric sulfate deposition on MeHg production from effects caused by upland inputs, only data from the central bog sites were considered for this paper. In 2006 two additional transects were established in the newly created recovery treatment, and transects located in the experimental treatment were repositioned down-gradient to ensure sampling occurred well within the treated area. Peat porewater samples were collected from each plot on day −1, +1, +3, and +7 relative to each sulfate addition. Extra sampling days were added to spring and fall samplings on days −7 and +14.

Porewater samples were collected by portable peristaltic pump through a 1.9-cm ID, Teflon probe with a custom-machined tip perforated with 5-mm holes. The probe was inserted into the peat to a depth approximately 5 cm below the water table and porewater was pumped via Teflon tubing through acid-washed, 47-mm Teflon filter-holders (Savillex Co.) pre-loaded with ashed, 0.7-μm, glass-fiber filters directly into new, 125-mL PETG bottles. Bottles were rinsed in triplicate with porewater prior to filling, and samples were preserved with high-purity HCl to 0.5% (v/v). Samples were collected for dissolved Hg_T, MeHg, and major anions on each sampling day throughout the course of the project. Hg_T and MeHg samples were collected using accepted clean sampling techniques.[22] Field duplicates and equipment blanks accounted for 10% of samples.

Peat Samples. Surficial peat cores were collected annually from each treatment in 2003, 2005−2007, and 2009 by coring or cutting and hand-collection (SI Table S2). All peat samples were kept in frozen storage and freeze-dried prior to analysis of Hg_T and MeHg.

Invertebrate Samples. In late spring 2009, near the end of the study, mosquito (*Culex* spp.) larvae were collected in triplicate batches from each treatment by netting with vinyl-coated aquarium nets. Mosquito larvae were hand-picked at the MEF laboratory, placed in vials of deionized water overnight to purge gut contents, and then frozen. Samples were freeze-dried prior to analysis of Hg_T content. Where enough mass remained, samples were also analyzed for MeHg content.

Laboratory Analyses. *Porewaters.* Aqueous Hg_T was analyzed according to EPA method 1631 Revision E.[23] Samples were oxidized overnight with BrCl and then neutralized with NH_2OH. Stannous chloride reduced the oxidized mercury species to Hg^0, which was purged and trapped on gold traps. Mercury was thermally desorbed from the traps in a stream of Ar and analyzed by cold vapor atomic fluorescence spectroscopy (CVAFS) on a Tekran 2600 Automated Total Mercury Analyzer. Daily calibrations were checked with lab-made standards. Each run included 20% deionized-water blanks, 10% sample duplicates, and 5% sample matrix spikes.

Aqueous MeHg was analyzed according to methods described in Bloom[24] and Liang et al.[25] at the Branfireun laboratory (2005 samples), the Jeremiason laboratory (2006 samples), or the Balogh laboratory (2007 and 2008 samples). Samples were distilled with 8 M H_2SO_4 and 20% KCl in an acid-cleaned, Teflon, extraction manifold and distillates were analyzed within 48 h. Mercury species were ethylated with sodium tetraethylborate and then purged from solution and trapped on Tenax traps. Mercury species were thermally desorbed from the traps and carried in a stream of Ar or He through a short chromatographic column. The separated mercury species passed through a pyrolytic trap where they were thermally transformed into Hg^0, and analyzed by CVAFS on a Tekran 2500 spectrometer (Branfireun and Jeremiason laboratories) or a Brooks Rand Model III (Balogh laboratory). Each run included 5% deionized-water blanks, 10% sample duplicates, and 5% sample matrix spikes.

Water samples for major anions (SO_4^{2-}, Cl^-, Br^-) were analyzed on a Dionex DX-500 ion chromatograph according to standard methods by the USFS Northern Research Station laboratory in Grand Rapids, Minnesota. Each run included 10% deionized-water blanks, 10% sample duplicates, and check standards. Replicate standard measures and lab duplicates were within 10% and method detection limits were 0.1 mg L^{-1} each year

Peat Samples. For Hg_T analysis, peat samples were microwave digested in concentrated HNO_3 and diluted prior to analysis by dual gold-trap amalgamation CVAFS, as described above for porewaters. For MeHg analysis, peat samples were distilled as outlined for porewaters, but with the inclusion of a known mass spike of enriched $Me^{199}Hg$ in each vessel. Samples were analyzed by isotope dilution−gas chromatography−inductively coupled plasma mass spectrometry (ID-GC-ICPMS) with mercury detection on an Agilent 7700 ICPMS according to the methods of Hintelmann et al.[26] In addition to blanks and duplicates, certified reference materials (MESS-3 for Hg_T; ERM-CC580 for MeHg) were analyzed in 10% of samples.

Quality assurance and control results for aqueous and solid phase Hg_T and MeHg for each year can be found in Tables S2−S4 of the Supporting Information.

Mosquito Larvae Samples. For Hg_T analysis, mosquito larvae samples were microwave digested in concentrated HNO_3 and diluted prior to analysis by dual gold-trap amalgamation CVAFS, as described for porewaters. MeHg in mosquito larvae samples was heat extracted in a solution of 25% KOH in methanol, with a known mass spike of enriched $Me^{199}Hg$ in each vessel. Samples were analyzed by ID-GC-ICPMS. In addition to blanks and duplicates, the certified reference material DORM-3 was analyzed in 10% of samples.

Numerical Analysis. Weighted means were calculated for annual porewater results because sampling dates were not evenly distributed throughout the season. Annual porewater values from each treatment were calculated by multiplying the mean result on each sampling day within a treatment by a weighting factor and then summing. The weighting factor was equal to the fraction of the season represented by a sample since the previous sampling date (e.g., the day − 1 sample collected for a summer addition had a much larger weighting factor than a sample collected 2 days later on day +1). The season began on the first date on which peat soil temperatures at 10-cm depth were greater than 1 °C, and ended with the last sampling date each year. Bulk density of the peat did not change appreciably within the top 8 cm (one-way Anova, p = 0.18), and so mean results for each peat core were calculated by multiplying concentrations for each interval by a weighting factor related to interval thickness (2 or 4 cm) and summing. Treatment means were then calculated from the weighted averages. Mosquito larvae results from each sample batch were averaged for each treatment.

The program R was used for all statistical analyses.[27] The distributions for both porewater and solid data were right-skewed, so each data set was natural-log-transformed prior to statistical analyses to obtain a normal distribution. A linear-least-squares model of the transformed data was fit on treatment and year factors. Residual plots of the transformed data did not show any systematic bias. General linearized hypothesis tests were used to compare the estimated slopes for each treatment in each year and generate p-values. A p-value <0.05 was considered significant.

■ RESULTS AND DISCUSSION

MeHg Response to Sulfate Applications. The short and long-term processes whereby elevated sulfate deposition affected MeHg production within the S6 peatland were explored through intensive sampling of porewaters and periodic collections of peat cores, respectively (Figure 1). Although the MeHg pool in porewaters can be affected by factors other than methylation, such as changes in water chemistry, partitioning between the aqueous and solid phases, and the character and abundance of organic ligands,[13,28,29] MeHg in porewater nevertheless represents the most dynamic and mobile MeHg pool and is thus important for considering downstream effects. The solid peat represented the major sink for MeHg and Hg_T—of the total mercury mass in the upper 8 cm of peat matrix, >99.7% of MeHg and >99.8% of Hg_T was bound to the peat.

Porewaters. An increase in porewater MeHg concentration in response to sulfate addition was clearly evident following spring sulfate application to the central-bog as illustrated here for the spring of 2006 and 2008 (Figure 2), the first and last year of

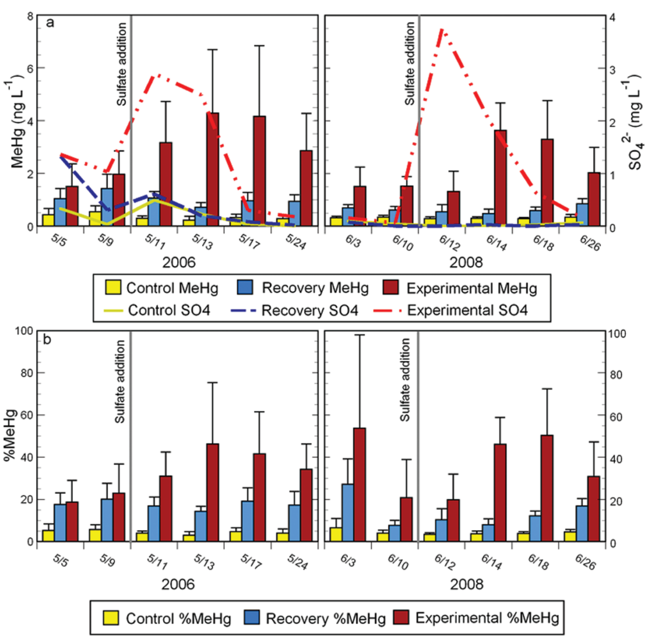


Figure 2. (a) Sulfate and MeHg concentrations (±1 s.d.), and (b) %MeHg (the ratio of MeHg to Hg_T; ± 1 s.d.) in control, recovery, and experimental treatment porewaters of the S6 peatland over the period of spring sulfate addition in 2006 and 2008. The spring 2006 and 2008 addition periods were chosen because they illustrate patterns in the first and last year of recovery, respectively.

recovery, respectively. In each year porewater sulfate concentrations in the experimental treatment peaked one day following the additions (2.9 ± 2.1 mg L^{-1} in 2006 and 3.8 ± 2.2 mg L^{-1} in 2008). As sulfate concentrations declined, the porewater MeHg pool increased dramatically (Figure 2a). MeHg concentrations peaked by the third day post-addition in each year (4.3 ± 2.1 ng L^{-1} in 2006 and 3.6 ± 1.0 ng L^{-1} in 2008). MeHg as percentage of Hg_T (%MeHg) followed a very similar pattern, peaking at 46 ± 29% three days after the addition in 2006 and at 50 ± 22% seven days after the addition in 2008 (Figure 2b). In contrast, mean sulfate and MeHg concentrations and %MeHg in the control area were consistently low each spring (<0.5 mg L^{-1}, < 0.6 ng L^{-1}, and <7%, respectively). MeHg concentrations and %MeHg were significantly higher in the experimental treatment than in the control on each day shown in Figure 2 ($p < 0.05$). Peak MeHg concentrations and %MeHg in the experimental treatment, postaddition, were significantly higher than preaddition levels ($p < 0.05$). Annual, seasonally weighted, average porewater MeHg concentrations and %MeHg in the experimental treatment were 4−9× higher than corresponding levels in the control section (Figure 3).

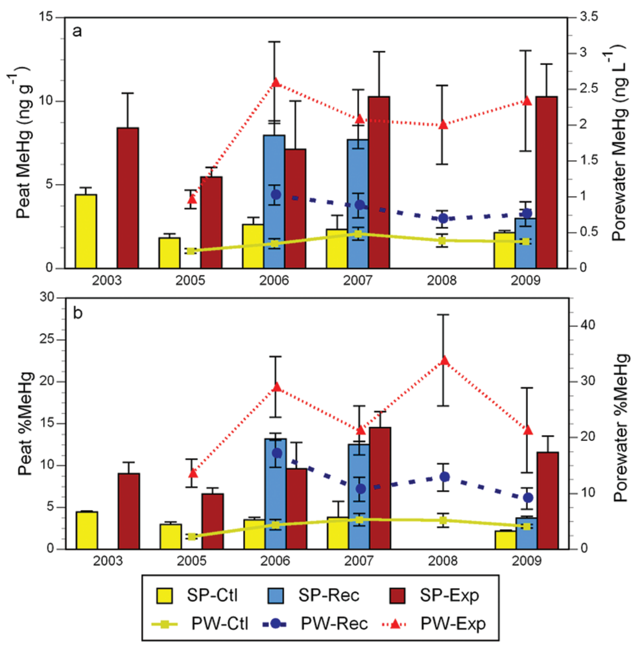


Figure 3. (a) MeHg concentrations and (b) %MeHg levels in the solid peat (SP; interval-weighted average values) and porewaters (PW; annual, seasonally weighted average values) in the control, recovery, and experimental sections of the S6 peatland 2003−2009. Error bars for peat are standard errors of weighted treatment means. Error bars on porewaters are standard deviations calculated from weighted annual means.

The order-of-magnitude increases in MeHg concentrations and %MeHg in porewaters of the experimental treatment following sulfate application are of similar magnitude and timing to the responses reported by Jeremiason et al.[9] for the first year of this study and other mesocosm-scale studies in nutrient-poor, boreal peatlands.[14,30] Our interpretation of these results is that the added sulfate stimulated SRB activity resulting in a net increase in Hg methylation. The steady buildup of a large pool of solid-phase MeHg in the peat matrix (see below) provides strong evidence for this de novo production of MeHg.

An alternative explanation for the observed increase in porewater MeHg is a change in partitioning of MeHg and Hg_T between the aqueous and solid phase resulting from an increase in the dissolved sulfide pool.[28] We modeled mercury speciation in response to increasing dissolved sulfide concentrations and found that the molar ratio of MeHg to Hg peaked at 0.3 μM sulfide and subsequently decreased, which is similar to previously reported findings (model parameters shown in SI Table S6).[28] However, at low sulfide concentrations the model did not accurately predict MeHg and Hg concentrations in the dissolved phase possibly because of uncertainty in the log K value for the reaction between MeHg and thiol groups or because of kinetic limitations controlling adsorption/desorption of MeHg. Many studies have demonstrated the difficulty of accurately representing mercury speciation in the presence of high DOC.[29,31−33] Although we can not rule out the possibility that sulfide-driven changes in solid-phase partitioning caused porewater MeHg to increase, the weakness of the simple equilibrium model and the fact that the total pool of MeHg in the experimental section increased progressively over time argues strongly that increased MeHg production, rather than sorption/desorption reactions, is responsible for the MeHg patterns seen following sulfate addition.

Peat. The solid-phase data integrate the responses to sulfate additions that were noted above for porewater MeHg concentrations and %MeHg in the experimental treatment (Figure 2). In the control section, MeHg concentrations and %MeHg remained consistently low in both peat and porewaters (Figure 3). Average MeHg concentrations and %MeHg in the peat of the experimental treatment were 4−9× greater than the corresponding values in the control section. There was no significant effect of treatment on Hg_T concentrations in peat, which ranged between 63 and 110 ng g^{-1} across the peatland over the 5-year period.

The MeHg pool within a peatland represents a dynamic equilibrium between MeHg production, predominantly through biotic methylation, and removal processes, including biotic and abiotic demethylation, bioaccumulation, and advective transport.[13,14,34] In sulfur-limited systems, such as the experimental peatland in this study, sulfate addition represents an important factor influencing MeHg production and contributes to higher MeHg concentrations in wetland porewaters and soils than would be expected based on atmospheric Hg inputs alone.[12−14,35] The increases in %MeHg in peat and porewaters of the experimental treatment relative to those in the control indicate that experimentally increasing sulfate loads shifts that equilibrium toward greater MeHg production.

Recovery from Elevated Sulfate Deposition. *Porewaters.* The recovery treatment—a subsection of the experimental treatment to which sulfate application was halted—was created in the spring of 2006. Sulfate concentrations in recovery porewaters declined almost immediately thereafter, generally remaining low and following a temporal pattern similar to that of the control in each year (Figure 2a). In contrast to sulfate, MeHg concentrations and %MeHg in recovery treatment porewaters remained elevated well above control levels during the first year of recovery ($p < 0.001$). In 2007 annual, seasonally weighted %MeHg declined 37% from 2006 levels ($p < 0.001$), but then held steady between 2007 and 2009. MeHg concentrations fell more gradually over the recovery period, declining 32% between 2006 and 2008 ($p < 0.001$). Both MeHg concentrations and %MeHg in the recovery section remained elevated relative to control values through the end of the study (Figure 3). The continued difference in porewater MeHg between the control and recovery treatments likely reflects equilibrium with the peat rather than continued elevation of MeHg production.

Peat. MeHg concentrations and %MeHg in recovery treatment peat declined by 62% and 76%, respectively, between 2006 and 2009 ($p < 0.005$ and $p < 0.02$). Demethylation was a more important MeHg loss process than desorption coupled with advective transport out of the system. This conclusion follows from the observation that concentrations of MeHg in porewaters were too low to account for the mass of MeHg lost from the recovery-section peat. Jeremiason et al.[9] found that nearly 1800 μg MeHg was exported from the S6 peatland in 2002. The mass of MeHg lost in the top 8 cm of the recovery treatment alone between 2006 and 2009 was approximately 120 mg, or more than 65× the amount exported in outflow in 2002 from the entire peatland.

Methylmercury concentrations in the peat of the recovery treatment did not show significant declines within the first two years after sulfate additions were halted. This could either imply that the kinetics of desorption of the newly accumulated MeHg from the peat was much slower than the decreases in methylation rates in porewaters, or that elevated MeHg production was sustained for a period of time by internal recycling of the previously added sulfate. Such recycling has been proposed by others[13,14] and would also explain our observed short-term response to sulfate addition in which sulfate disappeared from experimental porewaters within three days of application, while porewater MeHg levels remained elevated two weeks later (Figure 2). Urban et al.[10] investigated sulfur biogeochemistry in a small peatland 1 km from the S6 site and determined that annual recycling of sulfur was equivalent to annual external sulfur inputs. Blodau et al.[36] found evidence that an anaerobic sulfur cycle sustained SRB activity under reducing conditions in an ombrotrophic peatland, providing an explanation for the high sulfur recycling rates observed by Urban et al.[10] Thus one possible mechanism for recovery following the cessation of sulfate addition to the S6 peatland is that sulfur compounds within the peat become more recalcitrant over time. That is, as the pool of added sulfur is repeatedly turned over, labile sulfur compounds are preferentially consumed and progressively converted into refractory organic forms, which are much more slowly cycled by anaerobic and aerobic processes. In line with this hypothesis, differential sulfate release was observed among treatments in the S6 peatland following drying events, which can expose reduced sulfur moieties to oxygen (SI Table S5). The highest sulfate release into porewaters occurred in the experimental treatment, and the lowest release was observed in the control section. Because there was no significant difference among treatments in size of the total sulfur pool in the peat, these results suggest that the newly added sulfate was more susceptible to release/recycling than the pre-existing pool of ambient sulfur.

Interannual Variability. Despite the significant trends in peat MeHg concentrations and %MeHg (increases in the experimental treatment and decreases in the recovery treatment), there is some unexplained variability in the data—for example, the decrease in peat %MeHg between 2003 and 2005 and the fluctuating porewater values in the experimental treatment (Figure 3). These variations are likely the result of year-to-year differences in precipitation and hydrology, such as the series of summer droughts that persisted at the MEF from 2005 to 2007. Hydrologic variability can affect mercury cycling in peatlands by altering peat accumulation and decomposition, redox conditions, and methylation potentials.[37−40] Such effects are most clearly evident in the S6 control treatment where interannual fluctuations in both porewater and peat MeHg cannot be the result of sulfate manipulation. In the experimental and recovery treatments the effects of these large-scale physical processes are superimposed on trends due to sulfate addition alone. For example, the 2007−2009 decline of MeHg in the recovery section can be explained, at least in part, by the cessation of sulfate amendments, but this should not be the case for the experimental treatment where sulfate additions continued. Thus it appears that some of the interannual variability in MeHg

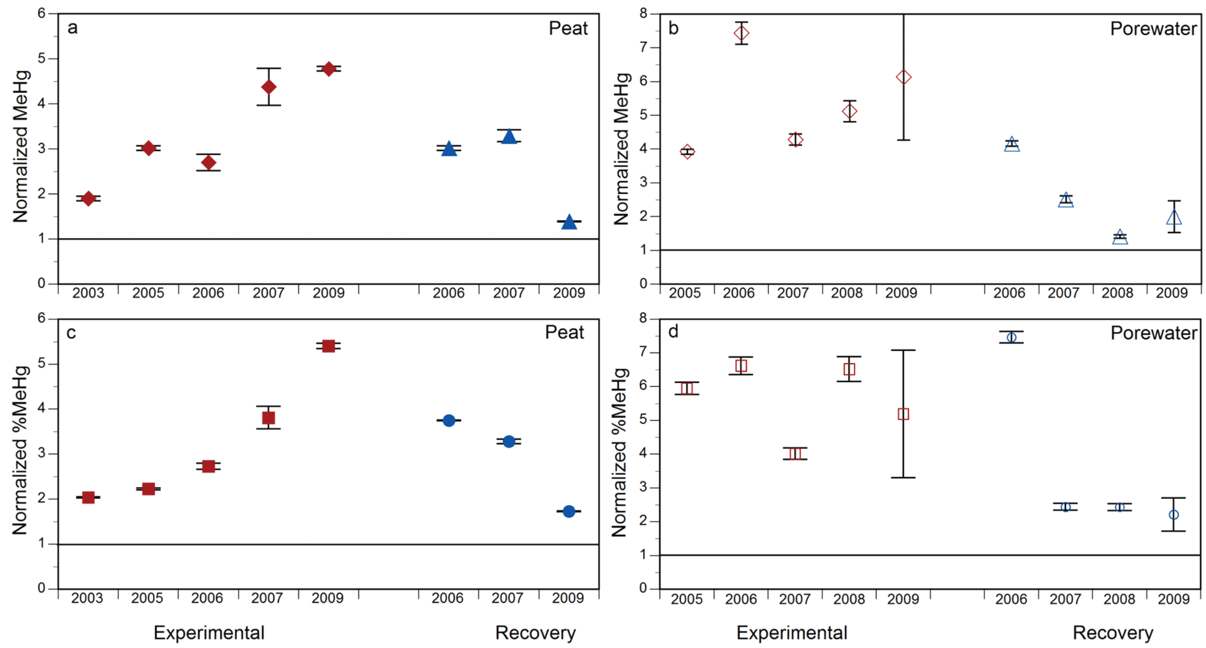


Figure 4. Ratio of [MeHg] and %MeHg in recovery and experimental treatments to [MeHg] and %MeHg in the control treatment in the peat (a and c) 2003–2009 and porewaters (b and d) 2005–2009 ([MeHg] experimental peat (♦), [MeHg] experimental porewater (◊), %MeHg experimental peat (■),%MeHg experimental porewater (□), [MeHg] recovery peat (▲), [MeHg] recovery porewater (Δ), %MeHg recovery peat (●), %MeHg recovery porewater (○)). Peat error propagated from standard errors of mean [MeHg] and %MeHg in control and respective treatment (experimental or recovery). Porewater error propagated from standard deviations for control and respective treatment. The horizontal line at $y = 1$ in each figure represents a ratio of 1:1 or a return to control levels in the treatments.

concentrations and %MeHg in each treatment (Figure 3) was the result of overriding climatic and/or hydrologic effects.

To remove the influence of natural hydrologic variability from the longer-term effects of experimental sulfate addition, we normalized MeHg concentrations and %MeHg in the experimental and recovery treatments to corresponding values in the control treatment for porewaters and peat in each year (Figure 4). Normalized MeHg concentrations and %MeHg in the experimental peat increased cumulatively with time such that by 2009 these values in the experimental treatment were 5–6× higher than those of the control ($p < 0.005$). In the recovery treatment the opposite trend occurred, and by 2009 normalized MeHg concentrations and %MeHg approached a value of 1, indicating a near-return to control levels. However, the trend was not significant ($p = 0.28$) owing to small sample sizes ($n = 4$) from each treatment. Normalized MeHg concentrations in the porewaters of the experimental treatment did not show any discernible trend with time, presumably because most newly produced MeHg accumulated in the peat. The large loss of MeHg from the recovery-section following the discontinuation of sulfate addition indicates that reductions in sulfate deposition could produce a relatively rapid decline in MeHg export to connected lakes and streams.

Biotic Response. In the spring of 2009 mosquito larvae (*Culex* spp.) were collected in the S6 peatland to compare mercury concentrations in biota among treatments, as mosquitoes are sensitive indicators of mercury loading to, and MeHg production within, aquatic systems.[41] Dry-weight, Hg_T concentrations in *Culex* spp. larvae mimicked %MeHg trends in peat samples, with experimental-treatment larvae having significantly elevated mercury concentrations relative to those found in the control and recovery sections ($p < 0.05$; Figure 5). Significant differences in mosquito-larvae Hg_T also persisted between the control and recovery sections ($p < 0.05$). Although sample masses were

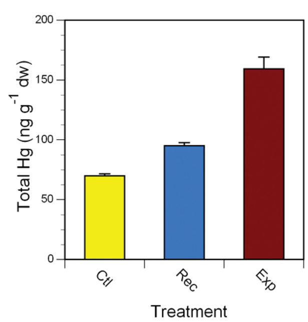


Figure 5. Dry-weight, Hg_T concentrations (±1 s.d.) in mosquito larvae (*Culex* spp.) in control (Ctl), recovery (Rec), and experimental (Exp) treatments in spring 2009.

insufficient to allow MeHg analysis of all mosquito larvae samples, for the six samples measured for both Hg_T and MeHg in this study, MeHg comprised 62 ± 19% of Hg_T in mosquito larvae, and Hg_T explained 75% of the variability in MeHg concentrations (SI Figure S2).

These biotic results provide direct evidence that increasing/decreasing sulfate loading to peatlands translates into significant increases/declines in biotic mercury concentrations. Whereas MeHg in experimental-treatment peat was >4.5× that in the control by 2009, Hg_T in mosquito larvae from the experimental treatment in the same year was just over 2× the levels found in the control. Apparently some of the MeHg produced as a result of sulfate-stimulation became less bioavailable with time. This finding agrees with other studies which have found that recently produced MeHg is more available to biota than older MeHg.[42,43]

Because detritivorous mosquito larvae spend a short time in their aquatic habitat, they present a snapshot of mercury bioaccumulation in the season during which they hatch. Mercury bioaccumulation within sulfate-impacted peatlands may be even

dx.doi.org/10.1021/es300865f | *Environ. Sci. Technol.* 2012, 46, 6663–6671

greater for invertebrates with long aquatic larval stages and those higher in the food chain, such that recovery from sulfate deposition may take longer than for mosquito larvae. Although the S6 wetland does not itself support fish, its outflow contributes to the MeHg load of downstream lakes that have susceptible fish populations. Moreover, direct transfer of MeHg to terrestrial foodwebs through the emergence and predation of aquatic insects has been identified as an important trophic pathway that may contribute to lowered reproductive success for insectivorous birds that exploit riparian and wetland habitats.[44,45]

Broader Impacts. Our long-term sulfate-loading experiment created an opportunity to observe the in situ processes whereby sulfate deposition enhanced MeHg production within a peatland, MeHg declined once sulfate additions were discontinued, and mercury levels in biota mirrored changes in sulfate inputs. Increasing sulfate deposition by 4× led to a MeHg increase of similar magnitude in both porewaters and peat. These changes in MeHg production occurred despite flat trends in Hg deposition over the study period.[46] The steady accumulation of MeHg in the peat over time, relative to the control, suggests sustained disequilibrium between methylation and demethylation over the course of the experiment. At what point equilibrium between MeHg production and removal processes would be achieved at these elevated levels of sulfate deposition is an open question. The finding that most of the MeHg lost from the recovery treatment was likely due to in situ demethylation rather than export from the system implies that the majority of the MeHg produced in response to elevated sulfate deposition may not be transported to downstream aquatic systems. This is supported by the finding that peat and porewater MeHg increased by ∼4× in response to a 4× increase in sulfate deposition but MeHg flux from the wetland in the first year of this study only increased by 2×.[9]

The proportional, synchronous decreases in mosquito-larvae mercury with cessation of sulfate addition indicate that declines in sulfate deposition can directly reduce MeHg in biota. Wetland recovery from elevated, anthropogenic sulfate deposition may explain some of the downward trends seen in fish and wildlife mercury across North America and Europe in the late 20th century as regulations on sulfur emissions took effect.[19,47−49] It is important to note that atmospheric mercury deposition declined concurrently with the reductions in sulfate deposition in many areas[50] and may also be responsible for declining mercury concentrations in biota.

In this study MeHg responses to climatic variability were superimposed on the trends caused by sulfate addition alone. The fluctuations in peat MeHg seen in the control section, and the declines in MeHg concentrations in the experimental treatment over the periods 2003−2005 and 2007−2009, demonstrate that physical processes can also alter the balance between methylation and demethylation from year to year. Climatic events such as severe droughts, which lead to oxidation of reduced sulfur species and sulfate formation, may slow or reverse declining MeHg levels in wetlands. The influence of drought on sulfate release from wetlands and sulfate export from watersheds are well documented.[5,51−54] Altered sulfur cycling consequent to climatic shifts may thus explain some of the recently reported reversals in downward fish mercury trends noted above.[49,55]

Sulfate deposition to ecosystems downwind of industrial centers increased by more than an order of magnitude over natural background rates by the mid-20th century.[21] It is reasonable to infer that such large increases in sulfate loading caused comparably large increases in MeHg production in sulfur-limited peatlands—increases above and beyond those arising from the 3−4× rise in mercury deposition during that same time period.[56,57] Subsequent regulations of sulfur emissions, such as the 1970 Clean Air Act and its 1990 amendments in the United States, led to substantial reductions in sulfate deposition across regions once affected by very high levels of atmospheric loading.[5] As of 2009 sulfate deposition across eastern North America remained well above background levels[21] highlighting the potential benefits to additional reductions. Our finding that peatland MeHg responds rapidly to reductions in sulfate inputs implies an opportunity to mitigate mercury contamination through policies aimed at further reducing sulfur emissions and deposition.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

Information regarding peat sample collection, quality control data for aqueous and solid total- and methyl-mercury analyses, average sulfate concentrations in porewaters during a water table rise in 2007, annual sulfate deposition rates at the Marcell Experimental Forest, the correlation between Hg_T and MeHg concentrations in invertebrates samples, and equilibrium model parameters. This information is available free of charge via the Internet at http://pubs.acs.org.

■ AUTHOR INFORMATION

Corresponding Author

*E-mail: colemajk@umn.edu.

Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

Funding for this long-term project came from the U.S. EPA—Science To Achieve Results (STAR) Program, Grant R827630, the Great Lakes Commission, Great Lakes Air Deposition program, and the Minnesota Pollution Control Agency. The USDA Forest Service's Northern Research Station provided access to the study site as well as substantial in-kind support. Many individuals assisted with sulfate additions and sample collection including P. Hoff and D. Helwig (Minnesota Pollution Control Agency), A. Stephens, A. Baczynski, and W. Daniels (St. Croix Watershed Research Station), and J. Heissel, C. Green, and J. Westlake (Northern Research Station). We also gratefully acknowledge the support of the analysts and technicians including Y. Nollet (Metropolitan Council Environmental Services), A. Hong (Univ. of Toronto—Scarborough), D. Nelson and J. Larson (Northern Research Station), and C. Eckley and M. Collins (Univ. of Toronto—Mississauga). Special thanks go to R. Kyllander and C. Dorrance at the Northern Research Station for administrative and field assistance throughout the course of the project.

■ REFERENCES

(1) Likens, G. E.; Bormann, F. H. Acid rain: A serious regional environmental problem. *Science* **1974**, *184* (4142), 1176−1179.

(2) Rodhe, H. Acidification in a global perspective. *Ambio* **1989**, *18* (3), 155−160.

(3) Driscoll, C. T.; Lawrence, G. B.; Bulger, A. J.; Butler, T. J.; Cronan, C. S.; Egar, C.; Lambert, K. F.; Likens, G. E.; Stoddard, J. L.; Weathers, K. C. Acidic deposition in the northeastern United States: Sources and inputs, ecosystem effects, and management strategies. *Bioscience* **2001**, *51* (3), 180−198.

(4) Schopp, W.; Posch, M.; Mylona, S.; Johansson, M. Long-term development of acid deposition (1880−2030) in sensitive freshwater regions in Europe. *Hydrol. Earth Syst. Sci.* **2003**, *7* (4), 436−446.

(5) Mitchell, M. J.; Likens, G. E. Watershed sulfur biogeochemistry: shift from atmospheric deposition dominance to climatic regulation. *Environ. Sci. Technol.* **2011**, *45*, 5267−5271.

(6) Stoddard, J. L.; Jeffries, D. S.; Lukewille, A.; Clair, T. A.; Dillon, P. J.; Driscoll, C. T.; Forsius, M.; Johannessen, M.; Kahl, J. S.; Kellogg, J. H.; Kemp, A.; Mannio, J.; Montieth, D. T.; Murdoch, P. S.; Patrick, S.; Rebsdorf, A.; Skjelkvale, B. L.; Stainton, M. P.; Traaen, T.; van Dam, H. Regional trends in aquatic recovery from acidification in North America and Europe. *Nature* **1999**, *401* (6753), 575−578.

(7) Dillon, P. J.; Somers, K. M.; Findeis, J.; Eimers, M. C. Coherent response of lakes in Ontario, Canada to reductions in sulphur deposition: The effects of climate on sulphate concentration. *Hydrol. Earth Syst. Sci.* **2003**, *7*, 583−595.

(8) Keller, W.; Heneberry, J. H.; Dixit, S. S. Decreased acid deposition and the chemical recovery of Killarney, Ontario, Lakes. *Ambio* **2003**, *32* (3), 183−189.

(9) Jeremiason, J. D.; Engstrom, D. R.; Swain, E. B.; Nater, E. A.; Johnson, B. M.; Almendinger, J. E.; Monson, B. A.; Kolka, R. K. Sulfate addition increases methylmercury production in an experimental wetland. *Environ. Sci. Technol.* **2006**, *40*, 3800−3806.

(10) Urban, N. R.; Eisenreich, S. J.; Grigal, D. F. Sulfur cycling in a forested *Sphagnum* bog in northern Minnesota. *Biogeochemistry* **1989**, *7*, 81−109.

(11) St. Louis, V. L.; Rudd, J. W. M.; Kelly, C. A.; Beaty, K. G.; Bloom, N. S.; Flett, R. J. Importance of Wetlands as Sources of Methyl Mercury to Boreal Forest Ecosystems. *Can. J. Fish. Aquat. Sci.* **1994**, *51* (5), 1065−1076.

(12) Gilmour, C. C.; Henry, E. A.; Mitchell, R. Sulfate stimulation of mercury methylation in freshwater sediments. *Environ. Sci. Technol.* **1992**, *26*, 2281−2287.

(13) Gilmour, C. C.; Riedel, G. S.; Ederington, M. C.; Bell, J. T.; Benoit, J. M.; Gill, G. A.; Stordal, M. C. Methylmercury concentrations and production rates across a trophic gradient in the northern Everglades. *Biogeochemistry* **1998**, *40*, 327−345.

(14) Branfireun, B. A.; Roulet, N. T.; Kelly, C. A.; Rudd, J. W. M. In situ sulphate stimulation of mercury methylation in a boreal peatland: Toward a link between acid rain and methylmercury contamination in remote environments. *Global Biogeochem. Cycles* **1999**, *13* (3), 743−750.

(15) Benoit, J. M.; Gilmour, C. C.; Mason, R. P.; Heyes, A. Sulfide controls on mercury speciation and bioavailability to methylating bacteria in sediment pore waters. *Environ. Sci. Technol.* **1999**, *33*, 951−957.

(16) Branfireun, B. A.; Bishop, K.; Roulet, N. T.; Granberg, G.; Nilsson, M. Mercury cycling in boreal ecosystems: The long-term effect of acid rain constituents on peatland pore water methylmercury concentrations. *Geophys. Res. Lett.* **2001**, *28* (7), 1227−1230.

(17) Mitchell, C. P. J.; Branfireun, B. A.; Kolka, R. K. Spatial characteristics of net methylmercury production hot spots in peatlands. *Environ. Sci. Technol.* **2008**, *42*, 1010−1016.

(18) Hrabik, T. R.; Watras, C. J. Recent declines in mercury concentration in a freshwater fishery: Isolating the effects of de-acidification and decreased atmospheric mercury deposition in Little Rock Lake. *Sci. Total Environ.* **2002**, *297*, 229−237.

(19) Drevnick, P. E.; Canfield, D. E.; Gorski, P. R.; Shinneman, A. L. C.; Engstrom, D. R.; Muir, D. C. G.; Smith, G. R.; Garrison, P. J.; Cleckner, L. B.; Hurely, J. P.; Noble, R. B.; Otter, R. R.; Oris, J. T. Deposition and cycling of sulfur controls mercury accumulation in Isle Royale fish. *Environ. Sci. Technol.* **2007**, *41* (21), 7266−7272.

(20) Kolka, R. K.; Mitchell, C. P. J.; Jeremiason, J. D.; Hines, N. A.; Grigal, D. F.; Engstrom, D. R.; Coleman-Wasik, J. K.; Nater, E. A.; Swain, E. B.; Monson, B. A.; Fleck, J. A.; Johnson, B.; Almendinger, J. E.; Branfireun, B. A.; Brezonik, P. L.; Cotner, J. B. Mercury cycling in peatland watersheds. In *Peatland Biogeochemistry and Watershed Hydrology at the Marcell Experimental Forest*; Kolka, R. K., Sebestyen, S. D., Verry, E. S., Brooks, K. N., Eds.; CRC Press: Boca Raton, FL, 2011; pp 349−370.

(21) National Atmospheric Deposition Program (NRSP-3). NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820; 2011; http://nadp.sws.uiuc.edu/.

(22) Bloom, N. S.; Fitzgerald, W. F. Determination of volatile mercury species at the picogram level by low-temperature gas chromatography with cold-vapour atomic fluorescence detection. *Anal. Chim. Acta* **1988**, *208*, 151−161.

(23) U.S.EPA. *Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry*; Office of Water: Washington, DC, 2002.

(24) Bloom, N. S. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas chromatography with cold vapour atomic fluorescence detection. *Can. J. Fish. Aquat. Sci.* **1989**, *46* (7), 1131−1140.

(25) Liang, L.; Horvat, M.; Bloom, N. S. An improved speciation method for mercury by GC/CVAFS after aqueous phase ethylation and room temperature precollection. *Talanta* **1994**, *41* (3), 371−379.

(26) Hintelmann, H.; Evans, R. D.; Villeneuve, J. Y. Measurement of mercury methylation in sediments by using enriched stable mercury isotopes combined with methylmercury determination by gas chromatography-inductively coupled plasma mass spectrometry. *J. Anal. Atom. Spectrom.* **1995**, *10* (9), 619−624.

(27) R-Development-Core-Team R: A Language and Environment for Statistical Computing. http://www.R-project.org.

(28) Skyllberg, U. Competition among thiols and inorganic sulfides and polysulfides for Hg and MeHg in wetland soils and sediments under suboxic conditions: Illumination of controversies and implications for MeHg net production. *J. Geophys. Res.* **2008**, *113*, G00C03.

(29) Miller, C. L.; Mason, R. P.; Gilmour, C. C.; Heyes, A. Influence of dissolved organic matter on the complexation of mercury under sulfidic conditions. *Environ. Toxicol. Chem.* **2007**, *26* (4), 624−633.

(30) Mitchell, C. P. J.; Branfireun, B. A.; Kolka, R. K. Assessing sulfate and carbon controls on net methylmercury production in peatlands: An in situ mesocosm approach. *Appl. Geochem.* **2008**, *23* (3), 503−518.

(31) Drexel, R. T.; Haitzer, M.; Ryan, J. N.; Aiken, G. R.; Nagy, K. L. Mercury (II) sorption to two Florida Everglades peats: Evidence for strong and weak binding and competition by dissolved organic matter released from the peat. *Environ. Sci. Technol.* **2002**, *36* (19), 4058−4064.

(32) Hsu, H.; Sedlak, D. L. Strong Hg(II) Complexation in Municipal Wastewater Effluent and Surface Waters. *Environ. Sci. Technol.* **2003**, *37* (12), 2743−2749.

(33) Ravichandran, M. Interactions between mercury and dissolved organic matter--a review. *Chemosphere* **2004**, *55*, 319−331.

(34) Gilmour, C. C.; Henry, E. A. Mercury methylation in aquatic systems affected by acid deposition. *Environ. Pollut.* **1991**, *71*, 131−169.

(35) Benoit, J. M.; Gilmour, C. C.; Heyes, A.; Mason, R. P.; Miller, C. L. Geochemical and Biological Controls over Methylmercury Production and Degradation in Aquatic Ecosystems. In *Biogeochemistry of Environmentally Important Trace Elements*; American Chemical Society: Washington, DC, 2002; Vol. *835*, pp 262−297.

(36) Blodau, C.; Mayer, B.; Peiffer, S.; Moore, T. R., Support for an anaerobic sulfur cycle in two Canadian peatland soils. *J. Geophys. Res.* **2007**, *112*, G02004, doi:10.1029/2006JG000364.

(37) St. Louis, V. L.; Rudd, J. W. M.; Kelly, C. A.; Bodaly, R. A.; Paterson, M. J.; Beaty, K. G.; Hesslein, R. H.; Heyes, A.; Majewski, A. R. The rise and fall of mercury methylation in an experimental reservoir. *Environ. Sci. Technol.* **2004**, *38* (5), 1348−1358.

(38) Brigham, M. E.; Krabbenhoft, D. P.; Olson, M. L.; DeWild, J. F. Methylmercury in flood-control impoundments and natural waters of northwestern minnesota, 1997−99. *Water, Air, Soil Pollut.* **2002**, *138* (1), 61−78.

(39) Hall, B. D.; St. Louis, V. L.; Rolfhus, K. R.; Bodaly, R. A.; Beaty, K. G.; Paterson, M. J.; Cherewyk, K. A. P. Impacts of reservoir creation

on the biogeochemical cycling of methyl and total mercury in boreal upland forests. *Ecosystems* **2005**, *8* (3), 248−266.

(40) Balogh, S. J.; Swain, E. B.; Nollet, Y. H. Elevated methylmercury concentrations and loadings during flooding in Minnesota rivers. *Sci. Total Environ.* **2006**, *368*, 138−148.

(41) Hammerschmidt, C. R.; Fitzgerald, W. F. Methylmercury in mosquitoes related to atmospheric mercury deposition and contamination. *Environ. Sci. Technol.* **2005**, *39*, 3034−3039.

(42) Orihel, D. M.; Paterson, M. J.; Blanchfield, P. J.; Bodaly, R. A.; Gilmour, C. C.; Hintelmann, H. Temporal changes in the distribution, methylation, and bioaccumulation of newly deposited mercury in an aquatic ecosystem. *Environ. Pollut.* **2008**, *154* (1), 77−88.

(43) Harris, R. C.; Rudd, J. W. M.; Amyot, M.; Babiarz, C. L.; Beaty, K. G.; Blanchfield, P. J.; Bodaly, R. A.; Branfireun, B. A.; Gilmour, C. C.; Graydon, J. A. Whole-ecosystem study shows rapid fish-mercury reponse to changes in deposition. *Proc. Natl. Acad. Sci. U.S.A.* **2007**, *104*, 16586−16591.

(44) Custer, C.; Custer, T.; Hill, E. Mercury exposure and effects on cavity-nesting birds from the carson river, nevada. *Arch. Environ. Contam. Toxicol.* **2007**, *52* (1), 129−136.

(45) Cristol, D. A.; Brasso, R. L.; Condon, A. M.; Fovargue, R. E.; Friedman, S. L.; Hallinger, K. K.; Monroe, A. P.; White, A. E. The movement of aquatic mercury through terrestrial food webs. *Science* **2008**, *320* (5874), 335.

(46) Risch, M. R.; Gay, D. A.; Fowler, K. K.; Keeler, G. J.; Backus, S. M.; Blanchard, P.; Barres, J. A.; Dvonch, J. T. Spatial patterns and temporal trends in mercury concentrations, precipitation depths, and wet deposition in the North American Great Lakes region, 2002−2008. *Environ. Pollut.* **2012**, *161* (0), 261−271.

(47) Monson, B. A.; Staples, D.; Bhavsar, S.; Holsen, T.; Schrank, C.; Moses, S.; McGoldrick, D.; Backus, S.; Williams, K. Spatiotemporal trends of mercury in walleye and largemouth bass from the Laurentian Great Lakes Region. *Ecotoxicology* **2011**, *20* (7), 1555−1567.

(48) Chalmers, A. T.; Argue, D. M.; Gay, D. A.; Brigham, M. E.; Schmitt, C. J.; Lorenz, D. L. Mercury trends in fish from rivers and lakes in the United States, 1969−2005. *Environ. Monit. Assess.* **2011**, *175*, 175−191.

(49) Evers, D.; Wiener, J.; Basu, N.; Bodaly, R.; Morrison, H.; Williams, K. Mercury in the Great Lakes region: bioaccumulation, spatiotemporal patterns, ecological risks, and policy. *Ecotoxicology* **2011**, *20* (7), 1487−1499.

(50) Driscoll, C. T.; Han, Y. J.; Chen, C. Y.; Evers, D. C.; Lambert, K. F.; Holsen, T. M.; Kamman, N. C.; Munson, R. K. Mercury contamination in forest and freshwater ecosystems in the northeastern United States. *Bioscience* **2007**, *57* (1), 17−28.

(51) Bayley, S. E.; Behr, R. S.; Kelly, C. A. Retention and release of S from a freshwater wetland. *Water, Air, Soil Pollut.* **1986**, *31*, 101−114.

(52) Devito, K. J.; Hill, A. R. Sulphate mobilization and pore water chemistry in relation to groundwater hydrology and summer drought in two conifer swamps on the Canadian Shield. *Water, Air, Soil Pollut.* **1999**, *113*, 97−114.

(53) Warren, F. J.; Waddington, J. M.; Bourbonniere, R. A.; Day, S. M. Effect of drought on hydrology and sulphate dynamics in a temperate swamp. *Hydrol. Process.* **2001**, *15*, 3133−3150.

(54) Eimers, M. C.; Watmough, S. A.; Buttle, J. M.; Dillon, P. J. Drought-induced sulphate release from a wetland in south-central Ontario. *Environ. Monit. Assess.* **2007**, *127*, 399−407.

(55) Monson, B. A. Trend reversal of mercury concentrations in piscivorous fish from minnesota lakes: 1982−2006. *Environ. Sci. Technol.* **2009**, *43* (6), 1750−1755.

(56) Lindberg, S.; Bullock, R.; Ebinghaus, R.; Engstrom, D.; Feng, X.; Fitzgerald, W.; Pirrone, N.; Prestbo, E.; Seigneur, C. A synthesis of progress and uncertainties in attributing the sources of mercury in deposition. *Ambio* **2007**, *36* (1), 19−32.

(57) Munthe, J.; Bodaly, R. A.; Branfireun, B. A.; Driscoll, C. T.; Gilmour, C. C.; Harris, R.; Horvat, M.; Lucotte, M.; Malm, O. Recovery of mercury-contaminated fisheries. *Ambio* **2007**, *36* (1), 33−44.

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT K

(Myrbo, A, *et al*, Increase in Nutrients, Mercury, and Methylmercury as a Consequence of Elevated Sulfate Reduction to Sulfide in Experimental Wetland Mesocosms, 2017)

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Biogeosciences

RESEARCH ARTICLE

10.1002/2017JG003788

This article is a companion to Myrbo et al. (2017), https://doi.org/10.10022017JG003787 and Pollman et al. (2017), https://doi.org/10.10022017JG003785.

Key Points:
- Sulfate addition increased organic matter mineralization in wetland sediment, releasing C, N, P, and Hg to the water column
- Sulfate reduction caused not only higher methylmercury concentrations but higher total mercury concentrations in the surface water
- Increased sulfate loading to freshwaters can cause deleterious effects separate from direct sulfide toxicity to organisms

Supporting Information:
- Supporting Information S1
- Figure S1
- Data Set S1

Correspondence to:
A. Myrbo,
amyrbo@umn.edu

Citation:
Myrbo, A., Swain, E. B., Johnson, N. W., Engstrom, D. R., Pastor, J., Dewey, B., … Peters, E. B. (2017). Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *Journal of Geophysical Research: Biogeosciences*, *122*, 2769–2785. https://doi.org/10.1002/2017JG003788

Received 25 JAN 2017
Accepted 6 SEP 2017
Accepted article online 25 SEP 2017
Published online 2 NOV 2017

©2017. The Authors.
This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

Increase in Nutrients, Mercury, and Methylmercury as a Consequence of Elevated Sulfate Reduction to Sulfide in Experimental Wetland Mesocosms

A. Myrbo[1], E. B. Swain[2], N. W. Johnson[3], D. R. Engstrom[4], J. Pastor[5], B. Dewey[5], P. Monson[2], J. Brenner[6], M. Dykhuizen Shore[2,7], and E. B. Peters[2,8]

[1]LacCore/CSDCO and Department Earth Sciences, University of Minnesota, Minneapolis, MN, USA, [2]Minnesota Pollution Control Agency, St. Paul, MN, USA, [3]Department Civil Engineering, University of Minnesota, Duluth, MN, USA, [4]St.Croix Watershed Research Station, Science Museum of Minnesota, St. Paul, MN, USA, [5]Biology Department, University of Minnesota, Duluth, MN, USA, [6]Minnesota Department of Health, St. Paul, MN, USA, [7]Now at Biostatistics Division, School of Public Health, University of Minnesota, MN, USA, [8]Now at Minnesota Department of Natural Resources, St. Paul, MN, USA

Abstract Microbial sulfate reduction (MSR) in both freshwater and marine ecosystems is a pathway for the decomposition of sedimentary organic matter (OM) after oxygen has been consumed. In experimental freshwater wetland mesocosms, sulfate additions allowed MSR to mineralize OM that would not otherwise have been decomposed. The mineralization of OM by MSR increased surface water concentrations of ecologically important constituents of OM: dissolved inorganic carbon, dissolved organic carbon, phosphorus, nitrogen, total mercury, and methylmercury. Increases in surface water concentrations, except for methylmercury, were in proportion to cumulative sulfate reduction, which was estimated by sulfate loss from the surface water into the sediments. Stoichiometric analysis shows that the increases were less than would be predicted from ratios with carbon in sediment, indicating that there are processes that limit P, N, and Hg mobilization to, or retention in, surface water. The highest sulfate treatment produced high levels of sulfide that retarded the methylation of mercury but simultaneously mobilized sedimentary inorganic mercury into surface water. As a result, the proportion of mercury in the surface water as methylmercury peaked at intermediate pore water sulfide concentrations. The mesocosms have a relatively high ratio of wall and sediment surfaces to the volume of overlying water, perhaps enhancing the removal of nutrients and mercury to periphyton. The presence of wild rice decreased sediment sulfide concentrations by 30%, which was most likely a result of oxygen release from the wild rice roots. An additional consequence of the enhanced MSR was that sulfate additions produced phytotoxic levels of sulfide in sediment pore water.

Plain Language Summary In the water-saturated soils of wetlands, which are usually anoxic, decomposition of dead plants and other organic matter is greatly retarded by the absence of oxygen. However, the addition of sulfate can allow bacteria that respire sulfate, instead of oxygen, to decompose organic matter that would not otherwise decay. The accelerated decay has multiple consequences that are concerning. The bacteria that respire sulfate "breathe out" hydrogen sulfide (also called sulfide), analogous to the conversion or respiration of oxygen to CO_2. Sulfide is very reactive with metals, which makes it toxic at higher concentrations. In addition to the release of sulfide, the sulfate-accelerated decomposition of plants releases phosphorus and nitrogen, fertilizing the waterbody. Decomposition also mobilizes mercury (which is everywhere, thanks to atmospheric transport) into the surface water. The microbes that convert sulfate to sulfide also methylate mercury, producing methylmercury, the only form of mercury that contaminates fish. This study demonstrates that adding sulfate to a wetland can not only produce toxic levels of sulfide but also increase the surface water concentrations of nitrogen, phosphorus, mercury, and methylmercury.

1. Introduction

Organic matter (OM) accumulates in the sediments of aquatic systems when sediment concentrations of terminal electron acceptors (TEAs) are too low for microbes to completely decompose OM, especially when the supply of the most energy-efficient TEA, oxygen, is low. In water-saturated, organic-rich sediment, microbial sulfate reduction (MSR) can be a dominant pathway for the respiration of OM because oxygen is depleted in the uppermost sediment (Boye et al., 2017). Dissolved sulfate (SO_4) concentrations in continental surface waters are often low (less than 50 mgL^{-1} or 0.5 mmol L^{-1}) (e.g., Gorham et al., 1983) compared to ocean concentrations (2,800 mg L^{-1} or 29 mmol L^{-1}). Because of lower SO_4 concentrations, and because MSR rates can be limited by SO_4 concentrations (Holmer & Storkholm, 2001), the biogeochemical significance of MSR is often considered minimal in freshwater and low-salinity systems (e.g., Capone & Kiene, 1988; Nielsen et al., 2003; Stagg et al., 2017). However, absolute rates of MSR are not clearly lower in freshwater systems than in marine systems (Pallud & Van Cappellen, 2006), and in some cases, rapid cycling between oxidized and reduced forms of S can occur (Hansel et al., 2015).

In this study, we investigated the cascade of biogeochemical effects associated with increased MSR that result from increased surface water SO_4. We simultaneously quantified three different categories of biogeochemical responses related to MSR: (1) mineralization of organic matter and associated release of dissolved C, N, P, and Hg; (2) methylation of Hg; and (3) production of sulfide.

The stoichiometric release of the constituents of OM during MSR, notably C, N, and P, is a phenomenon long recognized by marine scientists. For instance, Boudreau and Westrich (1984) constructed a model of the MSR-mediated decomposition of marine sediment. They showed that SO_4 is reduced to sulfide (H_2S) in stoichiometric proportion to the mineralization of C, N, and P according to the reaction

$$2(CH_2O)_x(NH_3)_y(H_3PO_4)_z + xSO_4{}^{2-} \rightarrow 2xHCO_3{}^{-} + xH_2S + 2yNH_3 + 2zH_3PO_4 \quad (1)$$

C is released as both dissolved inorganic carbon (DIC, from complete oxidation, produced as bicarbonate alkalinity in stoichiometric proportion to sulfide (reaction (1); Boudreau & Westrich, 1984)) and dissolved organic carbon (DOC, from partial oxidation). The nutrients N and P are released in forms that are readily taken up by plants; N is released as ammonia, and P as phosphate. The mineralization of sediment organic matter associated with MSR releases sulfide (S^{2-}) into sediment pore water, which speciates, depending on the pH, into hydrogen sulfide (H_2S) and bisulfide (HS^{-}), henceforth collectively termed sulfide. If reduced S compounds accumulate in the sediment, there may be additional consequences to an aquatic system, such as toxic concentrations of sulfide in pore water (Lamers et al., 2013; Pastor et al., 2017; Myrbo et al., 2017) or conversion of sediment Fe(III) to FeS compounds, which enhances the mobilization of P (Curtis, 1989; Maynard et al., 2011).

The multiple biogeochemical consequences of MSR in freshwater systems have been investigated and documented in more than two dozen publications (Table S1 in the supporting information), which typically address a single issue, such as the production of alkalinity that neutralizes atmospherically deposited H_2SO_4 (Baker et al., 1986; Cook et al., 1986; and others) or the methylation of Hg (Gilmour et al., 1992; Branfireun et al., 1999, 2001; and others). Experimental studies addressing SO_4 reduction, sulfide production, associated OM mineralization, and release of nutrients have been broader (Lamers et al., 2001, 2002; Weston et al., 2006, 2011; and others), but aside from the results reported in this paper, only the experiments of Gilmour, Krabbenhoft, et al. (2007) and Gilmour, Orem, et al. (2007) have investigated all three categories of biogeochemical consequences of SO_4 reduction: OM mineralization, Hg methylation, and sulfide accumulation (Table S1). We also investigated the potential for Hg to be released by mineralization, a phenomenon proposed by Regnell and Hammar (2004).

Sulfate-driven enhanced mineralization of sediment OM and release of dissolved sulfide, N, P, DOC, DIC, and associated increases in alkalinity and pH have the potential to change the nature of an aquatic ecosystem. The immediate release is to the sediment pore water, but these dissolved materials can diffuse into the surface water. Increased internal loading of N and P can drive a system toward eutrophy, which can increase carbon fixation and amplify the cascade of biogeochemical effects associated with increased MSR. Increases in DOC also have the potential to fundamentally change the nature of a waterbody. DOC influences many processes in freshwater ecosystems, including light availability for macrophyte growth, thermal stratification, and bioavailability of metals, P, and C. In addition, DOC interferes with drinking water purification (Williamson et al., 1999). Increases in DIC, alkalinity, and pH can also change the nature of a system. Aquatic macrophyte and algal species often have different optimal alkalinity concentrations (e.g., Moyle, 1945; Vestergaard & Sand-Jensen, 2000), so increases in alkalinity may change aquatic community composition. Because pH is a master variable in aquatic systems (Stumm & Morgan, 2012), increases in pH can cause changes in both aquatic chemistry and the biota that dominate a system, as best documented by changes in diatom assemblages (Patrick et al., 1968).

The release of sulfide into sediment pore water has multiple biological and geochemical consequences, several of which are related to the reactivity of sulfide with metals. If dissolved sulfide accumulates in pore water, it can negatively affect multicellular organisms inhabiting the sediment because sulfide can denature a range of metal-containing biomolecules, including cytochrome C oxidase, which is essential for respiration by both animals and plants (Bagarinao, 1992). Because aquatic sediment is a primary site of sulfide production, plants that root in sediment are vulnerable to toxic sulfide concentrations (Lamers et al., 2013; Pastor et al., 2017). However, if the watershed supplies sufficiently high loading of reactive Fe or other metals to the sediment, pore water sulfide concentrations may stay below toxic levels even while MSR proceeds as an important mineralization process (Pollman et al., 2017). The formation of FeS compounds effectively detoxifies sulfide (e.g., Marbà et al., 2007; Van der Welle et al., 2007). When Fe availability exceeds the production of sulfide, the accumulation of FeS is a measure of cumulative SO_4 reduction, which can be quantified as acid-volatile sulfide (AVS) (Heijs & van Gemerden, 2000). In addition, phosphorus is mobilized when oxidized Fe compounds with significant capacity to bind phosphate are converted to FeS compounds, which are incapable of binding phosphate (Lamers et al., 1998; Maynard et al., 2011). Thus, MSR mobilizes P both by mineralization of P-containing OM and by changing the form of Fe in sediment.

In addition to releasing C, N, and P, producing potentially toxic concentrations of sulfide, and reducing the solubility of metals, MSR is a primary process leading to the formation of MeHg, the bioaccumulative form of Hg (Gilmour et al., 1992; Hsu-Kim et al., 2013), although other microbial groups can also methylate Hg (Podar et al., 2015). In some cases, MSR can lead to toxic levels of MeHg higher in the food chain. The relationship between SO_4 concentrations and MeHg production is complex, however, and both field and laboratory studies in freshwater and saline ecosystems suggest that there is a dual effect of S on Hg methylation. At low SO_4 concentrations, the addition of SO_4 can stimulate MSR and Hg methylation (Jeremiason et al., 2006). At higher SO_4 concentrations, a greater abundance of inorganic sulfide appears to decrease the availability of inorganic Hg for Hg methylation (Hsu-Kim et al., 2013; Johnson et al., 2016). Because it has been observed that low SO_4 additions often increase Hg methylation and higher SO_4 concentrations decrease methylation, it has been proposed that there is a range of SO_4 and sulfide concentrations are optimal for Hg methylation, above which methylation is inhibited (Hsu-Kim et al., 2013). There is some debate regarding the underlying mechanism, but there is substantial evidence suggesting that dissolved inorganic sulfide above concentrations of 300–3,000 $\mu g\ L^{-1}$ has an inhibitory effect on Hg methylation (Bailey et al., 2017).

This study presents results from 30 wetland mesocosms in which the surface waters were treated to maintain a wide range of SO_4 concentrations over the course of 5 years (2011–2015) to assess the impact on wild rice, *Zizania palustris* (Pastor et al., 2017). We took advantage of this experiment to analyze the geochemical conditions in surface and pore water in the mesocosms during late summer 2013, 3 years into the experiment. Pastor et al. (2017) specifically examined the effect of increased SO_4 loading on wild rice, whereas this paper examines the broader biogeochemical impact of augmenting SO_4 to a low-SO_4 system.

2. Materials and Methods

2.1. Experimental Design

The experimental setup (Figure S1 in the supporting information), described in detail by Pastor et al. (2017), consisted of thirty 375 L polyethylene stock tanks containing sediment from a wild rice lake (Rice Portage Lake; +46.6987°, −92.6886°) in which wild rice was grown in self-perpetuating populations at five SO_4 treatment levels (control, 50, 100, 150, and 300 mg L^{-1}). SO_4 concentrations in six replicate mesocosms were routinely monitored, and amendments of SO_4 were added as Na_2SO_4 during the growing season as SO_4 was removed by MSR (Figure 1). Due to MSR, the mesocosm surface waters actually had time-weighted average concentrations of 7, 27, 59, 93, and 207 mg L^{-1}, respectively. Local well water containing an average of 10.6 mg L^{-1} SO_4 was added as needed to compensate for evapotranspiration. Precipitation in the region contains an average of 2.1 mg L^{-1} SO_4, and Rice Portage Lake has an average SO_4 concentration of 2.2 mg L^{-1} (Fond du Lac Band, 2016), so the control was slightly elevated above the ambient SO_4 concentration of the sediment source for the experiment. During the ice-free period (generally May through October), the surface water temperature (T) measured in the morning was correlated with the previous day's mean air temperature (mesocosm T = 0.72 air T + 4.4 °C; R^2 = 0.65). Peak air temperature is reached in July, when the average

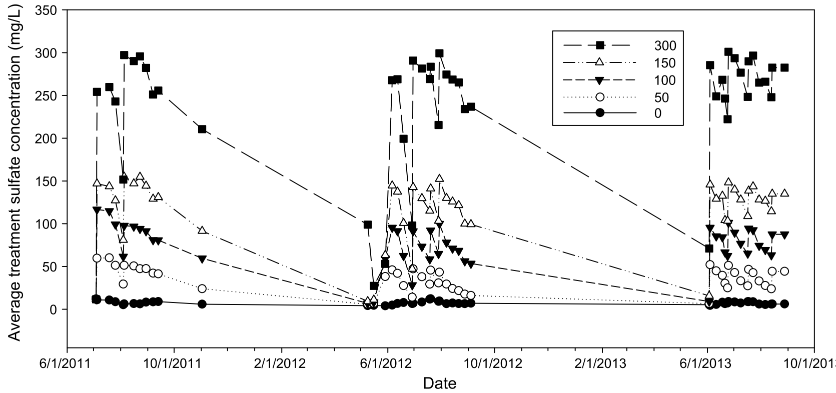


Figure 1. SO_4 concentrations in surface waters of each treatment, showing repetitive depletion and periodic amendment with Na_2SO_4 (average of six mesocosms per treatment on each sampling date).

temperature is 18.8°C (based on 1981–2010 air temperatures measured at the Duluth, Minnesota, airport, 10 km from the experimental site).

The experiments had been in progress for three growing seasons at the time of the sampling for this study, 27 and 28 August 2013, and for five growing seasons at the time of the second, less intensive, sampling (August 2015). The sediment of each mesocosm was divided into two parts for the 2013 growing season by a clear acrylic plate and all wild rice plants removed from one side in order to evaluate the effects of plant root presence on the geochemistry of the sediments. The plate was situated near one end of each mesocosm, such that about 10% of the surface area of 0.6 m^2 was plant-free (Figure S1). The plate was positioned to segregate the sediment without impeding the circulation of the surface water above all of the sediment. Sediment chemistry results presented here are from the side with wild rice plants present, except when analyzing the difference in AVS between the two sides.

2.2. Methods

2.2.1. Sample Collection

Rhizon™ samplers with a 10 cm long, 2.5 mm diameter, cylindrical porous tip (hydrophilic membrane pore size 0.12–0.18 μm (Rhizosphere.com, Netherlands; Shotbolt, 2010)), were connected by Teflon-taped Luer-Lok connectors and silicone tubing to a syringe needle. The sampler was inserted into the sediment, and the needle was then inserted through the 20 mm thick butyl rubber septum of an evacuated serum bottle (Bellco Glass) to initiate pore water draw through the tubing and displace air. After water was observed entering the serum bottle, the needle was removed from the first sacrificial bottle and inserted through the septum of a second evacuated serum bottle to collect the sample. One Rhizon and bottle were used to collect a sample for dissolved iron, preserved with 20% nitric acid. A second Rhizon and evacuated, N_2 gas-flushed sealed bottle, preloaded with 0.2 mL 2 N zinc acetate, 0.5 mL 15 M NaOH, and a stir bar, was used to collect a sample for dissolved sulfide analysis. Each Rhizon was positioned to sample pore water from the top 10 cm of sediment and to avoid collecting water from above the sediment surface. However, it is conceivable that some surface water was able to follow the path of the Rhizon into the sediment and dilute or partially oxidize the pore water sample.

Surface water in each mesocosm was collected for analysis of nitrate + nitrite, TP, TN, DOC, pH, temperature, and alkalinity from 5 cm below the surface of the water. Surface water samples for analysis of total Hg (THg) and MeHg were collected using clean hands/dirty hands protocols in September 2013, filtered through 0.45 μm glass fiber filters, and immediately acidified with 0.5% (by volume) trace metal hydrochloric acid. Samples were stored on ice during transport and at 4°C until analysis.

Pore water P availability was measured with three mixed bed ion exchange bags (Fisher Rexyn 300 resin) placed in the sediment of each tank in spring and harvested at the end of the growing season in 2013. A 3.8 cm diameter piston corer was used to obtain 10 cm long sediment samples for various analyses. Sediment samples for the analysis of AVS were taken monthly from June to October 2013 from replicate mesocosms of four SO_4 treatments (control, 50 150, and 300 mg L^{-1}; no mesocosm was sampled more than once). Sediment samples were also taken on 8 October 2013 for the analysis of THg in bulk sediment and on 6 October 2015 for the analysis of total organic carbon (TOC).

2.2.2. Laboratory Analyses

Surface water and pore water analyses were conducted by the Minnesota Department of Health Environmental Laboratory (MDHEL). Total P was measured by in-line ultraviolet/persulfate digestion and flow injection (APHA, 2005, 4500 P-I), DOC by persulfate-ultraviolet oxidation and IR CO_2 detection (APHA, 2005, 5310-C), and alkalinity by automated titration (APHA, 2005, 2320-B). Pore water sulfide samples were prepared for inline distillation and flow injection colorimetric analysis using procedures that avoided exposure to oxygen. The sulfide serum bottle was weighed to determine the amount of sample collected and to adjust for the slight dilution factor of an alkaline antioxidant that was added by injection through the stoppers. The sealed samples were then placed on a stir plate for at least 1 h and subsamples withdrawn for analysis through a needle. Reanalysis of sealed, processed samples 12 months later shows no significant difference in sulfide concentrations, indicating that the sulfide samples were stable prior to analysis (data not shown). SO_4 concentration was measured using a Lachat QuikChem 8000 Autoanalyzer (Lachat Method 10-116-10-1-A). The resin was eluted using a KCl solution and analyzed for PO_4 using a Lachat Autoanalyzer, following the methods of Walker et al. (2006).

An aliquot of the nitrate + nitrite/TP/TN/DOC serum bottle was filtered in the lab within 10 days of sampling using a 0.45 μm filter, preserved to a pH < 2 with 10% sulfuric acid, and transferred to a 250 mL polyethylene bottle for DOC analysis. The remaining sample was preserved to a pH < 2, with 10% sulfuric acid and transferred to 250 mL polyethylene bottle for nitrate + nitrite/TP/TN analysis. The contents of the metal serum bottle were transferred to a 250 mL polyethylene bottle and preserved to a pH < 2 with 10% nitric acid. Analyses were conducted within 30 days of sampling.

THg in surface water and bulk sediment were analyzed with EPA method 1631 by MDHEL, and surface water MeHg was analyzed with EPA method 1630 by Frontier Global Sciences (Bothell, Washington). Inorganic Hg (iHg) was calculated as the difference between THg and MeHg. Sediment AVS was analyzed colorimetrically, as above for pore water sulfide, following acid distillation and in-line alkaline trapping (APHA, 2005; SM 4500-S2). Sediment TOC was analyzed following SM5310C (APHA, 2005), using an OI Analytical Aurora 1030 at Pace Analytical Services, Virginia, Minnesota.

3. Data Analysis

3.1. Sulfate Depletion as the Independent Variable

Because SO_4 is relatively unreactive under oxidized conditions, its loss is attributable to diffusion or transpiration-driven advection (Bachand et al., 2014) into sediment and conversion to sulfide by bacteria. Surface water SO_4 concentrations decreased partly due to dilution by precipitation but largely from loss after movement into the sediment and reduction to sulfide. Sulfide would largely be retained in the sediment as FeS compounds, although some could be lost to the atmosphere as H_2S gas (Bagarinao, 1992) or as volatile organic sulfur compounds (Lomans et al., 2002). The cumulative SO_4 lost from surface water was calculated from a mass balance for each mesocosm from the inception of the experiment in spring 2011 through fall 2013; this quantity, termed here SO_4 depletion, $(SO_4)_{Depl}$, is used as a proxy for net MSR, following Weston et al. (2006). The surface water remained frozen from approximately 1 December to 1 April each winter, and the mesocosms were covered with plastic from November to late April each year and not amended with SO_4. SO_4 reduction was the major biogeochemical process altered by the experimental treatments, and therefore, $(SO_4)_{Depl}$ is the independent variable used in subsequent data analyses. It was only possible to perform a complete mass balance for SO_4, the only parameter consistently quantified in source water, precipitation, and overflow water.

3.2. Calculation of DIC From Measured Alkalinity

Dissolved inorganic carbon (DIC ≡ $[CO_3^{2-}] + [HCO_3^{-}] + [CO_2^*]$, where $[CO_2^*] = [CO_{2(g)}] + [H_2CO_3]$) was calculated from measured alkalinity and speciated using pH, temperature, and specific conductance of the surface water. At the pH range of the mesocosms (7.60–8.84), 95–98% of DIC is in the form of HCO_3^-, so DIC concentration on a molar basis is nearly the same as alkalinity (ALK) on an equivalent basis (DIC = 0.988 ALK + 0.077, $R^2 = 0.995$). In studies of freshwater, most inorganic carbon data are presented in terms of alkalinity because alkalinity is a familiar metric; however, in comparisons with DOC, inorganic carbon data are presented as DIC so that the units are directly comparable. PHREEQC version 3 geochemical modeling software (Parkhurst & Appelo, 2013) was used to calculate saturation indices for carbonate minerals.

3.3. Statistical Analysis

Statistical analysis was conducted with R version 3.2.3 and STATA (StataCorp, 2015). The effect of increased sulfate availability was assessed through both categorical analysis of the sulfate treatments (Kruskal-Wallis ANOVA test, followed by Dunn's test for multiple comparisons with Holm-Sidak corrections) and through linear regression and nonparametric Spearman rank correlations. We rely primarily on regressions against SO_4 depletion to detect the effects of enhanced sulfate-reduction driven mineralization, rather than categorical analysis of the sulfate treatment results, because (a) biogeochemical changes are not driven directly by SO_4 concentration, but rather by MSR, quantified as SO_4 depletion; (b) although SO_4 depletion may be highly correlated to SO_4 concentration, deviations between experimental mesocosms develop over time, so cumulative SO_4 depletion values eventually no longer align exactly with treatment categories, but rather become continuous variables; and (c) regression provides more statistical power than ANOVA and builds models that allowed us to describe the relationships between SO_4 depletion and response variables (Cottingham et al., 2005). However, when the relationship is not linear, ANOVA and comparison of treatments through Dunn's analysis can help describe the nature of a relationship.

4. Results and Discussion

4.1. The Impact of SO_4 Reduction on Mineralization of Sediment Organic Matter

Increased concentrations of surface water SO_4 resulted in increased sulfate reduction, which necessarily increased the mineralization of organic carbon, as described by reaction (1). Concentrations of surface water DOC and DIC increased in proportion to sulfate reduction, as measured by $(SO_4)_{Depl}$ (Table 1 and Figure 2). The marine literature generally assumes complete mineralization of particulate organic carbon (POC) to DIC in the water column (e.g., Boudreau & Westrich, 1984) (reaction 1), but in freshwater systems and especially wetlands, not all carbon is completely oxidized during decomposition, and a portion of POC may be mobilized as DOC (Howes et al., 1985; Selvendiran et al., 2008). In principle, the constituents of organic matter, such as the nutrients N and P, are mobilized in proportion to the mass of carbon mineralized as a result of MSR-driven decomposition. Surface water DOC and DIC, and the sum DOC + DIC, are therefore used as indicators of OM mineralization in interpreting the mobilization of N, P, and Hg to surface waters (Figure 2 and Tables 2 and 3).

In contrast to many marine systems, it is likely that SO_4 reduction in these sediments was limited more by SO_4 than by organic carbon, given that $(SO_4)_{Depl}$ was linearly proportional to the average SO_4 concentration (Figure S2a; R^2 = 0.87), without any obvious curvature to the relationship that would indicate saturation of MSR.

Regressions of surface water DOC and DIC against SO_4 depletion demonstrate that, on a net basis, about 60% more DIC than DOC was mobilized to the surface water as a result of MSR-driven mineralization (slope of 0.235 mM C per unit SO_4 depletion compared to 0.148; Table 2). The significantly positive slope of the DIC:DOC ratio against SO_4 depletion (Table 2) indicates that increasingly more DIC than DOC was observed in the surface water as sulfate depletion increased. Some mineralization of DOC to DIC likely occurs in the surface water as a result of exposure to oxygen, aerobic bacteria, and sunlight, processes that could have a larger effect as DOC increases.

Not only did surface water DIC and DOC increase in concert with sulfate reduction, but parallel increases occurred in surface water concentrations of constituents of organic matter: N, P, and Hg (Table 1 and Figure 2). DIC, DOC, total P, total N, ammonia, and total Hg in surface water all had increases from the control to the highest SO_4 addition of about twofold, (2.3, 1.7, 1.9, 1.8, 1.7, and 2.6-fold, respectively, Table 1). However, available phosphate in the sediment, an estimate of P availability in pore water, had a larger increase (7.5-fold). MSR consumes acidity as the DIC-based alkalinity is produced (Baker et al., 1986), which increased the average pH from 7.57 to 7.81, a 44% decrease in hydrogen ion concentration (Table 1). If the sulfide subsequently oxidizes (which could happen in a natural system during drought (Laudon et al., 2004) or intentional dewatering), a proportional quantity of alkalinity is consumed as acid is produced

Table 1
Summary of Effects of Experimentally Increased SO_4 Concentrations on SO_4 Reduction (Quantified as SO_4 Depletion), Organic Matter Mineralization, and Mercury Methylation

		Average of each sulfate treatment (n = 6 for each treatment)						Correlation with SO_4 depletion (Spearman)	
Variable	Matrix	Control	50	100	150	300	Max/Min	Rho	p value
				Variables mainly associated with SO_4 reduction					
SO_4 (T-W mean mg SO_4 L^{-1})	sw	6.7^{a}	26.9^{ab}	58.5^{abc}	93.2^{BC}	206.5^{c}	31.0	0.93	<0.0001
SO_4 depletion (mg S cm^{-2})	sw	0.14^{a}	2.52^{ab}	3.63^{abc}	4.28^{BC}	6.90^{c}	48.5	1	
Pore water sulfide (μg S L^{-1})	pw	69^{a}	184^{a}	224^{a}	393^{b}	728^{b}	10.5	0.81	<0.0001
Pore water iron (μg L^{-1})	pw	$12{,}883^{a}$	$11{,}122^{ab}$	$6{,}808^{abc}$	$4{,}483^{BC}$	$3{,}032^{c}$	4.25	−0.82	<0.0001
AVS (mg S kg^{-1})	sed	102^{a}	483^{ab}	NA	826^{ab}	$1{,}413^{b}$	13.8	0.77	<0.0001
pH	pw	7.57^{a}	7.52^{a}	7.55^{a}	7.75^{a}	7.81^{a}	1.03	0.39	=0.03
H^{+} ion (μmol L^{-1})	pw	0.027	0.030	0.028	0.018	0.015	1.72	0.39	=0.03
				Variables mainly associated with mineralization of organic matter					
TOC (% dry mass)	sed	9.26^{a}	7.90^{a}	8.18^{a}	7.17^{a}	8.22^{a}	1.29	−0.34	=0.065
DIC (mg C L^{-1})	sw	28.9^{a}	47.2^{ab}	56.3^{BC}	56.7^{BC}	66.3^{c}	2.30	0.94	<0.0001
DOC (mg C L^{-1})	sw	16.3^{a}	21.4^{a}	26.8^{BC}	24.0^{abc}	28.3^{bc}	1.74	0.79	<0.0001
Total N (mg N L^{-1})	sw	1.42^{a}	1.75^{a}	2.35^{BC}	2.03^{abc}	2.57^{BC}	1.81	0.77	<0.0001
Ammonia (mg N L^{-1})	sw	0.09^{a}	0.09^{a}	0.10^{a}	0.10^{a}	0.16^{a}	1.70	0.38	=0.04
Total P (μg P L^{-1})	sw	13^{a}	16^{ab}	22^{ab}	21^{ab}	25^{b}	1.92	0.73	<0.0001
Available P (μg P g^{-1} resin)	Resin in sed	0.34^{a}	0.40^{a}	0.59^{ab}	0.92^{ab}	2.56^{b}	7.45	0.86	<0.0001
Total Hg (ng L^{-1})	sw	1.83^{a}	2.09^{a}	3.61^{ab}	3.25^{ab}	4.80^{b}	2.63	0.82	<0.0001
				Variables mainly associated with Hg methylation					
Methylmercury (ng Hg L^{-1})	sw	0.20^{a}	0.49^{ab}	1.21^{b}	1.08^{b}	1.18^{b}	5.91	0.66	<0.0001
Inorganic Hg (ng L^{-1})	sw	1.63^{a}	1.60^{ab}	2.40^{abc}	2.17^{BC}	3.62^{c}	2.22	0.80	<0.0001
Percent methylmercury	sw	$11\%^{a}$	$23\%^{ab}$	$30\%^{b}$	$32\%^{b}$	$23\%^{ab}$	2.90	0.45	=0.02

Note. Matrix abbreviations: sw = surface water, pw = pore water, sed = bulk sediment. Averages with superscript letters in common are not significantly different at the 0.05 level.

(Hall et al., 2006). However, the sulfide reoxidation does not reverse the mobilization of the constituents of organic matter (C, N, P, and Hg) or the production of methylmercury (MeHg; see below). Rather, any production of SO_4 from sulfide oxidation creates the potential for additional MSR-driven OM mineralization and Hg methylation (Coleman Wasik et al., 2015; Hansel et al., 2015).

The slope of linear regressions of the C, N, and P in surface water against $(SO_4)_{Depl}$ is an estimate of the increase of that variable in mesocosm surface waters per unit SO_4 reduction (Table 2). The regression slopes provide a basis for estimates of stoichiometric ratios of the constituents mobilized from the sediment solid phase, similar to the calculation that Weston et al. (2006) performed for pore water. The calculation of stoichiometric ratios from the slopes of regressions with $(SO_4)_{Depl}$ is more accurate than calculating ratios from surface water concentrations alone, as the use of slopes accounts for the concentrations of the control (the intercept of the linear regression).

The regression slopes of surface water C versus surface water N, P, and Hg in mesocosms are estimates of the net release of each element relative to that of C (Table 3). These estimates can then be compared to the ratio of these constituents in the primary source material—the sediment—to determine the efficiency of mobilization of sediment N, P, and Hg to surface water, compared to C (Table 3). Although we present efficiency relative to only DOC and only DIC, calculating efficiency relative to the sum of mineralized OM (DOC + DIC) represents the overall net efficiency of mineralization, which ranges from 8% to 38% for the three constituents (Table 3). Although the increases in surface water N, P, and Hg are consistent with the hypothesis that those elements were released to the surface water through sulfate-enhanced mineralization of sediment OM, their lower mobilization efficiencies relative to carbon suggest that other processes were operating to either increase carbon, decrease N, P, and Hg mobilization relative to carbon, and/or increase N, P, and Hg losses. It is likely that some carbon was introduced to the surface waters from sources other than the sediment (e.g., photosynthetic fixation of atmospheric carbon) and that there were losses for N, P, and Hg from the surface water (though adsorption, settling, biological uptake, or atmospheric evasion of N and Hg).

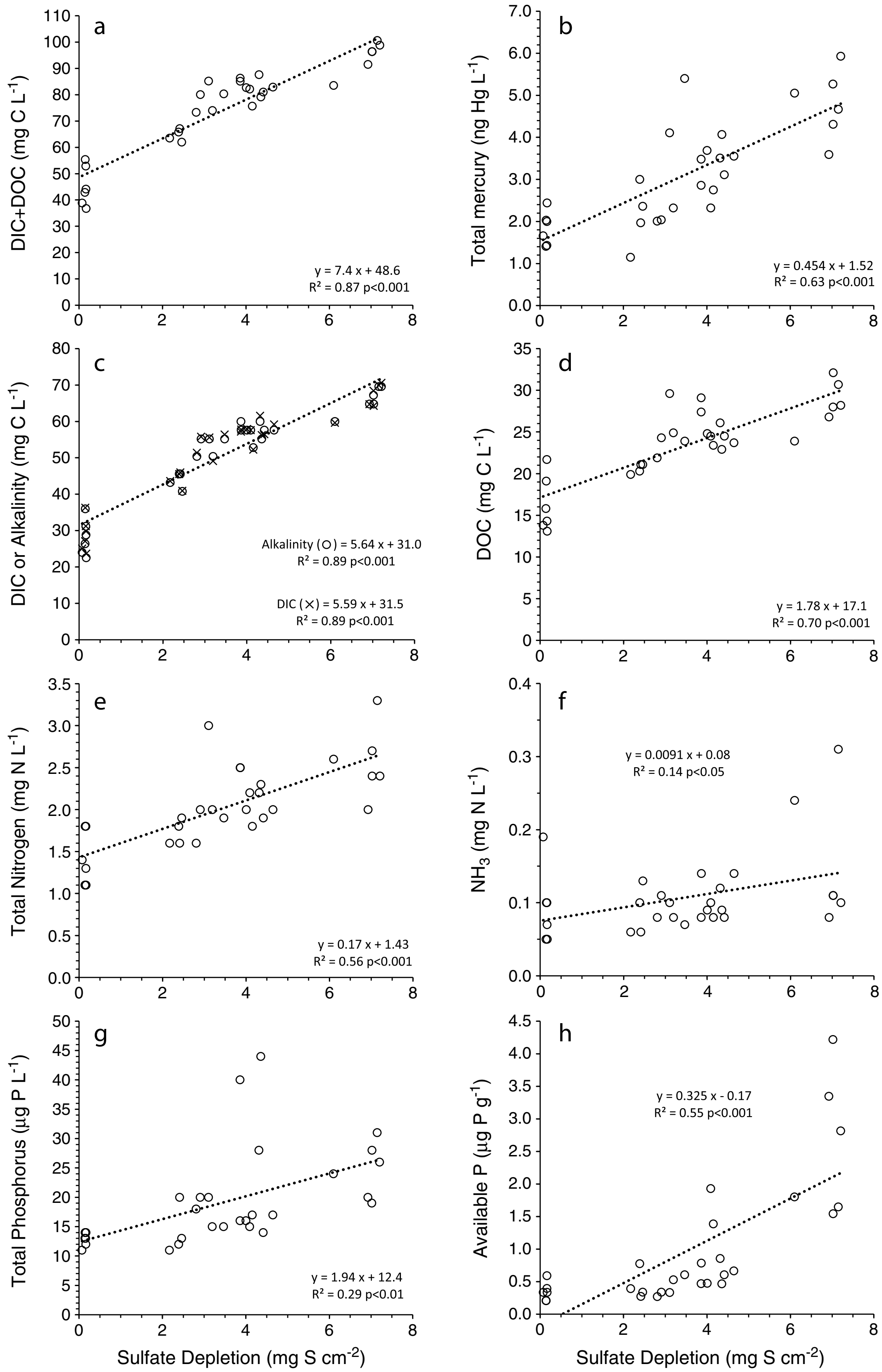


Figure 2. The release of constituents of sedimentary organic matter as a function of SO_4 depletion, showing linear regressions (dotted lines). (a) Sum of surface water DIC and DOC; (b) surface water total mercury; (c) surface water alkalinity and DIC (symbols ○ and ×, respectively; the two regressions are superimposed); (d) surface water DOC; (e) surface water total nitrogen; (f) surface water ammonia; (g) surface water total phosphorus; (h) available phosphate in the sediment, as quantified on ion-exchange resin.

Table 2
Slopes of Regressions of Surface Water Parameters (mM) Against SO_4 Depletion (mg S cm^{-2})

Surface water variable (molar basis)	Regression against $(SO_4)_{Depl}$ (mg S cm^{-2}) Slope	R^2	*p*
DIC	0.235	0.89	<0.0001
DOC	0.148	0.70	<0.0001
DIC + DOC	0.383	0.84	<0.0001
DIC: DOC	0.044	0.56	<0.0001
TN	0.0121	0.56	<0.0001
TN: DIC	−0.0028	0.25	<0.01
TN: DOC	0.0004	0.01	NS
TN: DIC + DOC	−0.0006	0.08	NS
TP	6.26E−05	0.29	<0.002
TP: DIC	−7.00E−06	0.03	NS
TP: DOC	7.00E−06	0.02	NS
TP: DIC + DOC	−1.00E−07	0.00	NS
THg	2.26E−09	0.63	<0.0001
THg: DIC	9.00E−06	0.46	<0.0001
THg: DOC	6.00E−06	0.23	<0.01
THg: DIC + DOC	2.00E−05	0.42	<0.0001

Note. When a sediment constituent's ratio to DIC or DOC has a significant slope against sulfate depletion, it indicates that the constituent was mobilized to the surface water at a significantly different rate than the DIC or DOC.

In addition to increases of TP in the surface water, the sediment pore water in the highest SO_4 treatment contained 7.5-fold greater available phosphate than the controls, as quantified with ion-exchange resin (Table 1 and Figure 2h). In comparison, the increase in surface water TP was only 1.9-fold (Table 1 and Figure 2g). The difference between phosphorus response in the resin and the surface water may be partly due to (a) loss of TP from the surface water after mobilization or (b) irreversible trapping of mobilized P on the resin. If phosphorus is released from sediment en masse in response to an S-induced shift from iron oxides to iron sulfides, the sediment pore water would experience this release first, while release to surface waters would take longer due to diffusion-limited transport and potentially an iron-oxide barrier at the sediment-water (anoxic-oxic) interface.

DIC in surface water is not conservative, being subject to exchange across the air-water interface, carbonate mineral precipitation, and photosynthetic uptake. Surface water pCO_2 in all mesocosms was above saturation with respect to atmospheric equilibrium by a factor of 1.4–15.5 (based on the DIC speciation calculations discussed earlier; data not shown), so the mesocosms were losing, not gaining, C through gas exchange with the atmosphere. The pCO_2 values in the mesocosms are similar to those reported from epilimnia of small, organic-rich, temperate lakes of low to moderate salinity (Cole et al., 1994; Myrbo & Shapley, 2006). With respect to mineral precipitation, based on geochemical equilibrium calculations, surface waters were undersaturated with respect to all carbonate minerals. Thus, although DIC in surface water is subject to several transport and transformation processes, the sustained presence of CO_2 at quantities significantly above saturation with respect to the atmosphere and the observation of increasing DIC and DOC with increasing $(SO_4)_{Depl}$ (Table 1) provide strong evidence of sulfate-induced increases in net carbon mineralization in the mesocosms.

In addition to the carbon originally present in the sediment, organic carbon was also photosynthetically fixed by wild rice and algae in the mesocosms and subsequently subjected to respiration and some decomposition, adding to the DIC and DOC in surface waters. DOC may also have been released into sediment pore water as an exudate from the wild rice roots (Rothenberg et al., 2014; Windham-Myers et al., 2009). Exudate DOC, however, does not account for the observed increase in DOC, since a negative relationship between the number of wild rice plants and DOC was observed (Spearman's rho = −0.63, $p < 0.001$, Table S2).

4.2. Effects of SO_4 Reduction on Mercury and Methylmercury in Surface Water

We interpret Hg mobilization to the surface water in an analogous manner to C, N, and P, as Hg tends to associate strongly with organic matter in sediment (Feyte et al., 2010). In the mesocosm surface waters,

Table 3
Elemental Ratios in Sediment and Surface Water Across the Range of SO_4 Depletion

Molar ratio in sediment[a]		Molar ratio in surface water[b] DIC	DOC	DOC + DIC	Efficiency of mobilization of sediment N, P, or Hg to surface water, relative to carbon: DIC	DOC	DOC + DIC
C: N	12[a]	19	12	32	63%	100%	38%
C: P	463[a]	3,752	2,366	6,118	12%	20%	8%
C: Hg	1.90E + 07	1.04E + 08	6.5E + 07	1.69E + 08	18%	29%	11%

Note. Together, the ratios are used to calculate the efficiency of mobilization of the constituents of particulate organic matter into the surface water.
[a]Sediment data from Hildebrandt, Pastor, and Dewey (2012), a mesocosm study that obtained sediment from the same natural wild rice stand. [b]Regression slopes of C versus N, P, and Hg in mesocosm surface waters; calculations are made based on surface water DIC alone, surface water DOC alone, and the sum of surface water DOC + DIC.

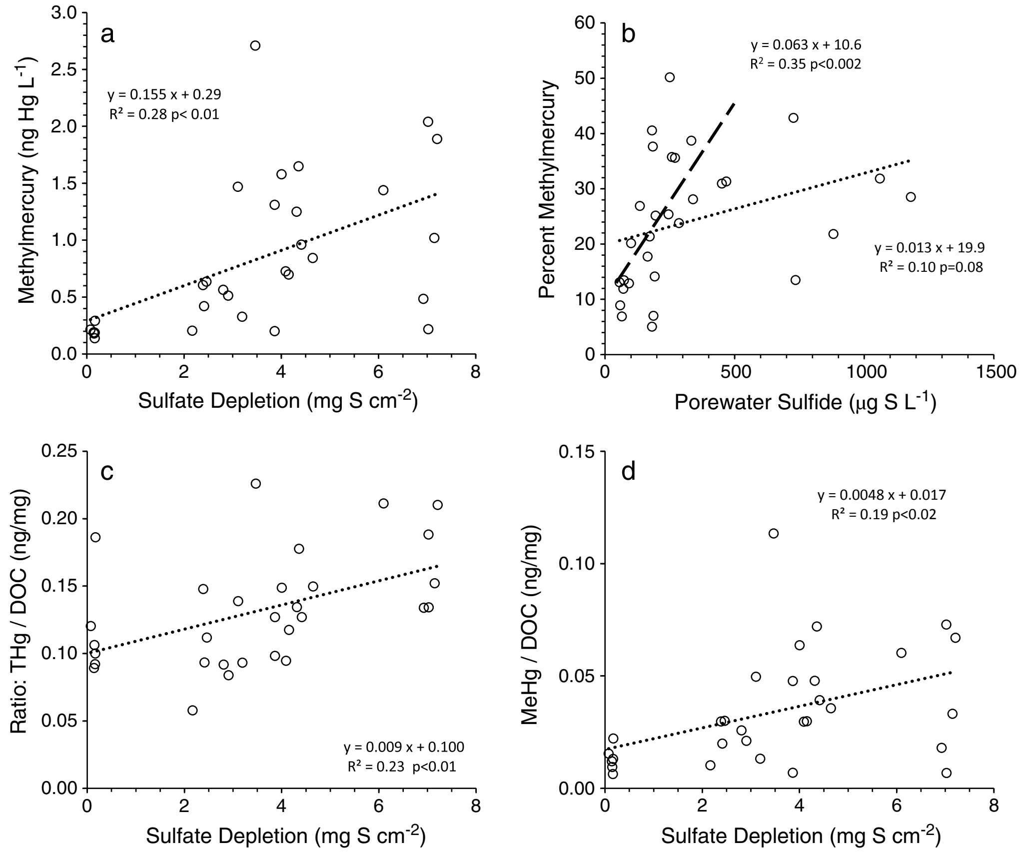


Figure 3. The response of surface water Hg variables to SO_4 depletion and the production of pore water sulfide, showing linear regressions. (a) MeHg as a function of SO_4 depletion; (b) percent MeHg as a function of pore water sulfide, showing regressions for all data (dotted line) and for the subset of data extending only to a pore water sulfide concentration of 468 µg S L^{-1} (dashed line); (c) ratio of THg to DOC as a function of SO_4 depletion; (d) ratio of MeHg to DOC as a function of SO_4 depletion.

THg, inorganic Hg (iHg), and MeHg all increased significantly with increased $(SO_4)_{Depl}$ (Table 1 and Figures 2b and 3a, $p < 0.0001$) and were greater in the highest sulfate amendment by factors of 2.6, 2.2, and 5.9, respectively (Table 1). The relative increase in THg (2.6-fold) is greater than that for DIC, DOC, TN, and TP, which range from 1.7 to 2.3-fold (Table 1). DOC enhances the solubility of both iHg and MeHg and can facilitate the movement of Hg from sediment into surface water (Ravichandran, 2004). The 5.9-fold increase in MeHg indicates that MeHg flux to surface waters was enhanced by sulfate loading disproportionately more than sedimentary release of THg (2.6-fold) and the increase in surface water DOC (1.7-fold).

The genes required to methylate Hg have been found in a wide variety of anaerobic bacteria, including SO_4-reducing bacteria, iron-reducing bacteria, and methanogens (Podar et al., 2015). Though some pure culture and experimental evidence exist for mercury methylation by other bacteria, extensive pure culture, experimental, and landscape-scale observations suggest SO_4-reducing bacteria dominate Hg methylation in many freshwater and marine environments. The relatively large increase in surface water MeHg in response to increased $(SO_4)_{Depl}$ in this experiment supports the assumption that MSR was responsible for most of the observed production of MeHg. It is likely that increased SO_4 loading to low-SO_4 aquatic systems with organic sediment will result in increased Hg methylation even though the relative importance of Hg methylation in the environment by different groups of bacteria is still a subject of debate (Paranjape & Hall, 2017).

If movement of DOC from sediment to surface water were the sole mechanism for the Hg increase in surface water, a constant Hg:DOC ratio would be expected on the $(SO_4)_{Depl}$ gradient. However, THg:DOC, iHg:DOC, and MeHg:DOC ratios in surface water are all significantly correlated with SO_4 depletion (Table S2 and Figures 3c and 3d). Therefore, all forms of Hg (THg, iHg, and MeHg) increase in surface waters more than does DOC, indicating that a sulfate-induced enhancement of carbon mineralization may act in combination with either enhanced methylation or an enhanced capacity of DOC to carry Hg. Changes to the binding strength of the DOC in heavily S-impacted mesocosm sediment are possible, as thiol groups on DOC are dominant binding sites for Hg (Skyllberg, 2008). The dual role of organic carbon and sulfur in driving both the production of MeHg and the transport of MeHg could be responsible for the substantially larger maximum increase in MeHg:DOC ratio relative to the increase in the THg:DOC ratio (an average 206% increase relative to a 63% increase, Figures 3c and 3d), as postulated by Bailey et al. (2017).

Regnell and Hammar (2004) identified three MSR-driven processes that might cause mobilization of Hg from sediment in a wetland, (1) mineralization of organic matter; (2) extraction of iHg by reduced S compounds, which could be associated with mobilized DOC; and (3) enhanced production of MeHg, which is more mobile than iHg. They argued that enhanced production of MeHg explained THg mobilization in the minerotrophic peat bog that they studied. However, in this study, increases in surface water MeHg concentrations (Figure 3a) are not sufficient to explain the linear increase in THg observed in this experiment (Figure 2b) because most (67%) of the increase is iHg (Table 1). Some of the increase in surface water iHg could be the result of increased production of MeHg that moved to surface water and was subsequently demethylated. Regardless of the underlying mechanism, our observations clearly show increases in surface water Hg that were greater than the increases in C, N, and P (Table 3); this corroborates other studies (Bouchet et al., 2013; Merritt & Amirbahman, 2007; Regnell & Hammar, 2004) that suggest sediment Hg may be synergistically mobilized to surface waters through mineralization, methylation, and enhanced mobility with DOC.

Recent research has shown that in many ecosystems, higher concentrations of pore water sulfide may inhibit MeHg production through either thermodynamically or kinetically controlled reactions with inorganic Hg (Benoit et al., 2003; Hsu-Kim et al., 2013). We plotted %MeHg, rather than the MeHg concentration, against pore water sulfide because we are interested in identifying the pore water sulfide zone of greatest efficiency for the methylation and mobilization of mercury. In this experiment the MSR-driven mineralization of OM released THg to surface water in addition to producing pore water sulfide. Accordingly, because THg is not constant, plotting %MeHg is the most accurate way to identify peak methylation efficiency. In principle, the restricted bioavailability of Hg to methylating bacteria results in a maximum in MeHg production at intermediate concentrations of pore water sulfide. Consistent with previous research in sulfate-impacted freshwater ecosystems (Gilmour et al., 1998; Gilmour, Krabbenhoft, et al., 2007, Gilmour, Orem, et al., 2007; Bailey et al., 2017), MeHg production was most efficient at intermediate sulfide concentrations. In the control, where average sulfide was 69 $\mu g\ S\ L^{-1}$, MeHg averaged only 11% of THg in surface waters. In the intermediate SO_4 treatments, which had average sulfide concentrations of 224 and 393 $\mu g\ S\ L^{-1}$, MeHg production efficiency peaked significantly higher, at averages of 30% and 32%, respectively (Table 1). %MeHg declined to an average of 23% in the highest SO4 treatment, which had an average sulfide concentration of 728 $\mu g\ S\ L^{-1}$. Given the relatively great scatter in the relationship between %MeHg and sulfide (Figure 3b), it would be most defensible to conclude that the decrease in %MeHg began to occur somewhere between 300 and 700 $\mu g\ S\ L^{-1}$. There is a strong positive relationship ($p < 0.001$) between sulfide and %MeHg if the five sulfide concentrations greater than 727 $\mu g\ S\ L^{-1}$ are excluded from the regression (which leaves only sulfide concentrations less than 468 $\mu g\ S\ L^{-1}$, since there is a gap in sulfide concentrations; Figure 3b). Other studies have identified sulfide zones of peak methylation roughly comparable to that found here. In South Florida, Orem et al. (2011) found that sulfide ranging from 5 to 150 $\mu g\ S\ L^{-1}$ did not inhibit methylation but that sulfide concentrations greater than 1,000 $\mu g\ S\ L^{-1}$ did. In a subboreal Minnesota wetland enriched in SO_4 from mining discharge, Bailey et al. (2017) found that sulfide concentrations above ~650 $\mu g\ S\ L^{-1}$ inhibited methylation.

The relationship between surface water SO_4 and Hg methylation can be strongly affected by site-specific conditions. Because of the variable conversion of SO_4 in surface water to sulfide in pore water—primarily due to differences in OM and Fe availability (Pollman et al., 2017)—researchers have found a broad range in the SO_4 concentration associated with maximum efficiency of Hg methylation. For example, Orem et al. (2014) observed that two different areas in the Everglades Protection Area had peak surface water MeHg concentrations at SO_4 concentrations of 2 and 10–15 mg L^{-1}. In the mesocosms presented here peak surface water %MeHg was observed in the two sulfate treatments that averaged 59 and 93 mg L^{-1} (Table 1).

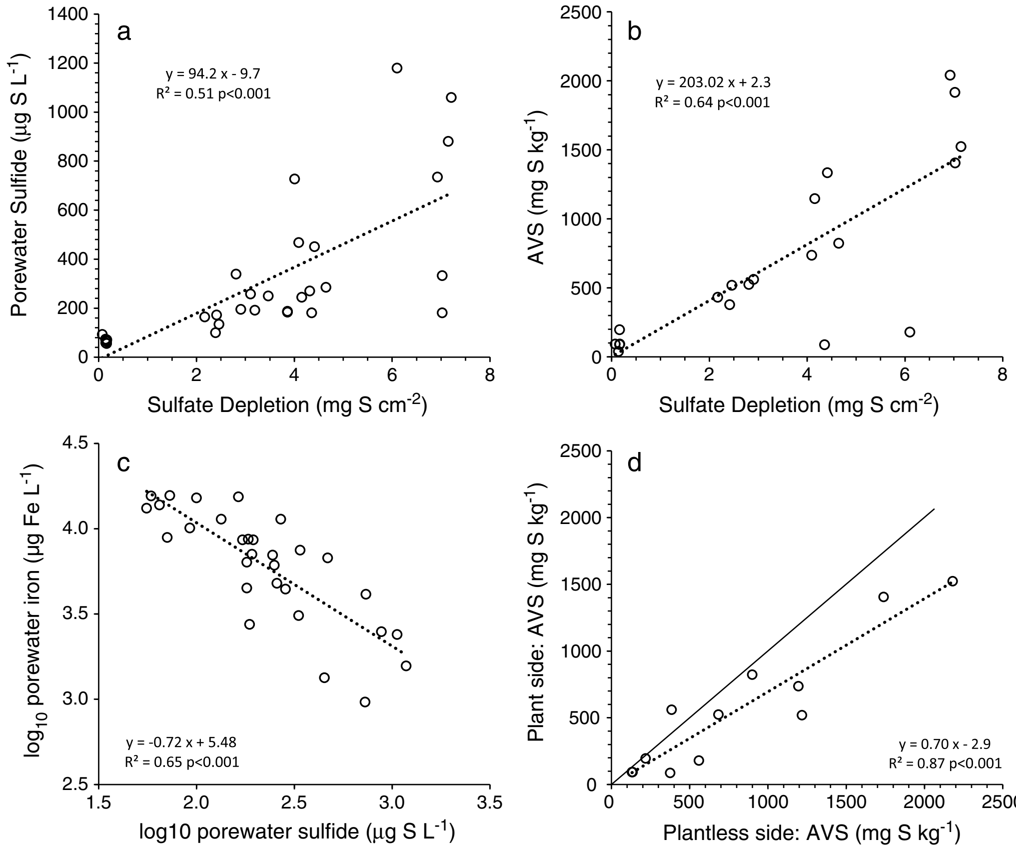


Figure 4. AVS and pore water sulfide, as related to SO_4 depletion, pore water iron, and presence of rooted plants. (a) Pore water sulfide as a function of SO_4 depletion; (b) AVS from the vegetated side of the mesocosms as a function of SO_4 depletion; (c) pore water iron as a function of pore water sulfide; (d) AVS compared between the vegetated side and nonvegetated side. The solid 1:1 line shows that in almost all mesocosms more AVS is found in the side without plants.

4.3. Effects of SO_4 Reduction on Pore Water and Sediment Sulfide

Pore water sulfide increased at higher $(SO_4)_{Depl}$, although with greater variance at higher $(SO_4)_{Depl}$ (Figure 4a), possibly as a result of variable oxidation of sulfide that may depend on the proximity of the Rhizon sampler to plant roots (Schmidt et al., 2011) or of variable bioturbation by invertebrates (Lawrence et al., 1982). When SO_4 is reduced through MSR, the sulfide produced has a number of nonexclusive potential fates: the sulfide could (1) be oxidized within the sediment; (2) remain in the sediment pore water as free sulfide; (3) diffuse into oxygenated surface water, to be oxidized; (4) react with metals in the sediment, forming insoluble precipitates (dominated by iron-sulfide compounds); or (5) be lost to the atmosphere as H_2S gas or as volatile organic sulfur compounds. Because precipitation reactions are fast relative to redox reactions and diffusion, most of the sulfide probably forms metal precipitates if metals are available. When precipitation dominates the fate of sulfide produced from MSR, the continuous reduction of SO_4 and precipitation of iron sulfides form quasi-steady states between surface water SO_4 and pore water sulfide (Figure S2b) and between pore water sulfide and pore water iron (Figures 3 and 4c). The overall mass of sulfide in the mesocosm sediment, quantified through analysis of AVS (from sediment in the vegetated area), is closely correlated with SO_4 depletion (Figure 4b) even though AVS may not include all the reduced sulfide in sediments. It is likely that most of the AVS in these sediments is present as an FeS precipitate because other metals are at low concentrations in these sediments, which came from a relatively pristine (unpolluted) lake (Fond du Lac Band, 2016; Pastor et al., 2017). Note that there are two mesocosms with especially low AVS concentrations (Figure 4b). It is possible that the AVS in the specific location in these mesocosms where sediment core samples were collected was influenced by a spatially heterogeneous oxidization process (e.g., root oxygen or benthic invertebrates) that limited the accumulation of sulfide.

AVS was 30% lower in the vegetated side of the mesocosms, suggesting that wild rice released oxygen into the sediment, inhibiting the production of sulfide and/or decreasing sulfide concentrations through oxidation (Figure 4d; Wilcoxon paired test, $p = 0.007$). It is notable that this 30% difference developed in just one growing season, despite the previous 2 years of sulfate treatment. Pore water sulfide showed no statistically significant difference between the two sides owing to high variability within treatments. Numerous investigations have found that rooted aquatic plants release oxygen from their roots, a phenomenon that is usually interpreted as an adaptation to limit the toxicity of reduced chemical species in the pore water, especially sulfide (Lamers et al., 2013). Although oxygen release has been observed in white rice, *Oryza sativa* (Colmer, 2002), it has never been documented in wild rice, which is in the same tribe (Oryzeae) of grasses as white rice, and also develops aerenchyma (Jorgenson et al., 2013), plant structures that provide a low-resistance internal pathway for movement of oxygen to the roots. Since the growth and reproduction of rooted plants can be inhibited by sulfide (Pastor et al., 2017), there may be a tipping point of exposure to sulfide above which oxygen release is insufficient to mitigate phytotoxic effects, and the plant population declines over time, possibly to extirpation. In this experiment, in the third treatment year, the increase in pore water sulfide was the apparent cause of a decrease in the average number of wild rice stems from 17 in the control mesocosms to 3 in the highest-sulfate treatment mesocosms (Pastor et al., 2017).

4.4. Mesocosms as Models for Ecosystem-Scale Effects of SO_4 Reduction

Although mesocosms, as contained ecosystems, are useful because they mimic ecological and biogeochemical processes that occur in the field, extrapolating findings to nature is challenging when plastic walls have prevented exchange of water and materials (Petersen et al., 2009). These wall-based challenges are manifest in three phenomena in this experiment, (1) relatively long surface water residence times due to the lack of a constant throughflow; (2) the presence of the wall itself, which provides a surface for periphyton; and (3) lack of either overland or groundwater loading of external materials:

1. Relatively long surface water residence times: the increased loading of N, P, C, Hg, and MeHg to the surface water of the mesocosms was readily detected because the lack of hydraulic loading from a watershed minimized dilution and loss through the outflow. The impact of an increase in SO_4 loading on surface water concentrations of N, P, C, Hg, DIC, and DOC would be lower in waters with shorter residence times. For instance, Baker and Brezonik (1988), in modeling increases in alkalinity from atmospheric SO_4 loading, noted that net increases in alkalinity would be most important in waters with long residence times (>5 years) and that there would be little increase in alkalinity in waters with much shorter residence times (<1 year). However, the measured concentrations may not represent the maximum impact of MSR-driven mineralization because the mesocosm wall may enhance removal from the surface water (point number 2, below).
2. Presence of the mesocosm wall: the mesocosms have a relatively high ratio of wall and sediment surfaces to the volume of overlying water, enhancing the removal of surface water nutrients and Hg to periphyton or inorganic sinks such as iron oxyhydroxides. Natural aquatic systems have less proportional loss to surfaces. The quantitative estimates of internal loading of N, P, and Hg in response to MSR-induced carbon mineralization may have been underestimated by the measured surface water concentrations, given that significant loss of these constituents to periphyton may have occurred. In addition, THg was filtered prior to analysis, which would have removed any Hg associated with phytoplankton or other suspended particles.
3. Lack of either overland or groundwater loading of particulate and dissolved material, specifically iron: the availability of iron in sediment is a primary controller of the fate of MSR-produced sulfide (Pollman et al., 2017). In natural aquatic systems, iron would be supplied at a relatively constant rate from the system's watershed over the long term, although varying in magnitude from watershed to watershed (Maranger et al., 2006; Winter, 2001). This experiment was not an accurate long-term mimic of pore water sulfide concentrations because the external supply of iron was cut off at the inception of the experiment. With no loading of iron, but continued loading of SO_4, the continued production of sulfide would be expected to eventually consume all available Fe, allowing pore water sulfide levels to exceed those expected in a natural system at equivalent surface water SO_4 concentrations. This mesocosm experiment provides

evidence for just such a result. The experiment continued for 2 years after the 2013 sampling presented here. In the fifth year (August 2015) pore water sulfide was much greater than had been observed in 2013, and disproportionately so in the highest SO_4 treatment, which was most likely to consume available Fe. Between the 2013 and 2015, pore water sulfide increased in the control SO_4 treatment (about 7 mg SO_4 L^{-1}) from an average value of 69 μg L^{-1} in 2013 to 116 μg L^{-1} in 2015, a 68% increase. Pore water sulfide in the highest treatment (nominally 300 mg SO_4 L^{-1}, Table 1) increased from an average value of 728 μg L^{-1}in 2013 to 9,350 μg L^{-1} in 2015, a 1,184% increase (Pastor et al., 2017). In a survey of 108 Minnesota waterbodies with a wide range of surface water sulfate, only two exceeded a pore water sulfide level of 3,200 μg L^{-1} (Myrbo et al., 2017).

5. Conclusions

This study demonstrates that increased SO_4 loading to inland waters with organic-rich sediments can significantly increase the decomposition of sedimentary organic matter, which increases internal loading to surface water of the chemical constituents of organic matter, including DIC, DOC, P, N, and Hg. Associated changes include increased production of sulfide and methylmercury and increased alkalinity and pH. Any one of these changes could alone cause significant secondary changes in the structure of an aquatic ecosystem but, taken together, could cause a cascade of primary and secondary environmental changes: increased availability of nutrients (N and P), which can alter dominant plant species, organic carbon production, oxygen consumption, and redox; increased pore water sulfide, which can be toxic to benthic animals and plants; increased MeHg production, which can affect fish and other consumers in the aquatic food web; increased DOC, which can alter light transmission, thermal stratification, and aquatic chemistry; and increased DIC production, which increases alkalinity and pH, affecting aquatic chemistry and biota. Each of these changes resulting from higher surface water SO_4 and consequent increases in MSR has been documented in the literature, but the entire suite of associated changes in aquatic chemistry has not heretofore been demonstrated in an integrated fashion. The degree to which an increase in SO_4 loading affects the ecological structure of the receiving water will depend on the relative increases in N, P, DIC, DOC, Hg, MeHg, pH, and sulfide, which will be a function of background geochemistry and hydrology of the specific system. In this experiment, the changes in these parameters were linearly proportional to SO_4 reduction, which, in turn, was linearly proportional to the time-weighted average SO_4 concentration. The linear responses of the parameters to SO_4 additions suggest that ecologically significant changes may occur even when SO_4 concentrations are elevated only modestly and that dramatic changes may occur with higher sulfate loading.

Acknowledgments
This work was supported by the Clean Water Fund, created by the Clean Water, Land and Legacy Amendment to Minnesota's constitution; by the Fond du Lac and Grand Portage Bands of Lake Superior Chippewa with band funds and water quality funds provided by the Environmental Protection Agency; by Minnesota Sea Grant; by NSF 0715808 to Pastor and others; and by NSF 0949962 to Myrbo and others. A partial data set is available in the EarthChem database: https://doi.org/10.1594/IEDA/100701. The full data set is available in the Data Repository for U of M (DRUM): https://doi.org/10.13020/D6595Z.

References

Åkerblom, S., Bishop, K., Björn, E., Lambertsson, L., Eriksson, T., & Nilsson, M. B. (2013). Significant interaction effects from sulfate deposition and climate on sulfur concentrations constitute major controls on methylmercury production in peatlands. *Geochimica et Cosmochimica Acta*, *102*, 1–11.

APHA (2005). *Standard Methods for Examination of Water and Wastewater* (21st ed.). Washington, DC: American Public Health Association.

Bachand, P. A. M., Bachand, S., Fleck, J., Anderson, F., & Windham-Myers, L. (2014). Differentiating transpiration from evaporation in seasonal agricultural wetlands and the link to advective fluxes in the root zone. *Science of the Total Environment*, *484*, 232–248.

Bagarinao, T. (1992). Sulfide as an environmental factor and toxicant: Tolerance and adaptations in aquatic organisms. *Aquatic Toxicology*, *24*, 21–62.

Bailey, L. T., Mitchell, C. P. J., Engstrom, D. R., Berndt, M. E., Coleman Wasik, J. K., & Johnson, N. W. (2017). Influence of porewater sulfide on methylmercury production and partitioning in sulfate-impacted lake sediments. *Science of the Total Environment*, *580*, 1,197–1,204.

Baker, L. A., & Brezonik, P. L. (1988). Dynamic model of in-lake alkalinity generation. *Water Resources Research*, *24*, 65–74. https://doi.org/10.1029/WR024i001p00065

Baker, L. A., Brezonik, P. L., & Pollman, C. D. (1986). Model of internal alkalinity generation: Sulfate retention component. *Water, Air, and Soil Pollution*, *31*, 89–94.

Baker, L. A., Pollman, C. D., & Eilers, J. M. (1988). Alkalinity regulation in softwater Florida lakes. *Water Resources Research*, *24*, 1069–1082. https://doi.org/10.1029/WR024i007p01069

Baldwin, D. S., & Mitchell, A. (2012). Impact of sulfate pollution on anaerobic biogeochemical cycles in a wetland sediment. *Water Research*, *46*, 965–974. https://doi.org/10.1016/j.watres.2011.11.065

Benoit, J. M., Gilmour, C. C., Heyes, A., Mason, R. P., & Miller, C. L. (2003). Geochemical and biological controls over methylmercury production and degradation in aquatic ecosystems, Chapter 19. In *Biogeochemistry of Environmentally Important Trace Elements, ACS Symposium Series* (Vol. 835, pp. 262–297). Washington, DC: American Chemical Society.

Bergman, I., Bishop, K., Tu, Q., Frech, W., Åkerblom, S., & Nilsson, M. (2012). The influence of sulphate deposition on the seasonal variation of peat pore water methyl Hg in a boreal mire. *PLoS One*, *7*(9), e45547. https://doi.org/10.1371/journal.pone.0045547

Bouchet, S., Amouroux, D., Rodriguez-Gonzalez, P., Tessier, E., Monperrus, M., Thouzeau, G., … Anschutz, P. (2013). MMHg production and export from intertidal sediments to the water column of a tidal lagoon (Arcachon Bay, France). *Biogeochemistry*, *114*, 341–358.

Boudreau, B. P., & Westrich, J. T. (1984). The dependence of bacterial sulfate reduction on sulfate concentration in marine sediments. *Geochimica et Cosmochimica Acta*, *48*, 2503–2516.

Boye, K., Noël, V., Tfaily, M. M., Bone, S. E., Williams, K. H., Bargar, J. R., & Fendorf, S. (2017). Thermodynamically controlled preservation of organic carbon in floodplains. *Nature Geoscience*, *10*, 415–419. https://doi.org/10.1038/ngeo29

Branfireun, B. A., Bishop, K., Roulet, N. T., Granberg, G., & Nilsson, M. (2001). Mercury cycling in boreal ecosystems: The long-term effect of acid rain constituents on peatland pore water methylmercury concentrations. *Geophysical Research Letters*, *28*, 1227–1230. https://doi.org/10.1029/2000GL011867

Branfireun, B. A., Roulet, N. T., Kelly, C. A., & Rudd, J. W. M. (1999). In situ sulphate stimulation of mercury methylation in a boreal peatland: Toward a link between acid rain and methylmercury contamination in remote environments. *Global Biogeochemical Cycles*, *13*, 743–750. https://doi.org/10.1029/1999GB900033

Capone, D. G., & Kiene, R. P. (1988). Comparison of microbial dynamics in marine and freshwater sediments: Contrasts in anaerobic carbon catabolism. *Limnology and Oceanography*, *33*, 725–749.

Caraco, N. F., Cole, J. J., & Likens, G. E. (1993). Sulfate control of phosphorus availability in lakes. *Hydrobiologia*, *253*, 275–280.

Cole, J. J., Caraco, N. F., Kling, G. W., & Kratz, T. K. (1994). Carbon dioxide supersaturation in the surface waters of lakes. *Science*, *265*, 1,568–1,570.

Coleman Wasik, J. K., Engstrom, D. R., Mitchell, C. P. J., Swain, E. B., Monson, B. A., Balogh, S. J., … Almendinger, J. E. (2015). The effects of hydrologic fluctuation and sulfate regeneration on mercury cycling in an experimental peatland. *Journal of Geophysical Research: Biogeosciences*, *120*, 1697–1715. https://doi.org/10.1002/2015JG002993

Colmer, T. D. (2002). Aerenchyma and an inducible barrier to radial oxygen loss facilitate root aeration in upland, paddy and deep-water rice (*Oryza sativa* L.). *Annals of Botany*, *91*, 301–309.

Cook, R. B., Kelly, C. A., Schindler, D. W., & Turner, M. A. (1986). Mechanisms of hydrogen ion neutralization in an experimentally acidified lake. *Limnology and Oceanography*, *31*, 134–148.

Cottingham, K. L., Lennon, J. T., & Brown, B. L. (2005). Knowing when to draw the line: Designing more informative ecological experiments. *Frontiers in Ecology and the Environment*, *3*(3), 145–152.

Curtis, P. J. (1989). Effects of hydrogen ion and sulphate on the phosphorus cycle of a Precambrian Shield lake. *Nature*, *337*, 156–158.

Feyte, S., Tessier, A., Gobeil, C., & Cossa, D. (2010). In situ adsorption of mercury, methylmercury and other elements by iron oxyhydroxides and organic matter in lake sediments. *Applied Geochemistry*, *25*, 984–995.

Fond du Lac Band (2016). Fond du Lac Lakes and Streams Data Table. Retrieved from: http://www.fdlrez.com/RM/waterquality.htm, accessed 2 Dec 2016.

Geurts, J. J. M., Sarneel, J. M., Willers, B. J. C., Roelofs, J. G. M., Verhoeven, J. T. A., & Lamers, L. P. M. (2009). Interacting effects of sulphate pollution, sulphide toxicity and eutrophication on vegetation development in fens: A mesocosm experiment. *Environmental Pollution*, *157*, 2072–2081.

Giblin, A. E., Likens, G. E., White, D., & Howarth, R. W. (1990). Sulfur storage and alkalinity generation in New England lake sediments. *Limnology and Oceanography*, *35*, 852–869.

Gilmour, C., Krabbenhoft, D., Orem, W., Aiken, G., & Roden, E. (2007). Appendix 3B-2: Status report on ACME studies on the control of mercury methylation and bioaccumulation in the Everglades, 2007 South Florida Environmental Report. South Florida Water Management District, West Palm Beach, FL.

Gilmour, C., Orem, W., Krabbenhoft, D., & Mendelssohn, I. (2007). Appendix 3B-3: Preliminary assessment of sulfur sources, trends and effects in the Everglades. 2007 South Florida Environmental Report. South Florida Water Management District, West Palm Beach, FL.

Gilmour, C. C., Henry, E. A., & Mitchell, R. (1992). Sulfate stimulation of mercury methylation in freshwater sediments. *Environmental Science & Technology*, *26*, 2,281–2,287.

Gilmour, C. C., Riedel, G. S., Ederington, M. C., Bell, J. T., Benoit, J. M., Gill, G. A., & Stordal, M. C. (1998). Methylmercury concentrations and production rates across a trophic gradient in the northern Everglades. *Biogeochemistry*, *40*(2–3), 327–345.

Gorham, E., Dean, W. E., & Sanger, J. E. (1983). The chemical composition of lakes in the north-central United States. *Limnology and Oceanography*, *28*, 287–301.

Hall, K. C., Baldwin, D. S., Rees, G. N., & Richardson, A. J. (2006). Distribution of inland wetlands with sulfidic sediments in the Murray-Darling Basin, Australia. *Science of the Total Environment*, *370*, 235–244.

Hansel, C. M., Lentini, C. J., Tang, Y., Johnson, D. T., Wankel, S. D., & Jardine, P. M. (2015). Dominance of sulfur-fueled iron oxide reduction in low-sulfate freshwater sediments. *The ISME Journal*, *9*, 2400–2412. https://doi.org/10.1038/ismej.2015.50

Harmon, S. M., King, J. K., Gladden, J. B., Chandler, G. T., & Newman, L. A. (2004). Methylmercury formation in a wetland mesocosm amended with sulfate. *Environmental Science & Technology*, *38*, 650–656.

Heijs, S. K., & van Gemerden, H. (2000). Microbiological and environmental variables involved in the sulfide buffering capacity along a eutrophication gradient in a coastal lagoon (Bassin d'Arcachon, France). *Hydrobiologia*, *437*(1–3), 121–131.

Hildebrandt, L., Pastor, J., & Dewey, B. (2012). Effects of external and internal nutrient supplies on decomposition of wild rice, *Zizania palustris*. *Aquatic Botany*, *97*, 35–43.

Holmer, M., & Storkholm, P. (2001). Sulphate reduction and sulphur cycling in lake sediments: A review. *Freshwater Biology*, *46*, 431–451.

Howes, B. L., Dacey, J. W. H., & Teal, J. M. (1985). Annual carbon mineralization and belowground production of Spartina alterniflora in a New England salt marsh. *Ecology*, *66*(2), 595–605.

Hsu-Kim, H., Kucharzyk, K. H., Zhang, T., & Deshusses, M. A. (2013). Mechanisms regulating mercury bioavailability for methylating microorganisms in the aquatic environment: A critical review. *Environmental Science & Technology*, *47*(6), 2,441–2,456.

Jeremiason, J. D., Engstrom, D. R., Swain, E. B., Nater, E. A., Johnson, B. M., Almendinger, J. E., … Kolka, R. K. (2006). Sulfate addition increases methylmercury production in an experimental wetland. *Environmental Science & Technology*, *40*, 3,800–3,806.

Johnson, N. W., Mitchell, C. P., Engstrom, D. R., Bailey, L. T., Coleman Wasik, J. K., & Berndt, M. E. (2016). Methylmercury production in a chronically sulfate-impacted sub-boreal wetland. *Environmental Science: Processes & Impacts*, *18*(6), 725–734.

Jorgenson, K. D., Lee, P. F., & Kanavillil, N. (2013). Ecological relationships of wild rice, *Zizania* spp. 11. Electron microscopy study of iron plaques on the roots of northern wild rice (*Zizania palustris*). *Botany*, *91*, 189–201.

Lamers, L. P. M., Falla, S.-J., Samborska, E. M., Van Dulken, I. A. R., Van Hengstum, G., & Roelofs, J. G. M. (2002). Factors controlling the extent of eutrophication and toxicity in sulfate-polluted freshwater wetlands. *Limnology and Oceanography*, *47*, 585–593.

Lamers, L. P. M., Govers, L. L., Janssen, I. C. J. M., Geurts, J. J. M., Van Der Welle, M. E. W., Van Katwijk, M. M., … Smolders, A. J. P. (2013). Sulfide as a soil phytotoxin. *Frontiers in Plant Science*, *4*, 1–14.

Lamers, L. P. M., Ten Dolle, G. E., Van Den Berg, S. T. G., Van Delft, S. P. J., & Roelofs, J. G. M. (2001). Differential responses of freshwater wetland soils to sulphate pollution. *Biogeochemistry*, *55*, 87–102.

Lamers, L. P. M., Tomassen, H. B. M., & Roelofs, J. G. M. (1998). Sulfate-induced eutrophication and phytotoxicity in freshwater wetlands. *Environmental Science & Technology*, *32*, 199–205.
Laudon, H., Dillon, P. J., Eimers, M. C., Semkin, R. G., & Jeffries, D. S. (2004). Climate-induced episodic acidification of streams in central Ontario. *Environmental Science & Technology*, *38*, 6009–6015.
Lawrence, G. B., Mitchell, M. J., & Landers, D. H. (1982). Effects of the burrowing mayfly, Hexagenia, on nitrogen and sulfur fractions in lake sediment microcosms. *Hydrobiologia*, *87*, 273–283.
Lomans, B. P., van der Drift, C., Pol, A., & Op den Camp, H. J. M. (2002). Microbial cycling of volatile organic sulfur compounds. *Cellular and Molecular Life Sciences*, *59*, 575–588.
Maranger, R., Canham, C. D., Pace, M. L., & Papaik, M. J. (2006). A spatially explicit model of iron loading to lakes. *Limnology and Oceanography*, *51*, 247–256.
Marbà, N., Calleja, M. L., Duarte, C. M., Álvarez, E., Díaz-Almela, E., & Holmer, M. (2007). Iron additions reduce sulfide intrusion and reverse seagrass (Posidonia oceanica) decline in carbonate sediments. *Ecosystems*, *10*, 745–756.
Maynard, J. J., O'Geen, A. T., & Dahlgren, R. A. (2011). Sulfide induced mobilization of wetland phosphorus depends strongly on redox and iron geochemistry. *Soil Science Society of America Journal*, *75*, 1986–1999.
Merritt, K. A., & Amirbahman, A. (2007). Mercury dynamics in sulfide-rich sediments: Geochemical influence on contaminant mobilization with the Penobscot River estuary, Maine, USA. *Geochimica et Cosmochimica Acta*, *71*, 929–941.
Mitchell, C. P. J., Branfireun, B. A., & Kolka, R. K. (2008). Assessing sulfate and carbon controls on net methylmercury production in peatlands: An in situ mesocosm approach. *Applied Geochemistry*, *23*, 503–518.
Moyle, J. B. (1945). Some chemical factors influencing the distribution of aquatic plants in Minnesota. *The American Midland Naturalist*, *34*, 402–420.
Myrbo, A., & Shapley, M. D. (2006). Seasonal water-column dynamics of dissolved inorganic carbon stable isotopic compositions ($\delta^{13}C_{DIC}$) in small hardwater lakes in Minnesota and Montana. *Geochimica et Cosmochimica Acta*, *70*, 2699–2714.
Myrbo, A., Swain, E. B., Engstrom, D. R., Coleman Wasik, J., Brenner, J., Dykhuizen Shore, M., … Blaha, G. (2017). Sulfide generated by sulfate reduction is a primary controller of the occurrence of wild rice (Zizania palustris) in shallow aquatic ecosystems. *Journal of Geophysical Research: Biogeosciences*, *122*. https://doi.org/10.1002/2017JG003787
Nielsen, D. L., Brock, M. A., Rees, G. N., & Baldwin, D. S. (2003). Effects of increasing salinity on freshwater ecosystems in Australia. *Australian Journal of Botany*, *51*, 655–665.
Orem, W., Fitz, H. C., Krabbenhoft, D., Tate, M., Gilmour, C., & Shafer, M. (2014). Modeling sulfate transport and distribution and methylmercury production associated with Aquifer Storage and Recovery implementation in the Everglades Protection Area. *Sustainability Water Quality and Ecology*, *3-4*, 33–46.
Orem, W., Gilmour, C., Axelrad, D., Krabbenhoft, D., Scheidt, D., Kalla, P., … Aiken, G. (2011). Sulfur in the South Florida ecosystem: Distribution, sources, biogeochemistry, impacts, and management for restoration. *Critical Reviews in Environmental Science and Technology*, *41*(S1), 249–288. https://doi.org/10.1080/10643389.2010.531201
Pallud, C., & Van Cappellen, P. (2006). Kinetics of microbial sulfate reduction in estuarine sediments. *Geochimica et Cosmochimica Acta*, *70*, 1,148–1,162.
Paranjape, A. R., & Hall, B. D. (2017). Recent advances in the study of mercury methylation in aquatic systems. *FACETS*, *2*, 85–119. https://doi.org/10.1139/facets-2016-0027
Parkhurst, D. L., & Appelo, C. A. J.(2013). Description of input and examples for PHREEQC version 3—A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. U.S. Geological Survey Techniques and Methods, book 6, chap. A43, 497 p. Retrieved from: http://pubs.usgs.gov/tm/06/a43/, Accessed 20 Nov 2016.
Pastor, J., Dewey, B., Johnson, N. W., Swain, E. B., Monson, P., Peters, E. B., & Myrbo, A. (2017). Effects of sulfate and sulfide on the life cycle of *Zizania palustris* in hydroponic and mesocosm experiments. *Ecological Applications*, *27*, 321–336.
Patrick, R., Roberts, N. A., & Davis, B. (1968). The effect of changes in pH on the structure of diatom communities. *Notulae Naturae (Philadelphia)*, *416*, 1–16.
Petersen, J. E., Kennedy, V. S., Dennison, W. C., & Kemp, W. M. (Eds.) (2009). *Enclosed Experimental Ecosystems and Scale: Tools for Understanding and Managing Coastal Ecosystems* (pp. 221). New York: Springer.
Podar, M., Gilmour, C. C., Brandt, C. C., Soren, A., Brown, S. D., Crable, B. R., … Elias, D. A. (2015). Global prevalence and distribution of genes and microorganisms involved in mercury methylation. *Science Advances*, *1*, e1500675.
Pollman, C. D., Swain, E. B., Bael, D., Myrbo, A., Monson, P., & Dykhuizen Shore, M. (2017). The evolution of sulfide in shallow aquatic ecosystem sediments—An analysis of the roles of sulfate, organic carbon, iron and feedback constraints using structural equation modeling. *Journal of Geophysical Research: Biogeosciences*, *122*, https://doi.org/10.1002/2017JG003785
Ravichandran, M. (2004). Interactions between mercury and dissolved organic matter—A review. *Chemosphere*, *55*, 319–331.
Regnell, O., & Hammar, T. (2004). Coupling of methyl and total mercury in a minerotrophic peat bog in southeastern Sweden. *Canadian Journal of Fisheries and Aquatic Sciences*, *61*, 2014–2023.
Rothenberg, S. E., Windham-Myers, L., & Creswell, J. E. (2014). Rice methylmercury exposure and mitigation: A comprehensive review. *Environmental Research*, *133*, 407–423.
Schindler, D. W. (1986). The significance of in-lake production of alkalinity. *Water, Air, and Soil Pollution*, *30*, 931–944.
Schindler, D. W., Turner, M. A., Stainton, M. P., & Linsey, G. A. (1986). Natural sources of acid neutralizing capacity in low alkalinity lakes of the Precambrian Shield. *Science*, *232*, 844–847.
Schmidt, H., Eickhorst, T., & Tippkötter, R. (2011). Monitoring of root growth and redox conditions in paddy soil rhizotrons by redox electrodes and image analysis. *Plant and Soil*, *341*, 221–232.
Selvendiran, P., Driscoll, C. T., Bushey, J. T., & Montesdeoca, M. R. (2008). Wetland influence on mercury fate and transport in a temperate forested watershed. *Environmental Pollution*, *154*, 46–55.
Shotbolt, L. (2010). Pore water sampling from lake and estuary sediments using Rhizon samplers. *Journal of Paleolimnology*, *44*(2), 695–700. https://doi.org/10.1007/s10933-008-9301-8
Skyllberg, U. (2008). Competition among thiols and inorganic sulfides and polysulfides for Hg and MeHg in wetland soils and sediments under suboxic conditions: Illumination of controversies and implications for MeHg net production. *Journal of Geophysical Research: Biogeosciences*, *113*, 2005–2012. https://doi.org/10.1029/2008JG000745
Stagg, C. L., Schoolmaster, D. R., Krauss, K. W., Cormier, N., & Conner, W. H. (2017). Causal mechanisms of soil organic matter decomposition: Deconstructing salinity and flooding impacts in coastal wetlands. *Ecology*, *98*, 2003–2018. https://doi.org/10.1002/ecy.1890
StataCorp (2015). *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.
Stumm, W., & Morgan, J. J. (2012). *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters*. New York: John Wiley.

Van der Welle, M. E. W., Smolders, A. J. P., Op den Camp, H. J. M., Roelofs, J. G. M., & Lamers, L. P. M. (2007). Biogeochemical interactions between iron and sulphate in freshwater wetlands and their implications for interspecific competition between aquatic macrophytes. *Freshwater Biology*, *52*, 434–447.

Vestergaard, O., & Sand-Jensen, K. (2000). Alkalinity and trophic state regulate aquatic plant distribution in Danish lakes. *Aquatic Botany*, *67*, 85–107.

Walker, R. D., Pastor, J., & Dewey, B. W. (2006). Effects of wild rice (*Zizania palustris*) straw on biomass and seed production in northern Minnesota. *Canadian Journal of Botany*, *84*, 1019–1024.

Weston, N. B., Porubsky, W. P., Samarkin, V. A., Erickson, M., Macavoy, S. E., & Joye, S. B. (2006). Porewater stoichiometry of terminal metabolic products, sulfate, and dissolved organic carbon and nitrogen in estuarine intertidal creek-bank sediments. *Biogeochemistry*, *77*, 375–408.

Weston, N. B., Vile, M. A., Neubauer, S. C., & Velinsky, D. J. (2011). Accelerated microbial organic matter mineralization following salt-water intrusion into tidal freshwater marsh soils. *Biogeochemistry*, *102*, 135–151.

Williamson, C. E., Morris, D. P., Pace, M. L., & Olson, O. G. (1999). Dissolved organic carbon and nutrients as regulators of lake ecosystems: Resurrection of a more integrated paradigm. *Limnology and Oceanography*, *44*, 795–803.

Windham-Myers, L., Marvin-Dipasquale, M., Krabbenhoft, D. P., Agee, J. L., Cox, M. H., Heredia-Middleton, P., … Kakouros, E. (2009). Experimental removal of wetland emergent vegetation leads to decreased methylmercury production in surface sediment. *Journal of Geophysical Research*, *114*, G00C05. https://doi.org/10.1029/2008JG000815

Winter, T. C. (2001). The concept of hydrologic landscapes. *Journal of the American Water Resources Association*, *37*, 335–349.

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT L

Minn. Chamber of Commerce v. Minn. Pollution Control Agency
(Minn. Dist. Ct., 2nd Jud. Dist., May 10, 2012)

Minn. Chamber of Commerce v. Minn. Pollution Control Agency

Minnesota District Court, County of Ramsey, Second Judicial District

May 10, 2012, Decided; May 10, 2012, Entered

Court File No. 62-CV-10-11824

Reporter
2012 Minn. Dist. LEXIS 194 *

Minnesota Chamber of Commerce, Plaintiff, vs. Minnesota Pollution Control Agency, Defendant, and WaterLegacy, Defendant-Intervenor.

Subsequent History: Affirmed by Minn. Chamber of Commerce v. Minn. Pollution Control Agency, 2012 Minn. App. Unpub. LEXIS 1199 (Minn. Ct. App., Dec. 17, 2012)

Prior History: Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency, 469 N.W.2d 100, 1991 Minn. App. LEXIS 388 (Minn. Ct. App., 1991)

Core Terms

wild rice, sulfate, waters, water quality standards, void for vagueness, stands, cultivated, irrigation, narrative, plant, rice, summary judgment, discharges, unconstitutionally vague, Clean Water Act, agricultural, designated, wildlife, levels, vague, declaratory judgment, matter of law, susceptible, injunction, Pollution, aquatic

Counsel: **[*1]** For Plaintiff: Thaddeus Lightfoot, Esq.

For Minnesota Pollution Control Agency, Defendant: Robert B. Roche, Assistant Attorney General.

For WaterLegacy, Defendant-Intervenor: Paula Maccabee, Esq.

Judges: HON. MARGARET M. MARRINAN, JUDGE OF DISTRICT COURT.

Opinion by: MARGARET M. MARRINAN

Opinion

FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER FOR JUDGMENT

This matter came on for hearing on the parties' cross motions for summary judgment on March 1, 2012. Thaddeus Lightfoot, Esq., appeared on behalf of Plaintiff; Assistant Attorney General Robert B. Roche appeared on behalf of Defendant Minnesota Pollution Control Agency; Paula Maccabee, Esq., appeared on behalf of Defendant-Intervenor WaterLegacy.

Plaintiff has withdrawn its claim regarding Count I of the Amended Complaint.

Plaintiff seeks partial summary judgment on the remaining following counts:

1) Count II: in which it alleges that the "Wild Rice Rule" is unconstitutionally vague and thus a violation of due process. The basis for this allegation is that the term "when rice may be susceptible to damage from high sulfate levels" is not defined.

2) Count III: in which it alleges that Defendant's actions applying the "Wild Rice Rule" exceed Defendant's statutory authority **[*2]** and are arbitrary and capricious because:

a. Defendant would apply them to all waters in the state rather than limit them to waters used for agricultural irrigation in the production of wild rice; and

b. Defendant has created a narrative wild rice classification for Class 4A waters without specifically listing or otherwise classifying those waters; and

> c. Defendant has required that Plaintiff members perform wild rice surveys to determine whether waters fall within the narrative sub-classification.

3) Count IV: in which it asks the Court to construe the Wild Rice Rule under the authority of the Minnesota Declaratory Judgments Act (Minn. Stat. Ch.555).

Defendant and Defendant-Intervenor seek summary judgment regarding all of Plaintiff's claims.

FINDINGS OF FACT

1. The Minnesota Legislature has adopted wild rice as the official grain of the State of Minnesota and has explicitly recognized the importance of protecting it. Minn. Stat. § 1.148, subd. 1 (2010).

2. In keeping with the policy set by Minn. R. 7050.0186,[1] and in order to comply with the United States Environmental Protection Agency (EPA) requirements under the Federal Water Pollution Control Act Amendments of 1972, in 1973 the Minnesota Pollution Control Agency **[*3]** (MPCA) adopted water quality standards for Class 4 waters of the state.

The rationale for protection of these waters is addressed by Minn. R. 7050.0224, subp.1:

> The *numeric* and *narrative* [emphasis supplied] water quality standards in this part prescribe the qualities or properties of the waters of the state that are necessary for the agriculture and wildlife designated public uses and benefits. Wild rice is an aquatic plant resource found in certain waters within the state. The harvest and use of grains from this plant serve as a food source for wildlife and humans. In recognition of the ecological importance of this resource, and in conjunction with Minnesota Indian tribes, selected wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subp.1.[2] The quality of these waters and the aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded. If the standards in this part are exceeded in waters of the state that have the Class 4 designation, it is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental, or injurious with **[*4]** respect to the designated uses.

Minnesota's wild rice sulfate standard is found in Minn. R. 7050.0224, subp. 2 (2011). The rule provides in pertinent part:

> Class 4A waters. The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects *upon any crops or vegetation usually grown in the waters or area*, [emphasis supplied] including truck garden crops. The following standards shall be used as a guide in determining the suitability of the waters for such uses ...: Sulfates (SO_4) 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.
>
> Minn. R. 7050.0224, subp. 2 (2011).

Of the subparts to the water quality standards in Minn.R. 7050.0224, subpart 2 (Class 4A waters) is the only one that specifically refers to crops and vegetation. Classes 4B and C have as their focus livestock and wildlife.

3. The MPCA adopted a wild rice numeric sulfate standard of 10 milligrams per liter ("mg/L") for water used for production of wild rice based on recommendations by the Minnesota Department of Natural Resources ("MDNR") that sulfate concentrations above that level are a serious detriment to the natural and cultivated growth of wild rice.

4. In addition to the numeric standard, Minnesota Rules

---

[1] "It is the policy of the state to protect wetlands and prevent significant adverse impacts on wetland beneficial uses caused by chemical, physical, biological or radiological changes. The quality of wetlands shall be maintained to permit the **[*5]** propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, preserve wildlife habitat, and support biological diversity of the landscape. In addition these waters shall be suitable for.... irrigation... as specified in part 7050.0224, subpart 4...."

[2] This rule specifically identifies as [WR] the sub-set of wild rice waters in the Lake Superior watershed.

also adopted a narrative standard that applies only to specifically identified wild rice waters. Minn.R. 7050.0224, subp.1, *supra*.

5. Whether standing alone, or viewed in tandem with the above rules, the term "when the rice may be susceptible to damage by high sulfate levels" is straightforward and understandable: if the rice is at a point in development when sulfates can damage it, the maximum sulfate **[*6]** level is 10 mg/L.

6. Testimony from the hearing on the initial adoption of the wild rice sulfate standard clearly establishes that, from the time of its initial adoption, the MPCA intended the wild rice sulfate standard to protect both naturally growing and cultivated wild rice.[3]

7. The first time that the MPCA imposed a discharge limit based on the wild rice sulfate rule (Minn. R. 7050.0224, Subp. 2) was in a 1975 permit for the Clay Boswell Steam Electric Station ("Clay Boswell Permit").

8. The record of the administrative hearing for the Clay Boswell Permit reflects that the hearing examiner supported application of a sulfate limit in that permit in order to protect natural stands of wild rice, not agricultural irrigation of cultivated wild rice.[4]

9. The MPCA issued sulfate limits three other times: a June 17, 2010 permit modification for U.S. Steel Corporation (Keetac mining area) and two October 25, 2011 permits for U.S. Steel (Keetac mining area and tailings basin). It is notable that the areas **[*7]** in question affect *natural* stands of wild rice, not the agricultural irrigation of cultivated rice. The direct receiving waters included both listed waters (Welcome Creek and O'Brien Creek) and unlisted waters (Welcome Lake and O'Brien Reservoir). All of these waters were classified as Class 4A and 4B waters. U.S. Steel neither requested an administrative hearing nor challenged the permit at the Court of Appeals.

10. In 2010, the EPA, addressing the issue of sulfate discharge for the Keetac mine expansion and the proposed PolyMet NorthMet mining project, advised Defendant MPCA that the wild rice protection rule must be applied to limit that discharge in receiving waters. Both of those projects affected natural stands of wild rice, rather than agricultural irrigation for cultivated rice[5] The waters to which this sulfate limit applied included lakes, rivers and creeks not specifically listed as wild rice waters in Minn. R. 7050.0470, Subp. 1.[6]

11. The MPCA has approximately ten years of sulfate data for mining discharges because it has monitored wastewater discharges from **[*8]** mining operations in order to evaluate their overall toxicity and their potential to adversely affect groundwater. The agency concluded that this data could be useful in evaluating the potential impact of mining discharges on the wild rice sulfate standard.[7]

12. To determine whether sulfate dischargers are potentially interfering with attaining the wild rice sulfate standard, the MPCA reviews permit applications on a case-by-case basis. Where the data suggests that a discharge has high levels of sulfates upstream of a water identified as one potentially used for production of wild rice, the agency may request dischargers to conduct surveys to determine if the discharge is, in fact, upstream of a water used for production of wild rice. This authority derives from M.S. 115.03, subd. 1 (e) (7) **[*9]** which gives the agency the authority to require owners and operators of such discharge systems to do so.

13. As part of the permit review process, the MPCA reviews the following information: (i) available wild rice records and databases that the MDNR maintains; (ii) consultation with aquatic plant biologists at the MDNR; (iii) information received from external stakeholders, including, but not limited to, Native

[3] Affidavit of Gerald Blaha, Ex. C, p. 27: testimony of John McGuire, Chief of the Section of Standards and Surveys, Division of Water Quality, MPCA.

[4] Affidavit of Gerald Blaha, Paragraph 9.

[5] Affidavit of Paula Maccabee, Ex. 8 and 9.

[6] Swan Lake, Swan River, Hay Creek, Hay Lake and Upper Partridge River. *Id*.

[7] The MPCA does not yet have similar data for municipal discharges, but is in the process of obtaining it as part of a broader MPCA strategy to evaluate the impact of wastewater discharges on Class 3 and Class 4 water standards. It intends to use the monitoring data to determine whether additional discharge limits are necessary to protect Class 3 and 4 water quality standards, including the wild rice sulfate standard.

American tribes and environmental groups; and (iv) information provided by the discharger.

14. The MDNR's list of waters where wild rice has been identified is not an exhaustive list of waters used for production of wild rice. Where a permit applicant discharges upstream of a water that is not on the MDNR list, but which has been identified as potentially producing wild rice, the MPCA has requested that the permit applicant conduct a survey of any wild rice stands in the receiving waters to help determine whether the receiving water is a water used for production of wild rice.

15. Any party who disagrees with the MPCA's determination of 1) whether a water qualifies as a water used for production of wild rice or 2) whether the permit needs to include a sulfate limit **[*10]** has the option of requesting a contested case hearing before an administrative law judge on the issue pursuant to Minn. R. 7000.1800. Although Plaintiff's members allege they have been affected by the wild rice sulfate standard, they failed to request such a hearing, and have sought relief under Chapter 555 of the Minnesota Statutes.

16. During the 2011 Minnesota Legislative Session, it was proposed that the application of Minnesota's wild rice sulfate standard be suspended, or that the sulfate standard be increased from 10 mg/L to 50 mg/L. In response to those proposals, on May 13, 2011 the U.S. EPA[8] wrote the sponsoring legislators warning that:

> 1) "[L]egislation changes [to] the EPA-approved water quality standards for Minnesota...must be submitted to EPA for review...and are not effective for Clean Water Act (CWA) purposes, including [National Pollutant Discharge Elimination System] permits, unless and until approved by EPA; and
> 2) If it "determined that a state is not administering its federally approved NPDES program in accordance with requirements of the CWA, EPA has the authority to...withdraw authorization of the program...."

17. Rather than passing either of the above bills, the 2011 Minnesota legislature passed, and the governor signed, a bill regarding the wild rice sulfate standard. Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32. That law requires the MPCA to form an advisory group and conduct an extensive study of the impacts of sulfates and other substances on wild rice. *Id*. at § 32(c)&(d). Once that research is complete, the bill requires the MPCA to amend the wild rice sulfate standard to:

> (i) address water quality for both natural stands of wild rice and cultivated wild rice;
>
> (ii) specifically designate waters to which the wild rice sulfate standard applies; and
>
> (iii) designate the times of year when the standard applies. *Id*. at § 32(a)(1)-(3).

18. Pursuant to that legislation, the MPCA has formed an advisory group and held three meetings of that group to date (October 10, 2011, November 30, 2011 and March 27, 2012), established a study protocol, published a Request for Proposals to undertake research outlined in the study protocol, submitted a legislative report as required by December 15, 2011, and awarded a contract to the University of Minnesota to conduct the **[*12]** wild rice/sulfate studies.

CONCLUSIONS OF LAW

1. Plaintiff has withdrawn its claim that the MPCA's application of the wild rice sulfate standard has violated the Equal Protection Clause of the United States Constitution. Summary Judgment in favor of the MPCA and Defendant-Intervenor is therefore proper as to that claim.

2. Summary judgment is appropriate under the Minnesota Rules of Civil Procedure, when "the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that either party is entitled to judgment as a matter of law. Minn.R.Civ.P. 56.03.

3. There are no genuine issues of material fact and the MPCA has demonstrated that it is entitled to judgment as a matter of law on each of Plaintiff's alleged claims.

A. Counts II and Count III: The Wild Rice Rule does not violate due process. It is not unconstitutionally

[8] The EPA has delegated the administration of the federal **[*11]** Clean Water Act in Minnesota to the MPCA.

vague, nor is the application of the rule arbitrary and capricious.

4. An agency rule is unreasonable (and therefore invalid) when it fails to comport with substantive due process because it is not rationally related to the objective sought to be achieved.[9] **[*13]** The rationale underlying the Wild Rice Rule (Minn. R. 7050.0224, subp. 2) is found in the subparagraph preceding it: since wild rice is a food source for both wildlife and humans, the quality of the waters and the aquatic habitat necessary to support its propagation and maintenance must not be materially impaired or degraded. The policy upon which this rationale is based (Minn.R.7050.0186) is the protection of the quality of wetlands so as to "permit the propagation and maintenance of a healthy community of...species indigenous to wetlands...In addition these waters shall be suitable for...irrigation...."

5. Where a rule is challenged as "invalid as applied", Minnesota law allows only limited judicial inquiry into the validity of an administrative regulation in question. The party challenging the rule bears a heavy burden and must establish that the rule is not rationally related to the legislative ends sought to be achieved or that in adopting the rule the MPCA exceeded its statutory authority.[10]

6. **[*14]** Plaintiff has not met its burden of proving that the MPCA's application of the wild rice sulfate rule conflicts with statutory authority or is otherwise not rationally related to the legislative goal of protecting the environment. MPCA's application of the wild rice sulfate rule is reasonably related to achieving the legitimate goal of protecting Minnesota's environment.

7. Minnesota's Class 4 waters, which encompass the sub-classification of Class 4A waters, are "waters of the state that are or may be used for any agricultural purposes, including stock watering and irrigation, or by waterfowl or other wildlife, and for which quality control is or may be necessary to protect terrestrial life and its habitat or the public health, safety, or welfare." Minn. R. 7050.0140, subp. 5 (2011).

8. Minnesota's Class 4A water quality standards are intended to protect both naturally occurring vegetation grown in the waters themselves and cultivated crops in the area around the water. The MPCA's application of the wild rice sulfate standard to protect naturally growing wild rice in ambient waters of the state is legally valid because it is consistent with the plain language of the water quality standard. **[*15]** Minn. R. 7050.0224, subp. 2.

9. Under Minnesota law, "[t]he object of all interpretation and construction of laws is to ascertain and effectuate the intention of the legislature." Minn. Stat. § 645.16 (2010). Minnesota courts apply the provisions of chapter 645 to both statutes and administrative rules. The administrative and legislative records clearly demonstrate that the MPCA has always intended the wild rice sulfate rule to protect both cultivated and natural stands of wild rice. The agency's application of the rule to waters with natural stands of wild rice is legally valid because it is consistent with the administrative history and intention of the regulation.

10. The MPCA's application of the wild rice sulfate rule to protect waters with natural stands of wild rice is also consistent with a number of established legislative policies and statutory duties, among them the duty to ensure that the State of Minnesota maintains its responsibility to administer the federal Clean Water Act in Minnesota.[11]

11. In the 2011 special session, the legislature specifically directed the MPCA to adopt an amended rule which shall "address water quality standards for waters containing natural beds of wild rice, as well as for irrigation waters used for production of wild rice . . . ." Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32 (a)(1). The MPCA's application of the wild rice rule to protect natural stands of wild rice is consistent with legislative policy that explicitly recognizes the importance of wild rice to the State of Minnesota.

---

[9] *Mammenga v. Dep't of Human Services*, 442 N.W. 2d 786, 789 (Minn. 1989).

[10] *Mammenga v. Dep't of Human Services*, 442 N.W. 2d 786 (Minn. 1989); *Hirsch v. Bartley-Lindsay Co*., 537 N.W.2d 480 (Minn. 1995).

[11] Minn. Stat. § 115.03, subd. 5 (2010) ("the agency shall have the authority to . . . establish and appl[y] rules . . . and permit conditions, consistent with and, therefore not less **[*16]** stringent than the provisions of the Federal Water Pollution Control Act, as amended, applicable to the participation by the State of Minnesota in the national pollutant discharge elimination system (NPDES)")

12. The wild rice sulfate standard is a numeric standard set forth in Minn. R. 7050.0224, subp. 2. Minn. R. 7050.0224, subp.1 also includes a narrative standard that applies only to specifically identified wild rice waters. Minn. R. 7050.0470, subp. 1 (2011), in turn, specifically identifies [WR] the sub-set of wild rice waters in the Lake Superior watershed to which this narrative applies.

To the extent Plaintiff claims that the narrative wild rice standard does **[*17]** not identify the waters to which that narrative standard applies, the claim fails as a matter of law.

13. Under Minnesota law, "[a] statute that does not implicate First Amendment freedoms is facially void for vagueness only if it is vague in all its applications. Unless the statute proscribes no comprehensible course of conduct at all, it will be upheld against a facial challenge."[12]

14. The Plaintiff has not established that the wild rice sulfate rule is vague in all of its applications or that it proscribes no comprehensible course of conduct at all. The MPCA applied this rule in the Clay Boswell Permit and an independent hearing examiner supported the application of the rule in that case. The MPCA has recently applied the rule in the reissuance of the U.S. Steel Keewatin Taconite permit. U.S. Steel neither requested an administrative hearing nor challenged the permit in the Court of Appeals.

15. Under Minnesota law, a party challenging a law on constitutional grounds, including vagueness, bears a heavy burden **[*18]** of proof.[13] The Plaintiff must overcome every presumption of constitutionality and show that the wild rice sulfate standard is unconstitutionally vague as applied to Plaintiff's members. Plaintiff has not met this burden.

Sulfate Standard not Void for Vagueness

16. Contrary to Plaintiff's assertion, the fact that the wild rice sulfate standard does not include an explicit definition for the term "when the rice may be susceptible to damage by high sulfate levels" does not render the rule void as applied. The void for vagueness doctrine demands **[*19]** only that laws be drafted with "sufficient definiteness that ordinary people can understand what conduct is prohibited."[14] Even if a law speaks in "broad, flexible standards that require persons subject to a statute to exercise judgment," or requires persons to "rely on common sense and intelligence to determine whether their conduct complies with the law [it] does not render the law unconstitutionally vague."[15]

17. The civil, regulatory nature of the wild rice sulfate standard is subject to a "vagueness test" that is less strict than for criminal statutes. "To find a civil statute void for vagueness, the statute must be 'so vague and indefinite as really to be no rule or standard at all.'"[16] The challenged law must "define the forbidden or required act in terms so vague that individuals must guess at its meaning . . . ."[17] Put another way: "a statute will be upheld against a facial challenge unless [it] proscribes no comprehensible course of conduct at all".[18]

18. Civil laws regulating business are less likely to be void for vagueness than criminal laws "because businesses, which face economic demands to plan behavior carefully, can be expected to consult relevant

[12] *State v. Normandale Properties, Inc.*, 420 N.W.2d 259, 262 (Minn. Ct. App. 1988) (citing *Village of Hoffman Estates v. Flipside Hoffman Estates, Inc.*, 455 U.S. 489, 102 S.Ct. 1186, 1191, 71 L. Ed. 2d 362 (1982).

[13] "In attacking a rule on due process grounds, including a vagueness challenge, the challenger bears a heavy burden [cit. om.] The standard for determining vagueness is well-settled: [it is] void for vagueness if it fails to give a person of ordinary intelligence a reasonable opportunity to know what is prohibited or fails to provide sufficient standards for enforcement...The rule should be upheld unless the terms are so uncertain and indefinite that after exhausting all rules of construction it is impossible to ascertain legislative intent." *Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, 469 N.W.2d 100, 107 (Mn.App. 1991).

[14] *State v. Romine*, 757 N.W.2d 884, 891 (Minn. Ct. App. 2008) (quoting *Kolender v. Lawson*, 461 U.S. 352, 103 S. Ct. 1855, 1858, 75 L. Ed. 2d 903 (1983)).

[15] *State v. Enyeart*, 676 N.W.2d 311, 321 (Minn. Ct. App. 2004).

[16] *Seniors Civil Liberties Ass'n v. Kemp*, 965 F.2d 1030, 1036 (11th Cir. 1992).

[17] *Humenansky v. Minn. Bd. of Med. Examiners*, 525 N.W.2d 559, 564 **[*20]** (citing Kolender v. Lawson, 461 U.S. 352, 103 S. Ct. 1855, 1858, 75 L. Ed. 2d 903 (1983).

[18] *State v. Normandale Properties, Inc.*, 420 N.W.2d 259, 262 (Minn. App 1988).

legislation in advance of action. Indeed, the regulated enterprise may have the ability to clarify the meaning of the regulation by its own inquiry, or by resort to an administrative process."[19]

19. The application of the wild rice sulfate rule to Plaintiff in this case is not unconstitutionally vague under this standard. Plaintiff's members are not left to guess as to what conduct is prohibited or required under this rule.

20. The wild rice sulfate rule is an ambient water quality standard. As such, it describes the desired condition of Minnesota's waters, but is not a discharge standard and does not proscribe or prohibit conduct.[20] The only way that the MPCA can require or prohibit action based on the wild rice sulfate standard is through a permitting action.[21]

21. Before the MPCA issues a permit for a point source such as Plaintiff's members, it is legally required to publish a draft of the permit for public review and comment. Minn. R. 7001.0100 (2011). If Plaintiff's proposed permit includes a limit based on that rule, then Plaintiff's members have thirty days to review, comment on, and question that proposed limit. Any party who disagrees with the terms of a proposed MPCA permit has the right to request a contested case hearing before an administrative law judge to review and clarify the terms of the proposed permit. Minn. R. 7000.1800 (2011). Any party who is aggrieved by the agency's final decision in a permitting action has a right of certiorari review by the Court of Appeals. Minn. Stat. § 115.05, subd. 11 (2010). Plaintiff **[*22]** has not and cannot show that any of its members have been left guessing as to what conduct is required or prohibited. Plaintiff's void for vagueness challenge fails as a matter of law.

22. The term "when the rice may be susceptible to damage by high sulfate levels" is straightforward and can be understood using plain language. If wild rice is at a point in its life cycle when sulfates will damage the plant, then the receiving water must not exceed 10 mg/L. Because the rule can be applied based on its plain language, it is not void for vagueness. The goal of the law is to protect production of wild rice in Minnesota. In view of that goal it is reasonable to conclude that the standard applies at a point in the wild rice life cycle when sulfate is found to damage the plant. The rule is not void for vagueness.

"Bodies of Water" not Void for Vagueness

23. The fact that the MPCA does not specifically list every body of water to which the wild rice sulfate standard applies neither violates the Due Process clause of the Constitution nor does it exceed MPCA's statutory authority: neither the Constitution nor Minnesota or federal statutes require a state to list expressly every surface water to **[*23]** which a water quality standard applies. Such a requirement would be particularly absurd in a state such as Minnesota.[22]

24. Nor does the lack of a specific listing render the rule unconstitutionally vague. Plaintiff's members are not left guessing as to whether the wild rice sulfate standard applies to a particular water or as to what is required of them under the standard because the proposed permit details exactly what is required of Plaintiff's members.

25. The wild rice sulfate standard is likewise consistent with state and federal statutory requirements.

State Law

26. Under Minnesota law, the MPCA has the duty and the authority "to establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary for the purposes of this chapter . . . ." Minn. Stat. § 115.03, subd. 1(c) (2010). Nothing in the statute suggests that the MPCA is required to list

---

[19] *Village of Hoffman Estates*, 102 S.Ct. at 1193

[20] Minn. R. 7050.0224, subp. 2.

[21] See, for **[*21]** example., 40 C.F.R. § 122.44(d)(1) (2011) (requiring permitting authority to impose discharge limits in permits where evidence shows that discharge has reasonable potential to cause or contribute to a violation of a water quality standard in a receiving water); Minn. R. 7001.0150, subp. 2 (2011) (requiring MPCA issued permits to include terms necessary to achieve compliance with applicable state and federal law).

[22] According to the Minnesota Legislative Manual (2011-2012) there are 11,842 lakes of more than 10 acres, 3 major river systems, and 6,564 (69,200 miles) rivers and streams.

every single water to which a water quality standard applies. The **[*24]** legislature has given the MPCA broad discretion as to how to best structure Minnesota's water quality standards and has expressly recognized that it is proper for the MPCA to establish water quality standards for *groups* of waters instead of listing every single water to which a standard applies. The legislature has required the MPCA to "group the designated waters of the state into classes, and adopt classifications and standards of purity and quality therefore." Minn. Stat. § 115.44, subd. 2 (2010).

27. The MPCA's administrative rules likewise recognize the need for the agency to employ grouping in the establishment of water quality standards.[23] The assertion that Minnesota law requires a specific list of each water to which a water quality standard applies is without merit.

28. In adopting the wild rice sulfate standard, the MPCA established a group of waters to which the standard applies. That group of waters consists of "waters used for production of wild rice." Minn. R. 7050.0224, subp. 2 (2011). This type of grouping is expressly authorized under Minnesota **[*25]** law.

29. As the EPA made clear in its May 13, 2011 letter to the Minnesota Legislature, the EPA has formally approved Minnesota's wild rice sulfate standard. When the EPA approves a state's water quality standard, it must determine whether the standard is "consistent with the requirements of the Clean Water Act." 40 C.F.R. § 131.5 (a)(1). In approving the wild rice sulfate standard, the EPA concluded that the standard is consistent with the federal Clean Water Act. Plaintiff's assertion that the wild rice sulfate standard is in any way inconsistent with the Clean Water Act lacks merit.

Federal Law

30. There is no requirement in federal law for the state to list expressly every single water to which a water quality standard applies in order for the standard to apply. On the contrary, the federal Clean Water Act allows for application of water quality standards to water bodies that are implicated without being expressly listed on an individual basis.

31. Minn. Laws 2011 1 Sp. c. 2, art. 4, § 32(a)(2) directs the MPCA to initiate rulemaking regarding identification of waters to which this wild rice sulfate standard applies. Plaintiff's assertion that state and federal law would require such **[*26]** a listing is inaccurate and would significantly impede the MPCA's ability to fulfill its statutory obligation to promulgate and enforce water quality standards for the State of Minnesota.

32. The Wild Rice Rule (Minn. R. 7050.0224, subp.2) is rationally related to both the stated policy and rationale of the rules and is not void for vagueness.

B. Count IV: Plaintiff's are not entitled to a Declaratory Judgment.

33. M.S. 555.02 specifies the actions a court may construe under the Declaratory Judgment Act:

> Any person...whose rights, status or other legal relations are affected by a statute, municipal ordinance, contract, or franchise may have determined any question of construction or validity arising [under the same] and obtain a declaration of rights, status or other legal relations thereunder.

34. This act is not an express independent source of jurisdiction[24]: it does not create an independent cause of action. Because Plaintiff's substantive claims all fail as a matter of law, Plaintiff's Declaratory Judgment Act claim must also be dismissed.

35. To the extent that Plaintiff's claims are **[*27]** based on permitting actions that the MPCA may take in the future, those claims are conjectural and not subject to court action at this time.[25]

36. Given the above, Plaintiff has adequate remedies at law and is not entitled to a declaratory judgment.

C. Request for Equitable Relief

---

[23] *See* Minn. R. 7050.0140, subp. 1 ("the waters of the state are grouped into one or more of the classes in subparts 2 to 8.")

[24] *Alliance for Metropolitan Stability v. Metropolitan Council*, 671 N.W.2d 905, 915 (Minn. App. 2003).

[25] Any such quasi-judicial action is reviewable via certiorari to the Court of Appeals under M.S. 115.05, subd. 11(2010).

37. Plaintiff has requested that the Court "preliminarily and permanently" enjoin the MPCA from imposing any of the sulfate discharge limitations discussed above. Case law addressing Minn.R.Civ. P. 65.02 (temporary injunctions) has established five factors determining whether such an injunction should be granted: a) the nature of the relationship; b) relative hardships; c) likelihood of success on the merits; d) public policy; and e) administrative burdens.[26]

38. Analyzed under those factors, Plaintiff's request should be denied. As with Minn. R. Civ.P.65.01, the threshold question is whether there is immediate and irreparable injury that constitutes a ground for the issuance of the injunction and whether that party **[*28]** does not have an adequate remedy at law.[27] The failure to meet this burden is, in and of itself, a sufficient basis on which to deny the relief.[28] In this case, each of Plaintiff's claims are based on actions that the MPCA allegedly *may* take in the context of permitting proceedings. Plaintiff has an adequate remedy at law for any MPCA permitting decision: the right to request a contested case hearing before an administrative law judge on any MPCA permitting matter,[29] and a statutory right of certiorari review of any final MPCA permitting decision before the Minnesota Court of Appeals.[30] Because Plaintiff clearly has adequate remedies at law in this case its request for equitable relief must be denied.

39. Analyzed under the *Dahlberg* factors, the Court reaches the same conclusion. In this case the determinative factors under *Dahlberg* are a) the likelihood of success on the merits (see discussion, *supra*;) and b) public policy[31] Balancing the relative hardships between **[*29]** the parties, the analysis also favors the Defendant. While complying with the rules may be more costly to the Plaintiff's members, the rationale for Defendant's action is clearly stated in Minn.R. 7050.0224, subp.1:

> "...The harvest and use of grains from this plant serve as a food source for wildlife and humans...the quality of these waters and aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded...

40. Plaintiff's argument that its members may have to take action to comply with the wild rice sulfate standard during the interim period in which the MPCA conducts the research necessary to amend the rule as directed by the Legislature is without merit. The Legislature has already addressed how the wild rice sulfate standard is to be applied during that interim period.[32]

For this Court to second-guess the Legislature's determination of how the standard should be applied while the standard is in the process of being amended is inappropriate. Plaintiff's request for injunctive relief **[*30]** should be denied.

NOW THEREFORE, IT IS HEREBY ORDERED:

1. The motion for summary judgment of Defendant MPCA and Defendant-Intervenor WaterLegacy's is granted in its entirety.
2. Plaintiff's motion for a "preliminary and permanent" injunction is denied.
2. Plaintiff's partial motion for summary judgment is denied in its entirety.
3. Plaintiff's Complaint is dismissed in its entirety with prejudice and on the merits.

10 May 2012

/s/ Margaret M. Marrinan

HON. MARGARET M. MARRINAN

JUDGE OF DISTRICT COURT

End of Document

[26] *Dahlberg Bros., Inc. v. Ford Motor Co*., 272 Minn. 264, 137 N.W.2d 314 (1965).

[27] *Unlimited Horizon Mktg., Inc. v. Precision Hub, Inc*., 533 N.W. 2d 63 (Minn. App. 1995).

[28] *Morse v. City of Waterville*, 458 N.W. 2d 728 (Minn. App. 1990).

[29] Minn. R. 7000.1800 (2011).

[30] Minn. Stat. § 115.05, subd. 11(1) (2010).

[31] See discussion supra at p. 3 regarding Minn.R. 7050.0186, M.S. 1.148, subd. 1.

[32] Minn. Laws. 2011 1 Sp. c. 2, art. 4, § 32 (e).

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT M

(ALJ Report, *In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice*, 2018)

OAH 80-9003-34519
Revisor R-4324

STATE OF MINNESOTA
OFFICE OF ADMINISTRATIVE HEARINGS

In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers, Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205, and 7053.0406

REPORT OF THE ADMINISTRATIVE LAW JUDGE

Administrative Law Judge LauraSue Schlatter conducted several public hearings on this rulemaking proceeding at various locations throughout the state. The hearings were held on the following dates at the following locations: the Harold Stassen Building in St. Paul, Minnesota, on October 23, 2017; the Mesabi Range College in Virginia, Minnesota, on October 24, 2017; Bemidji State University in Bemidji, Minnesota, on October 25, 2017; the Fond du Lac Tribal Community College in Cloquet, Minnesota, on October 26, 2017; and Central Lakes Community College in Brainerd, Minnesota, on October 30, 2017. Judge Schlatter held an additional hearing at the offices of the Minnesota Pollution Control Agency (MPCA or Agency) in St. Paul, Minnesota, on November 2, 2017. This hearing was also broadcast via interactive video conference to the MPCA's regional offices in Detroit Lakes, Duluth, Mankato, Marshall, and Rochester. All of the hearings continued until everyone present had an opportunity to be heard concerning the proposed rules.[1]

The MPCA proposes to amend the rules governing Minnesota's water quality standard to protect wild rice from excess sulfate. The existing standard limits sulfate to 10 milligrams per liter in water used for the production of wild rice. The proposed amendments would establish an equation to determine the protective level of sulfate in each "wild rice water" based on the concentration of iron and organic carbon in the sediment. When sulfate in the water interacts with iron and organic carbon in the sediment, they can form sulfide, which the MPCA has determined is toxic to wild rice.[2] The proposed rules would limit sulfide in the sediment of a wild rice water to 120 micrograms per liter; identify approximately 1,300 lakes, rivers, and streams as wild rice waters; establish a process for the future identification of wild rice waters; and describe

---

[1] Throughout this Report, the terms "rule" and "rules," as well as the terms "standard" and "standards," are used interchangeably and in a manner intended to reflect typical usage while encompassing the fact that the rulemaking proceeding addresses a proposed rule made up of various identified parts.
[2] Ex. D (SONAR) at 12.

the sampling and analytical methods to characterize sediment and determine porewater sulfide.[3]

The public hearings and this Report are part of a rulemaking process governed by the Minnesota Administrative Procedure Act.[4] The Minnesota Legislature designed the rulemaking process to ensure that state agencies meet all of the requirements that Minnesota law specifies for adopting rules.[5] The rulemaking process also includes a hearing when 25 or more persons request one or when ordered by the agency.[6]

The hearings were conducted to allow the Agency representatives and the Administrative Law Judge reviewing the proposed rules to hear public comment regarding the impact of the proposed rules and what changes might be appropriate.[7] Further, the hearing process provided the general public an opportunity to review, discuss, and critique the proposed rules.

The Agency must establish that the proposed rules are within the Agency's statutory authority; necessary and reasonable; follow from compliance with the required procedures; and that any modifications that the Agency made after the proposed rules were initially published in the *State Register* are within the scope of the matter that was originally announced.[8]

Adonis Neblett, General Counsel, represented the MPCA at the hearing. The members of the MPCA's hearing panel (Agency Panel) included Carol Nankivel, Rulemaking Coordinator; Shannon Lotthammer, Division Director for the Environmental Analysis and Outcomes Division; Ed Swain, Research Scientist with the Environmental Analysis and Outcomes Division; Catherine Neuschler, Water Assessment Section Manager; Gerald Blaha, Research Scientist with the Water Quality Standards Unit; Elizabeth Kaufenberg, Research Scientist with the Effluent Limits Unit; Phillip Monso, Research Scientist with the Water Quality Standards Unit; Scott Kyser, Engineer with the Effluent Limits Unit; and Debra Klooz, a Paralegal in the Legal Services unit.

The MPCA received thousands of written comments on the proposed rules between August 21, 2017 and November 2, 2017. Approximately 57 people attended the first public hearing on October 23rd in St. Paul, Minnesota and signed the hearing register. Fourteen members of the public provided oral comments regarding the proposed rules during the October 23rd hearing and one public exhibit was received during that hearing.[9]

Approximately 88 people attended the October 24th hearing in Virginia, Minnesota and signed the hearing register. Twenty-five members of the public provided oral

---

[3] Porewater is the water present in saturated sediment between the solid particles of minerals and organic matter.
[4] Minn. Stat. §§ 14.131-.20 (2016).
[5] *See* Minn. Stat. §§ 14.05-.20 (2016); Minn. R. 1400.2000-.2240 (2017).
[6] See Minn. Stat. § 14.25 (2016).
[7] *See* Minn. Stat. § 14.14; Minn. R. 1400.2210-.2230.
[8] Minn. Stat. §§ 14.05, 14.23, 14.25, 14.50 (2016).
[9] Exhibit (Ex.) 1000.

comments regarding the proposed rules during the October 24th hearing. Twelve public exhibits[10] and two Agency exhibits[11] were received during the October 24th hearing.

Approximately 44 people attended the October 25th hearing in Bemidji, Minnesota, and signed the hearing register. Fourteen members of the public provided oral comments regarding the proposed rules during the October 25th hearing and two public exhibits were received during that hearing.[12]

Approximately 89 people attended the October 26th hearing in Cloquet, Minnesota, and signed the hearing register. Twenty-seven members of the public provided oral comments regarding the proposed rules during the October 26th hearing and nine written public exhibits were received during that hearing.[13]

Approximately 53 people attended the October 30th hearing in Brainerd, Minnesota, and signed the hearing register. Twenty members of the public provided oral comments regarding the proposed rules during the October 30th hearing and nine public exhibits were received during that hearing.[14]

Approximately 26 people attended the November 2nd hearing in St. Paul, Minnesota, or watched via interactive video conference at one of the MPCA's regional offices in Detroit Lakes, Duluth, Mankato, Marshall, and Rochester. Eight members of the public provided oral comments regarding the proposed rules during the November 2nd hearing and three public exhibits were received during that hearing.[15]

In total, 38 exhibits were received during the public hearings.[16]

After the close of the last of the hearings, the Administrative Law Judge kept the rulemaking record open for an additional 20 calendar days, until November 22, 2017, to allow interested persons and the Agency to submit written comments. Thereafter, the record remained open for an additional five business days, until December 1, 2017, to allow interested persons and the Agency to file written responses to any comments received during the initial comment period.[17]

Approximately 1,500 written comments were received from members of the public after the hearings, along with two responses from the Agency.[18] To aid the public in participating in this matter, all comments were posted at the Office of Administrative

[10] Exs. 1001-1012.
[11] Exs. 1013-1014.
[12] Exs. 1015-1016.
[13] Exs. 1017-1024A.
[14] Exs. 1025-1033.
[15] Exs. 1033-1036.
[16] Exs. 1000-1036, which includes Exs. 1024 and 1024A.
[17] *See* Minn. Stat. § 14.15, subd. 1.
[18] MPCA Response to Public Comments (Nov. 22, 2017) and MPCA Rebuttal Response to Public Comments (Dec. 1, 2017).

Hearings' Rulemaking eComments website. In total, the Administrative Law Judge received more than 4,500 written comments on the proposed rule amendments.[19]

The hearing record closed for all purposes on December 1, 2017.[20]

NOTICE

The Agency must make this Report available for review by anyone who wishes to review it for at least five working days before the Agency takes any further action to adopt final rules or to modify or withdraw the proposed rules. If the Agency makes changes in the rules other than those recommended in this report, it must submit the rules, along with the complete hearing record, to the Chief Administrative Law Judge for a review of those changes before it may adopt the rules in final form.

Because the Administrative Law Judge has determined that the proposed rules are defective in certain respects, state law requires that this Report be submitted to the Chief Administrative Law Judge for her approval. If the Chief Administrative Law Judge approves the adverse findings contained in this Report, she will advise the Agency of actions that will correct the defects, and the Agency may not adopt the rules until the Chief Administrative Law Judge determines that the defects have been corrected. However, if the Chief Administrative Law Judge identifies defects that relate to the issues of need or reasonableness, the Agency may either adopt the actions suggested by the Chief Administrative Law Judge to cure the defects or, in the alternative, submit the proposed rules to the Legislative Coordinating Commission for the Commission's advice and comment. The Agency may not adopt the rules until it has received and considered the advice of the Commission. However, the Agency is not required to wait for the Commission's advice for more than 60 days after the Commission has received the Agency's submission.

If the Agency elects to adopt the actions suggested by the Chief Administrative Law Judge and make no other changes; and the Chief Administrative Law Judge determines that the defects have been corrected, it may proceed to adopt the rules. If the Agency makes changes in the rules other than those suggested by the Administrative Law Judge and the Chief Administrative Law Judge, it must submit copies of the rules showing its changes, the rules as initially proposed, and the proposed order adopting the rules to the Chief Administrative Law Judge for a review of those changes before it may adopt the rules in final form.

After adopting the final version of the rules, the Agency must submit them to the Revisor of Statutes for a review of their form. If the Revisor of Statutes approves the form of the rules, the Revisor will submit certified copies to the Administrative Law Judge, who will then review them and file them with the Secretary of State. When they are filed with

---

[19] Of these comments, the vast majority were form letters, form postcards, or petitions. *See* https://minnesotaoah.granicusideas.com/discussions/minnesota-pollution-control-agency-environmental-assessment-and-outcomes-division.

[20] Pursuant to Minn. Stat. § 14.15, subd. 2, a one week extension was granted for the preparation of this Report. *See* Order Extending Deadline for Rule Report (Dec. 28, 2017).

the Secretary of State, the Administrative Law Judge will notify the Agency, and the Agency will notify those persons who requested to be informed of their filing.

SUMMARY OF CONCLUSIONS

The MPCA has established that it has the statutory authority to adopt the proposed rules and that it followed the legal requirements to promulgate the rules.

The Administrative Law Judge **DISAPPROVES** the proposed repeal of the 10 mg/L sulfate standard at **Minn. R. 7050.0220, subps. 3a, 4a, 5a, 6a** and **Minn. R. 7050.0224, subp. 2,** due to the Agency's failure to establish the reasonableness of the repeal, and because the repeal conflicts with the requirements 33 U.S.C. § 1313(c), 40 C.F.R. § 131.10(b) (2015) and Minn. R. 7050.0155 (2017).

The Administrative Law Judge **DISAPPROVES** the proposed equation-based sulfate standard at **Minn. R. 7050.0224, subp. 5, B (1)** because the proposed rule fails to meet the definition of a rule under Minn. Stat. § 14.38 (2016) and Minn. R. 1400.2100.G (2017). In addition, the proposed equation-based sulfate standard is not rationally related to the Agency's objective in this proceeding, and is unconstitutionally void for vagueness.

The Administrative Law Judge **DISAPPROVES** the proposed list of approximately 1,300 wild rice waters at **Minn. R. 7050.0471, subps. 3 through 9** because it violates 40 C.F.R. §§ 131.3 and .11(h)(1).

In addition, the Administrative Law Judge **DISAPPROVES** the following proposed rules because the Agency failed to demonstrate that the proposed rules meet the required legal standards:

a. Proposed **Minn. R. 7050.0224, subp. 5, A** – to the extent the language incorporates the standard in items B(1) and (2) the language violates Minn. Stat. § 14.38 and Minn. R. 1400.2100.B and G (2017).

b. Proposed **Minn. R. 7050.0224, subp. 5, A** – to the extent the language incorporates the standard in item C, the language violates Minn. R. 1400.2100.D (2017).

c. Proposed **Minn. R. 7050.0224, subp. 5, C** – violates Minn. R. 1400.2100D.

d. Proposed **Minn. R. 7050.0224, subp. 6** – fails to establish need or reasonableness for rule. No reason for distinguishing between [WR], which are provided additional protection of narrative standard, and other wild rice waters listed at Minn. R. 7050.0471 violates 1400.2100.B.

The Administrative Law Judge finds that the Agency failed to provide adequate regulatory analyses as required by Minn. Stat. § 14.131 (1), (5), (7), and (8). While the Agency made the cost determination required by Minn. Stat. § 14.127, the Administrative

Law Judge concludes that this determination is not adequately supported in the rulemaking record.[21]

Based upon all the testimony, exhibits, and written comments the Administrative Law Judge makes the following:

FINDINGS OF FACT

I. Background to the Proposed Rules

1. This rulemaking concerns amendments to Minnesota's water quality standard to protect wild rice from adverse impacts due to sulfate pollution. Wild rice is an important natural resource in Minnesota. In addition to providing food to people and waterfowl generally, it has spiritual, cultural, and nutritional significance to the Dakota and Ojibwe people.

2. Under the federal regulations implementing the Clean Water Act (CWA), the MPCA is responsible for establishing, reviewing, and revising water quality standards.[22]

3. Federal law defines "water quality standards" to "consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are intended to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act."[23]

4. Water quality standards "must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use."[24]

5. Minnesota Rules, chapter 7050 (2017) establishes water quality standards for "all waters of the state, both surface and underground."[25] This chapter sets out a classification system for the beneficial uses of waters, establishes numeric and narrative water quality standards, and provides nondegradation provisions, and other provisions to protect the physical, chemical, and biological integrity of waters of the state.[26] Water use classifications, and their accompanying narrative and numeric standards and antidegradation provisions, make up the state's set of water quality standards.

6. In Minnesota, the wild rice resource is protected with a unique water quality standard. The existing wild rice standards, found at Minn. R. 7050.0224, consist of a narrative standard in subpart 1 applicable to selected wild rice waters specifically identified in rule, and a numeric standard in subpart 2 that establishes a sulfate standard

---

[21] *See Builders Ass'n. of Twin Cities v. Minnesota Dept. of Labor and Industry*, 872 N.W. 2d 263 (Minn. Ct. App. 2015).
[22] 40 C.F.R. § 131.4(a) (2017). Under state and federal law, the MPCA is charged with the administration and enforcement of the CWA. *See* 33 U.S.C. §§ 1251-1387 (2016); 40 C.F.R. § 123.25(a) (2017); Minn. Stat. § 115.03, subds. 1, 5 (2016).
[23] 40 C.F.R. § 131.3(i) (2017).
[24] 40 C.F.R. § 131.11(a)(1) (2017); *see also* 40 C.F.R. § 131.5(a)(2) (2017).
[25] Minn. R. 7050.0110.
[26] *Id.*

applicable to "water used for production of wild rice." The purpose of a designated use of a water body to protect wild rice is described as "the harvest and use of grains from this plant serve as a food source for wildlife and humans."[27]

7. Minnesota first adopted a sulfate standard to protect wild rice in 1973.[28] The sulfate standard was based on research conducted in the 1930s and 1940s that found that higher levels of sulfate in water correlated with reduced presence of wild rice.[29] Based on this research, the MPCA set the numeric standard at 10 mg/L of sulfate applicable to "water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels."[30]

8. Over the years, the MPCA has received comments and questions about the appropriateness of the sulfate standard and the meaning of the phrase "waters used for production of wild rice."[31] In 2011, the Minnesota Legislature directed the MPCA to undertake further study of the wild rice sulfate water quality standard and to revise the standard as necessary.[32] This rulemaking proceeding is the result of that legislative directive.[33]

9. In 2011, the Minnesota Legislature provided the MPCA with a $1.5 million appropriation from the Clean Water Fund to conduct a Wild Rice Sulfate Study to gather additional information about the effects of sulfate and other substances on the growth of wild rice.[34] The Legislature also directed the MPCA to undertake rulemaking to identify wild rice waters and to make any other needed changes to the standards following completion of the study.[35] The rulemaking was to be completed by January 15, 2018.[36]

10. The Minnesota Legislature also directed the MPCA to create an advisory group comprised of tribal government representatives and a variety of other stakeholders to provide input on the research and the development of future rule amendments.[37] The legislation further directed the MPCA to establish criteria for waters containing natural beds of wild rice after consulting Minnesota tribes, the Minnesota Department of Natural Resources (DNR), and stakeholders.[38]

11. In 2017, the MPCA received $180,000 from the Legislative Citizens Commission on Minnesota Resources to analyze wastewater treatment alternatives to

[27] Minn. R. 7050.0224, subp. 1.
[28] Ex. D SONAR at 11-12, 33-34.
[29] Ex. D at 11.
[30] Minn. R. 7050.0224, subp. 2.
[31] Ex. D at 11-12.
[32] 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4, § 32.
[33] Ex. D. at 13.
[34] Ex. D at 13; 2015 Minn. Laws 1st Spec. Sess. ch. 4, art. 4, § 136.
[35] Ex. D at 13.
[36] 2015 Minn. Laws 1st Spec. Sess. ch. 4, art. 4, § 136.
[37] 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4, § 32.
[38] *Id.*

inform the development of the proposed rules. The analysis is expected to be completed by May of 2018.[39]

12. In 2017, the Minnesota Legislature extended the deadline for completing this rulemaking by one year to January 15, 2019.[40]

II. Rulemaking Authority

13. The MPCA relies upon its general rulemaking authority under Minn. Stat. § 115.03, subd. 1 (2016), as its statutory authority to adopt these proposed rules. This statute provides that the Agency is given and charged with the following powers and duties:

> (a) to administer and enforce all laws relating to the pollution of any of the waters of the state;
>
> (b) to investigate the extent, character, and effect of the pollution of the waters of this state and to gather data and information necessary or desirable in the administration or enforcement of pollution laws, and to make such classification of the waters of the state as it may deem necessary;
>
> (c) to establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary for the purposes of this chapter and, with respect to the pollution of waters of the state, chapter 116;
>
> (d) to encourage waste treatment, including advanced waste treatment, instead of stream low-flow augmentation for dilution purposes to control and prevent pollution; and
>
> (e) to adopt, issue, reissue, modify, deny, or revoke, enter into, or enforce reasonable orders, permits, variances, standards, rules, schedules of compliance, and stipulation agreements, under such conditions as it may prescribe, in order to prevent, control, or abate water pollution, or for the installation or operation of disposal systems or parts thereof, or for other equipment and facilities.[41]

14. The MPCA also relies upon its general authority to "group the designated waters of the state into classes, and adopt classifications and standards of purity and quality" under Minn. Stat. § 115.44, subd. 2 (2016), as a source of statutory authority to adopt the proposed rules. Minn. Stat. § 115.44, subd. 2, provides in part:

[39] Ex. 1015; Letter from Iron Range Legislative Delegation (Nov. 2, 2017); Testimony (Test.) of Rep. Matt Bliss at Tr. 85 (Oct. 25, 2017); Test. of Rep. Rob Ecklund at 69-72 (Oct. 30, 2017).
[40] 2017 Minn. Laws, ch. 93, art. 2, § 149.
[41] Minn. Stat. § 115.03, subd. 1.

> In order to attain the objectives of sections 115.41 to 115.53, the agency after proper study, and after conducting public hearing upon due notice, shall, as soon as practicable, group the designated waters of the state into classes, and adopt classifications and standards of purity and quality therefor.

15. Additionally, the MPCA cites the specific legislative authorities that require it to initiate a process to amend the state water quality standards in Minn. R. ch. 7050,[42] and that extended the deadline for completing the mandated rule revisions.[43]

16. The Administrative Law Judge concludes that the Agency has the statutory authority to adopt the proposed rules.

III. Procedural Requirements of Chapter 14 (2016)

A. Publications

17. On October 26, 2015, the Agency published a Request for Comments in the *State Register* seeking comments on "its planned changes to rules governing water quality standards, Minnesota Rules chapter 7050 (Waters of the State)."[44]

18. On August 3, 2017, the Agency requested review and approval of its Notice of Hearing and Additional Notice Plan.

19. On August 8, 2017, Administrative Law Judge Eric Lipman issued an Order on behalf of Administrative Law Judge LauraSue Schlatter approving the Additional Notice Plan and Hearing Notice.

20. On August 21, 2017, the Agency published a Notice of Hearing in the State Register stating its intention to adopt rules following the receipt of input from the public.[45] In the Notice, the Agency announced a series public hearings scheduled for October 23, 24, 25, 30, and November 2, 2017.[46]

21. On August 21, 2017, the Agency sent via electronic mail the Notice of Hearing to all persons and associations who had registered their names with the Agency for the purpose of receiving such notice.[47] The Agency also provided a copy of the Notice of Hearing to all persons and associations identified in the Agency's Additional Notice Plan.[48]

---

[42] 2011 Minn. Laws 1st Spec. Sess, ch. 2, art. 4, § 32.
[43] 2017 Minn. Laws ch. 93, art. 2, § 149.
[44] Ex. A; 40 *State Register* 477-78 (Oct. 26, 2015).
[45] Ex. F; 42 *State Register* 171-172 (Aug. 21, 2017).
[46] *Id*.
[47] Ex. G.
[48] Ex. H1.

22. On September 18, 2017, the Agency sent via electronic mail the Notice of Additional Hearing to all persons and associations who had registered their names with the Agency for the purpose of receiving such notice and to all persons and associations identified in the Agency's Additional Notice Plan.[49] In the Notice, the Agency announced an additional public hearing to take place in Cloquet, Minnesota, on October 26, 2017.[50]

23. The Agency published the Notice of Additional Hearing in the *State Register* on September 18, 2017.[51]

24. At the hearing on October 23, 2017, the MPCA filed copies of the following documents as required by Minn. R. 1400.2220 (2017):

a. MPCA's Request for Comments as published in the *State Register* on October 26, 2015;[52]

b. A Petition for Rulemaking submitted by the Minnesota Chamber of Commerce on December 17, 2010, and a Memorandum in Support of the Minnesota Chamber of Commerce's Petition for Rulemaking dated December 6, 2010;[53]

c. Proposed rules dated July 24, 2017, including the Revisor's approval;[54]

d. The MPCA's Statement of Need and Reasonableness (SONAR);[55]

e. The Certificate of Mailing the SONAR to the Legislative Reference Library on August 21, 2017;[56]

f. The Notice of Hearing as mailed and as published in the *State Register* on August 21, 2017; and the Notice of Additional Hearing as mailed and as published in the *State Register* on September 18, 2017;[57]

g. Certificate of Mailing the Notice of Hearing to the rulemaking mailing list and Certificate of Accuracy of the Mailing List dated August 21, 2017, and Certificate of Mailing the Notice of Additional Hearing to the rulemaking list and Certificate of Accuracy of the Mailing List dated September 18, 2017;[58]

---

[49] Ex. H2.
[50] *Id*.
[51] Ex. F; 42 *State Register* 369-370 (Sept. 18, 2017).
[52] Ex. A; 40 *State Register* 477-478 (Oct. 26, 2015).
[53] Ex. B.
[54] Ex. C.
[55] Ex. D.
[56] Ex. E.
[57] Ex. F.
[58] Ex. G.

h. Certificate of Providing Additional Notice of the August 21, 2017, Notice of Hearing[59] and Certificate of Providing Additional Notice of the September 18, 2017, Notice of Additional Hearings;[60]

i. Written comments received during the prehearing comment period and a link to the Minnesota Office of Administrative Hearings' rulemaking eComments website, where written comments on the proposed rules received by the Agency prior to the hearing were posted;[61]

j. Chief Judge's authorization to omit from the notice of hearing published in the *State Register* the text of the proposed rules (not applicable);

k. Other documents or evidence to show compliance with any other law or rule which the agency is required to follow in adopting this rule:

K1 – Certificate of Sending the Notice of Hearing and SONAR to legislators and the Legislative Coordinating Commission on August 21, 2017;[62]

K2 – Notice to Department of Agriculture of Agency's intent to adopt rules as required by Minn. Stat. § 14.111, dated July 19, 2017;[63]

K3 – Notice to the Minnesota Department of Management and Budget and a September 17, 2017, memorandum from the Minnesota Department of Management and Budget;[64]

K4 – Notices sent to affected municipalities as required by Minn. Stat. § 115.44, subd. 7 (2016).[65]

l. Additional documents submitted at the hearing:

Peer-reviewed articles on sulfur processes and sulfate treatment;[66] the MPCA's rule hearing presentation; errata correcting minor errors in the SONAR; and MPCA Changes to Specific Water Identification Numbers (WID). [67]

---

[59] Ex. H1.
[60] Ex. H2.
[61] Ex. I.
[62] Ex. K1.
[63] Ex. K2.
[64] Ex. K3.
[65] Ex. K4.
[66] Exs. L1–L5 and L8.
[67] Exs. L6, L7, and L9.

B. Additional Notice Requirements

25. Minn. Stat. §§ 14.131 and 14.23 require that an agency include in its SONAR a description of its efforts to provide additional notification to persons or classes of persons who may be affected by the proposed rule or, alternatively, the agency must detail why these notification efforts were not made.

26. The MPCA states that the proposed revisions have been in development for many years and that it has made extensive efforts to inform and engage specific stakeholders and the general public. In April of 2011, the MPCA created a webpage to provide background about the existing wild rice sulfate standard and its plan to evaluate the standard. Since 2011, the MPCA has also used the GovDelivery system to share information about the wild rice standard with subscribers. In addition, pursuant to a 2011 legislative directive, the MPCA established an advisory committee to provide input to the Commissioner on various topics related to the wild rice scientific study and proposed rulemaking. The MPCA also made a special effort to communicate and consult with Minnesota tribes, given their sovereign status and the great importance of wild rice to the Ojibwe and Dakota people.[68]

27. The MPCA also held numerous meetings over the course of developing the proposed revisions to engage interested persons and obtain feedback.[69] The MPCA released a draft proposal of the proposed wild rice water quality standard in March 2015, along with a draft list of waters where the standard would apply. The MPCA sent notice of the availability of the draft proposal to the MPCA's GovDelivery mailing list of people who had registered their interest in this topic and posted the draft proposal on its rulemaking webpage.[70] Before officially proposing the rules, the MPCA held a series of three open house meetings to provide an informal opportunity for the public to review the proposal and ask questions.[71]

28. Pursuant to the Additional Notice Plan approved by the Office of Administrative Hearings, on August 8, 2017, the Agency:

a. posted the Notice of Hearing, SONAR, SONAR attachments, proposed rule language, documents incorporated by reference, information about how to file comments, and the times and locations of hearings on an Agency webpage established to provide information about the proposed rule amendments;

b. Published the Notice of Hearing on the MPCA's Public Notice webpage;

c. issued a press release via the GovDelivery system to 534 news media contacts and more than 3,400 media contacts and persons

---

[68] Ex. D at 126-128.
[69] *Id*. at 128.
[70] *Id*. at 129.
[71] *Id*.

registered to be notified of news releases to provide information about the proposed rule amendments and how to comment;

d. provided an extended comment period to allow additional time for review of the proposed rule amendments;

e. held multiple public hearings in various locations throughout the state and provided daytime and evening opportunities for people to attend and comment;

f. provided notice to a series of nonprofit organizations that represent and serve Native American communities in Minnesota; trade associations that serve mining communities and mining companies; and municipalities that operate wastewater treatment facilities and associations that represent them;

g. provided an electronic copy of the Notice of Hearing to more than 2,600 interested parties as certified in the MPCA's Certificate of Mailing Notice;

h. provided an electronic copy of the Notice of Hearing to municipalities as required by Minn. Stat. § 115.44, subd. 7;

i. posted the Notice of Hearing with links to the SONAR and proposed rule language on the Agency's public notice website for the term of the public notice comment period; and

j. posted the Notice of Hearing, SONAR, and proposed rule language on an Agency webpage established to provide information about the proposed amendments.[72]

29. The Administrative Law Judge finds that the Agency has fulfilled its additional notice requirements.

C. Notice Practice

1. Notice to Stakeholders

30. On August 21, 2017, the Agency provided a copy of the Notice of Hearing to its official rulemaking list (maintained under Minn. Stat. § 14.14) and to stakeholders identified in its Additional Notice Plan.[73]

31. On September 18, 2017, the Agency provided a copy of the Notice of Additional Hearing to its official rulemaking list (maintained under Minn. Stat. § 14.14) and to stakeholders identified in its Additional Notice Plan.[74]

[72] Exs. H1 and G. *See also* Ex. D at 131-132.
[73] Exs. G and H1.
[74] Exs. G and H1.

32. Hearings on the proposed rules were held on October 23, 24, 25, 26, 30, and November 2, 2017.[75]

33. There are 62 days between August 21, 2017 and October 23, 2017, the date of the first hearing in this matter. There are 37 days between September 18, 2017 and October 26, 2017, which was the date of the additional hearing.

34. The Administrative Law Judge concludes that the Agency fulfilled its responsibility to mail the Notice of Hearing and Notice of Additional Hearing "at least 33 days before the . . . start of the hearing."[76]

2. Notice to Legislators

35. On August 21, 2017, the Agency sent a copy of the Notice of Hearing and the SONAR to legislators and the Legislative Coordinating Commission as required by Minn. Stat. § 14.116.[77]

36. Minn. Stat. § 14.116(b) requires the agency to send a copy of the Notice of Hearing and the SONAR to certain legislators on the same date that it mails its Notice of Hearing to persons on its rulemaking list and pursuant to its additional notice plan.

37. The Administrative Law Judge concludes that the MPCA fulfilled the requirements of Minn. Stat. § 14.116(b).[78]

3. Notice to the Legislative Reference Library

38. On August 21, 2017, the MPCA mailed a copy of the SONAR to the Legislative Reference Library.[79]

39. Minn. Stat. § 14.23 requires the agency to send a copy of the SONAR to the Legislative Reference Library when the Notice of Intent to Adopt is mailed.

40. The Administrative Law Judge concludes that the Agency met the requirement of Minn. Stat. § 14.23 that it send a copy of the SONAR to the Legislative Reference Library when the Notice of Intent is mailed.

D. Impact on Farming Operations

41. Minn. Stat. § 14.111 imposes additional notice requirements when the proposed rules affect farming operations. The statute requires that an agency provide a copy of any such changes to the Commissioner of Agriculture at least 30 days prior to publishing the proposed rules in the *State Register*.

---

[75] Ex. G.
[76] Minn. R. 1400.2080, subp. 6.
[77] Ex. K1.
[78] Minn. R. 1400.2080, subp. 6.
[79] Ex. E.

42. The MPCA provided the Commissioner of Agriculture with a copy of the proposed rules and notice of its intent to adopt the rules. This notice was provided on July 19, 2017, 32 days prior to the publication of the Notice of Hearing in the State Register.[80]

43. The Administrative Law Judge concludes that the MPCA fulfilled its responsibilities under Minn. Stat. § 14.111.

E. Statutory Requirements for the SONAR

44. The Administrative Procedure Act obliges an agency adopting rules to address certain factors in its SONAR.[81] Those factors are:

> (1) a description of the classes of persons who probably will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule;
>
> (2) the probable costs to the agency and to any other agency of the implementation and enforcement of the proposed rule and any anticipated effect on state revenues;
>
> (3) a determination of whether there are less costly methods or less intrusive methods for achieving the purpose of the proposed rule;
>
> (4) a description of any alternative methods for achieving the purpose of the proposed rule that were seriously considered by the agency and the reasons why they were rejected in favor of the proposed rule;
>
> (5) the probable costs of complying with the proposed rule, including the portion of the total costs that will be borne by identifiable categories of affected parties, such as separate classes of governmental units, businesses, or individuals;
>
> (6) the probable costs or consequences of not adopting the proposed rule, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals;
>
> (7) an assessment of any differences between the proposed rule and existing federal regulations and a specific analysis of the need for and reasonableness of each difference; and

[80] Ex. K2.
[81] Minn. Stat. § 14.131.

(8) an assessment of the cumulative effect of the rule with other federal and state regulations related to the specific purpose of the rule.

1. The Agency's Regulatory Analysis

(1) A description of the classes of persons who probably will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule.

45. The MPCA's analysis focuses on regulated facilities that discharge wastewater to certain waters containing beds of natural wild rice, and on people interested in enjoying the beneficial uses that the water quality standards protect. The Agency states that the beneficial uses includes fishing, swimming, boating, and harvesting wild rice.

a. Classes that will bear costs.

46. The Agency points out that effluent limits imposed on regulated facilities as a result of the proposed rules will be applied through National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) permits. These permits are reviewed and re-issued every five years. Any facility that discharges sulfate directly to, or is located upstream of, a wild rice water governed by the rules has the potential to be affected by the proposed rules. These facilities are generally either industrial facilities, or municipal water or wastewater treatment plants.[82]

47. The MPCA describes the process for adopting the proposed equation-based water quality standards as follows:

> In the case of this wild rice sulfate standard, this implementation process will begin with data collection. As noted . . . , the data required will be sediment data to calculate the sulfate standard (or porewater sulfide data to establish an alternate standard), surface water sulfate data, and effluent sulfate data. The MPCA plans to collect the sediment data over time, largely in conjunction with its regular ten-year cycle of intensive watershed monitoring, focusing first on wild rice waters that are most likely to be impacted by high levels of sulfate. The exception would be that where a new or expanded discharge is proposed, the proposer may be required to collect the sediment data following the procedures proposed to be incorporated into the rule.[83]

48. The Agency notes that regulated facilities that are not already monitoring their sulfate effluent data will probably have to do so for their first five-year permit due to the fact that the permit will be reissued following adoption of the rule. Facilities will also be impacted by an effluent limit review, which involves analysis of site-specific variables

---

[82] Ex. D (SONAR) at 145-146.
[83] *Id.*

to determine whether the facility's permit must include a limit to ensure that the sulfate standard is not exceeded.[84]

49. The variables include specifics of the facility as well as the receiving water, including the level of the receiving water's sulfate pollutant The MPCA estimates that, for facilities that already monitor their effluent's sulfate discharge, the effluent limit review will likely occur in the first five-year permit reissuance after the rule is adopted. For facilities that do not, the effluent review will likely not occur until the second five-year permit reissuance after the rule is adopted.[85]

50. Another necessary variable for this analysis is a numeric sulfate standard for at least one wild rice water which is affected by the facility's discharge. To calculate the numeric sulfate standard in accordance with the proposed rule, certain data must be obtained, including the amount of organic carbon and extractable iron in the wild rice water sediment.[86]

51. By identifying the industrial and municipal waste water treatment plants (WWTPs) within a specified distance of a regulated wild rice water, the MPCA was able to estimate "the universe of affected dischargers."[87]

52. Based on an analysis of 2015 NPDES/SDS permit information, the Agency estimated that there are approximately 745 discharge stations upstream of at least one wild rice water to be regulated pursuant to the proposed rules, ranging in distance between one mile to 413 river miles from the nearest regulated wild rice water. About 319 of the stations are within 60 miles of a proposed regulated wild rice water, and about 135 are within 25 miles of a proposed regulated wild rice water. While noting that "25 miles is not a definite predictor for impact . . . ,"[88] the MPCA focuses on the 135 WWTPs as those most likely to be affected by the proposed rule. These facilities are most likely to require an effluent limit review and possibly to incur the treatment costs needed to meet an applicable water quality standard. But, the Agency notes, "[s]everal factors will affect a facility's potential to impact a wild rice water and those factors cannot be determined in advance of establishing the numeric sulfate standard and evaluating the specific circumstances associated with each discharge and each wild rice water."[89] The new standards could result in costs, if more treatment is needed to meet a standard that is more stringent than the current 10 mg/L standard, or in cost savings, if the standard is more relaxed than the current standard.[90]

53. The Agency states that industrial WWTPs are likely to pass along the costs of new treatment equipment or technologies to their customers and municipal WWTPs are likely to pass along similar costs to their residential, commercial, and industrial system

[84] Ex. D at 146.
[85] *Id.*
[86] Ex. C (proposed rule 7050.0224, subp. 5, B) at li. 7.25-8.12.
[87] *Id.* at 147.
[88] *Id*.
[89] *Id.*
[90] *Id.* at 148.

users. The Agency speculates that, to the extent the market will not support increased industrial costs, such costs may have to be absorbed, and will thus reduce profits, making the industry less competitive in the marketplace, negatively impacting shareholders and employees, and possibly resulting in a company ceasing operations rather than investing in the expensive technology needed to meet a new standard. The Agency acknowledges that employment is a particularly key issue for the mining economy of Minnesota's Iron Range, but it is unable to predict whether the consequences of adopting the proposed rule will be "as minor as a small increase in the price of the product, or may be as extensive as the consequences to an entire community when a company ceases operations."[91]

54. Adopting the standards through the MPCA's water assessment cycle will, in itself, take up to ten years:

> The MPCA's current Intensive Watershed Monitoring plan includes intensive data collection across the state following a 10-year cycle. The MPCA is working with field staff to incorporate data collection needs for the proposed sulfate wild rice standard into that effort. In most cases, the MPCA will integrate the collection of sediment data in wild rice waters into our regular monitoring work around the state. The agency will prioritize data collection for wild rice waters most likely to be affected by discharges, and some work may be prioritized outside the regular monitoring schedule.[92]

55. In its Rebuttal to Comments following the rule hearings, the Agency explains:

> [E]valuating the need for and (as needed) determining a water quality based effluent limit requires data specific to the discharge being evaluated and the receiving water(s) being discharged to. Data needs unique to the proposed rule revisions are the sediment iron and carbon (or porewater sulfide) data. Collecting all the data necessary to calculate all effluent limits statewide would take at least ten to fifteen years, even if the sediment data were not needed. Necessary steps such as gathering five years of effluent data to evaluate and set effluent limits combined with the 10-year surface water monitoring schedule to gather surface water data cumulatively add up to the necessary data not being available for some permitted discharges until at least ten to fifteen years after rule promulgation. The MPCA does plan to prioritize data collection based on factors such as those mentioned in the EPA comments, Appendix 2 – the likelihood of sulfate impacts (because of type and location of dischargers) and permitting schedules. It is unreasonable to delay this rulemaking for ten to fifteen years to provide total certainty regarding future effluent limits for specific facility discharges and the exact future costs. In addition, every facility is unique and detailed engineering is needed to estimate the costs of installing any treatment

[91] Ex. D. at 148.
[92] MPCA Response to Comments, Cover Memorandum at 10 (Nov. 22, 2017) (Response Cover Memo).

system. This is why the MPCA provided general effluent limit considerations and the range of costs detailed in the SONAR. A delay such as would be necessary to gather data and estimate the cost for all potentially affected facilities is particularly unreasonable given that while the rulemaking would be delayed the existing sulfate standard would remain in place and need to be addressed as required by the Clean Water Act and federal regulations. [93]

56. The Administrative Law Judge concludes that the Agency has correctly described the various types of WWTPs that discharge sulfate directly to, or that are located upstream of, wild rice waters governed by the proposed rules as classes that will bear the cost of the proposed rules. However, the Administrative Law Judge further concludes that the Agency omitted to include, in its discussion of the WWTPs' possible costs, the Agency's SONAR-based expectation, which is not set forth in the rule, that regulated parties will bear the cost of conducting sediment sampling for a new or expanded discharge.[94]

57. The Agency's predictions about the number of dischargers likely to be affected is unreliable because "[s]everal factors will affect a facility's potential to impact a wild rice water and those factors cannot be determined in advance of establishing the numeric sulfate standard and evaluating the specific circumstances associated with each discharge and each wild rice water."[95]

58. The Agency did not identify Minnesota Indian tribes or individual Native Americans as classes of persons who would bear a burden under the proposed rules because the Agency believes that the proposed new sulfate standards will be protective of wild rice.[96]

59. Wild rice is not only a food source for Native American communities, but a source of deep spiritual importance and, for some, a life-giving being.[97] Many in the Native American communities who submitted comments, testified at the public hearings, and worked with the MPCA during the development of this rule do not believe that the rule will be protective of wild rice. Among the reasons that some of the representatives of Native American communities presented as their concerns about the rule are:

a. A higher sulfate standard will be harmful to the rice because the higher levels of iron underlying the higher sulfate standard cause plaque to form on the roots of the wild rice plants, interfering with the ability of the plant to absorb nutrients and ultimately leading to barren seeds;[98]

---

[93] MPCA Rebuttal Memo at 40-41.
[94] Ex. D at 146.
[95] *Id.* at 147.
[96] *Id.*at 145.
[97] Exs. 1000 and 1020; Tr. at 142-145 (Oct. 24, 2017); Comments from Fond du Lac Band of Lake Superior Chippewa (filed Nov. 22, 2017).
[98] Comments from 1854 Treaty Authority (filed Nov. 21, 2017); Comments from Fond du Lac Band of Lake Superior Chippewa (filed Nov. 22, 2017).

b. A higher sulfate standard will lead to higher levels of methylmercury in fish, which in turn leads to serious health concerns for Native American and other populations who rely heavily on fish for food;[99]

c. The list of wild rice waters excludes a number of waters identified by the 1854 Exclusionary Act Treaty as well as the Minnesota DNR's 2008 wild rice waters list;[100] and

d. The MPCA's inclusion, in the wild rice waters listed in the proposed rule, of waters that are within the boundaries of the Fond du Lac and Grand Portage reservations despite requests that those waters be excluded.[101]

60. While the MPCA had responses to each of these concerns, the volume and nature of the comments from the Native American community demonstrated that the Agency has not succeeded in building an atmosphere of trust regarding this proposed rule, or in making the Minnesota Native American community feel that it has been heard.

61. Implementation of the rule as proposed is a burden to the Minnesota Indian tribes, and many Native American individuals, whose testimony and written comments during the rulemaking process demonstrate that they are compelled to continue to challenge the rule because they believe that the long-term survival of wild rice is in peril and do not believe that the Agency understands the importance of wild rice in Native American culture and life.[102]

62. The Administrative Law Judge concludes that the Agency failed to recognize the proposed rule's burden on the Native American community in its discussion of classes of people who will be burdened by adoption of the proposed rule.

b. Classes that will benefit from the new standard.

63. The MPCA states generally that any person who uses Minnesota waters for drinking, swimming, boating, fishing, commerce, scientific, educational, or cultural purposes, or general aesthetic enjoyment will benefit from the proposed rules. Specifically, the Agency states that any person who harvests wild rice for food or who eats wild rice will benefit. The Agency emphasizes that many Native Americans, especially members of the Ojibwe and Dakota tribes, will benefit from the proposed rule. The Agency states that tribal rights to harvest wild rice are protected in treaties and that harvesting, preparing, sharing, and selling wild rice is important culturally, spiritually, and socially to Native American Minnesotans.[103]

---

[99] Tr. at 65-68 (Oct. 25, 2017).
[100] Exs. 1000 and 1020; Comments from 1854 Treaty Authority (filed Nov. 21, 2017); Comments from Fond du Lac Band of Lake Superior Chippewa (filed Nov. 22, 2017).
[101] Ex. 1020; Comments from 1854 Treaty Authority (filed Nov. 21, 2017); Comments from Fond du Lac Band of Lake Superior Chippewa (filed Nov. 22, 2017).
[102] Exs. 1000 and 1020; Comments from Fond du Lac Band of Lake Superior Chippewa (filed Nov.22, 2017); eComments Nicolette Slagle on behalf of Honor the Earth (Nov. 22, 2017); eComments from George Crocker on behalf of North American Water Office (Nov. 22, 2017).
[103] Ex. D at 149.

64. The Agency asserts that the varied benefits of wild rice include the following:

> Transactions and activities associated with the wild rice harvest benefit individuals and local economies. Some tribal members have shared stories about how money from ricing paid for each year's school supplies. Many people place a high value on wild rice as food, especially for its availability, flavor, and health benefits. For persons who have limited incomes or a cultural connection, wild rice can be an important subsistence food.[104]

65. In addition, the MPCA states that wildlife, especially the migratory waterfowl that depend on wild rice as a food source, along with the people who hunt waterfowl, engage in bird watching and other wildlife-related activities, plus businesses that support those activities, will benefit from the proposed rules. The Agency adds that businesses that benefit from tourism and people who derive a value from ecosystem services generally will also benefit from the proposed rules.[105]

66. The Agency explains that, where the proposed rule will require ambient sulfate levels to be less than 10 mg/L, the equation-based standard will be more protective of the wild rice than the current standard and thus provide a benefit to those who use and value wild rice.[106]

67. To the contrary according to the MPCA, where the proposed rule will permit ambient sulfate levels to be higher than 10 mg/L while still maintaining a protective level of sulfide to the wild rice, the equation-based standard will potentially reduce treatment costs. In addition, the proposed alternate standard, which can be used in certain cases where the equation is not appropriate, could also allow sulfate levels to be higher than that calculated by the equation-based standard.[107]

68. The proposed rules may thus allow some municipal or industrial dischargers to reduce or eliminate sulfate treatment, or the need for a variance, to operate at a lower level of sulfate treatment. This could permit dischargers to avoid paying for a higher level of wastewater treatment, or applying for, and justifying, a variance request. In addition to the monetary costs of wastewater treatment, the MPCA notes that wastewater treatment for sulfate involves energy use and the generation of by-products, both of which could be lessened or avoided through application of the proposed rules. [108]

69. The Agency does not analyze how less-protective standards of wild rice waters that neighbor wild rice waters on tribal lands will affect waters on tribal lands. Nor does the Agency explain how it will insure that increased sulfate levels will not add to mercury methylation.

---

[104] *Id.* at 150.
[105] *Id.*
[106] *Id.* at 151.
[107] *Id.* In its Rebuttal, the Agency proposes to change the way in which the Alternate Standard is established from the rule as originally proposed. MPCA Rebuttal Response to Public Comments (MPCA Rebuttal) at 6-7 (Dec. 1, 2017). *See* Ex. C. (proposed rule 7050.0224, subp. 5, B (2)) at li. 8.18-8.25.
[108] Ex. D at 151.

70. The Administrative Law Judge concludes that, to the extent the proposed rule fails to maintain a level of water quality that provides for the attainment and maintenance of the water quality standards of downstream waters, including waters on tribal lands, the proposed rule will not benefit wildlife, or the Objibwe, Dakota or other people who harvest or depend on wild rice for food, spiritual or cultural nourishment, or as a means of earning money.

c. Classes that will benefit from clarity regarding how and where the standard applies.

71. The MPCA states that the proposed rule may benefit dischargers "in the form of the benefit of regulatory certainty, prompt permit renewal, and protection from litigation."[109] By "regulatory certainty," the MPCA means "the general ability of permittees to know and anticipate environmental regulations and reasonably plan for compliance. . . ."[110]

72. The MPCA identifies two areas of difficulty for dischargers of sulfate: (1) a lack of duration or averaging time in the current sulfate rule, leading to uncertainty regarding whether the standard applies at all times or is to be averaged over some period of time; and (2) a lack of clear criteria for determining whether a given water is used for production for wild rice, resulting in case-by-case decisions regarding the applicability of the sulfate standards.[111]

73. According to the MPCA, it is this lack of clarity concerning waters used for the production of wild rice that has resulted in delayed issuance of new or renewed NPDES/SDS permits. Because the proposed rule specifically identifies wild rice waters and provides more details about the standard, the proposed rule provides dischargers with more certainty regarding "whether their effluent may impact a wild rice water and whether they will need to take actions because of the standard – from monitoring their effluent to undergoing an effluent limit review to installing treatment."[112]

74. The MPCA predicts that the proposed rule will speed permitting, reduce permitting backlogs, and reduce the risk of litigation. In addition, the Agency states that the proposed rule will "allow existing facilities to implement improvements and innovations that are currently stalled."[113] According to the Agency, industries and taxpayers will benefit because dischargers will be able to obtain and update their permits more effectively under the proposed rule.[114]

75. Finally, the MPCA envisages that greater clarity about how and where the wild rice sulfate standard applies will also allow the development of a clear process of

---

[109] *Id.*
[110] *Id*. at 151, n.24.
[111] *Id*. at 151-152.
[112] Ex. D at 152.
[113] *Id.*
[114] *Id.*

assessing wild rice waters to determine attainment of the standard. This is important both for assessment and identifying impaired waters and for developing point source permit limits to ensure compliance with the standard. In this way, a clearer, more effective standard will also benefit those concerned about the effective protection of wild rice waters.[115]

76. The tribal representatives and the WaterLegacy and other environmental organizations disagreed strongly with the exclusion of water bodies where wild rice is an existing use under the CWA as demonstrated by their inclusion on the 1854 Treaty list and the Minnesota Department of Natural Resources' (MDNR) 2008 list of Minnesota wild rice waters.[116] While not identifying specific reasons for excluding individual water bodies, the Agency acknowledges that it excluded from the proposed rule some water bodies where wild rice has been an existing use.[117]

77. The Administrative Law Judge concludes that because the proposed rule listing wild rice waters is not in compliance with the CWA it will not improve the permitting process by providing certainty as to the water bodies which are identified. Therefore, the proposed rule will not provide the benefit of clarity regarding identification of wild rice waters to WTTP owners and operators.

78. Because the Agency has not sampled the affected waters before proposing the rules, it cannot state what the standard will be for any given discharger, or whether that discharger's effluent will exceed a new standard, and what treatment may be needed to meet the standard, once it is ascertained.[118]

79. Regulated parties predict extremely large costs for wastewater sulfate treatment and express frustration at the lack of specific information which would allow them to accurately predict and plan for water treatment requirements or variance requests.[119]

80. The Administrative Law Judge concludes that the Agency's decision to promulgate this rule without defining a standard applicable to each regulated wild rice water undermines many of the potential benefits the rule could provide to WWTP owners and operators, including improvements in their ability to plan, certainty about regulated waters, and efficiency in the regulated environment.

81. The Administrative Law Judge concludes that the proposed rule may continue to give rise to litigation regarding the identification of wild rice waters subject to the sulfate standard. In addition, the rule as proposed is more likely to give rise to litigation

[115] *Id.*
[116] Comments from 1854 Treaty Authority (filed Nov. 21, 2017); Comments from WaterLegacy (filed Nov. 22, 2017).
[117] Ex D at 58.
[118] *Id*. at 145-149, 165, 182-186.
[119] See, e.g., Exs. 1009, 1029, U.S. Steel Corporation comments (filed Nov. 22, 2017); Comments from Hibbing Chamber of Commerce (filed Nov. 2, 2017); Comments from Alexandria Lake Area Sanitary District (filed Nov. 20, 2017).

regarding the standard itself.[120] Therefore, the Administrative Law Judge concludes that the Agency incorrectly determined that the proposed rule will lead to less litigation concerning the water quality standards for wild rice waters.

82. The Administrative Law Judge finds that the Agency performed an analysis of classes of persons who probably will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule as required by Minn. Stat. § 14.131(1). However, the Administrative Law Judge finds that the Agency's determinations as a result of that analysis are not supported by the record.

(2) The probable costs to the Agency and to any other agency of the implementation and enforcement of the proposed rule and any anticipated effect on state revenues.

83. The MPCA implements water quality standards primarily through permitting and assessment. The Agency states that it will continue its activities related to permit applications, variance requests, assessments, impaired water identification, and compliance enforcement using the revised standard instead of the previous standard.[121]

84. The MPCA predicts that it will incur the following additional costs if the proposed rules are adopted:

a. Updating the list of wild rice waters (data gathering and rulemaking);

b. Conducting sediment and surface water sampling and analysis;

c. Processing permit applications;

d. Reviewing variance requests; and

e. Responding to possible litigation.[122]

85. In this rulemaking, the Agency is proposing to identify approximately 1,300 waters as wild rice waters. While the Agency expects that these waters make up most of the wild rice waters in Minnesota, it expects it will be need to amend the rule within three years to add newly identified wild rice waters.[123]

86. The MPCA presumes that it will be able to gather information leading to the identification of additional wild rice waters through its existing triennial standards review process and its routine water assessment activities. Therefore, the MPCA does not expect to incur additional costs to obtain wild rice information.[124]

[120] *See* discussion in this Report at 55-58.
[121] Ex. D SONAR at 152.
[122] Ex. D at 152-153.
[123] Ex. D at 153.
[124] *Id.*

87. The MPCA estimates the cost of a rulemaking including a hearing in three years will be approximately $129,000. The Agency projects that future amendments may not be controversial and may either be adopted without the need for a hearing, making them less costly, or may be combined with other rulemaking projects at no additional cost.[125]

88. Another cost of implementing the proposed rule will be calculating the new sulfate standard pursuant to the proposed equation-based standard or the alternative standard at each of the approximately 1,300 identified regulated wild rice waters. The MPCA plans to conduct analyses of the sediment of wild rice waters as part of its permitting process for new or expanding discharge sources, and its regular 10-year cycle of intensive watershed monitoring. The MPCA plans to initially focus its efforts to calculate the sulfate standard on wild rice waters associated with existing permitted dischargers.[126]

89. According to the MPCA, between 1,050 and 1,100 of the wild rice waters identified in the proposed rule are not currently impacted by a discharge, leaving approximately 200-250 waters for the MPCA to prioritize. The MPCA's plan to collect and sample the sediment, in order to calculate the standard under the proposed rule, is spelled out in the SONAR but not in the rule:

> [D]uring the existing process of preparation for each year's lake and stream monitoring, the MPCA will review how many wild rice waters are in the watershed, and the resources to collect and sample sediment. Waters to be sampled, if there are more than resources allow, will be prioritized based on factors such as the distance from dischargers, type of discharger, and timeline for permit reissuance.[127]

90. Using procedures for collection and analysis of the sediment according to the methods prescribed in its document entitled "Sampling and Analytical Methods for Wild Rice Waters,"[128] the MPCA determined that an average cost to conduct the necessary sampling analysis of a wild rice water in order to calculate the numeric sulfate standard will be approximately $1,200 per regulated wild rice water, including laboratory services.[129]

91. The MPCA separately calculated that the costs for porewater sampling and analysis to establish an alternate sulfate standard will be approximately $1,050 per

---

[125] *Id.*

[126] As stated above, the MPCA expects that, for new or expanded discharge sites, the permittee will be responsible for the cost of characterizing sediment total extractable iron and sediment total organic carbon. Ex. D at 154. This expectation is not stated in the rule.

[127] Ex. D at 154.

[128] The MPCA incorporated the Sampling and Analytical Methods for Wild Rice Waters by reference into the proposed rule. Ex. C. at lines 9.8-9.12 (part 7050.0224, subp. 5, E). However, as discussed later in this Report, the MPCA's December 1, 2017 Rebuttal comments include a proposal to allow people to use methods consistent with its methods, rather than strictly conforming to the methods as written. In addition, the MPCA mentions that it may make changes to the Sampling and Analytical Methods document. MPCA Rebuttal at 6-7.

[129] Ex. D at 154.

regulated wild rice water, including laboratory analysis of 10 porewater samples. For the alternate standard, the $1,050 is in addition to the initial $1,200 for calculating the numeric sulfate standard, resulting in a total of $2,250.[130]

92. The MPCA was unable to estimate the costs for establishing a site-specific standard, except to state that they will be highly variable:

> In addition to the cost of sediment sampling, and possibly porewater sampling, there will be other costs unique to the situation. It is likely that more extensive sampling and analysis will be needed and additional costs will be incurred to determine the factors affecting the wild rice beneficial use in that water body.[131]

93. The MPCA predicts that, while the complexity of the proposed wild rice sulfate standard will require increased staff time and costs to review permit applications, that increase will be balanced by a decrease in time required to resolve questions about whether the sulfate standard applies to a particular receiving water. Only those waters listed as wild rice waters in the proposed rule will be subject to the rule's sulfate standard. The MPCA states that the determination of "whether a water is a 'water used for production of wild rice' has been a significant obstacle to efficiently applying the existing sulfate standard, requiring time from multiple staff to make a determination."[132]

94. Because such determinations will no longer be required under the proposed rule, the MPCA anticipates that the proposed rule will not result in significant changes to the Agency's current administrative costs to review permit applications.[133]

95. Similarly, the Agency states it does not believe that it will incur significant increases in costs to process variance requests as a result of the proposed rule. The Agency acknowledges that a revised standard will likely result in requests for variances from the new standard, but states "it is difficult to predict how many, when they will be received, and the degree of complexity of those requests."[134] Nonetheless, the MPCA concludes that, as with permitting costs, it "does not expect that the costs associated with increased variance reviews will exceed the costs associated with the complicated and time consuming process required to implement the current rules."[135]

96. The MPCA recognizes that the portion of the proposed rule allowing for an exemption from the fees for municipal WWTPs seeking a variance from a wild rice standard or effluent limit will entail a cost to the MPCA.[136] The MPCA forecasts that the fee waiver will not have a significant impact on its resources because it is developing a streamlined variance application and review process specifically for the sulfate standard.

---

[130] *Id*. at 154-155.
[131] *Id*. at 154.
[132] *Id*. at 155.
[133] *Id.*
[134] Ex. D at 156.
[135] *Id.*
[136] *Id.* Ex. C. at 67.20-67.21 (proposed rule 7053.0406, subp. 2, C).

The Agency expects that the streamlined process will result in a reduced level of staff effort required to review applications for variances from the proposed sulfate standards.[137]

97. The Agency stated frequently during public hearings that it expects WWTPs that are required to meet higher sulfate standards to apply for variances from those standards.[138] The cost analysis does not reflect an anticipated increase in variance requests, or a discussion of whether the Agency expects variance requests to increase as a result of expected higher standards for some dischargers under the proposed rules.

98. The MPCA anticipates litigation costs regardless of whether the proposed rules are adopted. It is not able to estimate what the costs will be, but surmises that the costs will be higher if the new standard is not adopted than if it is adopted. This is based on the MPCA's assumption that legal challenges under the existing standard will have to do with the identification of waters used for the production of wild rice, and that legal challenges under the proposed standard will be to permits issued under the revised standard.[139]

99. The MPCA does not include in its litigation estimate any possible challenges from one or more of the many groups that have vigorously opposed this rule. Those groups include Native American communities, environmental groups, mining companies, power companies, municipal WWTPs, and a variety of governmental entities. The Administrative Law Judge concludes the MPCA may have underestimated litigation costs that could follow if the rule is adopted.

100. Explaining that other state agencies incur costs if they have permitted projects or operations required to comply with water quality standards, the MPCA states that other agencies, especially the Minnesota Department of Transportation (MnDOT), and the Minnesota Department of Natural Resources (MDNR) may incur additional costs under the proposed rules. MnDOT operates highway rest areas and MDNR operates campgrounds and fish hatcheries, all of which generate wastewater. The wastewater treatment systems associated with these activities are often subsurface sewage treatment systems that do not discharge. However, the MPCA has determined that eight MnDOT or MDNR facilities operate WWTPs that discharge to proposed wild rice waters.[140]

101. Another situation that could result in costs to MnDOT will arise if MnDOT conducts road construction in an area of high sulfate rock, resulting in increased sulfate storm water runoff to nearby regulated wild rice waters. The MPCA explains that state agency costs "in these situations will vary based on the treatment facility and receiving water characteristics and may be incurred regardless of the adoption of the proposed

[137] Ex. D at 109, 156.
[138] *See* Tr. at 51-54 (Oct. 23, 2017); Tr. at 47-48 (Oct. 24, 2017); Tr. at 59-60 (Oct. 30, 2017).
[139] Ex. D at 156.
[140] Ex. D at 157.

rules."[141] The MPCA concludes that it is unable to provide a reasonable estimate of possible costs without considering the site-specific factors.[142]

102. The MPCA predicts that the proposed sulfate rule's greater protection for regulated wild rice will increase the value provided by the wild rice, including tourism dollars related to increased wild rice harvesting and related activities, and sales tax on more abundant marketed wild rice. The MPCA predicts that if the proposed rules are not adopted these benefits to state revenue will be lost.[143]

103. The MPCA theorizes that the proposed rule, if adopted, may inhibit industrial growth or expansion due to the added costs of complying with more stringent sulfate standards. This could result in lost jobs and reduced state tax revenue. Conversely, the MPCA posits that, to the extent that the new standard requires less treatment of wastewater, there could be additional investment in new and existing industrial facilities, with added jobs and financial benefits to the state. The MPCA also points out that where additional treatment is required at existing facilities, the costs of new treatment systems, and the installation and operation of those systems, could provide additional employment, increased income, and equipment purchases with resulting increases in income and sales tax revenue for the state.[144]

104. Ultimately, the Agency concludes that, while the proposed rule change will likely affect state revenues, it cannot predict the direction or magnitude of the impact on revenues.[145]

105. The Administrative Law Judge concludes that the Agency performed the analysis required regarding probable costs to itself, and to any other agency, of the implementation and enforcement of the proposed rule and any anticipated effect on state revenues to the extent that it was able to do so with incomplete information.

(3) The determination of whether there are less costly methods or less intrusive methods for achieving the purpose of the proposed rule.

106. The Agency combined its response to this statutory requirement with its response to statutory requirement (4) below.

[141] *Id.*
[142] *Id.*
[143] *Id.*
[144] Ex. D at 157-158.
[145] *Id*. at 158.

(4) A description of any alternative methods for achieving the purpose of the proposed rule that were seriously considered by the agency and the reasons why they were rejected in favor of the proposed rule.

107. The MPCA notes that the determination of whether there are less costly or less intrusive methods to protect wild rice waters depends on what level of protection is desired. A less protective sulfate standard may result in lower treatment costs for some dischargers, but may be less beneficial for the groups who value wild rice. Similarly, a more narrow definition of what constitutes a wild rice water may be deemed a benefit to some, but overly restrictive to others.[146]

108. The MPCA considered a number of possible alternatives to the proposed rule including: (1) adopting a narrative standard; (2) adopting a higher protective sulfide value; (3) maintaining the existing 10 mg/L sulfate standard or adopting a different fixed numeric standard instead of the proposed equation; and (4) adopting an alternative equation standard other than the proposed equation.[147]

109. After reviewing the possible alternatives, the MPCA concluded that its proposed equation standard, which tailors the sulfate standard to the naturally variable environmental conditions, represents the best current scientific understanding of the effect of sulfate and sulfide on wild rice and provides the most precise protection of wild rice water's beneficial use.[148] The MPCA concluded that a narrative standard would not represent a significant improvement over the current fixed standard and could not be effectively implemented through permitting or assessment.[149] The MPCA also maintains that fixed numeric standards ignore current scientific information correlating wild rice viability with sulfide resulting from the interaction of sulfate with other compounds in the sediment.[150] According to the MPCA, the most accurate fixed standard is still much less accurate than the proposed equation-based standard.[151] The MPCA states that it considered other equation standards but ultimately concluded that its proposed equation standard is appreciably more accurate (misclassification rate of 16 to 19 percent) than the other modeling it analyzed.[152]

110. The MPCA also considered applying the current 10 mg/L standard or adopting an interim standard for all wild rice waters where no equation-based sulfate value has been calculated. Commenters expressed concern that it will take the MPCA many years to calculate a standard for the 1,300 wild rice waters identified in this rulemaking.[153] The MPCA acknowledges the validity of the concern about the length of time it will take to characterize 1,300 wild rice waters it proposes to list in the rule.

[146] Ex. D at 159.
[147] *Id*. at 160-161.
[148] Ex. D at 159-163; MPCA's Response to Public Comments Attachment 1 at 3 (Nov. 22, 2017).
[149] Ex. D at 160.
[150] *Id*. at 161.
[151] *Id*.
[152] *Id*.
[153] Ex. D at 162.

However, it maintains it plans to prioritize those wild rice waters that receive or may receive a discharge from a permitted facility.[154] According to the MPCA, approximately 250-350 of the identified wild rice waters receive a discharge and it has developed an implementation plan to prioritize the sampling needed to calculate a numeric sulfate standard for those waters.[155]

111. The MPCA considered applying a "no net increase" in sulfate discharges to wild rice waters until a numeric standard is determined. But this proved to be difficult to create in rule and the Agency concluded it was unnecessary as no new discharges will be permitted without a sulfate standard being first calculated.[156]

112. The Agency also considered a number of alternatives to its criteria for identifying wild rice waters. The MPCA proposes to identify a wild rice water using the unique numeric identification it assigns to streams, rivers, and lakes.[157] This numeric identification is referred to as a water ID or WID.[158] Commenters expressed concern that identifying an entire large body of water as a wild rice water would not be reasonable if wild rice was only located in a small portion of the water body.[159] In response to these concerns, the MPCA considered identifying as a wild rice water only the specific area within a water where wild rice beds are found.[160] The MPCA concluded, however, that such an approach would be unreasonable because: (1) it would create a completely new system to identify a water, and (2) wild rice beds are known to move within a stream reach from one year to the next depending on hydrology and other factors.[161] According to the MPCA, a new form of identification would be inconsistent with the MPCA's many other data collection uses and would result in information that could not be effectively or efficiently compared and shared.[162]

113. The MPCA also received comments that its process of identifying wild rice waters was based on consideration of either too little or too much wild rice.[163] The MPCA maintains that the process it uses to identify wild rice waters reasonably characterizes them in regard to both the beneficial use of a Class 4D water (use of the grain as a food source by wildlife and humans) and the statutory mandate to consider the acreage and density of wild rice.[164] Under the proposed rules, the Commissioner is required to consider information about wild rice waters in the regular triennial water quality standards review process, which includes a public notice and comment period.[165]

---

[154] *Id.*
[155] *Id.*
[156] *Id.*
[157] Ex. D at 40.
[158] *Id*. at 39.
[159] *Id*. at 162.
[160] *Id*. at 40.
[161] *Id*. at 40,162.
[162] *Id*. at 40-41.
[163] *Id*. at 162.
[164] *Id*.
[165] Ex. D at 163.

114. The MPCA considered alternatives for future identification of wild rice waters based on water bodies meeting specific stem densities or observation of wild rice over several growing seasons.[166] Ultimately, the MPCA decided that a specific threshold for determining wild rice waters was too limiting.[167] The MPCA maintains it is better to evaluate adding water bodies based on their unique factors as they relate to the beneficial use, which is the process the MPCA employed to identify the 1,300 wild rice waters being proposed.[168] The MPCA notes that, because each addition to the list of wild rice waters will be required to go through rulemaking, the specific factors demonstrating the beneficial use necessary to establish the water as a wild rice water will be considered in the SONAR and can be evaluated in that rulemaking.[169]

115. The MPCA also considered alternatives to the application of the proposed equation-based sulfate standard.[170] The MPCA contemplated applying averaging periods other than the annual average proposed. Some commenters suggested that a monthly average would be more protective of wild rice during critical growth periods.[171] Ultimately, the MPCA rejected shorter averaging periods. The MPCA maintains that its research supports the conclusion that porewater sulfide is a function of long-term (at least one year) average concentrations of sulfate, rather than short-term changes in surface water sulfate.[172]

116. The MPCA also considered alternatives for sediment sampling and analytical results in the equation-based standard.[173] The proposed rule establishes how many sediment samples must be taken and analyzed for iron and carbon and how the resulting values are used in the equation.[174] The MPCA proposes that the sediment of a wild rice water can be adequately characterized by a composite of five sediment cores from each of five different areas within the water body.[175] The MPCA proposes to designate the lowest of the five calculated sulfate concentrations as the sulfate standard for that wild rice water.[176]

117. Some commenters suggested taking the average value of the five sulfate concentrations, rather than the lowest.[177] Others suggested calculating the 10th or 20th percentile concentration from the data.[178] The MPCA considered these alternatives and concluded that taking the lower value would be the best approach. The MPCA contends that an average value would not be protective of the entire wild rice population and is susceptible to biasing high if the analysis yields one unusually high value that is

---

[166] *Id*.
[167] *Id*.
[168] *Id*.
[169] *Id*.
[170] Ex. D at 164.
[171] *Id*.
[172] *Id*.
[173] *Id.*
[174] *Id*.
[175] *Id*.
[176] Ex. D at 165.
[177] *Id*.
[178] *Id.*

incorporated into the average.[179] Using the lowest value is also easier to implement than calculating a percentile value. The MPCA maintains that using the lowest value from the set of calculated sulfate concentrations is a reasonable method to produce a protective sulfate concentration for a wild rice water.[180]

118. Both Representative Rob Ecklund (Minnesota House District 3A) and Representative Matt Bliss (Minnesota House District 5A) noted that the MPCA had received $180,000 from the Legislative Citizens Commission on Minnesota Resources to analyze wastewater treatment alternatives to inform the development and analysis of wild rice, sulfate, and other water quality standards.[181] That analysis will be completed in May of 2018.[182] Both Representatives Ecklund and Bliss were critical of the MPCA for proposing the new sulfate standard before the analysis of wastewater treatment alternatives was completed. Representative Bliss stated that the legislature moved the deadline for completing this rulemaking to January of 2019 specifically so the MPCA could use the results of the study to further inform its new wild rice standard.[183]

119. The Iron Range Legislative Delegation[184] commented in a joint letter pointing out that, during the 2017 Legislative Session, the legislature provided the MPCA with an additional year, until January, 2019, to adopt a new wild rice water quality standard. The letter states that "[t]he proposed rules are premature . . ." because the sulfate treatment cost analysis is not complete. The letter also expressed concerns about the relative untested nature of the science underlying the proposed standard, and supported eliminating the 10 mg/L standard.[185]

120. WaterLegacy opposes the MPCA's proposed equation standard.[186] It contends that the MPCA's assumption that iron protects wild rice from the harmful effects of sulfate loading is premature and inconsistent with both laboratory experiments and field experience.[187] According to WaterLegacy, the proposed equation standard will neither provide effective protection of wild rice nor clarify implementation.[188]

121. WaterLegacy also opposes the MPCA's proposed identification of wild rice waters.[189] According to WaterLegacy, the MPCA's proposal to restrict the water bodies in which any wild rice sulfate standard would apply is arbitrary and would remove a

---

[179] *Id*.
[180] *Id*.
[181] Tr. at 87 (Oct. 25, 2017); Tr. at 69-72 (Oct. 30, 2017); Ex. 1015.
[182] Ex. 1015.
[183] *Id.*
[184] Letter from Iron Range Legislative Delegation (Senators David Tomassoni, Thomas Bakk, and Justin Eichorn, and Representatives Jason Metsa, Rob Ecklund, Julie Sandstede, Dale Lueck, and Sandy Layman) (Nov. 2, 2017).
[185] *Id.* at 1.
[186] WaterLegacy comments (filed Nov. 22, 2017).
[187] *Id*. at 18.
[188] *Id*.
[189] WaterLegacy comments (filed Nov. 22, 2017) at 30.

designated use and de-list wild rice waters identified by Minnesota state agencies, including waters downstream of existing and potential mining discharge.[190]

122. Similarly, both the Friends of the Boundary Waters and the Fond du Lac Band complained that the MPCA was removing a designated use when it failed to identify certain waters as wild rice waters.[191] The comments referred to all waters listed in Appendix B of the MDNR's 2008 *Natural Wild Rice in Minnesota* report and the 1854 Treaty Authority's 2016 and 2017 lists of wild rice waters.[192]

123. The MPCA maintains that not all surface waters in the state are class 4A waters used for the production of wild rice. The MPCA points out that the existing sulfate standard is applicable only to "water used in the production of wild rice" and that this modifying language clearly demonstrates that not all Class 4A waters are wild rice waters.[193] The MPCA also contends that the presence of a waterbody in the MDNR's 2008 inventory[194] is not sufficient to demonstrate beneficial use.[195]

124. Other commenters, like Mining Minnesota, complained that the MPCA was over-designating waters as wild rice waters.[196]

125. The Administrative Law Judge concludes that the MPCA provided the analysis required by Minn. Stat. § 14.131(4).

(5) The probable costs of complying with the proposed rules, including the portion of the total costs that will be borne by identifiable categories of affected parties, such as separate classes of governmental units, businesses, or individuals.

126. The MPCA states that, because many of the variables affecting costs cannot be determined until the standard is actually implemented at a specific location it has limited information about the probable costs of complying with the proposed rules.[197]

127. The MPCA acknowledges that if a facility needs to treat its wastewater discharge to comply with the revised water quality standard, the design, construction, installation, and operation of the treatment system will be a major cost.[198]

---

[190] *Id*.
[191] *See* MPCA's Rebuttal Response to Public Comments Submitted during the Post-Hearing Public Comment Period at 12 (filed Dec. 1, 2017).
[192] *Id*.
[193] *Id*.
[194] MDNR's 2008 *Natural Wild Rice in Minnesota – A Wild Rice Report Study Report to the Legislature* (2008), Appendix B.
[195] *Id*.
[196] *See* Comments from Mining Minnesota (filed Nov. 22, 2017) and MPCA's Rebuttal Response to Public Comments Submitted during the Post-Hearing Public Comment Period at 13 (filed Dec. 1, 2017).
[197] *Id*.
[198] Ex. D at 166.

128. In addition to municipal WWTPs, the MPCA permits nearly 520 industrial wastewater discharges under its NPDES/SDS permitting program.[199] The MPCA permits a variety of types of industrial wastewater discharge, including discharges from non-contact cooling water systems, ethanol producers, manufacturing facilities, food processors, paper mills, and power plants. Industrial wastewater dischargers also include sand/gravel/stone mining, peat mining, and taconite mining operations.[200]

129. The MPCA acknowledges that treatment for sulfate can be extremely expensive.[201] According to the MPCA, reverse osmosis (RO) membrane filtration is the most practical sulfate treatment technology currently available for removing sulfate from wastewater discharges.[202] However, the MPCA states that there are significant design uncertainties that make it difficult to estimate costs for RO treatment of sulfate.[203] According to the MPCA, a design engineer would need to perform extensive site-specific analysis and engineering testing in order to get the correct parameters to design and cost a full-scale plant capable of removing sulfate and meeting all potential permit limits.[204] The MPCA states that, if bench or pilot testing of operations is required to obtain design parameters, it will add well over a year to the full-scale plant design time and hundreds of thousands of dollars to the design costs.[205]

130. The MPCA states that treating municipal wastewater using RO followed by evaporation and crystallization is likely to have high capital costs associated with sulfate-polishing costs that are above the costs of conventional WWTPs.[206] There will also be high operation and maintenance costs associated with concentrate management.[207] Energy and disposal costs are the primary drivers of concentrate management operations and maintenance costs.[208] The MPCA notes that RO is an energy intensive process but evaporation with crystallization is much more so.[209] In addition, the crystalized salts must be disposed of at a landfill and the tipping and hauling fees will add cost.[210] The MPCA cites to the Barr report that found five to ten percent of operations and maintenance costs were associated with disposal fees.[211]

131. RO membrane treatment with evaporation and crystallization also has significant secondary costs such as high carbon emissions, advanced operator training requirements, and an increased need for operator labor hours.[212] According to the MPCA, when evaporators and crystalizers are operated in conjunction with a RO plant,

[199] Ex. D at 169.
[200] *Id*.
[201] Ex. D at 182.
[202] *Id*. at 181-182.
[203] *Id*. at 181.
[204] *Id.*
[205] *Id.*
[206] Ex. D at 183.
[207] *Id*.
[208] *Id*.
[209] *Id*.
[210] Ex. D at 184.
[211] *Id*. citing SONAR Ex. 42.
[212] Ex. D at 184.

four to eight additional labor hours per eight-hour shift are normally required.[213] The MPCA acknowledges that the combination of these secondary considerations could prove prohibitively burdensome for affected communities.[214]

132. The MPCA notes that, with respect to municipal dischargers, there are some state programs available to mitigate the cost of activities necessary to comply with the proposed sulfate standard.[215]

133. With respect to taconite mine dischargers, the MPCA states that it is impossible to estimate the costs for treatment of taconite mine wastewater with a high degree of certainty as it will vary depending on the volume, concentration, level of treatment, and process used.[216] A mining company's 2012 estimate of costs associated with mining wastewater treatment to achieve the current wild rice sulfate standard of 10 mg/L identified total capital costs at over $20 million and annual operation and maintenance costs at nearly $3 million.[217]

134. The MPCA notes that the identification of 1,300 wild rice waters in the proposed rule will expand the number of permittees required to address sulfate treatment in their discharges.[218] This requirement will likely increase the cost of preparing a permit application for these permittees and the fees associated with the review of the application.[219]

135. In addition, the MPCA includes approximately $1,200 per body of wild rice water for taking samples to characterize the sediment and collecting and analyzing porewater for sulfide in order to develop the numeric standard.[220]

136. The record indicates that some industries and cities will incur substantial costs in complying with the proposed rules.

137. Many commenters expressed concern about the potential significant costs to municipal and industrial dischargers associated with achieving a revised sulfate standard. For example, the Duluth Area Chamber of Commerce indicated its opposition to the proposed rule revisions citing the prohibitively expensive treatment options.[221] Likewise, Nancy McReady with Conservationists with Common Sense (CWCS) predicted the proposed rules could bankrupt cities and businesses and result in large increases to residential sewer and water bills.[222]

---

213 *Id.*
214 *Id.*
215 Ex. D at 188.
216 *Id*. at 184.
217 Ex. D at 185, Table 18.
218 Ex. D at 186.
219 *Id*.
220 *Id.*
221 Rulemaking eComment from David Ross (filed Nov. 6, 2017).
222 Rulemaking eComment from Nancy McReady (filed Nov. 4, 2017).

138. State Representative Mike Sundin (Minnesota House District 11A) echoed the Western Lake Superior Sanitary District's concern that implementation of RO treatment could require a $500 million investment, resulting in residential sewer bills increasing upwards of five times.[223] Gerard Bettendorf, mayor of the city of Foley, commented that the proposed rule could have a devastating economic impact on Foley and other cities throughout Minnesota.[224]

139. In its Response to Public Comments, the MPCA states that the conclusions made by some commenters regarding the extensive costs of implementing the proposed standard are premature.[225] The MPCA asserts that it intends to make use of available tools and "pursue creative strategies" to avoid impacts to municipalities and industries that would affect jobs, affordability of municipal services, and economic vitality.[226] According to the MPCA, economic and environmental health are not mutually exclusive.[227]

140. The Administrative Law Judge concludes that the MPCA has attempted to engage in the analysis required by Minn. Stat. § 14.131 but that the record does not support an adequate analysis.

(6) The probable costs or consequences of not adopting the proposed rule, including those costs borne by individual categories of affected parties, such as separate classes of governmental units, businesses, or individuals.

141. The MPCA asserts that there are two primary problems with the existing standard that would not be resolved if the proposed revisions are not adopted.[228] The first problem is the difficulty of determining how the standard applies and defining the waters to which the existing standard applies.[229] The existing standard has no clear information about duration and frequency and implementing the current standard requires a detailed case-by-case analysis to determine whether the wild rice beneficial use exists.[230]

142. According to the MPCA, failing to adopt the proposed revisions will result in continued uncertainty and the attendant need for case-by-case interpretation as to whether or not a water used for the production of wild rice is downstream of a discharge.[231] This confusion results in delays in the permitting process and increased costs of permit design and review.[232]

---

223 Rulemaking eComment from Rep. Mike Sundin (filed Nov. 21, 2017).
224 Ex. 1029.
225 MPCA's Response to Public Comments at 11 (filed Nov. 22, 2017).
226 *Id*.
227 *Id*.
228 Ex. D at 189.
229 *Id*.
230 *Id*.
231 *Id*.
232 *Id*.

143. The MPCA states that the second problem is the existing numeric sulfate standard's lack of accuracy in protecting wild rice beneficial use.[233] The MPCA maintains that current scientific understanding of sulfate toxicity means that the existing standard may be, depending on the circumstances, either over-protective or under-protective.[234] By retaining the existing standard and not adopting the proposed equation-based approach, the MPCA believes there will be higher misclassification rates and less accurate and effective protection of wild rice.[235]

144. The MPCA also contends that failing to adopt the proposed equation-based standard will result in less effective protection of wild rice, negatively impacting the economic, ecological, and cultural benefits provided by wild rice waters.[236]

145. Many commenters urged the MPCA to not adopt the proposed rule and to instead retain the existing 10 mg/L standard.[237] These commenters noted that keeping the existing 10 mg/L standard would be easier to enforce and more cost effective than trying to implement the proposed equation.[238]

146. Many commenters also agreed that the sulfate standard should be enforced year-round as proposed in the rule, rather than just during the wild rice growing season as required by the existing rule.[239]

147. The Administrative Law Judge concludes that the Agency conducted the analysis required by Minn. Stat. § 14.131(6).

(7) An assessment of any differences between the proposed rules and existing federal regulation and a specific analysis of the need for and reasonableness of each difference.

148. The MPCA states that there is no federal counterpart to the equation-based sulfate standard for wild rice waters or the process for identifying wild rice waters.[240] Therefore, it is not possible to assess any differences between the proposed rule revisions and existing federal regulations. The MPCA maintains, however, that the proposed revisions are consistent with the intent of the CWA as well as reasonable interpretations of federal guidance and the federal expectation that states develop state-specific water quality standards.[241]

---

[233] Ex. D at 190.
[234] *Id*.
[235] *Id*.
[236] Ex. D at 193.
[237] *See, e.g.,* Rulemaking eComment from Kris Wegerson (filed Nov. 21, 2017).
[238] *Id*.
[239] Ex. 1020.
[240] Ex. D at 197.
[241] *Id.*

149. No other state has established a beneficial use class for wild rice or established a sulfate standard applicable to wild rice.[242]

150. The Grand Portage and Fond du Lac Bands of the Minnesota Chippewa Tribe have each established a water quality standard for wild rice.[243] The water quality standards for both tribes generally define wild rice areas as bodies of water that "presently has or historically had the potential to sustain the growth of wild rice." Both also establish a numeric sulfate standard of 10 mg/L.[244]

151. The MPCA's current wild rice sulfate standard and proposed revisions to the wild rice sulfate standard differ from the tribal standards as follows:

a. The proposed revisions clarify the existing beneficial use to "the use of the grain of wild rice as a food source for wildlife and humans."

b. The proposed rule revisions apply the standard to identified wild rice waters based on supporting the beneficial use. The tribal standards apply the standards more broadly to waters on the basis of past, present, or future potential to sustain growth of wild rice.

c. The existing state rules apply the sulfate standard "during periods when the rice may be susceptible to damage by high sulfate levels." The proposed revisions apply the sulfate standard as an annual average that can be exceeded once in ten years. The Grand Portage tribal standards do not specify when the standard applies. The Fond du Lac sulfate standard is an instantaneous maximum limit.

d. The proposed revisions to the state sulfate standard establish the protective sulfate value through an equation rather than a fixed 10 mg/L standard. Both tribal sulfate standards are fixed numeric standards of 10mg/L.[245]

152. The Administrative Law Judge finds that the Agency failed to discuss the definition of "existing use" under the CWA, and how its decision to exclude certain waters previously identified as wild rice waters corresponds with the CWA's definition of "existing use." Therefore, the Administrative Law Judge determines that the Agency has not met its obligation under Minn. Stat. § 14.131(7) to assess the differences between the proposed rule and federal regulations and the reasonableness of each difference.

153. The Administrative Law Judge notes that the Agency failed to address the potential conflict between the 10 mg/L sulfate standard on the Fond du Lac and Grand Portage Indian Reservations and the proposed equation-based sulfate standard. While this failure may not technically violate the requirements of Minn. Stat. § 116.07, subd. 2(f) (2016), the Administrative Law Judge views this as a violation of the underlying purpose of this statutory requirement.

[242] *Id.*
[243] Id.; SONAR Exs. 45 and 46.
[244] Ex. D at 197; SONAR Exs. 45 and 46.
[245] Ex. D at 197-198; SONAR Exs. 45 and 46.

154. The Administrative Law Judge finds that the Agency has met its special obligations under Minn. Stat. § 116.07, subd. 2(f), to assess the impact of the proposed rule and the approaches taken by neighboring states.

(8) Assessment of the cumulative effect of the rule with other federal and state regulations related to the specific purpose of the rule.

155. "Cumulative effect" means the incremental impact of the proposed rule in addition to other rules, regardless of what state or federal agency has adopted the other rules. Cumulative effects can result from individually minor, but collectively significant, rules adopted over a period of time.[246]

156. As noted above, there is no federal counterpart to the wild rice sulfate standard. Therefore, there is no cumulative effect to assess with respect to other federal regulations.

157. The MPCA maintains that, because it is replacing the existing water quality standard and not proposing an additional standard, the revised standard does not create cumulative impacts.[247] According to the MPCA, an assessment of whether a regulation has a cumulative effect is "whether the proposed revisions duplicate an existing rule that achieves the same purpose."[248]

158. The Administrative Law Judge disagrees that this is the proper analysis for the question of cumulative effect. The Administrative Law Judge looks first to the plain language of the word "cumulative." The first dictionary definition of "cumulative" is "increasing by successive additions."[249] "Duplicative," in contrast, means "consisting of or existing in two corresponding or identical parts or examples."[250]

159. The legislative history of Minn. Stat. § 14.131(8) demonstrates that Minnesota legislators were not concerned with agencies promulgating rules that were duplicative. They were concerned with regulations that have an increasing effect on regulated parties. At a hearing before the Senate Committee on Finance when the "cumulative effect" language was under consideration, the MPCA's legislative director spoke to the committee:[251]

> One example [is] our agency deals with hazardous waste, medical waste. As we deal on the disposal side of it, once it gets to a landfill. However, up the chain of control of that issue that is handled by a number of additional

[246] Minn. Stat. § 14.131.
[247] Ex. D at 199.
[248] *Id.*
[249] Merriam-Webster online dictionary, https://www.merriam-webster.com/dictionary/cumulative.
[250] Merriam-Webster online dictionary, https://www.merriam-webster.com/dictionary/duplicative.
[251] Testimony of Kirk Koudelka, legislative director, MPCA before Senate Comm. On Finance, S.F. 1922 (Mar. 29, 2012).

agencies that could have an impact on that. Us then having to do a cumulative effect on how a hospital handles their medical waste or how MnDOT regulates how they transport medical waste before it gets to the landfill.

160. In response to the Committee Chair Robling's concern that the MPCA was not considering the cumulative effect of regulations, and that legislators were hearing from constituents that the cumulative effect was overwhelming,[252] Mr. Koudelka replied:[253]

> For instance, right now we are working on some mercury rules for facilities and their mercury emissions. We do look at what other requirements are on the federal level on that. . . . . The way this is written, all other rules that affect that waste, through its chain of command, even though we may not personally have any authority over it, would have to be looked at. There is some concern on what that does to the scope from a number of agencies . . . .

161. The Administrative Law Judge finds that the MPCA has not met its obligation to assess the cumulative effect of the rule with other federal and state regulations related to the specific purpose of the proposed rule.

2. Performance-Based Regulation

162. The Administrative Procedure Act[254] also requires an agency to describe how it has considered and implemented the legislative policy supporting performance based regulatory systems. A performance-based rule is one that emphasizes superior achievement in meeting the agency's regulatory objectives and maximum flexibility for the regulated party and the agency in meeting those goals.[255]

163. The Agency asserts that the proposed rules meet the state's objectives for flexible, performance-based standards. It maintains that the existing WQS are a performance-based regulatory system. The WQS identify, using the best-available science, the conditions that must exist in Minnesota's water bodies to support each waters' designated uses. Because the proposed rules do not dictate how a regulated party must achieve the wild rice beneficial use or prescribe how they must operate to ensure compliance with the WQS, the Agency maintains they allow regulated parties maximum flexibility in meeting the standard. The Agency concedes, however, that, in the case of sulfate treatment, there are limited alternatives and options available to meet the standard. Nonetheless, the Agency contends that, by not dictating a single course of action and by allowing for variances, the proposed rules meet the requirement of emphasizing maximum flexibility for the regulated parties.[256]

---

[252] Chair Claire A. Robling, Senate Comm. On Finance, S.F. 1922 (Mar. 29, 2012).
[253] Testimony of Kirk Koudelka, legislative director, MPCA before Senate Comm. On Finance, S.F. 1922 (Mar. 29, 2012).
[254] Minn. Stat. § 14.131.
[255] Minn. Stat. § 14.002.
[256] Ex. D at 201.

164. The Administrative Law Judge finds that the Agency has met the requirements set forth in Minn. Stat. § 14.131 for consideration and implementation of the legislative policy supporting performance-based regulatory systems.

3. Consultation with the Commissioner of Minnesota Management and Budget (MMB)

165. By memorandum dated September 7, 2017, Sean Fahnhorst, an Executive Budget Officer with MMB, responded to the MPCA's request to evaluate the fiscal impact and benefit of the proposed rules on local units of government, as required by Minn. Stat. § 14.131.[257] The MPCA estimates that the 62 municipal wastewater treatment plants that discharge into or within 25 miles upstream of identified wild rice waters are most likely to incur major costs to upgrade their treatment processes to comply with these revised standards.[258] The MPCA provided a "preliminary analysis of the costs" in its SONAR and indicated that it expects to complete further analysis of the costs and alternatives of sulfate treatment by May 2018.[259]

166. MMB reviewed the proposed rules and the Agency's SONAR. MMB noted that municipal wastewater treatment plants are generally not designed to remove sulfate and that upgrades to existing facilities will be non-standard and require site-specific analysis and engineering testing. MMB noted further that few options exist for removing sulfate from wastewater, and the methods available can be very expensive. MMB concluded that cost estimates for upgrades are only possible with detailed wastewater treatment plant design information.[260]

167. MMB also noted that the MPCA expects to grant variances to some municipal wastewater treatment facilities, which would exempt them from discharge limits related to this standard if they demonstrate that economic or technological factors prevent their compliance. Local governments would incur administrative costs applying for the variance, but the MPCA proposes to reduce some of these expenses by waiving the variance application fee and assisting municipalities with the application process.[261]

168. Finally, MMB noted that, in terms of fiscal impacts, the proposed rules may benefit some local governments by identifying nearby wild rice waters, clarifying wastewater regulations and standards, and attracting tourists.[262]

169. The purpose of the consultation with MMB required by Minn. Stat. § 14.131 is "to help evaluate the fiscal impact and fiscal benefits of the proposed rule on units of local government." [263] In this case, given the scarcity of information available about the

---

[257] Ex. K3.
[258] *Id.*
[259] *Id.*
[260] *Id*.
[261] Ex. K3.
[262] *Id*.
[263] Minn. Stat. § 14.131.

actual costs and benefits that are likely to accrue to local governments, the MMB memorandum reaches no conclusions regarding the adequacy of the information and analysis provided by the Agency. Nor is MMB provided with enough information to engage in its own evaluation of the fiscal impacts and benefits of the proposed rule on units of local government.

170. The Administrative Law Judge finds that the Agency consulted with MMB as required under Minn. Stat. § 14.131, but failed to provide adequate information to help MMB evaluate the fiscal impacts and benefits of the proposed rule on units of local government.

4. Cost to Small Businesses and Cities under Minn. Stat. § 14.127

171. Minn. Stat. § 14.127 requires the Agency to "determine if the cost of complying with a proposed rule in the first year after the rule takes effect will exceed $25,000 for: (1) any one business that has less than 50 full-time employees; or (2) any one statutory or home rule charter city that has less than ten full-time employees." The Agency must make this determination before the close of the hearing record, and the Administrative Law Judge must review the determination and approve or disapprove it.[264]

172. The Agency concludes that a small business or city within the definition of Minn. Stat. § 14.127 may incur expenses in excess of $25,000 to comply with the proposed rule in the first year after the rule takes effect. However, the Agency believes that such a circumstance is unlikely to occur within a year after the rule takes effect.[265]

173. The Agency discusses the criteria it developed that are necessary to determine which small businesses and cities could potentially be included in an analysis pursuant to Minn. Stat. § 14.127. The criteria identified by the Agency are as follows:

a. The business or city must discharge to a surface water.

b. The surface water receiving the discharge must be a wild rice water or within a certain range of a wild rice water. For purposes of this evaluation, the MPCA selected a range of 25 miles.

c. The discharge must contain sulfate.

d. The affected business must have fewer than 50 full-time employees. Affected cities must have fewer than 10 full time employees.

e. The business or city must need to obtain a new or re-issued permit within the first year after the rules are adopted.

f. The MPCA must have sufficient information available to develop an effluent limit – including sediment data to set the numeric standard

[264] Minn. Stat. § 14.127, subds. 1 and 2.
[265] Ex. D at 202.

for the receiving wild rice water, sulfate levels in the receiving water, and data on sulfate concentrations in the business or city's effluent.

g. The application of the adopted sulfate standard must result in effluent limits that are more stringent.

h. The business or city must incur costs of more than $25,000 in the first year following adoption of the proposed revisions for planning, installation, or operation activities specifically to meet the revised standard.[266]

174. Using these criteria, the Agency calculates that, of the 135 dischargers within 25 miles of a regulated wild rice water, there are approximately 75 small businesses and cities that may be affected by the proposed revisions and currently have permits. Because the MPCA issues permits to dischargers on a five-year schedule, fewer than 75 will be required apply for a permit under the new standard in the first year. Nonetheless, assuming the rule is adopted in mid-2018,[267] the MPCA estimates that more than 60 dischargers will at least begin the process of updating their existing permits in 2018.[268]

175. According to the Agency, permit issuance or renewal involves "setting effluent limits, developing and reviewing plans and specifications, permit notice and approval, and construction activities."[269] In addition, the Agency recognizes that "dischargers may have to make a significant initial investment in planning and preliminary design work in advance of receiving the permit."[270]

176. The Agency explains that the cost driver for dischargers is the implementation of a sulfate effluent limit in a permit, which requires the discharger to take action to either limit the sulfate in its discharge or to request a variance. Before a discharger can be assigned an effluent limit, the MPCA must know the numeric sulfate standard applicable to the receiving wild rice water. In addition, the discharger's sulfate effluent concentrations must be available.[271]

177. The Agency states that a majority of dischargers do not have current effluent monitoring for sulfate. For these dischargers, the Agency estimates that sulfate limits could not be implemented before 2023.[272]

178. According to the Agency, only if a small business or city receives a more stringent effluent limit than was required under the existing standard will it have higher treatment costs than it would have had under the 10 mg/L standard, or incur the costs of applying for a variance.[273] However, a facility will not know whether its effluent limit is

---

[266] Ex. D at 204.
[267] *Id*. at 202.
[268] *Id*. at 206.
[269] *Id.*
[270] *Id.*
[271] *Id*. at 207.
[272] *Id.*
[273] *Id.*

more or less than it would be under the existing standard until the new standard has been set for the receiving wild rice water.[274]

179. The Agency does not explain why it estimates that it will take dischargers five years to monitor their own sulfate discharges.

180. Furthermore, the Agency states that it expects to take up to ten years to sample the 1,300 regulated wild rice waters identified in the proposed rule for the purpose of setting new standards.[275]

181. Nonetheless, for purposes of the rulemaking evaluation, the MPCA assumes that all the identified dischargers will have to either meet more stringent sulfate discharge limits or apply for variances. The cost to treat wastewater to remove sulfate is extremely high. The MPCA recognizes that the most effective treatment option at this time to remove sulfate from wastewater is an RO membrane treatment system.[276] The cost of designing, building and operating an RO system will certainly exceed $25,000. However, the MPCA expects permittees will not incur the full cost of treatment or design/build in the first year after adoption of the proposed rules.[277]

182. The MPCA expects that WWTPs that meet the above criteria may incur costs in the first year after the rules are adopted. Costs could include retaining a contractor or designer to begin the process of evaluating discharge and treatment options, among other items. The WTTP could also begin the process of bench-scale studies and facility design, although the MPCA believes a variance application is more likely. The MPCA notes that the cost of a variance alone could exceed $25,000, especially for an industrial facility for which there is no variance fee waiver in the rule. However, the MPCA does not presume that the cost of a variance for a municipality would necessarily be less than $25,000.[278]

183. The MPCA cannot estimate the cost of these activities "because of the extent of the variables,"[279] but the Agency concludes that such costs will "be significant" and "may exceed $25,000"[280] for some small businesses and cities in the first year after adoption of the proposed revisions.[281]

184. While the MPCA's analysis pursuant to Minn. Stat. § 14.127 discusses the question of whether small businesses and cities will spend more than $25,000 to comply with the proposed rule within one year after the rule is adopted, the statutory language

[274] Ex. D at 207.
[275] Response Cover Memo at 10.
[276] Ex. D at 207.
[277] *Id.*
[278] Ex. D at 208.
[279] *Id.*
[280] *Id.*
[281] *Id.*

requires this analysis to focus on the "cost of complying with a proposed rule in the first year after the rule <u>takes effect</u> . . . ."[282]

185. Because MPCA predicts that it will likely take five to ten years to sample the regulated wild rice waters identified in the proposed rule for the purpose of setting new standards that will provide the basis for new effluent limits, the Administrative Law Judge finds that the rule cannot take effect for purposes of the Agency's analysis under Minn. Stat. § 14.127 until the necessary sediment and porewater sampling have been completed and new sulfate standards calculated pursuant to the equation standard in the proposed rule.

186. Any attempt to perform the analysis required by Minn. Stat. § 14.127 is based on conjecture regarding whether and to what extent any given small business or city that meets the criteria outlined by the MPCA will be subject to a more stringent effluent limit once a new standard is determined for receiving waters subject to the wild rice sulfate rules.

187. The legislature's purpose in enacting Minn. Stat. § 14.127 was to better understand the impact of its regulatory delegations. For example, in its 1993 review of Minnesota's rulemaking process, the State Commission on Reform and Efficiency observed that the legislature is often "not aware of the specific costs of preparing and adopting the rules it authorizes or requires" and "lacks cost information when considering bills authorizing rulemaking."[283] In this context, the provisions of Minn. Stat. § 14.127 operate as a check against the legislature misjudging the cost of regulatory programs when it delegates rulemaking authority.

188. The structure and text of the exemptions in Minn. Stat. § 14.127, subd. 4, confirm this conclusion. Subdivision 4 provides that there is no safe harbor from regulatory compliance for small cities and small businesses when:

a. the legislature has appropriated sufficient funds for the costs of complying with the proposed rule;

b. the proposed rule follows from "a specific federal statutory or regulatory mandate";

c. the rules were promulgated under the limited exemption of the "good cause exempt" rulemaking procedure;

d. the legislature exempted the proposed rules from compliance with Chapter 14 rulemaking procedures;

e. the rules were promulgated by the Public Utilities Commission; or

[282] Minn. Stat. § 14.127 (emphasis added).

[283] *See* Finding 6, *Reforming Minnesota's Administrative Rulemaking System* (State Commission on Reform and Efficiency, 1993.).

f. the Governor waives the safe-harbor provisions by filing a notice with both houses of the legislature and publishing the same in the *State Register*.

189. These exemptions reflect an underlying legislative assumption that delegated rulemaking authority will not result in compliance costs of more than $25,000 for a small city or small business during the first year. If that cost assumption is not generally true for a particular agency (such as the Public Utilities Commission), or untrue with respect to a particular program (such that appropriation accompanies the rulemaking delegation), one of the listed exemptions will apply. In all other cases, the legislature offers the affected stakeholders the opportunity to revisit the question of compliance costs with the legislature and the agency.[284]

190. The Agency's application of the statute significantly narrows the protections for small businesses and small cities. Under Minn. Stat. § 14.127, a qualifying small city or small business may opt out of costly regulatory programs by filing "a written statement with the agency claiming a temporary exemption from the rules"[285] until "the rules are approved by a law enacted after the agency determination or administrative law judge disapproval."[286] Because, according to the MPCA, the small businesses and cities it has identified as potentially affected by $25,000 limitation in Minn. Stat. § 14.127 will not know for certain whether their effluent limits will be more or less stringent until the new sulfate standards are calculated, it is not technically possible for any small city or business to claim that it must spend $25,000 in order to comply with the new sulfate standards. Thus, the Agency's attempt to implement a rule without definite standards runs afoul of the statutory language of Minn. Stat. § 14.127, despite the Agency's finding that some small businesses and cities may spend $25,000 within a year after the proposed rule is adopted.

191. The Administrative Law Judge finds that the Agency has made a determination required by Minn. Stat. § 14.127, but that determination is not adequately supported in the rulemaking record. The hearing record does not establish that the compliance costs for any one qualifying small city or small business will be more than $25,000 in the first year following the adoption of the proposed rule because the hearing record does not establish that the compliance costs for any one qualifying small city or small business will be known within one year of adoption of the proposed rule.

192. The cost determination under Minn. Stat. § 14.127 is disapproved.

193. The result of this cost determination disapproval would usually be that any small business or city that must spend more than $25,000 to comply with this rule can file a statement with the Agency pursuant to Minn. Stat. § 14.127, subd. 3, claiming a temporary exemption pending further action by the legislature. Because the basis for the disapproval is that the Agency has failed to provide the information required to make a

[284] Minn. Stat. § 14.127, subd. 3.
[285] *Id.*
[286] *Id.*

finding under Minn. Stat. § 14.127, it is not possible for a small city or business to claim a temporary exemption at this time without further action by the Agency.

5. Adoption or Amendment of Local Ordinances

194. Under Minn. Stat. § 14.128 (2016) the Agency must determine if a local government will be required to adopt or amend an ordinance or other regulation to comply with a proposed agency rule. The Agency must make this determination before the close of the hearing record, and the Administrative Law Judge must review the determination and approve or disapprove it.[287]

195. The Agency states that, because state water quality standards are not implemented at the local level, no changes will be required to local ordinances or regulations in response to the proposed rule revisions. The Agency notes, however, that local units of government that own or operate a WWTP may be subject to additional conditions on discharges due to the proposed revisions. For example, a city may require pre-treatment of high sulfate wastewater or charge a higher fee for discharge of sulfate to the municipal WWTP. These conditions may be in the form of an ordinance or regulation, but they are not specifically required by the proposed rules.[288]

196. The Administrative Law Judge finds that the Agency has made the determination required by Minn. Stat. § 14.128 and approves that determination.

6. Economic Analysis and Identification of Cost-Effective Permitting

197. Pursuant to a 2015 Minnesota Session Law,[289] the MPCA is required to consider the effect the proposed revisions will have on MPCA's permit process for industrial and municipal dischargers.[290]

198. The MPCA states that it considered the effects its proposed revisions will have on the permit process and it recognizes that, for some dischargers, the proposed rules may result in substantial costs.[291]

199. The MPCA expects that, in most cases, dischargers can only meet the proposed sulfate standard by using membrane treatment. The MPCA recognizes that the current options for treating sulfate are costly and complex.[292]

---

[287] Minn. Stat. § 14.128, subd. 1. Moreover, a determination that the proposed rules require adoption or amendment of an ordinance may modify the effective date of the rule, subject to some exceptions. Minn. Stat. § 14.128, subds. 2 and 3.
[288] Ex. D at 201.
[289] 2015 Minn. Laws 1st Spec. Sess. ch. 4, art. 3, § 2, subd. 2 (authorizing funds for "enhanced economic analysis in the water quality standards rulemaking process, including more specific analysis and identification of cost-effective permitting.").
[290] Ex. D at 209-213.
[291] *Id*. at 209.
[292] *Id*.

200. The MPCA states that industrial dischargers could encounter substantial treatment costs if sulfate effluent limits are included in NPDES/SDS permits. The industries most likely to be affected include ethanol producers, food processors, power plants, ferrous (taconite) mining and processing, and any potential non-ferrous mining. The taconite industry on the Mesabi Iron Range is likely to be the most affected of the industrial categories because of the prevalence of wild rice in that region, the amount of sulfate generated by mining and processing, the aggregate volume of water discharged, and the elevated sulfate concentrations from legacy mining.[293]

201. The MPCA notes that variances from water quality standards are a permitting tool that may be used to temporarily address uncertain or costly treatment alternatives.[294] The MPCA expects variances to become an increasingly necessary component of the permit process as more stringent water quality-based effluent limits are implemented.[295] In considering a variance, the MCPA must determine the point at which costs would result in substantial and widespread negative economic and social impact such that compliance with the standard is not feasible.[296] All variances from a water quality standard are subject to final approval by the United States Environmental Protection Agency (EPA).[297]

202. Because the proposed sulfate effluent limits may prompt an increase in variance requests, the MPCA is considering implementing a streamlined variance process. According to the MPCA, the streamlined process will define the information required for obtaining final approval from the EPA and allow ample time for a discharger to consider its permitting options. The MPCA maintains that the streamlined process will reduce permitting uncertainty and application review time and result in more cost-effective permitting.[298]

203. The Administrative Law Judge concludes the Agency has made the analysis required under 2015 Minn. Laws 1st Spec. Sess. ch. 4, art. 3, § 2, subd. 2, given the limited information available.

7. External Review Panel

204. The Agency is required to convene an external review panel during the promulgation or amendment of a water quality standard, or state in the SONAR why such a panel was not convened.[299]

205. The MPCA conducted an external peer review on the state-sponsored wild rice study in 2014.[300] The report of the peer review panel was released in September

---

293 *Id*. at 209-210.
294 Ex. D at 210.
295 *Id*.
296 *Id*.
297 *Id*.
298 Ex. D at 216.
299 *See* Minn. Stat. § 115.035 (2016).
300 Ex. D at 217.

2014.[301] The names and affiliations of the peer reviewers are provided in Table 19 of the SONAR.[302] The MPCA states that the report of the peer review panel informed its analysis and interpretation of data regarding the effect of sulfate on wild rice and that analysis is reflected in its March 2015 draft proposal.[303]

206. The Administrative Law Judge finds that the Agency met the requirement of Minn. Stat. § 115.035 regarding external review panels.

IV. Rulemaking Legal Standards

207. The Administrative Law Judge must make the following inquiries: whether the agency has statutory authority to adopt the rule; whether the rule is unconstitutional or otherwise illegal; whether the agency has complied with the rule adoption procedures; whether the proposed rule grants undue discretion to government officials; whether the rule constitutes an undue delegation of authority to another entity; and whether the proposed language meets the definition of a rule.[304]

208. Under Minn. Stat. § 14.14, subd. 2 and Minn. R. 1400.2100 (2017), the agency must establish the need for, and reasonableness of, a proposed rule by an affirmative presentation of facts. In support of a rule, the agency may rely upon materials developed for the hearing record,[305] "legislative facts" (namely, general and well-established principles that are not related to the specifics of a particular case but which guide the development of law and policy),[306] and the agency's interpretation of related statutes.[307]

209. A proposed rule is reasonable if the agency can "explain on what evidence it is relying and how the evidence connects rationally with the agency's choice of action to be taken."[308] By contrast, a proposed rule will be deemed arbitrary and capricious where the agency's choice is based upon whim, devoid of articulated reasons or "represents its will and not its judgment."[309]

210. An important corollary to these standards is that when proposing new rules an agency is entitled to make choices between different possible regulatory approaches, so long as the alternative that is selected by the agency is a rational one.[310] Thus, while reasonable minds might differ as to whether one or another particular approach

---

[301] *Id*.; SONAR Ex. 9.
[302] Ex. D at 217.
[303] *Id*; SONAR Ex. 10.
[304] *See* Minn. R. 1400.2100.
[305] *See Manufactured Housing Institute v. Pettersen*, 347 N.W.2d 238, 240 (Minn. 1984); *Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, 469 N.W.2d 100, 103 (Minn. Ct. App. 1991).
[306] *Compare generally United States* v. *Gould,* 536 F.2d 216, 220 (8th Cir. 1976).
[307] *See Mammenga v. Agency of Human Services*, 442 N.W.2d 786, 789-92 (Minn. 1989); *Manufactured Manufactured Hous. Inst.*, 347 N.W.2d at 244.
[308] *Manufactured Hous. Inst.*, 347 N.W.2d at 244.
[309] *See Mammenga*, 442 N.W.2d at 789; *St. Paul Area Chamber of Commerce v. Minn. Pub. Serv. Comm'n,* 251 N.W.2d 350, 357-58 (Minn. 1977).
[310] *Peterson v. Minn. Dep't of Labor & Indus*., 591 N.W.2d 76, 78 (Minn. Ct. App. 1999).

represents "the best alternative," the agency's selection will be approved if it is one that a rational person could have made.[311]

211. Because both the Agency and the Administrative Law Judge suggested changes to the proposed rule language after the date it was originally published in the *State Register*, it is also necessary for the Administrative Law Judge to determine if this new language is substantially different from that which was originally proposed.

212. The standards to determine whether any changes to proposed rules create a substantially different rule are found in Minn. Stat. § 14.05, subd. 2(b). The statute specifies that a modification does not make a proposed rule substantially different if:

> (1) the differences are within the scope of the matter announced . . . in the notice of hearing and are in character with the issues raised in that notice;
>
> (2) the differences are a logical outgrowth of the contents of the . . . notice of hearing, and the comments submitted in response to the notice; and
>
> (3) the . . . notice of hearing provided fair warning that the outcome of that rulemaking proceeding could be the rule in question.

213. In reaching a determination regarding whether modifications result in a rule that is substantially different, the Administrative Law Judge must consider whether:

> (1) persons who will be affected by the rule should have understood that the rulemaking proceeding . . . could affect their interests;
>
> (2) the subject matter of the rule or issues determined by the rule are different from the subject matter or issues contained in the . . . notice of hearing; and
>
> (3) the effects of the rule differ from the effects of the proposed rule contained in the . . . notice of hearing.[312]

V. Analysis of the Proposed Rule

214. There were few sections of the proposed rule that were not opposed by any member of the public. This Report will first address the three portions of the rule that are central to its function and design: Minn. R. 7050.0224, subp. 2, which proposes to repeal the 10 mg/L sulfate standard; Minn. R. 7050.0224, subp. 5, B (1), which proposes to replace the 10 mg/L standard with the equation-based sulfate standard; and Minn. R. 7050.0471, subps. 3-9, which proposes the list of waters to be included as class 4D waters to be protected by the wild rice sulfate standard.

---

[311] *Minnesota Chamber of Commerce*, 469 N.W.2d at 103.
[312] *See* Minn. Stat. § 14.05, subd. 2.

A. Repeal of the 10 mg/L Sulfate Standard

215. Minn. R. 7050.0224, subp. 2, proposes to repeal the 10 mg/L sulfate standard applicable to wild rice waters, which are currently classified as Class 4A waters.[313]

216. Minn. R. 7050.0220, subps. 3a, 4a, 5a, and 6a, propose to delete references to the 10 mg/L sulfate wild rice water standard.[314]

217. A number of commenters support repeal of the 10 mg/L sulfate standard as it applies to wild rice waters, without regard to whether they are re-classified as Class 4D waters or remain classified as Class 4A waters.[315]

218. The MPCA responded that the decision to repeal the 10 mg/L standard "is not separate from moving forward with the proposed equation."[316] Because the MPCA has determined that sulfate negatively affects wild rice, albeit indirectly rather than directly, the MPCA determined that "[i]t is not scientifically defensible to conclude that simply eliminating the existing sulfate standard would protect" wild rice.[317]

219. The 1854 Treaty Authority, the Fond du Lac Band of Lake Superior Chippewa, the Grand Portage Band of Chippewa, WaterLegacy, and numerous individuals oppose repeal of the 10 mg/L sulfate standard.[318] These commenters and others express concerns that increases in sulfate could lead to increases in methyl mercury, which bio-accumulates in fish, has long-term serious health effects on humans, and is especially dangerous to developing fetuses.[319] Some commenters also question

---

[313] Ex. C at 7.16, proposed Minn. R. 7050.0224, subp. 5.

[314] Ex. C at 3.16, 4.11, 5.7, 5.23, proposed Minn. R. 7050.0220, subps. 3a, 4a, 5a, and 6a.

[315] Test. of Rob Beranek, Oct. 23 Tr. at 91; eComment from Kurt Anderson on behalf of Minnesota Power at 7 (Minnesota Power comment) (Nov. 21, 2017); eComment from Elizabeth Wefel on behalf of Coalition of Greater Minnesota Cities at 1-2 (Coalition of Greater MN Cities comment) (Nov. 22, 2017); Test. of Chrissy Bartovich, Oct. 24, 2017 Tr. at 82; Test. of Jason Metsa, Oct. 24, 2017 Tr. at 104; Letter from Iron Range Mayors (Hoyt Lakes, Ely, Virginia, Nashwauk, Aurora, Biwakbik, Grand Rapids, Hibbing, Babbitt, Mountain Iron) at 1 (Nov. 6, 2017); Letter from Iron Range Legislative Delegation (Senators David Tomassoni, Thomas Bakk, and Justin Eichorn, and Representatives Jason Metsa, Rob Ecklund, Julie Sandstede, Dale Lueck, and Sandy Layman) (Nov. 2, 2017).

[316] MPCA Response, Att. 1 at 24.

[317] MPCA Response at 3.

[318] eComment from Paula Maccabee on behalf of WaterLegacy at 11-12, 55-56 (WaterLegacy comment), (eComment filed Nov. 22, 2017); Letter from Darren Vogt at 5 (Nov. 21, 2017); eComment from Nancy Schuldt at 25 (Nov. 22, 2017); Test. of Dennis Scymialis, Oct. 26, 2017, Tr. at 70; Test. of Tom Thompson, Oct. 26, 2017, Tr. at 75. Some commenters objected to the Agency's classification of wild rice waters as class 4 waters rather than class 2 waters. Test. of Margaret Watkins, Oct. 26, 2017, Tr. at 89-90, Hearing Ex. 1020 (Letter from Dennis Morrison on behalf of Grand Portage Tribal Reservation Council at 8 and Letter from Robert L. Larsen on behalf of Minnesota Indian Affairs Council at 2).

[319] Test. of Dave Zentner, Oct. 26 Tr. at 117; Test. of Dr. Emily Onello, Oct. 26, 2017, Tr. at 68; Test. of Margaret Watkins, Oct. 26, 2017, Tr. at 89-90, Hearing Ex. 1020 (Letter from Dennis Morrison on behalf of Grand Portage Tribal Reservation Council at 8 and Letter from Robert L. Larsen on behalf of Minnesota Indian Affairs Council at 2).

whether the extraordinary nutritional value – and health benefits – of wild rice will be degraded by increased surface water sulfate levels.[320]

220. In response to the concerns raised about the effect of increased sulfate concentrations on the methylation of mercury, the MPCA acknowledges that "increased concentrations of sulfate have been shown to increase the methylation of mercury in aquatic systems where organic carbon is available and especially where background sulfate concentrations are low." The MPCA agrees that "enhanced production of methylmercury is a significant concern."[321]

221. Despite these concerns, and while acknowledging that it is "very concerned about actions that might increase the mercury content of fish," the Agency notes that "in a formal sense," the scope of this rulemaking does not encompass the effects of sulfate on the methylation of mercury.[322] The MPCA reports that it is "conducting a significant separate study concerning the factors that control mercury in fish."[323] At this time, the Agency states that it has determined

> that the relationship between sulfate and mercury methylation is significantly more complicated than the relationship between sulfate and sulfide on which the proposed wild rice rule is based. Therefore, it would be even more challenging to develop a proposed sulfate standard that addresses the role of sulfate in the potential for production of methylmercury.[324]

For these reasons, the Agency states, it is not making "any decisions as how to proceed on the question of enhanced mercury methylation until the results of the ongoing major study are available."[325]

222. Both the Fond du Lac Band and the Grand Portage Band of Lake Superior Chippewa have wild rice water quality standards that limit sulfates to 10 mg/L. Each Band has authority to set water quality standards on its reservation, and the EPA has approved the standard for each Band.[326]

223. The CWA requires that, any time a state revises or adopts a new water quality standard, the standard "shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of" the CWA.[327] Standards "shall

---

[320] Test. of Dr. Emily Onello, Oct. 26, 2017, Tr. at 68-69; Test. of Dr. Debby Allert, Oct. 26, 2017, Tr. at 107-112, Hearing Ex. 1024 (Materials submitted by Dr. Allert on behalf of Minnesota Academy of Family Physicians).
[321] MPCA Response Att. 1 at 21 (Nov. 22, 2017).
[322] *Id.*
[323] *Id.*
[324] *Id.*
[325] *Id.*
[326] Hearing Ex. 1020 (Letter from Dennis Morrison on behalf of Grand Portage Tribal Reservation Council at 11; Test. of Nancy Schuldt at 96 (Oct. 26, 2017); eComment from Paula Maccabee on behalf of WaterLegacy at 15 (eComment filed Nov. 22, 2017).
[327] 33 U.S.C. § 1313 (c).

be established taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes . . . ."[328] The federal regulations also require the state to "take into consideration the water quality standards of downstream waters and . . . ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters."[329]

224. Minn. R. 7050.0155 requires that "[a]ll waters must maintain a level of water quality that provides for the attainment and maintenance of the water quality standards of downstream waters, including the waters of another state."

225. The MPCA has proposed that the maximum value of sulfate which could result in application of the proposed equation-based standard would be 838 mg/L,[330] a standard more than 80 times the current standard of 10 mg/L.

226. In the face of challenges raised by the public concerning increased mercury methylation, further harm to wild rice, and degradation of waters due to algae blooms as a result of elevated sulfate standards, the MPCA has failed to make an affirmative presentation of facts which demonstrate that, in establishing standards which would allow increased levels of sulfate in wild rice waters, it is protecting the public health or welfare, enhancing the quality of water, and ensuring that the proposed water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters, as required by federal and state law.[331] Therefore, the Administrative Law Judge concludes that the proposed repeal of the 10 mg/L wild rice sulfate standard violates Minn. R. 1400.2100.D, prohibiting a rule that conflicts with other applicable law.

227. For the reasons set forth in the following section regarding the equation-based standard, the Administrative Law Judge further concludes that the MPCA has not presented facts adequate to support the reasonableness of the proposed repeal of the 10 mg/L sulfate standard without a replacement standard that is equally or more protective of wild rice waters. Therefore, the proposed rule repealing the 10 mg/L sulfate standard is defective because it violates Minn. R. 1400.2100.B.

---

328 33 U.S.C. § 1313 (c)

329 40 C.F.R. § 131.10(b) (2015).

330 MPCA Rebuttal at 4.

331 The Fond du Lac Band of the Minnesota Chippewa Tribe asserts that the Chippewa retain usufructuary rights to gather wild rice under the Treaties of 1837 and 1854. *Minnesota v. Mille Lacs Band of Chippewa Indians*, 526 U.S. 172, 196 (1999). The Fond du Lac Band, along with the entire Minnesota Indian Affairs Council, believes that equation-based sulfate standard is not proven to be protective of wild rice waters. Hearing Ex. 1020 (Letter from Dennis Morrison on behalf of Grand Portage Tribal Reservation Council at 8 and Letter from Robert L. Larsen on behalf of Minnesota Indian Affairs Council at 2). Therefore, the Fond du Lac Band argues, the State has an obligation under the 1837 and 1854 Treaties to insure that wild rice is not degraded or contaminated. The Fond du Lac Band contends that the proposed equation-based standard will not adequately protect wild rice or, by extension, the Band's Tribal treaty rights. eComment from Nancy Schuldt at 1,4-5 (Nov. 22, 2017). Because the Administrative Law Judge finds that repeal of the 10 mg/L violates federal and state law, this Report need not reach the treaty-rights arguments.

228. Should the Agency proceed with this rulemaking, it may cure the defect by retaining the 10 mg/L wild rice sulfate standard either by returning to the current wild rice classification as 4A waters, or by applying the 10 mg/L wild rice sulfate standard to wild rice in the 4D classification.

229. The Administrative Law Judge finds that the suggested changes would be needed and reasonable and would not constitute a substantially different rule under Minn. Stat. § 14.05, subd. 2(b).

B. Equation-based Sulfate Standard

230. **Part 7050.0224, subp. 5, B (1).** As stated above, the MPCA proposed the equation-based sulfate standard to replace the 10 mg/L sulfate standard.

231. Because the Administrative Law Judge has determined that the proposed repeal of the 10 mg/L sulfate standard is not needed or reasonable, the equation-based standard cannot be implemented as part of this rulemaking. Nonetheless, for purposes of the Agency's consideration in future rulemaking procedures, the Administrative Law Judge provides a review of the equation-based standard.

232. **Part 7050.0224, subp. 5, B (1)** contains the equation for the calculated sulfate standard as proposed by the Department. The standard is expressed as milligrams of sulfate ion per liter, as follows:[332]

$$\text{Calculated sulfated standard} = 0.0000121 \times \frac{\text{Iron}^{1.923}}{\text{Organic carbon}^{1.197}}$$

Where:

(a) organic carbon is the amount of organic matter in dry sediment. The concentration is expressed as percentage of carbon, as determined ~~using~~ consistent with the method for organic carbon analysis in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E;

(b) iron is the amount of extractable iron in dry sediment. The concentration is expressed as micrograms of iron per gram of dry sediment, as determined ~~using~~ consistent with the method for extractable iron in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E;

(c) sediment samples are collected ~~using~~ consistent with the procedures established in Sampling and Analytical Methods for Wild Rice Waters; and

[332] Ex. C at lines 7.25-7.26 and 8.1-8.17.

(d) the calculated sulfate standard is the lowest sulfate value resulting from the application of the equation to each pair of organic carbon and iron values collected and analyzed in accordance with units (a) to (c).[333]

233. Many of the commenters rejected the proposed equation-based standard. Concerns about the equation-based standard focused on the implementation of the standard and on the science underlying the equation.

1. Implementation of the Equation-based Standard

234. The equation will require measurements of iron and carbon to be taken from the sediment in each of the 1,300 or more identified wild rice waters. The data will then be inserted into the equation to calculate the equation-based sulfate standard for that particular water.[334] As stated above, the Agency estimates that it will take approximately ten years for agency staff to calculate the standards for the approximately 1,300 waters identified in the proposed rule.[335]

235. A number of commenters express concerns that it will take approximately ten years for the Agency to establish the standards under the proposed rule. Some of the concerns are that the Agency's delayed ability to implement the new standards will create confusion, and will defer enforcement of the water quality standards for wild rice waters.[336] Regulated parties assert that they lack the information they need to properly plan for compliance with the standards once they are implemented.[337] Others observe that the Agency has not enforced the 10 mg/L standard for most of the years the existing standard has been in place, and that the Agency, with its limited resources, has not shown that it will have the means to develop the 1,300 individual standards which must be calculated before they can be enforced.[338]

236. Cleveland Cliffs, which owns and operates United Taconite and Northshore Mining Company and partially owns and operates Hibbing Taconite, is a major employer on Minnesota's Iron Range. Cleveland Cliffs employs over 1,700 individuals and claims it has a total economic impact to the region of nearly $900 million.[339] In its post-hearing comments, Cleveland Cliffs asserts that the MPCA's implementation plan for the equation-based standard is unreasonable. Cleveland Cliffs contends that it is unreasonable that the MPCA cannot notify any potentially affected WWTP what revised standard will apply to it because the MPCA has not calculated sulfate standards in

---

[333] Ex. C at 8.5-8.17; MPCA Rebuttal Response to Public Comments at 5.
[334] MPCA Rebuttal at 44.
[335] Ex. D at 153-154; MPCA's Response to Public Comments at 10-11 (Nov. 22, 2017).
[336] Comments of Lea Foushee, Oct. 23 Hearing Tr. at 93; (MCEA eComment) at 6-8 (Nov. 22, 2017).
[337] Comments of Chrissy Bartovich, Oct. 24 Hearing Tr. at 82.
[338] Comments of Matt Tuchel, Oct. 24 Hearing Tr. at 151-152; Paula Maccabee letter at 7-11 (Nov. 22, 2017); Dorie Reisenweber, Oct. 26 Hearing Tr. at 106; Dave Zentner, Oct 26 Hearing Tr. at 114; Allen Richardson, Oct. 26 Hearing Tr. at 129; Barbara Cournyea, Oct. 30 Hearing Tr. at 88; Sydney Evans (eComment) (Oct. 23, 2017); Jeff Williams (eComment) (Nov. 2, 2017).
[339] Letter from Rob Beranek at 1 (Nov. 22, 2017) (Beranek Letter).

individual wild rice waters under the proposed rule.[340] To demonstrate the inadequacy of the MPCA's regulatory cost analysis,[341] Cleveland Cliffs cites the MPCA's statements in the SONAR that "sulfate treatment is prohibitively expensive for many dischargers"[342] and that "companies might choose to stop operations rather than invest in the treatment needed to meet a revised standard."[343]

237. The Agency's response to comments regarding implementation of the equation-based standard is that this water quality rule is not unique:

> With any standard, resources are required to collect a sufficient amount of data for implementation. In fact, the MPCA is not convinced that the resources needed to implement the proposed standard revision exceed those needed to implement the existing 10 mg/L sulfate standard if this rulemaking were not to proceed.[344]

238. In response to commenters' concerns regarding the time needed to develop the individual sulfate limits, the Agency states: "[i]t is not uncommon for data gathering to be necessary before a standard can be fully implemented in permits."[345]

239. The Agency explains that implementing the current 10 mg/L standard takes time, both because wild rice waters have to be identified and because surface waters have to be analyzed to see whether the 10 mg/L standard is being met.[346]

240. The Agency plans to make efficient use of its resources by collecting sediment iron and carbon data to develop the new sulfate standards using its existing 10-year intensive watershed monitoring program.[347]

241. The MPCA acknowledges that, because it does not have the data available to calculate the proposed equation-based standard, it does not know "how many dischargers will be required to install additional treatment"[348] or "how many wild rice waters need a standard more stringent than the existing 10 mg/L."[349] Similarly, the Agency states in the SONAR, "[b]ecause the number of dischargers who must meet a different limit (either more or less stringent) is not known, it is difficult to quantify the change in environmental costs or benefits based on this rule revision."[350]

242. In its rebuttal comments, the MPCA states:

---

340 Beranek Letter at 25-26.
341 Beranek Letter at 23.
342 Ex. D at 107.
343 Ex. D at 148.
344 MPCA Response at 10 (Nov. 22, 2017).
345 MPCA Response, Att. 2 at 39.
346 MPCA Response at 10-11 (Nov. 22, 2017).
347 MPCA Response at 10 (Nov. 22, 2017).
348 Ex. D at 144.
349 Ex. D at 143.
350 *Id.*

> [T]he MPCA understands that dischargers want clarity about how the standard will affect them, and we are sensitive to comments that the MPCA should strive to fully understand and articulate the implementation details of a rule prior to adopting the rule. In the case of water quality standards, the impact on permitted facilities comes through development of an effluent limit specific to a facility that ensures the permitted facility will not cause or contribute to a violation of the water quality standard. Effluent limit setting requires evaluating multiple factors as described beginning on page 96 of the SONAR.
>
> There are approximately 1000 facilities in Minnesota that hold water discharge permits. Site-specific data is required to evaluate the need for an effluent limit at each facility, and these issues are addressed in an individualized permitting process. This data is not immediately available for all facilities and it takes time to gather this data.
>
> This time and data need is inherent to the difference between water quality standards and effluent limits, and is not unique to the proposed revisions to the wild rice sulfate standard. As explained in Part 6G, pp. 96-99 of the SONAR, evaluating the need for and (as needed) determining a water quality based effluent limit requires data specific to the discharge being evaluated and the receiving water(s) being discharged to. Data needs unique to the proposed rule revisions are the sediment iron and carbon (or porewater sulfide) data.
>
> Collecting all the data necessary to calculate all effluent limits statewide would take at least ten to fifteen years, even if the sediment data were not needed. Necessary steps such as gathering five years of effluent data to evaluate and set effluent limits combined with the 10-year surface water monitoring schedule to gather surface water data cumulatively add up to the necessary data not being available for some permitted discharges until at least ten to fifteen years after rule promulgation. The MPCA does plan to prioritize data collection based on factors such as those mentioned in the EPA comments, Appendix 2 – the likelihood of sulfate impacts (because of type and location of dischargers) and permitting schedules.[351]

243. The rule, as proposed, gives regulated parties no notice of the numeric sulfate standard they will be expected to comply with, because it repeals the existing 10mg/L standard and replaces it with an equation based on variables that lack values. WWTPs will not know, until there is a final decision regarding the new water quality standards applicable to their discharge facilities, whether and to what extent they will have to treat their wastewater discharge for sulfate.

244. During the public hearings, MPCA staff distinguished between the process of setting standards and the permitting process. In her introductory remarks, Shannon Lotthammer, Division Director for the MPCA's Environmental Analysis and Outcomes

[351] MPCA Rebuttal Memo at 40.

Division, stated, “So one thing I want to point out is that the permitting process is not the same thing as establishing a water quality standard.”[352] Ms. Lotthammer made similar comments during her introductory remarks at each public hearing.[353]

245. To the extent that the Agency claims that the delay in setting standards does not disadvantage the WWTPs because the permitting process can also take years, that claim is undermined by the Agency’s own statements that setting water quality standards and permitting are two completely separate processes. The additional step of establishing a water quality standard before effluent limits can be established will prevent the WWTPs from planning, with any certainty, how to approach what will, at that point, be unknown compliance obligations.

246. The Administrative Law Judge finds that Part 7040.0224, subp. 5, B (1) violates Minn. R. 1400.2100.B. The equation-based sulfate standard is not rationally related to the Agency's objective. The Agency states that its objective in this proceeding is "[t]o amend the state water quality standards and the rules implementing those standards to protect wild rice from the impact of sulfate, so that wild rice can continue to be used as a food source by humans and wildlife.”[354] The equation-based sulfate standard does not update the standards because, while the rule repeals the existing sulfate standard of 10 mg/L,[355] it fails to provide the values necessary to insert into the proposed equation to calculate individualized standards for each wild rice water body. Therefore, if the rule is enacted as proposed, there will be no standards when the rule becomes effective. Regulated parties will not know what standards will apply to them, or even whether any sulfate standard applies to them. Therefore, the rule as proposed will not protect wild rice from the impact of sulfate, and is not rationally related to the Agency’s objective.

247. The Administrative Law Judge finds that Part 7040.0224, subp. 5, B (1) violates Minn. R. 1400.2100.E because it is unconstitutionally void for vagueness. “A rule, like a statute, is void for vagueness, if it fails to give a person of ordinary intelligence a reasonable opportunity to know what is prohibited or fails to provide sufficient standards for enforcement.”[356]

248. The Administrative Law Judge finds that Part 7040.0224, subp. 5, B (1) violates 1400.2100.G. By its own terms, the equation-based sulfate standard cannot have the force and effect of law. The equation lacks values to insert in the place of the iron and organic carbon variables, and thus cannot be calculated. Therefore, the proposed equation-based sulfate standard will not have the force and effect of law within five working days after notice of its adoption and violates the requirements of Minn. Stat. § 14.38.

---

[352] Comments of Shannon Lotthammer, Tr.at 49 (Oct. 23, 2017).
[353] Comments of Shannon Lotthammer, Tr.at 44-45 (Oct. 24, 2017); Tr. at 44 (Oct. 25, 2017); Tr. at 58 (Oct. 26, 2017); Tr. at 57 (Oct. 30, 2017); Tr. at 47-48 (Nov. 2, 2017).
[354] Ex. D at 1.
[355] Ex. C. at lines 7.8-7.10 (proposed Minn. R. 7050.0224, subp. 2).
[356] *In re N.P.*, 361 N.W. 2d 386, 394 (Minn. 1985), *citing Grayned v. City of Rockford*, 408 U.S. 104, 108-09, 92 S. Ct. 2294, 2298-99 (1972).

249. The Agency could cure the defects identified in this section only by conducting the sampling process necessary to provide the values for the equation proposed in the rule for each water identified in the rule, before proposing the rule. However, because the Agency cannot repeal the 10 mg/L sulfate standard for the reasons explained in section V. A., above, the Agency cannot implement the equation-based sulfate standard.

2. Science-based Objections to the Equation

250. The basis for many of the objections were disagreements with the scientific underpinnings of the equation. The science-based objections fall primarily into the following categories:

a. Disagreement with the MPCA's conclusion that sulfate harms wild rice.[357]

b. Disagreement with the MPCA's conclusion that the proposed sulfide standard will be protective of wild rice.[358]

c. Concerns that permitting higher sulfate levels will result in increased methyl mercury in fish.[359]

d. Criticisms of MPCA's research based on its decision to exclude from consideration stressors on wild rice growth other than sulfate or sulfide.[360]

e. Disagreement with the MPCA's conclusion that a level as low as 120 micrograms per liter of sulfide is the maximum level that is protective of wild rice. [361]

f. Criticisms of the MPCA's research on porewater sulfide.[362]

g. Criticisms of the MPCA's use of field data.[363]

h. Criticisms of the MPCA's choice of data sets.[364]

---

[357] eComment from Tom Scott (Nov. 22, 2017); Kurt Anderson, Tr. at 116 (Oct. 23, 2017); Sen. David Tomassoni Tr. at 53-55 (Oct. 24, 2017); Larry Sutherland, Tr. at 73 (Oct. 24, 2017).

[358] eComment from John Coleman on behalf of Great Lakes Indian Fish and Wildlife Commission at 3-7 (Nov. 22, 2017); eComment from Nancy Schuldt on behalf of Fond du Lac Band of Chippewa at 26-88 (Nov. 22, 2017).

[359] Jennifer Lang, Tr. at 61 (Oct. 23, 2017); Ex. 1000, Letter from Lea Foushee on behalf of North American Water Office at 1; eComment from Nancy Schuldt on behalf of Fond du Lac Band of Chippewa at 33 (Nov. 22, 2017); Test. of Dave Zentner on behalf of Izaak Walton League, Tr. at 116-117 (Oct. 26, 2017); E- comment from Kristin Blann on behalf of The Nature Conservancy (Nov. 22, 2017).

[360] Test. of O'Neill Tedrow, Tr. at 89-95 (Oct. 24, 2017) and Ex. 1008; Test. of Chrissy Bartovich, Tr. at 80 (Oct. 24, 2017).

[361] Test. of Kurt Anderson, Tr. at 113-116 (Oct. 23, 2017); Test. of Mike Bock, Tr. at 76-80 (Oct. 23, 2017); Test. of Mike Hansel, Tr. at 82 (Oct. 23, 2017); Test. of Rob Beranek, Tr. at 90 (Oct. 23, 2017); Tom Rukavina, Tr. at 134-148 (Oct. 24, 2017); Sen. Justin Eichorn, Tr. at 59-60 (Oct. 24, 2017).

[362] Test. of Mike Hansel, Tr. at 83 (Oct. 23, 2017).

[363] Test. of Mike Bock, Tr. at 79 (Oct. 23, 2017); eComment from John Coleman on behalf of Great Lakes Indian Fish and Wildlife Commission at 3-7 (Nov. 22, 2017).

[364] Test. of Rob Beranek, Tr. at 90 (Oct. 23, 2017); eComment from John Coleman on behalf of Great Lakes Indian Fish and Wildlife Commission at 4-5 (Nov. 22, 2017).

i. Concerns that the equation assumes steady state in a water body.[365]

j. Questions about upwelling of ground water.[366]

k. Questions about the long-term effectiveness of the calculated sulfide levels.[367]

l. Concerns about error rates in the equation.[368]

m. Disagreement about the use of EC_{10} concentration standard.[369]

n. Effect of sulfate on different parts of the wild rice plant.[370]

o. Challenges to the MPCA's analysis of its research and data.[371]

p. Concerns about response to peer review criticisms.[372]

q. Issues with the structural equation model (SEM).

251. The Administrative Law Judge finds that the MPCA presented sufficient evidence to demonstrate that there is an adequate scientific basis to conclude that the proposed equation-based sulfate standard is supported by peer-reviewed science and is needed and reasonable.

252. With one notable exception, the MPCA responded to each of the arguments raised by the commenters with arguments that were supported by peer-reviewed research.[373]

253. The exception, for which the MPCA did not offer a convincing response, was raised by several parties, most notably Dr. John Pastor, one of the scientists on whose foundational research the MPCA relied for its conclusions that sulfide, rather than sulfate, is the direct cause of damage to naturally-occurring wild rice.[374] Dr. Pastor's continuing mecocosm research has indicated that, while increased iron may counter the toxicity of sulfide to wild rice seedlings in the springtime, iron sulfide plaques form and

---

[365] John Pastor, PhD., Technical Review Comments on MPCA's Proposed Flexible Standard for Sulfate in Wild Rice Beds (Nov. 2017), submitted as attachment to WaterLegacy eComments (Nov. 22, 2017); eComment from Nancy Schuldt on behalf of Fond du Lac Band of Chippewa (Nov. 22, 2017); eComment from Miya Evans on behalf of Mesabi Nugget (Nov. 22, 2017).
[366] Test. of Meaghan Blair, Tr. at 117-119 (Oct. 24, 2017).
[367] John Pastor, PhD., Technical Review Comments on MPCA's Proposed Flexible Standard for Sulfate in Wild Rice Beds (Nov. 2017), submitted as attachment to WaterLegacy eComments (Nov. 22, 2017);
[368] Test. of Rob Beranek, Tr. at 91 (Oct. 23, 2017); Test. of Sen. David Tomassoni, Tr. at 55 (Oct. 24, 2017); Test. of Jack Croswell, Tr. at 99 (Oct. 24, 2017); Test. of Rep. Jason Metsa, Tr. at 102 (Oct. 24, 2017); Test. of Sen. Justin Eichorn, Tr. at 54, 61 (Oct. 25, 2017).
[369] eComment from Nancy Schuldt on behalf of Fond du Lac Band of Chippewa at 28-31 (Nov. 22, 2017); eComment from Rob Beranek at 12-13 (Nov. 22, 2017); eComment from John Coleman on behalf of Great Lakes Indian Fish and Wildlife Commission at 4-5 (Nov. 22, 2017).
[370] eComment from Rob Beranek at 6-8 (Nov. 22, 2017); Test. of Kurt Anderson, Tr. at 69-70 (Oct. 23, 2017).
[371] Test. of Mike Bock, Tr. at 78-79 (Oct. 23, 2017); Test. of Kurt Anderson, Tr. at 114 (Oct. 23, 2017).
[372] Test. of Kelsey Johnson, Tr. at 69 (Oct. 24, 2017).
[373] *See* MPCA Response Memorandum (Nov. 22, 2017) and Rebuttal Memorandum (Dec. 1, 2017).
[374] Ex. D at Ex. S-19.

precipitate on the plants' roots during the flowering and seed production phases of the wild rice life cycle. These plaques result in fewer and smaller seeds, with reduced nitrogen content, leading to extinction of the wild rice plant within 4 or 5 years at about 300 mg/L of sulfate, and greatly reducing wild rice plant population viability at lower concentrations of sulfate. Dr. Pastor hypothesizes that this occurs because the increased plaque appears to block uptake by the plant of nitrogen during the critical flowering and seed production portion of its life cycle.[375]

254. The MPCA's response to Dr. Pastor's reports about the plaque formation is, first, that "the only information the MPCA has on this issue is a four-page non-peer reviewed progress report . . . ." The MPCA also states that Dr. Pastor only presents evidence of nutrient uptake inhibition at 300 mg/L, asserting that this is "much higher than would be allowed using the MPCA's proposed equation."[376]

255. The Administrative Law Judge notes that the MPCA failed to mention the discussion of plaque formation in the peer-reviewed article which Dr. Pastor co-authored with MPCA staff, among others. The MPCA relies on this article, among others, to support the theory that increased iron in the porewater is protective against sulfide, permitting increased sulfate in the surface water.[377] This theory underlies, and is essential to, its equation-based sulfate standard. Furthermore, as discussed above, Dr. Pastor considered the effect of lower amounts of sulfate, as reported in his June 2017 article, concluding that, even at lower levels, sulfate greatly reduced plant viability when combined with increased iron.[378]

256. Nonetheless, Dr. Pastor's continued research regarding the harmful effects of increased sulfate with increased iron are not yet the subject of peer-reviewed publication. Therefore, the Administrative Law Judge finds that the MPCA demonstrated by an affirmative presentation of facts that it could rationally choose to proceed with the equation-based sulfate standard from a scientific standpoint.

257. The Administrative Law Judge finds that the MPCA's demonstration that the science underlying the equation-based standard is reasonable in that it describes a manner of calculating a sulfate level resulting in a level of sulfide in porewater protective of wild rice.

258. Nonetheless, because the MPCA failed to make an affirmative presentation of facts that implementation of the equation-based standard, or the alternate standard, would provide "for the attainment and maintenance of the water quality standards of downstream waters," the new proposed sulfate standards, even if based on science that a rational decision-maker could conclude is protective of wild rice, must be disapproved.

---

375 MPCA Response, Att. 5, N-34 at 3 (Pastor, Progress Report on Experiments on Effects of Sulfate and Sulfide on Wild Rice. June 28, 2017); eComment from John Coleman on behalf of Great Lakes Indian Fish and Wildlife Commission at 6 (Nov. 22, 2017).
376 MPCA Rebuttal at 25.
377 Ex. D at Ex. S-19.
378 MPCA Response, Att. 5, N-34 at 3 (Pastor, Progress Report on Experiments on Effects of Sulfate and Sulfide on Wild Rice. June 28, 2017).

C. List at Minn. R. 7050.0471 of Proposed 4D (Naturally Occurring) Wild Rice Waters

259. **Part 7050.0471, subparts 3-9,** proposes to list the waters that will be protected as Class 4D wild rice waters. There are approximately 1,300 Minnesota water bodies in the list as proposed by the MPCA.[379]

260. In the SONAR, the MPCA explains that the current rules "apply the wild rice beneficial use to 'water used for production of wild rice,'" without identifying the waters to which the use applies.[380] The MPCA states that the case-by-case process of evaluating potential wild rice waters has posed a significant challenge to the implementation of the existing standard.[381]

261. The proposed rule is a response to a legislative mandate first passed in 2011:[382]

> (a) Upon completion of the research referenced in paragraph (d), the commissioner of the Pollution Control Agency shall initiate a process to amend Minnesota Rules, chapter 7050. The amended rule shall:
>
> > (1) address water quality standards for waters containing natural beds of wild rice, as well as for irrigation waters used for the production of wild rice;
> >
> > (2) designate each body of water, or specific portion thereof, to which wild rice water quality standards apply; and
> >
> > (3) designate the specific times of year during which the standard applies.
>
> Nothing in this paragraph shall prevent the Pollution Control Agency from applying the narrative standard for all class 2 waters established in Minnesota Rules, part 7050.0150, subpart 3.
>
> (b) "Waters containing natural beds of wild rice" means waters where wild rice occurs naturally. Before designating waters containing natural beds of wild rice as waters subject to a standard, the commissioner of the Pollution Control Agency shall establish criteria for the waters after consultation with the Department of Natural Resources, Minnesota Indian tribes, and other interested parties and after public notice and comment.

[379] Ex. C at 11.16-11.17 and 12.7-66.8 (proposed Minn. R. 7050.0471, subps. 1 and 3-9). The original proposed list is slightly longer than the list as finally proposed by the MPCA, because the MPCA initially included waters within the boundaries of the Grand Portage and Fond du Lac reservations. The two tribes objected to inclusion of the waters within their reservations' boundaries, and the MPCA proposed to remove those waters from the proposed list. MPCA Response at 13.
[380] Ex. D at 38.
[381] *Id.*
[382] 2011 Minn. Laws, 1st Sp. Sess. ch. 2, art. 4, § 32(a)-(d).

The criteria shall include, but not be limited to, history of wild rice harvests, minimum acreage, and wild rice density.

(c) Within 30 days of the effective date of this section, the commissioner of the Pollution Control Agency must create an advisory group to provide input to the commissioner on a protocol for scientific research to assess the impacts of sulfates and other substances on the growth of wild rice, review research results, and provide other advice on the development of future rule amendments to protect wild rice. The group must include representatives of tribal governments, municipal wastewater treatment facilities, industrial dischargers, wild rice harvesters, wild rice research experts, and citizen organizations.

(d) After receiving the advice of the advisory group under paragraph (c), consultation with the commissioner of natural resources, and review of all reasonably available and applicable scientific research on water quality and other environmental impacts on the growth of wild rice, the commissioner of the Pollution Control Agency shall adopt and implement a wild rice research plan using the money appropriated to contract with appropriate scientific experts. The commissioner shall periodically review the results of the research with the commissioner of natural resources and the advisory group.

262. The proposed rule applies the sulfate standard only to waters specifically identified as Class 4D wild rice waters, which are listed in proposed Minn. R. 7050.0471.[383] Waters which are not listed in the rule are not subject to the sulfate standard.[384]

263. In determining which waters to include in the proposed rule, the MPCA relied on a number of sources, including:[385]

a. *Natural Wild Rice in Minnesota*) – A Wild Rice Study Report to the Legislature (2008) (Minnesota DNR) – MDNR Wild Rice Harvester Survey Report (2007);

b. Minnesota Wild Rice Management Workgroup List of 350 Important Wild Rice Waters (2010);

c. 1854 Treaty Authority List of wild rice waters (through March 2016 plus three additional waters since March 2016);

d. MDNR Aquatic Plant Management Database;

e. MPCA Biomonitoring Field Sites;

f. University of Minnesota/MPCA Wild Rice Study Field Survey Sites;

---

[383] Ex. C at li. 12.7-66.8 (proposed Minn. R. 7050.0471, subps. 3-9); Ex. D at 38.
[384] Test. of S. Lotthammer, Nov. 2, 2017 Tr. at 92.
[385] Ex. D at 42.

g. Minnesota Biological Survey Database;

h. MPCA Call for Data;

i. Permittee Monitoring Reports;

j. WR Waters (7050.0470);

k. Waters identified by MDNR in 2015 as wild rice waters; and

l. Waters Identified through MPCA Review of Various Water Surveys.

264. The MPCA found that it could not determine that certain waters were Class 4D wild rice waters based solely on the information it received from these sources. In some cases, the MPCA could not identify the location of the water from the information provided. In other cases, the MPCA could not correlate the location of a river or stream with a specific WID.[386]

265. The MPCA acknowledges that the MDNR's 2008 report "is widely considered the most comprehensive source of information regarding where rice may be found in Minnesota, and [the DNR report] was extensively reviewed."[387] The MDNR report represents the work of experts in the field from state, tribal, and federal governments, along with academia and the private sector.[388] However, the MPCA found the MDNR list insufficient on its face because it consolidated certain information on the location of natural wild rice stands, making it difficult for the MPCA to define the density or acreage of some rice stands. In addition, according to the MPCA, the MDNR report contains limited information about streams with wild rice.[389]

266. As part of this rulemaking, at proposed Minn. R. 7050.0471, subp. 2, the MPCA is proposing "[a]cceptable types of evidence"[390] that can be used in future rulemakings to add wild rice water bodies. The evidence must

> support a demonstration that the wild rice beneficial use exists or has existed on or after November 28, 1975, in the water body, such as by showing a history of human harvest or use of the grain as food for wildlife or by showing that a cumulative total of at least two acres of wild rice are present.[391]

267. The evidence the MPCA lists as acceptable evidence in its proposed Minn. R. 7050.0471, subp. 2, includes:

---

[386] Ex. D at 45.
[387] *Id.*
[388] *Id.*
[389] Ex. D at 46.
[390] Ex. C at line11.24 (proposed Minn. R. 7050.0471, subp. 2).
[391] Ex. C at lines11.21-11.24 (proposed Minn. R. 7050.0471, subp. 2) and MPCA Rebuttal at 8. The reference to the Rebuttal reflects some fairly minor proposed changes to the language in subpart 2 which the MPCA set forth in its December 1, 2017 Rebuttal Memorandum.

A. written or oral histories that meet the criteria of validity, reliability, and consistency;

B. written records, such as harvest records;

C. photographs, aerial surveys, or field surveys; or

D. other quantitative or qualitative information that provides a reasonable basis to conclude that the wild rice beneficial use exists.[392]

268. The MPCA found the MDNR report sufficiently reliable to presume that water bodies included in the report "with wild rice acreage estimates of two acres or more meet the beneficial use."[393] For waters in the MDNR report with fewer than two acre estimates, the MPCA looked to other sources to identify "high quality, harvestable wild rice waters."[394]

269. Several commenters maintained that, in rejecting waters listed in MNDR's 2008 report and in the 1854 Treaty Authority's list, the MPCA is removing a designated use from waters that already had wild rice as an "existing use" under federal law.[395] Under federal law, states are delegated authority to establish "designated uses" of waters and to set water quality standards to protect the designated uses.[396] According to these commenters, this action by the MPCA violates the CWA's prohibition against removing a designated use if the designated use is an "existing use[], as defined in [40 C.F.R.] § 131.3, unless a use requiring more stringent criteria is added . . . ."[397]

270. A number of commenters object to the MPCA's proposed list of Class 4D wild rice waters.[398] WaterLegacy and others assert that the MPCA's use of the term "beneficial use" with regard to the classification of wild rice waters is an imprecise and confusing use of a term that is not defined in either existing or proposed rules.[399]

271. WaterLegacy argues that the MPCA's proposed list of Class 4D waters is "arbitrary and exclusive" and will "de-list wild rice waters identified by Minnesota state agencies, including waters downstream of existing and potential mining discharge."[400]

272. WaterLegacy points out that the existing rules, at Minn. R. 7050.0220, subps. 3a, 4a, 5a, and 6a, apply the current 10 mg/L sulfate standard where wild rice is

---

[392] Ex. C at lines 12.1-12.6 (proposed Minn. R. 7050.0471, subp. 2).
[393] Ex. D at 46.
[394] Ex. D at 46.
[395] WaterLegacy eComment at 30. Hearing Ex. 1020, Written Comments of Dennis Morrison on behalf of Grand Portage Band of Chippewa (Grand Portage Comments) at 8 (Oct. 24, 2017). *See* eComment from Nancy Schuldt on behalf of Fond du Lac Band at 21-23 (Nov. 22, 2017).
[396] WaterLegacy eComment at 31. 40 C.F.R. § 131.3.
[397] 40 C.F.R. § 131.11(h)(1).
[398] eComment of Nancy Schuldt on behalf of Fond du Lac Band at 8-25 (Nov. 22, 2017), WaterLegacy eComment at 30-40; Hearing Ex. 1020, Grand Portage Comments at 4-8 (Oct. 24, 2017). eComment of Minnesota Center for Environmental Advocacy (MCEA eComment) at 2-5 (Nov. 22, 2017).
[399] WaterLegacy eComment at 30. Fond du Lac eComment at 20-21.
[400] WaterLegacy eComment at 30.

"present." Minn. R. 7050.0224, subp. 1, protects wild rice as a Class 4 water, "for wildlife designated public uses and benefits," recognizing it as a "food source for wildlife and humans." In addition, WaterLegacy cites Minn. R. 7050.0224, subp. 2, which limits sulfate to 10 mg/L in "water used for production of wild rice . . . ."[401]

273. WaterLegacy maintains that, while rescinding existing Minnesota rules that protect waters used for the production of wild rice and where wild rice is present, the proposed rules create a list of protected waters that excludes "many known and previously designated wild rice waters."[402]

274. WaterLegacy claims that the MPCA proposes to delist designated wild rice waters previously identified in consultation with the MDNR and Minnesota tribes. WaterLegacy contends that this delisting violates the CWA's prohibition on removing existing uses that have been attained at any time since November 28, 1975. In addition, according to WaterLegacy, the MPCA's proposed list fails to protect wild rice waters generally, and particularly fails to protect wild rice waters downstream of existing and proposed WWTPs.[403]

275. Other commenters disagree with the MPCA's proposed list of Class 4D waters for distinctly different reasons. Cleveland Cliffs focuses on the 2011 legislative requirement that the MPCA must consult "with the Department of Natural Resources, the Minnesota Indian tribes, and other interested parties and after public notice and comment"[404] to establish criteria for wild rice waters before the Agency designates such waters.[405] Cleveland Cliffs argues that this legislative language required the MPCA to engage in rulemaking to establish criteria for designating wild rice waters before it could designate such waters.[406]

276. In addition, Cleveland Cliffs contends that MPCA violated the language in the 2011 law requiring that "[t]he criteria shall include, but not be limited to, history of wild rice harvests, minimum acreage, and wild rice density" when it included waters in the Class 4D wild rice waters list, without regard to their failure to meet the MPCA's stated minimum acreage requirement or a known density of wild rice.[407]

277. U.S. Steel Corporation asserts the MPCA's listing of waters violates the 2011 legislation because the list does not contain information about wild rice density.[408]

[401] WaterLegacy eComment at 31.
[402] WaterLegacy eComment at 31. eComment of Nancy Schuldt on behalf of Fond du Lac Band at 8-25 (Nov. 22, 2017), Hearing Ex. 1020, Grand Portage Comments at 4-8 (Oct. 24, 2017).
[403] WaterLegacy eComment at 31.
[404] 2011 Minn. Laws, First Sp. Sess., Ch. 2, Art. 4(b).
[405] eComment from Rob Beranek on behalf of Cleveland Cliffs (Cleveland Cliffs eComment) at 16 (Nov. 22, 2017).
[406] Cleveland Cliffs eComment at 16.
[407] Cleveland Cliffs eComment at 17.
[408] Letter from Lawrence Sutherland on behalf of U.S. Steel (U.S. Steel letter) at 37-38 (Nov. 22, 2017).

278. The MPCA maintains that, for this rulemaking, it used a "weight-of-evidence approach as it reviewed the corroborating evidence from sources to determine if the wild rice beneficial use exists or has existed in a water." Further, the MPCA states:[409]

> Many of the supporting documents used in the MPCA's review do not contain complete information about the density or acreage of wild rice. Therefore, MPCA scientists used their best professional judgement to determine if the available information provided reasonable evidence that the water demonstrated the wild rice beneficial use (or had done so since November 28, 1975).
>
> For example, where a corroborating source qualitatively identified a water as having "lush" stands of wild rice, the MPCA considered that it met the beneficial use as a wild rice water. Because no single source provided comprehensive or consistent data about the presence of wild rice, the MPCA was not able to apply a strict criterion for what information did or did not reasonably characterize a wild rice water. The MPCA reasonably made the best use of the information from all sources as a basis for professional judgement.

279. In considering possible wild rice waters for inclusion in the list at 7050.0442, subp. 2, the MPCA did not explicitly apply the evidentiary expectations it proposes in Minn. R. 7050.0471, subp. 2. Nor did the MPCA explain why it rejected each proposed specific water that the MPCA excluded from the list in the proposed rule.

280. The MPCA acknowledges that it may not have included all of the waters where the wild rice use has existed since November 28, 1975 in the list proposed at Minn. R. 7050.0471.[410]

281. In the SONAR, the MPCA addresses the questions of whether it has included all wild rice waters with an existing use, stating that the Agency

> acknowledges that the wild rice waters in this rulemaking may not include every water in Minnesota where the wild rice beneficial use has existed since November 28, 1975. Although the MPCA has made reasonable use of the information available to develop and justify the proposed list of Class 4D wild rice waters, there are additional waters that may be wild rice waters but for which there is not yet sufficient information to determine that the beneficial use is demonstrated.[411]

282. In response to the commenters who believe that the list of wild rice waters is under-inclusive, the MPCA responds that "it is likely that not all wild rice waters have

[409] Ex. D at 47.
[410] Ex. D at 58.
[411] *Id.*

been identified and is proposing a specific process for future identification of wild rice waters" at proposed Minn. R. 7050.0471, subp. 2.[412]

283. In its December 1, 2017 Rebuttal memorandum, the MPCA states that it "does not agree that the presence (or evidence of past presence) of any amount of wild rice is indicative that the Class 4D wild rice beneficial use is an existing use in that water body."[413] In the same document, the MPCA states, with no affirmative presentation of facts to support the statement, that it "has identified those waters where wild rice is an existing use as wild rice waters. Some of those waters may not have wild rice today, but under the CWA must be protected if the use has existed since November 28, 1975."[414]

284. The 2011 legislature required the MPCA to engage in rulemaking only after completing significant research on "water quality and other environmental impacts on the growth of wild rice . . . ."[415] The amended rule was required to:

> (1) address water quality standards for waters containing natural beds of wild rice, as well as for irrigation waters used for the production of wild rice;
>
> (2) designate each body of water, or specific portion thereof, to which wild rice water quality standards apply; and
>
> (3) designate the specific times of year during which the standard applies.[416]

285. The MPCA was not authorized to engage in separate preliminary rulemaking to establish criteria for designating wild rice water bodies.[417]

286. The Administrative Law Judge concludes that the plain language in 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4, § 32(b), requires the MPCA to consider the criteria listed in the 2011 Session Law, but does not require that any one of the criteria be determinative. Therefore, the Administrative Law Judge concludes that there is no minimum wild rice acreage or density required for the MPCA to determine that a water body is included in the listing of wild rice water bodies.

287. The Administrative Law Judge concludes that the MPCA's proposed list of wild rice waters at Minn. R. 7050.0471, subps. 3 through 9 is defective because it fails to include all waters previously identified by the MDNR and federally recognized Indian tribes as waters where wild rice was an existing use since November 28, 1975. The MPCA's approach, in using a "weight-of-evidence" standard to identify waters such as those with "lush stands of wild rice" that would meet its criteria for "the beneficial use as a wild rice water" violates federal law, which prohibits removing an existing use for wildlife

[412] MPCA Response Memo at 13.
[413] MPCA Rebuttal Memo at 12.
[414] MPCA Rebuttal Memo at 13.
[415] 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4(d).
[416] 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4(a).
[417] 2011 Minn. Laws 1st Spec. Sess. ch. 2, art. 4.

unless more stringent criteria are applied.[418] Because Minn. R. 7050.0471 violates federal law, it fails to meet the requirements of Minn. R. 1400.2100.D and is defective.

288. The MPCA could cure the defect at Minn. R. 7050.0471 by amending the listed waters to include all waters previously identified by the MDNR and federally recognized Indian tribes as waters where wild rice was an existing use since November 28, 1975. The Administrative Law Judge concludes that adding the wild rice waters as described in this paragraph would not constitute modification that makes the rule substantially different than the rule as originally proposed based on the standards set forth at Minn. Stat. § 14.05, subd. 2.

D. Other Rule Parts Not Approved

287. In addition to the disapproved proposed rules and proposed changes to the proposed rules discussed above, there are several other rule parts which the Administrative Law Judge finds do not meet the legal requirements for rulemaking. Because of the significant underlying problems with these proposed rules overall, the following rules, and the standards they violate, are listed without additional discussion for the purpose of putting the Agency on notice should it reconsider this rulemaking in the future:

a. Minn. R. 7050.0224, 5, C. Site-specific sulfate standard. The proposed rule is disapproved based on a violation of Minn. R. 1400.2100.D. No process is provided for the commissioner to determine that "the beneficial use is not harmed." The criteria included in the rule, "reliable and representative data characterizing the health and viability of the wild rice . . . ," are vague and grant the commissioner discretion in excess of statutory authority to determine whether to substitute the existing standard.

b. Minn. R. 7050.0224, subp. 6. This proposed rule concerns the existing narrative standard for Class 4D [WR] waters currently at Minn. R. 7050.0224, subp. 1. The narrative standard applied to the only other wild rice waters previously identified in rule. The proposed rule moves the narrative standard to Minn. R. 7050.0224, subp. 6, and explicitly restricts application of the narrative standard to the wild rice waters originally identified in the rule, at Minn. R. 7050.0470, excluding the wild rice waters listed at 7050.0471 from the scope of its protections.[419] The Administrative Law Judge disapproves Minn. R. 7050.0224, subp. 6, to the extent that it does not apply to all wild rice waters. The MPCA provided no basis to distinguish between protections needed for the waters listed at Minn. R. 7050.0470 and those listed at Minn. R. 7050.0471. Therefore, to apply the narrative standard only to those listed at 7050.0470 violates Minn.

[418] 40 C.F.R. § 131.11(h)(1).
[419] Test. of Nancy Schuldt, Oct. 26, 2017 Tr. at 95-96.

R. 1400.2100.B because the record does not demonstrate the reasonableness of the rule.

E. Technical Errors

288. The language included in the following proposed rules appears to amend version of subparts which are no longer in effect. These are technical errors rather than legal defects. The Agency may cure the errors by amending the proposed language to propose changes to the current versions of the rule:

a. Minn. R. 7050.0220, subp. 5a

b. Minn. R. 7050.0470, subps. 1 through 9

F. Changes to the Proposed Rule

289. Following the public hearings, in its Response and Rebuttal Comments, the MPCA makes a number of proposed changes to the proposed rule. Because the Agency suggested changes to the proposed rule language after the date it was originally published in the *State Register*, it is necessary for the Administrative Law Judge to determine if this new language is substantially different from that which was originally proposed.

290. The standards to determine whether any changes to proposed rules create a substantially different rule are found in Minn. Stat. § 14.05, subd. 2(b). The statute specifies that a modification does not make a proposed rule substantially different if:

> (1) the differences are within the scope of the matter announced . . . in the notice of hearing and are in character with the issues raised in that notice;
>
> (2) the differences are a logical outgrowth of the contents of the . . . notice of hearing, and the comments submitted in response to the notice; and
>
> (3) the notice of hearing provided fair warning that the outcome of that rulemaking proceeding could be the rule in question.

291. In reaching a determination regarding whether modifications result in a rule that is substantially different, the Administrative Law Judge is to consider whether:

> (1) persons who will be affected by the rule should have understood that the rulemaking proceeding . . . could affect their interests;
>
> (2) the subject matter of the rule or issues determined by the rule are different from the subject matter or issues contained in the . . . notice of hearing; and

(3) the effects of the rule differ from the effects of the proposed rule contained in the . . . notice of hearing.[420]

292. To the extent that they are not approved, the MPCA's suggested language changes are described in the following paragraphs.

1. Changes That Are Not Approved

(1) Minn. R. 7050.0224, subp. 5, B (1)

293. The EPA comments that "it is not possible to say with certainty," regarding the equation-based sulfate standard set forth at Minn. R. 7050.0224, subp. 5, B (1), "that the relationships between sediment pore water sulfide and total organic carbon and total extractable iron used to calculate protective water column sulfate concentrations remain valid outside the range of the data used to develop the criterion."[421]

294. Commenter Nathan Johnson similarly observes:

> It is possible that a limitation on the model predictions could be imposed . . . which would not allow high sulfate concentrations to be calculated by the model if the statistical strength of the model's predictive abilities towards the edge of the domains is limited. Using the proposed equation to extrapolate to very high surface water sulfate concentrations (higher than those observed commonly in the observational dataset) represents a potential instance of applying the model beyond an appropriate domain of applicability. The same could be said for sediment carbon and iron.[422]

295. In response to these concerns, the Agency proposes to amend the equation for the numeric sulfate standard, "by setting constraints on the implementation of the equation that would ensure that the equation is protective."[423] The MPCA proposes to set these constraints so "that input values of carbon cannot be lower than the minimum value in the range of data used to develop the equation, because carbon enhances sulfide production." Similarly, under the MPCA's proposal the "input values of iron cannot be higher than the maximum value in the range of data used to develop the equation because iron removes sulfide from porewater."[424] The MPCA provides no specific values for its minimum carbon or maximum iron values.

296. As part of its response to the concerns raised by Mr. Johnson and the EPA about setting constraints consistent with the models, the MPCA proposes "that output

[420] *See* Minn. Stat. § 14.05, subd. 2.
[421] EPA Comments at 6.
[422] Nathan Johnson Comment at 1-2 (eComment Nov. 22, 2017).
[423] MPCA Rebuttal Memo at 3.
[424] *Id.*

values of sulfate cannot be higher than the maximum value in the range of data used to develop the equation, 838 mg/L."[425]

297. The MPCA asserts that the constraint on sulfate is appropriate "because observed sulfate levels were an input to the development of the equation, and the equation is of unknown validity outside the range used to develop it."[426] The Agency believes that this approach "will help assuage commenter concerns about exceedingly high sulfate levels that may result from the equation." However, the Agency realizes that imposing these limits may also raise concerns for other commenters.[427]

298. The Administrative Law Judge finds that, to the extent the equation-based standard remains a viable part of this rule, the sulfate cap is needed and reasonable and would not constitute a modification that makes the rule substantially different than the rule as originally proposed based on the standards set forth at Minn. Stat. § 14.05, subd. 2.

299. The Administrative Law Judge finds that, to the extent the equation-based standard remains a viable part of this rule, unspecified minimum carbon or maximum iron input values for the equation-based standard are not reasonable. They are unconstitutionally vague and violate the standards of Minn. R. 1400.2100.E.

(2) Minn. R. 7050.0224, subps. 5.E and F

300. In Minn. R. 7050.0224, subp. 5, E, the MPCA proposes to incorporate Sampling and Analytical Methods for Wild Rice Methods. As the name indicates, this document sets out methods for collecting and analyzing wild rice water sediment samples.

301. The MPCA explains that a "primary goal of incorporating the sampling methodology into the rule was to provide clarity so that others can conduct sampling and to ensure that the sampling, which is foundational to the developing of a numeric sulfate standard, is completed consistently and accurately." Because this goal is important to the MPCA, it plans to incorporate any changes to the methods incorporated by reference through rulemaking.[428]

302. Commenter Norman Miranda notes:

> The dilemma I see for utility managers regardless of whatever protective limit is adopted is to convince their respective City Council and rate payers that a very limited number of samples and sample locations yielded adequate and conclusive data to justify a significant capital investment. … I believe MPCA is on the right track offering a consistent sampling regime of a fixed number of samples at a prescribed location array. … I believe at least two sampling events conducted in appropriate but separate locations

[425] MPCA Rebuttal Memo at 4.
[426] *Id.*
[427] *Id.*
[428] MPCA Rebuttal at 5.

need to be conducted by the MPCA. I realize the MPCA has limited financial resources to conduct extensive sampling and analysis in multiple locations for every discharger. However, to offer some flexibility, I think the Rule should include a provision that municipalities/permitted facilities be given the opportunity to conduct additional sampling/testing beyond two events that would be required under the Rule. The ground rules for this additional sampling could include:

- Regulated party must submit a plan for MPCA approval showing proposed alternative sample locations.
- Sampling must follow MPCA "Sampling and Analytical Methods" and be conducted by approved lab/consultant.
- Sampling/testing to be done before or concurrent with MPCA sampling as not to delay MPCA's schedule.
- Cost of additional sampling events to be the responsibility of the Regulated Party.

In return I believe there should be language where the MPCA will give the Regulated Party's data set the same weight if all conditions are followed.[429]

303. The MPCA agrees that some flexibility may be needed as more sampling occurs, and appreciates that many permittees want to do more sampling, and perhaps sooner, than the MPCA plans to undertake. While the MPCA plans to do most sampling with its own resources, it plans to allow the use of data submitted by other parties (whether regulated parties or others) if the data was collected in accordance with the MPCA's requirements.[430]

304. The MPCA is proposing to amend Minn. R. 7050.0224, subp. 5, B (1) (a) - (c) at lines 8.6, 8.11, and 8.13, to require that analysis and sampling happen consistent with the methods that are incorporated by reference, rather than requiring exact adherence to the methods. This will allow some flexibility if, for example, an analytical method is slightly updated. The MPCA is also proposing to add language that the sediment samples are collected in areas where wild rice is growing or may grow within the wild rice water. The proposed rule language would read:[431]

Where:

(a) organic carbon is the amount of organic matter in dry sediment. The concentration is expressed as percentage of carbon, as determined ~~using~~ consistent with the method for organic carbon analysis in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E;

[429] eComment of Norman Miranda (Nov. 15, 2017).
[430] MPCA Rebuttal at 4-5.
[431] MPCA Rebuttal at 5.

(b) iron is the amount of extractable iron in dry sediment. The 8.10 concentration is expressed as micrograms of iron per gram of dry sediment, as determined ~~using~~ consistent with the method for extractable iron in Sampling and Analytical Methods for Wild Rice Waters;

(c) sediment samples are collected ~~using~~ consistent with the procedures established in 8.14 Sampling and Analytical Methods for Wild Rice Waters;

305. The MPCA is proposing additional related changes, likely to be codified as rule part 7050.0224, subp. 5, E, which would read as follows:[432]

> For each wild rice water identified in 7050.0471, the methods for selecting sediment sampling sites and for collecting, processing and analyzing sediment samples must be documented, including all QA/QC. Where methods are used that are consistent with but different from those specified in Sampling and Analytical Methods for Wild Rice Waters, the intended methods and how they will be used to calculate the numeric sulfate standard must be submitted to and approved by the Commissioner prior to sample collection.

306. The MPCA believes these changes will allow parties wishing to undertake sampling of wild rice waters needed to calculate a protective sulfate value the flexibility to do so, while ensuring necessary consistency. The MPCA intends that sampling by non-Agency personnel could occur at any time, even if MPCA sampling has already occurred. In those cases, the MPCA states, "the intended methods should describe how both the MPCA gathered data and any additional data will be used in concert." The MPCA intends that, in all cases, all sampling be documented.[433]

307. The Administrative Law Judge disapproves the MPCA's proposed language requiring prior approval of data collection methods to plan for allowing non-Agency personnel to engage in sampling and data collection of wild rice waters because the MPCA provides no criteria for approving alternate sampling plans. This delegates discretion to the Agency beyond what is allowed by law, in violation of Minn. R. 1400.2100.D.[434]

308. The MPCA states in its Rebuttal memorandum, but nowhere in the rule, that the MPCA will make the final determination about the numeric sulfate standard for any given water body.[435]

309. The MPCA includes no process and no criteria in the proposed rule language for the Agency to determine which of possible competing numeric sulfate

---

[432] MPCA Rebuttal at 5. The incorporation by reference would then be renumbered as Subp. 5, F. MPCA Rebuttal at 5.
[433] MPCA Rebuttal at 5.
[434] *See Lee v. Delmont*, 228 Minn. 101, 113, 36 N.W.2d 530, 538 (1949); *accord Anderson v. Commissioner of Highways*, 126 N.W.2d 778, 780 (Minn. 1964).
[435] MPCA Rebuttal at 5.

standards will apply in a given wild rice water. While the Administrative Law Judge does not disapprove incorporating by reference into the rule the Sampling and Analytical Methods for Wild Rice Waters, the Agency's larger scheme of permitting multiple players to propose standards with no written, transparent process or criteria for choosing among those standards exceeds the Agency's authority.

310. The Administrative Law Judge disapproves the MPCA's proposed language because, by granting the Agency authority to choose which standard to apply with no criteria in rule, the rule grants the Agency discretion beyond what is allowed by law in violation of Minn. R. 1400.2100.D.[436]

(3) Minn. R. 7050.0224, subp. 5, B (2)

311. The MPCA received several comments about the Alternate Standard set forth at Minn. R. 7050.0224, subp. 5, B (2). This alternate standard procedure develops a replicable approach to developing an alternate standard for areas where the equation does not fit – where there is high sulfate but low porewater sulfide. A number of commenters objected to the standard for a variety of reasons. [437]

312. In its Rebuttal, the MPCA proposes to revise Minn. R. 7050.0224, subp. 5, B (2), as follows:[438]

> The commissioner may establish an alternate sulfate standard for a wild rice water when the ~~ambient~~ surface water sulfate concentration is above the calculated sulfate standard and data demonstrates that sulfide concentrations in pore water are 120 micrograms per liter or less. Data must be gathered ~~using~~ consistent with the procedures specified in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E. The alternate sulfate standard ~~established must be either the annual average sulfate concentration in the ambient water or a level of sulfate the commissioner has determined will maintain the sulfide concentrations in pore water at or below 120 micrograms per liter.~~ is determined by calculating the ratio of measured sulfide, in micrograms per liter, to 120 micrograms per liter and applying that ratio to the surface water sulfate as follows $\frac{120}{porewater\ sulfate} * \textit{surface water sulfate}$.

313. The Administrative Law Judge disapproves of Minn. R. 7050.0224, subp. 5, B (2), because, as with the repeal of the 10 mg/L sulfate standard, the MPCA has failed to make an affirmative presentation of facts demonstrating that, in establishing an Alternative Standard which would allow increased levels of sulfate in wild rice waters, it

---

[436] *See Lee v. Delmont*, 228 Minn. 101, 113, 36 N.W.2d 530, 538 (1949); *accord Anderson v. Commissioner of Highways*, 126 N.W.2d 778, 780 (Minn. 1964).
[437] Test. of P. Maccabee, Oct. 23, 2017 Tr. at 104; eComment of Kurt Anderson on behalf of Minnesota Power (Minnesota Power eComment) at 18-19 (Nov. 21, 2017); eComment of Chrissy Bartovich and Lawrence Sutherland on behalf of U.S. Steel (U.S. Steel eComment) at 34 (Nov. 22, 2017).
[438] MPCA Rebuttal at 7.

is protecting the public health or welfare, enhancing the quality of water, and ensuring the proposed water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters, as required by federal and state law. Therefore, the Administrative Law Judge concludes that the proposed Alternative Standard violates Minn. R. 1400.2100.D, because it conflicts with other applicable law.

(4) Part 7050.0130, subp. 6a

314. **Part 7050.0130, subp. 6a** defines a "water identification number" or "WID" as a unique identifier used by the agency to identify a surface water.[439] Mining Minnesota objects to the MPCA's use of WIDs to describe the identified wild rice waters at proposed Minn. R. 7050.0471.[440] The basis for Mining Minnesota's objection is that the WIDs fail to describe the areas where wild rice beds are located with sufficient specificity, resulting in a list that designates waters with no wild rice, or no history of wild rice presence, as wild rice waters.[441] The result of the MPCA's use of what is essentially an administrative convenience, according to Mining Minnesota, is an overbroad regulation that "will inflict significant hardship on industry, companies, and private citizens across the state in a manner that is contrary to legislative intent."[442]

315. The MPCA disagrees with this criticism, stating that "WIDs are an important component of the MPCA's water programs."[443] The MPCA notes that the EPA agrees with the MPCA's assessment that rulemaking is required to make changes to a WID number that would entirely remove the WID from a particular water, or from a subpart of the water already identified as a wild rice water.[444] The MPCA contends that it is logical to apply the standard to the entire WID for lakes, wetlands, and reservoirs, because in these situations, the water generally "moves and mixes throughout the waterbody."[445] The MPCA notes that, in those cases where part of a lake or reservoir, such as a bay, is hydrologically isolated, the MPCA has a mechanism for assigning a separate WID to the hydrologically separate part of the waterbody.[446]

316. While the MPCA recognizes "that there may [be] cases where the presence of wild rice within a large or very diverse WID does not justify the application of the standard to the entire WID" the MPCA suggests that, in those cases, it "can split the WID and conduct a use and value determination . . . to remove the wild rice beneficial use from the WID that does not support the beneficial use."

317. The Administrative Law Judge concludes that the MPCA's proposal to "split the WID and conduct a use and value determination . . . to remove the wild rice beneficial

---

[439] Ex. C at lines 1.16-1.22.
[440] Letter from Frank Ongaro on behalf of Mining Minnesota (Mining Minnesota letter) at 3 (Nov. 22, 2017).
[441] Mining Minnesota letter at 3-4.
[442] Mining Minnesota letter at 7.
[443] MPCA Rebuttal at 14.
[444] *Id.*
[445] *Id.*
[446] *Id.*

use from the WID that does not support the beneficial use" at some time in the future would violate the federal prohibition on removing an existing use.[447] This proposal is not currently in the proposed rule and the Administrative Law Judge does not approve including it.

2. Changes That Are Approved

318. The MPCA proposes changes to a number of proposed rules in its Response and Rebuttal memoranda. Should the MPCA proceed with revisions to the overall rule, the Administrative Law Judge concludes that the MPCA's proposed changes to the rule parts listed below would be needed and reasonable and would not constitute modifications that make the rule substantially different than the rule as originally proposed based on the standards set forth at Minn. Stat. § 14.05, subd. 2:

a. Minn. R. 7050.0130, subp. 2b[448]

b. Minn. R. 7050.0130, subp. 6c[449]

c. Minn. R. 7050.0220, subps. 1, B (1-4), 3a, 4a, 5a and 6a[450]

d. Minn. R. 7050.0220, subp. 3a[451]

e. Minn. R. 7050.0224, subp. 5, B[452]

f. Minn. R. 7050.0471, subp. 3[453]

g. Minn. R. 7050.0471, subps. 6 and 8[454]

h. Minn. R. 7050.0471, subp. 8[455]

i. Minn. R. 7053.0406, subp. 1[456]

j. Minn. R. 7053.0406, subp. 2[457]

k. Minn. R. 7053.0406, subp. 2, B[458]

---

447 40 C.F.R. § 131.3 (e).
448 MPCA Rebuttal at 2.
449 MPCA Rebuttal at 3. The MPCA Rebuttal mistakenly refers to the rule part in question as part 7050.0220, subp. 6c.
450 MPCA Rebuttal at 2.
451 MPCA Rebuttal at 2-3.
452 Rebuttal at 7. EPA Comments at 5.
453 MPCA Response to Comments at 13.
454 MPCA Response to Comments at 14.
455 This WID location tool is intended to be supplementary to the Tableau interactive mapping tool presently available on the MPCA wild rice web page http://www.pca.state.mn.us/water/protectingwild-rice-waters. MPCA Response to Comments at 14.
456 MPCA Response to Comments at 14-15.
457 MPCA Response at 15. Minn. R. 7050.0190 contains provides that a variances from a water quality standard includes a variances for its related WQBEL. Environmental Protection Agency Comments (EPA Comments) at 15 (Nov. 22, 2017).
458 MPCA Response at 15.

G. Additional Findings

319. The Administrative Law Judge finds that the Agency has demonstrated by an affirmative presentation of facts the need for and reasonableness of all rule provisions that are not specifically addressed in this Report.

320. Further, the Administrative Law Judge finds that all provisions that are not specifically addressed in this Report are authorized by statute, and that, to the extent they are severable from the defective rules, there are no other defects that would bar the adoption of those rules.

321. Because some of the defects in the rule are defects in foundational portions of the proposed rules, the Administrative Law Judge advises the Agency against resubmitting the rule for approval of changes unless it addresses the defects in the wild rice water sulfate standard and the list of wild rice waters. However, the list of wild rice waters proposed at Minn. R. 7050.0471 is severable from the wild rice water sulfate standard. Therefore, the Administrative Law Judge finds that the Agency could choose to resubmit the proposed list of wild rice waters separately from the wild rice water sulfate standard.

Based upon the Findings of Fact and the contents of the rulemaking record, the Administrative Law Judge makes the following:

CONCLUSIONS OF LAW

1. The Agency gave proper notice of the hearing in this matter, pursuant to Minn. Stat. §14.14, subd. 1(a).

2. The Agency has failed to fulfill the procedural requirements of Minn. Stat. §§ 14.127 and 14.131, paragraphs 1, 5, 7, and 8. All other procedural requirements of rule and law have been satisfied for both the proposed repeal of the 10 mg/L sulfate standard and the adoption of the proposed rules.

3. The following proposed rules are **DISAPPROVED:**

   a. Proposed **Minn. R. 7050.0220, subps. 3a, 4a, 5a, 6a**: deleting reference to 10mg/L sulfate wild rice water standard violates Minn. R. 1400.2100 B and D.

   b. Proposed **Minn. R. 7050.0224, subp. 2**: repealing 10mg/L sulfate wild rice water standard violates Minn. R. 1400.2100.B and D.

   c. Proposed **Minn. R. 7050.0224, subp. 5, A**: to the extent the language incorporates the standard in items B (1) and (2) the language violates Minn. Stat. § 14.38 and Minn. R. 1400.2100.B and G.

d. Proposed **Minn. R. 7050.0224, subp. 5, A**: to the extent the language incorporates the standard in item C, the language violates Minn. R. 1400.2100.D.

e. Proposed **Minn. R. 7050.0224, subp. 5, B (1)**: violates Minn. R. 14.38 and Minn. R. 1400.2100.B, G, and E.

f. Proposed **Minn. R. 7050.0224, subp. 5, C**: violates Minn. R. 1400.2100.D.

g. Proposed **Minn. R. 7050.0224, subp. 6**: need or reasonableness for rule not established. Failure to distinguish between [WR], which are provided the additional protection of the narrative standard, and other wild rice waters listed at Minn. R. 7050.0471 violates 1400.2100.B.

h. Proposed **Minn. R. 7050.0471, subps. 3 through 9**: violates Minn. R. 1400.2100.D and E.

4. The following changes to rules as originally proposed are **DISAPPROVED:**

a. Proposed changes to **Minn. R. 7050.0224, subp. 5, B (1):** violates Minn. R. 1400.2100.E.

b. Proposed changed to **Minn. R. 7050.0224, subps. 5, E and F:** violate Minn. R. 1400.2100.D.

c. Proposed changes to **Minn. R. 7050.0224, subp. 5, B (2):** violates Minn. R. 1400.2100.D.

5. The Administrative Law Judge has suggested actions to correct some of the defects cited herein and to improve the clarity of the proposed rules should they be resubmitted for approval in the future.

6. Due to the disapproval of the proposed rules and the repeal of the existing rules, this Report has been submitted to the Chief Administrative Law Judge for her approval pursuant to Minn. Stat. § 14.15, subd. 3.

7. Any Findings that might properly be termed Conclusions, and any Conclusions that might properly be termed Findings, are hereby adopted as such.

8. A Finding or Conclusion of need and reasonableness with regard to any particular rule subsection does not preclude and should not discourage the Agency from further modification of the proposed rules based upon this Report and an examination of the public comments, provided that the rule finally adopted is based on facts appearing in this rule hearing record and is not substantially different from the proposed rule.

Based upon the foregoing Conclusions, the Administrative Law Judge makes the following:

RECOMMENDATION

IT IS HEREBY RECOMMENDED that the proposed rules be **DISAPPROVED.**

Dated: January 9, 2018

LAURASUE SCHLATTER
Administrative Law Judge

Reported:

Marcia L. Menth, Kirby Kennedy & Associates, St. Paul – 10/23
Calvin J. Everson, Danielson Court Reporting, Virginia – 10/24
Lorna D. Jacobson, Jacobson Reporting & Video Services, Bemidji – 10/25
Nathan D. Engen, Cloquet – 10/26
Nathan D. Engen, Brainerd – 10/30
Kelly L. Brede, Kirby Kennedy & Associates, St. Paul – 11/2

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT N

(Chief ALJ Order on Review of Rules, *In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice*, 2018)

OAH 80-9003-34519
Revisor R-4324

In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers, Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205 and 7053.0406

CHIEF ADMINISTRATIVE LAW JUDGE'S ORDER ON REVIEW OF RULES UNDER MINN. STAT. § 14.16, SUBD. 2, AND MINN. R. 1400.2240, SUBP. 5.

Background

The Minnesota Pollution Control Agency (MPCA or Agency) proposes to amend the state's existing rules governing Minnesota's water quality standard to protect wild rice from excess sulfate. The current standard limits sulfate to 10 milligrams per liter in waters used for the production of wild rice as well as in wild rice waters that do not contain cultivated wild rice.[1] The proposed rule amendments identify approximately 1,300 bodies of water in Minnesota as "wild rice waters" designated as subject to the new sulfate standard.[2]

The new standard is set forth in proposed rule at Minn. R. 7050.0224, subd. 5(B).[3] The proposed standard establishes an equation used to calculate the sulfate limit for each MPCA-designated body of water. The equation factors site-specific information and establishes a unique sulfate limit based upon the concentration of iron, organic carbon, and sulfide in the sediment of each designated body of water.[4]

When sulfate in water interacts with iron and organic carbon in sediment, sulfide can form, which the MPCA has determined is toxic to wild rice.[5] Key features of the proposed rules include limits on the amount of sulfide in the sediment of designated waters, and sampling and analytical methods to determine the amount of sulfide, carbon and iron present in the saturated sediment.[6]

---

[1] *See, e.g.,* Minn. R. 7050.0224, subps. 1 and 2 and Minn. R. 7050.0220, subps. 1, 3a, 4a,5a, and 6a (2017).
[2] MPCA Resubmission at 8 and Attachment 8, at 58 – 116.
[3] In the July 24, 2017 version of the proposed rules, the methods for calculating sulfate limits were found in part 7050.0224, subp. 5(B)(1). In the revised draft dated March 16, 2108, the requirements appear in part 7050.0224, subp. 5(B).
[4] *See* MPCA's Resubmission, Attachment 1, at 1, and Attachment 8, at 54-55.
[5] Report of the Administrative Law Judge, OAH Docket No. 80-9003-34519, at 1, 5 (January 9, 2018) (Report of the Administrative Law Judge).
[6] *See generally,* MPCA Resubmission, Attachment 8.

Procedural Posture

The Minnesota Pollution Control Agency commenced this rulemaking process on October 26, 2015 with its publication of a Request for Comments in the *State Register*.[7] With necessary approval, the Agency published its initial Notice of Hearing on August 21, 2017[8] and announced a series of hearings scheduled in October and November, 2017.[9] Over 350 individuals attended the six public hearings.[10] Members of the public submitted approximately 4,500 written comments on the proposed rule amendments.[11]

In a report dated January 9, 2018, Administrative Law Judge LauraSue Schlatter disapproved many of the proposed revisions to Minn. R. 7050.0220, 7050.0224 and 7050.0471. The matter then came before the Chief Administrative Law Judge pursuant to Minn. Stat. § 14.15, subd. 3 (2016), and Minn. R. 1400.2240, subp. 4 (2017). These authorities require that the Chief Administrative Law Judge review an Administrative Law Judge's disapproval of an Agency's proposed rule.

In a Report dated January 11, 2018, the Chief Administrative Law Judge concurred with the disapproval determinations of the Administrative Law Judge.[12] As a result:

1. The following proposed rules were disapproved:

    a. Proposed Minn. R. 7050.0220, subps. 3a, 4a, 5a, 6a
    b. Proposed Minn. R. 7050.0224, subp. 2
    c. Proposed Minn. R. 7050.0224, subp. 5, A
    d. Proposed Minn. R. 7050.0224, subp. 5, B (1)
    e. Proposed Minn. R. 7050.0224, subp. 5, C
    f. Proposed Minn. R. 7050.0224, subp. 6
    g. Proposed Minn. R. 7050.0471, subps. 3 through 9

2. The following modifications to rules as originally proposed were also disapproved:

    a. Proposed changes to Minn. R. 7050.0224, subp. 5, B (1)
    b. Proposed changed to Minn. R. 7050.0224, subps. 5, E, F
    c. Proposed changes to Minn. R. 7050.0224, subp. 5, B (2)

[7] *Id.* at 9, Finding 17.
[8] A second Notice of Hearing was published in September 2017 after the Agency scheduled a hearing to be held at the Fond du Lac Tribal Community College.
[9] *Id.* at 9, Finding 20.
[10] *Id.* at 2-3.
[11] *Id.* at 4.
[12] Report of the Chief Administrative Law Judge, OAH Docket No. 80-9003-34519, at 1, 5 (January 11, 2018) (Report of the Chief Administrative Law Judge).

The Report of the Chief Administrative Law Judge specifically instructed the MPCA on the statutory procedure for the Agency to follow in the event it decided not to correct the defects identified in the proposed rules, as follows:

> If the Department elects not to correct the defects associated with the repeal of the existing rules and the defects associated with the proposed rules, the Department must submit the proposed rules to the Legislative Coordinating Commission and the House of Representatives and Senate policy committees with primary jurisdiction over state governmental operations, for review under Minn. Stat. § 14.15, subd. 4 (2016).[13]

Effective on April 2, 2018, the MPCA requested that the Chief Administrative Law Judge review additional submissions in the matter, including the following:

a) March 28, 2018, Letter Response to the Report of the Chief Administrative Law Judge dated January 11, 2018 (Response), with the following attachments:

- Attachment 1: March 5, 2018 Letter from Christopher Korleski, Environmental Protection Agency, Region V, to Shannon Lotthammer, Assistant Commissioner, MPCA (EPA 2018 Letter);
- Attachment 2: November 5, 2015 Letter from Tinka G. Hyde, Environmental Protection Agency, Region V, to Rebecca Flood, MPCA (EPA 2015 Letter);
- Attachment 3: EPA's Review of Revisions to Minnesota's Water Quality Standards: Human Health Standards Methods (Nov. 5, 2015);
- Attachment 4: November 22, 2017 Letter from Christopher Korleski, Environmental Protection Agency, Region V, to LauraSue Schlatter, Administrative Law Judge with enclosed comments on Minnesota's "Proposed Rules Relating to Wild Rice Sulfate Standard and Wild Rice Water" (EPA 2017 Comments);
- Attachment 5: Sampling and Analytical Method for Wild Rice Methods (March 2018);
- Attachment 6: Technical Discussion of Proposed Equation Related Changes to the Rule;
- Attachment 7: List of Proposed Rule Changes;

[13] Report of the Chief Administrative Law Judge at 2.

- Attachment 8: Revisor's March 16, 2018, version of Proposed Rule incorporating changes as proposed in March 28, 2018 filing (Revisor's AR4324);

- Attachment 9: January 19, 1999 Memorandum from Marvin E. Hora, Manager, Environmental Research and Reporting, Environmental Outcomes Division to the Minnesota Pollution Control Agency Board Water Quality Committee regarding Proposed Revisions of Minn. Rules ch. 7050;

- Attachment 10: Statement of Need and Reasonableness "In the Matter of the Proposed Revisions to the Rules Governing the Classification and Standards for Waters of the State, Minnesota Rules Chapter 7050" page 54 (April 27, 1993) and attached draft rule page;

b) Draft Order Adopting Rules (filed April 2, 2018); and

c) Revisor's July 24, 2017, version of Proposed Rules (Revisor's RD4324A).

The MPCA's request for review was made pursuant to Minn. Stat. § 14.16, subd. 2 (2016) and Minn. R. 1400.2240, subp. 5 (2017).

Legal Analysis

Rulemaking is a statutory process governed by the provisions of the Minnesota Administrative Procedure Act (Act), Minn. Stat. Ch. 14. The Office of Administrative Hearings is statutorily required to review rulemaking matters in accordance with the dictates of that Act.[14]

Relevant to the current proceeding, Minn. Stat. § 14.14, subdivision 2 (2016), provides as follows:

> **At the public hearing** the agency shall make an affirmative presentation of facts establishing the need for and reasonableness of the proposed rule and fulfilling any relevant substantive or procedural requirements imposed on the agency by law or rule. The agency may, in addition to its affirmative presentation, rely upon facts presented by others on the record during the rule proceeding to support the rule adopted.[15]

In this case, the Administrative Law Judge determined that the MPCA failed to meet this and other requirements of the Act and therefore disapproved the proposed rule.[16] As required by law, the disapproval was reviewed by the Chief Administrative Law

[14] Minn. Stat. §§14.05 and 14.08 (2016).
[15] Emphasis added.
[16] Report of the Administrative Law Judge at 5-6.

Judge and, in a January 11, 2018 Report, the MPCA was advised regarding how to correct the determined defects.

Building upon the statutory directive that an agency meet all requirements of the Act relevant to rulemaking, Minn. Stat. § 14.15, subd. 4, provides as follows:

> If the chief administrative law judge determines that the need for or reasonableness of the rule has not been established pursuant to section 14.14, subdivision 2, and if the agency does not elect to follow the suggested actions of the chief administrative law judge to correct that defect, then the agency shall submit the proposed rule to the Legislative Coordinating Commission and to the house of representatives and senate policy committees with primary jurisdiction over state governmental operations for advice and comment. The agency may not adopt the rule until it has received and considered the advice of the commission and committees. However, the agency is not required to wait for advice for more than 60 days after the commission and committees have received the agency's submission.

The MPCA has not complied with the law in this regard. In its Resubmissions, it has not followed the Chief Administrative Law Judge's directives regarding how to correct the defects in the proposed rule, nor has it submitted the disapproved rule to the identified legislative bodies for advice. Instead, the MPCA has, in effect, requested reconsideration of the rule's disapproval and seeks an order allowing adoption of the proposed rule, in modified form.

The Chief Administrative Law Judge declines to grant the MPCA its requested relief. While it is clear that the Agency has made significant efforts to reexamine the proposed rule and make clarifications and revisions where deemed appropriate, it is just as clear that the Agency has not followed the provided directives for curing all identified defects, nor identified other record-based and public-vetted solutions to achieve the same ends consistent with the spirit and the letter of the Minnesota Administrative Procedure Act.[17] Neither has the Agency availed itself of the only other statutory alternative: seeking legislative advice as required by the law.

The Chief Administrative Law Judge is cognizant of the fact that the Agency is dedicated to protecting the quality of the waters in the state and so has invested significant human, temporal and financial resources in this effort. Mindful that the protection of Minnesota's wild rice waters will remain an important policy and regulatory goal for and in the state, the Chief Administrative Law Judge has set forth below additional information that may prove useful to the Agency as it continues to address this issue on behalf of all Minnesotans.

---

[17] Minn. Stat. 14.001 (2016).

Substantive Review of Agency Resubmissions

The Agency submitted three categories of information to the Chief Administrative Law Judge in support of its request for review. The bulk of the submissions constitute legal argument intended to serve as a basis for reversal of various findings of rule disapproval contained in both the Administrative Law Judge's Report and the Chief Administrative Law Judge's Report.[18] In addition, the submissions include proposed modifications to portions of the disapproved rule. Last, the filings encompass other proposed rule changes not recommended by the Administrative Law Judge.[19] The MPCA's filings are silent on many of the disapproved rule parts notwithstanding the fact that the Administrative Law Judge specified various legal grounds for their disapproval.

Below, the Chief Administrative Law Judge has summarily addressed each of the major issues raised in the MPCA's Resubmissions.

I. Equation-Based Standard

A. <u>Numeric Expression of the Standard</u>

The MPCA argues that the Administrative Law Judge found the proposed equation-based standard to be *per se* invalid, and argues that the existence of other approved rules which rely on mathematical equations proves the Administrative Law Judge's determination to be incorrect.[20] In fact, it is the MPCA that is incorrect. The Administrative Law Judge did not disapprove the proposed standard based on the fact that it contained an equation, but instead determined that the Agency had met its statutory burden to show the equation-based standard to be necessary and reasonable.[21] The Administrative Law Judge went on to find that the proposed implementation of the equation-based standard requires measurement of 1,300 identified waters, a feat that will require approximately ten years to accomplish, and until that is completed no one can know exactly what standard applies and must be met in each identified body of water.[22] Given these facts, the Administrative Law Judge determined that the proposed rule was insufficiently specific to be approved[23] and that it was not "rationally related to the Agency's objective" of "protect[ing] wild rice from the impact of sulfate, so that wild rice can continue to be used as a food source by humans and wildlife."[24] Pursuant to Minn. R. 1400.2100.B., a rule cannot lawfully be approved if it does not rationally relate to the

---

[18] The Report of the Chief Administrative Law Judge concurred in all respects with the findings and conclusions contained in the Report of the Administrative Law Judge. For the convenience of the reader, further references to the issued Reports will cite only to the Report of the Administrative Law Judge.
[19] MPCA Resubmission at 1.
[20] MPCA Resubmission at 1-4.
[21] Report of the Administrative Law Judge at 60-61, Findings 251, 256, 257.
[22] *Id.* at 61, Finding 258 and at 55-59, Findings 234-249.
[23] *Id.* at 58, Finding 247. *See also Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, 469 N.W.2d 100, 107 (Minn. Ct. App. 1991) ("A rule, like a statute, is void for vagueness if it fails to give a person of ordinary intelligence a reasonable opportunity to know what is prohibited or fails to provide sufficient standards for enforcement") (citing *Grayned v. City of Rockford,* 408 U.S. 104, 108-09 (1972)).
[24] Report of the Administrative Law Judge at 58, Finding 246.

Agency's objectives. Having reached this conclusion, the Administrative Law Judge disapproved the proposed rule.

In its Resubmissions the Agency reverts to its argument that:

> "[e]ffluent limit review is case-specific and includes evaluating information such as pollution concentrations in the receiving water and the discharge . . . and how many sources contribute to the receiving water. … Until that information is reviewed and the effluent limit is established, no permittee can know if or to what extent they will have to treat their wastewater discharge for the given pollutant, even if the standard that the effluent limit is protecting is a single numeric value."[25]

In essence, the Agency ignores the Administrative Law Judge's rational relationship analysis and continues to insist that the proposed equation-based rule should be approved based upon the fact that it is necessary and reasonable. Unfortunately, the Administrative Procedure Act does not provide for approval based on that factor alone; all other requirements of statute and rule must also be met in order for rule approval to be lawfully granted.[26]

Even while continuing to argue that the proposed equation-based standard is legally sufficient and should be approved, the MPCA's Resubmissions include several key clarifications and revisions to the equation and required analysis. Three major revisions, and the Chief Administrative Law Judge's responses to each, are addressed below.

(1) Removal of Second Lake

The MPCA revised the proposed equation through the removal of one of four identified outliers in the dataset upon which it had relied in originally promulgating the formulaic equation. This proposed change was made as a result of the Agency's apparent post-January 2018 recognition, grounded in "new information" published in a 2017 study which the Agency relied upon at the rulemaking hearings,[27] which established that "the equation would potentially be made inaccurate if the concentrations [of sulfate compared between groundwater and surface water] were significantly different."[28] A significant difference in the concentrations suggests that upwelling groundwater rather than downward-moving sediment from overlying surface water could be responsible for the "observed false positives in the MPCA data set (false positives are waterbodies for which the equation predicts that sulfide should exceed 120 micrograms per liter, but the sulfide is less than 120)."[29] Having found the concentrations to be materially different in four water bodies, but only having data documenting the fact of upwelling groundwater in one of the four (Second Creek), the Agency proposes removal of this one outlier water body

[25] *Id*. at 4.
[26] Minn. Stat. § 14.05 (2016).
[27] *See* Hearing Exhibit L.2, Ng et al., 2017.
[28] MPCA Resubmissions, Attachment 6 at 1.
[29] *Id.*

from the data set. The result of this removal is a resulting in a change in the mathematical terms included in the equation.[30]

The Agency's newly-submitted revision, based on the exclusion of one outlier in the data set, is based on information available at the time of hearings. This indicates that the Agency's discernment of the proper criteria for inclusion/non-inclusion in the proposed equation-based standard continues to evolve. While this is laudatory, it supports the view expressed at hearing that the proposed standard is too much a continuing work-in-progress to be adopted as an enforceable rule.

By law, a rule is defined as an "agency statement of general applicability and future effect, including amendments, suspensions, and repeals of rules, adopted to implement or make specific the law enforced or administered by that agency or to govern its organization or procedure."[31] It is not difficult to understand how the public questions whether a standard that is unknowable until sufficiently sampled and calculated over a period of ten years, which consists of an equation with mathematical terms that continue to evolve even before adoption, can constitute a rule by which their actions can be regulated.

(2) Inserted Caps

In the proposed revised standard, the MPCA sets minimum and maximum sulfate limits separate and apart from the site-specific limits derived from the equation calculation in proposed rule Minn. R. 7050.0224, subd. 5(B). Functioning as boundaries on the standard, the Agency proposes that the minimum numeric expression of the sulfate standard would be 0.5 milligrams per liter and the maximum numeric expression of the standard would be 335 milligrams per liter.[32]

The insertion of capped boundaries appears to be a prudent and reasonable change to the proposed standard. The Chief Administrative Law Judge notes, however, that the public has had no opportunity to comment regarding whether these specific, proposed caps are the appropriate ones for inclusion in the proposed rule.

(3) Choosing Between Competing Values

The Administrative Law Judge disapproved the proposed rule, in part, based upon the fact that the Agency allowed for any person to measure and propose the standard for an identified water body but had provided no written, transparent process or criteria for doing so. Neither had the Agency identified what process it would rely upon when required to choose among differing, submitted numeric standards.[33]

In its Resubmissions, the Agency clarified that any person, including persons who are not MPCA staff, are allowed to calculate the allowable amount of sulfate for a

---

[30] *Id.*; Part 7050.0224, subp. 5, Item B.
[31] Minn. Stat. § 14.02, subd. 4 (2016).
[32] MPCA Resubmissions, Attachment 8 at 55.
[33] Report of the Administrative Law Judge at 74, Findings 308-310.

particular body of water by undertaking collection and calculation processes in compliance with the Agency's publication titled *Sampling and Analytical Methods for Wild Rice Waters*.[34] This required technical methodology is incorporated by reference at proposed Minn. R. 7050.0224, subd. 5 (E).

In an apparent attempt to address the issue of choosing between competing and differently valued samples, the Agency's Resubmissions provide as follows:

> All data collected in a wild rice water would be used to set the numeric expression of the standard for that wild rice water. If MPCA has already collected and analyzed 15 (or more) values, then the next 15 (or more) values would be added to the calculation. Moving to a percentile approach will provide greater stability in the numeric expression of the standard – as more data is collected, the numeric expression will converge on the "true" value. This will reduce the likelihood of major changes in the calculated expression of the standard.[35]

The Chief Administrative Law Judge finds this statement to be an insufficient response to the stated concern. First, the statement is not contained in the language of the proposed rule; it is included only in correspondence filed with the Chief Administrative Law Judge as part of the Agency's Resubmissions. This will not become part of any published rule available for future reference or review, and will not have the force and effect of law. Second, the described process does not address the Agency's planned response when less than 15 samples are submitted. For example, assume that Measurer A samples, calculates and submits a proposed standard of .1X for an identified water and Measurer B samples, calculates and submits a proposed standard of 100X for the same body. While the Resubmissions imply that the Agency would average the two submissions into its existing 15 or more samples, that process is not explicitly stated.

In addition, the Agency's Resubmissions clearly indicate that "as more data is collected" the standard for any specified water body will continue to change.[36] In essence, then, the public will be unable to rely upon even the Agency's publication of any specified standard. As an example, consider a situation wherein a water body is sufficiently sampled and the standard calculated to be Y, a value with the Agency publishes on its website and is relied upon by the public. An hour after publication, a different measurer gathers, calculates and submits 15 additional samples to the Agency, which promptly "add[s] them to the calculation" so as to allows the standard to "converge on the 'true' value."[37] As a result, the enforceable standard is immediately changed, and the public would have no knowledge of the change absent continual monitoring of the Agency's website. In essence, the proposed standard becomes not a measuring stick, but a slide

[34] MPCA Resubmission at 4 ("the proposed wild rice rule requires sampling from specific water bodies in order to generate data needed to plug into the equation before a numeric expression can be developed and provides notice of how that data should be gathered and the numeric expression to be determined"). Part 7050.0224, subp. 5, item E.
[35] *Id*., Attachment 6 at 10.
[36] *Id.*
[37] *Id.*

rule. It is difficult to conclude that such a process could ever "give a person of ordinary intelligence a reasonable opportunity to know what is prohibited or … provide sufficient standards for enforcement."[38] Failing to do so, the proposed rule cannot withstand legal scrutiny.

Overall, it is possible that the Agency's submitted clarifications and revisions noted above may represent improvements in the proposed rule. Even so, the fact remains that none of these refinements were made available for public comment or discussion, at hearing or otherwise.

B. Repeal of existing 10 mg/L standard

In her Report disapproving the rule, the Administrative Law Judge noted the public's significant concern that increases in sulfate could lead to increases in methyl mercury, which bio-accumulates in fish and has long-term serious health effects on humans.[39] The MPCA agreed that "enhanced production of methylmercury is a significant concern,"[40] but insisted that this issue was outside the scope of this rulemaking process.[41]

In its Resubmissions, the Agency clarified that it would continue to rely on the state's existing eutrophication standards and mercury standards to ensure that all applicable water standards are met.[42] The Agency admitted that this fact was "so fundamental" to its work that it "escaped mention" in its written response to the public's comments on this issue.[43] If the Agency resubmits this rule in the future, it should include evidence in the record to support its allegations regarding its ability to ensure that all applicable water standards are met.

C. Downstream Waters: Tribes

Both the Fond du Lac Band and the Grand Portage Band of Lake Superior Chippewa have in place wild rice water quality standards that limit sulfate to 10 milligrams/liter. These standards are federally approved and not alterable by the state.[44] The Administrative Law Judge expressed a concern that loosening the sulfate standard for the state's designated waters could degrade the quality of the Bands' wild rice waters.[45]

In its Resubmissions, the Agency recognized the possibility that completing the calculation in proposed Minn. R. 7050.0224, subd. 5(B), might result in numeric expressions of the sulfate standard that are greater than 10 milligrams per liter. In such

---

[38] *Minnesota Chamber of Commerce v. Minnesota Pollution Control Agency*, 469 N.W.2d 100, 107 (Minn. Ct. App. 1991).
[39] Report of the Administrative Law Judge at 51-52, Findings 219-221.
[40] *Id.* at 52, Finding 220.
[41] *Id.* at 52, Finding 221.
[42] MPCA Resubmission at 5.
[43] *Id.* at 6.
[44] Minn. R. 7050.0155; Report of the Administrative Law Judge at 52, n. 326, citing Hearing Ex. 1020.
[45] Report of the Administrative Law Judge at 52-53, Findings 223-225.

cases, the Agency asserts that it would use other regulatory controls to ensure that waters flowing downstream into areas still governed by the current 10 milligram per liter standard continue to meet applicable water quality standards.[46] If this rule is resubmitted for approval, the Agency should include in the record sufficient evidence to support this assertion.

II. Proposed List of Waters

Federal law delegates to states the authority to establish designated uses of waters and to establish water quality criteria to protect those designated uses in bodies of water.[47] States are prohibited from removing a designated use, if such a use is an "existing use," unless a use with more stringent criteria is added.[48] An existing use is one "actually attained in the water body on or after November 28, 1975, whether or not it is included in the water quality standards."[49]

In the proposed rule, the Agency identified a list of approximately 1,300 waters at Minn. R. 7050.0471. The MPCA based its list upon, among other sources, a comprehensive, reviewed list compiled by the Minnesota Department of Natural Resources (DNR) in a 2008 Report to the Legislature.[50] The MPCA recognized that the DNR's list "is widely considered the most comprehensive source of information regarding where rice may be found in Minnesota" and so extensively reviewed the DNR list when making its designations.[51] In compliance with its legislative directive, the MPCA also consulted with the various Tribes when compiling its list.[52]

In making its determinations as to which water bodies would be included in the list, the MPCA did not explicitly apply the standards it intends to use in future rulemakings to determine whether a water body should be added to the list of wild rice waters.[53] Instead, the Agency used a "weight of evidence" standard to identify waters that met its criteria for "beneficial use as a wild rice water."[54] The rulemaking record does not identify each water considered and rejected for inclusion on the list, nor does it reveal on what basis the Agency rejected any proposed water from inclusion on the list.[55] The MPCA

---

[46] MPCA Resubmission, at 6 ("Protection of downstream waters is required by 40 CFR 131.10(b). The MPCA already complies with this requirement and there is now a state rule that expressly requires such compliance, Minn. R. 7050.0155…. [To protect these waters, MPCA will] 'facilitate consistent and efficient implementation and coordination of water quality-related management actions' such as permits.").
[47] 40 C.F.R. § 131.3.
[48] 40 C.F.R. § 131.11(h)(1).
[49] 40 C.F.R. § 131.3(e); *See* Report of the Administrative Law Judge at 65, 68, Findings 269, 283.
[50] Report of the Administrative Law Judge at 63-64, Findings 263, 265.
[51] *Id.* at 64, Finding 265.
[52] *Id.* at 62, Finding 261.
[53] *Id.* at 67, Finding 279.
[54] *Id.* at 67, Finding 278.
[55] *Id.* at 67, Finding 279. According to its Resubmissions, the Agency recently asked the federal Environmental Protection Agency (EPA) how uses are designated and whether an existing use can be a designated use. The EPA responded in a March 5, 2018 letter to the Agency (March 28 letter, Att. 1, at 5-8). The only discussion of "existing use" is a clarification of the regulatory definition at 40 CFR 131.3 (e) ("those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards.") The EPA explains "that existing uses are known to be 'actually

acknowledged that it may not have included in the proposed list all waters where the wild rice use has existed since Nov. 28, 1975.[56]

The Administrative Law Judge disapproved the proposed list, concluding that the MPCA's approach excluded hundreds of water bodies previously on lists from the DNR and other sources, including the 1854 Treaty Authority's 2016 and 2017 lists of wild rice waters.[57] The Administrative Law Judge determined that these exclusions violated the federal prohibition against removing a designated use if such a use is an existing use.[58] She also expressed concerns with the reasonableness of the Agency's exclusion of waters without any explicit standards or discussion.[59]

In its Resubmissions, the Agency argued that it compiled its list in consultation with the DNR and tribes, but insisted that it alone can determine what constitutes an "existing use" in Minnesota for purposes of the federal Clean Water Act (CWA).[60] Citing Minn. Stat. §§ 115.03, subd. 1(b) and 115.44, the MPCA argues that it is the only state agency with legal authority to classify waters of the state and assign designated uses.[61]

The Agency's authority is not as clear as it asserts. Minn. Stat. §§ 115.03, subd. 1(b) and 115.44 address the Agency's authority to classify waters, not specifically to determine existing uses for purposes of the CWA. While federal law provides that "the state" may determine existing uses, it does not specify which agency within a state has that unique authority.[62]

Even if the MPCA can establish that its authority trumps that of the DNR or any other state agency, it cannot establish that it is the sole decider of what constitutes an existing use for purposes of federal law. The CWA specifically authorizes certain Indian tribes to make designations as well. The Fond du Lac Band and the Grand Portage Band of Lake Superior Chippewa are both authorized to do so based on approved agreements with the federal government regarding water quality standards.[63] Both Bands agreed that, in rejecting the DNR's report and the 1854 Treaty Authority's list, the MPCA was removing waters that the Bands had already designated as having wild rice as an existing use under federal law.[64]

---

attained' when theh use has actually occurred *and* the water quality necessary to support the use has been attained. EPA recognizes, however, that all necessary data may not be available to determine whether the use actually occurred or the water quality to support the use has been attained. When determining an existing use, the EPA provides substantial flexibility to states and authorized tribes to evaluate the strength of the available data . . . ." *See* MPCA Resubmissions, Attachment 1 at 8, citing 80 Fed. Reg. 51027.

[56] Report of the Administrative Law Judge at 67, Findings 280-282.

[57] *Id.* at 65, Finding 269.

[58] *Id.* at 69, Finding 287.

[59] *Id.* at 68, Finding 283.

[60] MPCA Resubmissions at 8-10.

[61] *Id.* at 9.

[62] The Chief Administrative Law Judge notes that the MPCA is designated as the "agency responsible for providing section 401 certifications for nationwide permits: under the CWA. Minn. Stat. 115.03, subd. 4a (2016).

[63] MPCA Resubmissions at 9, n 44.

[64] Report of the Administrative Law Judge at 65, Finding 269, n 395.

III. **Narrative criteria**: Minn. R. 7050.0224, subp. 6

In Part 7050.0224, subp. 6,[65] the MPCA leaves in place an existing (but slightly re-worded) narrative standard for protecting certain wild rice waters. The Administrative Law Judge disapproved this standard because it applies only to some, and not all, wild rice waters.[66] The record reveals no showing of need and/or reasonableness for distinguishing between application of the narrative standard to some waters and the numeric standard to others.[67]

In its resubmissions, the Agency clarified that establishing a sulfate limit standard for certain bodies of water designated in the proposed rule does not remove protections under the federal Clean Water Act for other bodies of water not designated in the proposed rule.[68] The Agency argued that federal law allows a narrative standard to be applied to a set of identified waters that are not the same set to which a numeric standard applies.[69]

Without more, this argument is not convincing. While federal law clearly allows for different regulatory standards for subgroups of waters, Minnesota's rulemaking statute requires an explanation for differentiating between similarly situated groups in these circumstances. The missing explanation relates to whether the differentiation is necessary and reasonable, a foundational criteria for approval of any proposed rule.

IV. Unaddressed Technical Errors[70]

The Chief Administrative Law Judge's review of the Agency's resubmissions has revealed the following instances wherein the Agency has failed to address technical errors identified as additional bases for disapproval.

A. Part 7050.0220, subp. 5a.[71]

According to a review of the 2017 rule language published at the Revisor of Statutes website, the existing rule language highlighted below continues to be missing from the proposed rule amendment.

---

[65] *See* Lines 9.13 - 9.18 in 7/24/17 version and lines 56.18 - 56.23 in 3/16/18 version.

[66] Report of the Administrative Law Judge at 69, Finding 287b.

[67] Report of the Administrative Law Judge at 69-70.

[68] MPCA Resubmissions at 7 ("[H]aving different standards for different reaches is not inherently unprotective of downstream waters. As required by federal law, the MPCA has met, and will continue to meet requirements to ensure that downstream standards are protected in the permitting process. The MPCA submits that ... with respect to the proposed rule, as with all its rules, it has and is obligated to implement its rules so as to be protective of downstream uses.").

[69] *Id.*, Attachment 1 at 8-9. The EPA cited to 40 CFR 131.10(c), which provides that "States may adopt sub-categories of a use and set the appropriate criteria to reflect varying needs of such sub-categories of uses, for instance, to differentiate between cold water and warm water fisheries." The MPCA offers no explanation for distinguishing between the categories of wild rice waters.

[70] MPCA Resubmissions, Proposed Order at 7, comment 28.

[71] *See* Lines 4.19-4.24 of 7/24/17 version and lines 38.21-39.3 of 3/16/18 version.

Subp. 5a.

Cool and warm water aquatic life and habitat and associated use classes.

Water quality standards applicable to use classes 2B, 2Be, 2Bg, 2Bm, or 2D; 3A, 3B, or 3C; 4A and 4B; and 5 surface waters. See parts 7050.0223, subpart 5; 7050.0224, subpart 4; and 7050.0225, subpart 2, for class 3D, 4C, and 5 standards applicable to wetlands, respectively. The water quality standards in part 7050.0222, subpart 4, that apply to class 2B also apply to classes 2Be, 2Bg, and 2Bm. In addition to the water quality standards in part 7050.0222, subpart 4, the biological criteria defined in part 7050.0222, subpart 4d, apply to classes 2Be, 2Bg, and 2Bm.

B. Part 7050.0470, subps. 1 through 9.[72]

Based on the 2017 rule language available for review on the Revisor of Statutes website, the Agency is proposing to amend an outdated version of subparts 1-9. Subpart 1 is given as an example, below. The highlighted language is the language on the Revisor's website and noted as "published electronically on November 20, 2017." The language without highlighting is the language the Agency now presents as the current language, with proposed amendments indicated.

Subpart 1.

Lake Superior basin.

The water use classifications for the listed waters in the in the Lake Superior basin are as identified in items A to D. See parts 7050.0425 ~~and~~, 7050.0430, and 7050.0471 for the classifications of waters not listed. Thus, it appears that the Agency proposes to amend an out-of-date version of the rule. This applies to all 9 subparts of part 7050.0470.

Lake Superior basin.

The water-use classifications for the stream reaches within each of the major watersheds in the Lake Superior basin listed in item A are found in tables entitled "Beneficial Use Designations for Stream Reaches" published on the Web site of the Minnesota Pollution Control Agency at www.pca.state.mn.us/regulations/minnesota-rulemaking. The tables are incorporated by reference and are not subject to frequent change. The date after each watershed listed in item A is the publication date of the applicable table. The water-use classifications for the other listed waters in the Lake Superior basin are as identified in items B to D. See parts 7050.0425 and 7050.0430 for the classifications of waters not listed. Designated use information for water bodies can also be accessed through the agency's

[72] *See* Lines 9.21-11.13 of 7/24/17 version and lines 57.3-58.17 of 3/16/18 version.

Environmental Data Access (http://www.pca.state.mn.us/quick-links/eda-surface-water-data).

V. Approved Rule Modifications

In Attachment 7 of its Resubmissions, the Agency provides a list of 22 proposed rule changes for consideration by the Chief Administrative Law Judge. Upon review, the Chief Administrative Law Judges finds as follows:

- Proposed Rule Changes 1 – 4: Already approved in the Report of the Administrative Law Judge
- Proposed Rule Changes 5 – 8: Relate to the proposed equation-based standard and not approved for the reasons specified in the Report of the Administrative Law Judge and this Order.
- Proposed Rule Changes 9 – 11: Already approved in the Report of the Administrative Law Judge
- Proposed Rule Changes 12 – 13: Approved as related to Proposed Rule Change 11
- Proposed Rule Changes 14 – 16: Approved as minor clarifications
- Proposed Rule Changes 17 – 21: Already approved in the Report of the Administrative Law Judge
- Proposed Rule Change 22: Not approved for the reasons set forth in the Report of the Administrative Law Judge and this Order.

Based upon a review of the rulemaking docket, the Report of the Administrative Law Judge, the Report of the Chief Administrative Law Judge and the Agency's Resubmissions, the Chief Administrative Law Judge issues the following:

ORDER

1. The proposed rules, dated July 27, 2017, as modified by the Agency's Resubmissions, remain disapproved for the reasons set forth in the Report of the Administrative Law Judge, as modified and or clarified by the provisions of this Order.

2. Pursuant to Minn. Stat. 14.15, subd. 4, if the Agency elects not to correct the identified defects as identified in the Report of the Chief Administrative Law Judge, the Agency shall submit the proposed rule to the Legislative Coordinating Commission

and to the legislative policy committees with primary jurisdiction over state governmental operations for advice and comment. The Agency may not adopt the rule until it has either: received and considered the advice of the commission and committees; or 60 days have passed following the Agency's submission of the rule to the commission and committees.

Dated: April 12, 2018

TAMMY L. PUST
Chief Administrative Law Judge

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT O

(MPCA Analysis of the Wild Rice Sulfate Standard Study, Figure 1, 2014)

This document is made available electronically by the Minnesota Legislative Reference Library as part of an ongoing digital archiving project. http://www.leg.state.mn.us/lrl/lrl.asp

Analysis of the Wild Rice Sulfate Standard Study: Draft for Scientific Peer Review

Minnesota Pollution Control Agency

June 9, 2014

https://www.leg.mn.gov/docs/2014/other/140594.pdf

Environmental Setting for Wild Rice Growth in Minnesota

Dr. John Moyle published his observations on the correlation between wild rice occurrence and the chemistry of surface waters. Moyle stated that wild rice is a species that requires hard water, but low sulfate concentrations: "…no large stands are known from waters where the sulphate ions exceed 10 ppm. Plantings of wild rice in the high-sulphate waters area have generally failed. The cause-and-effect relationship between sulphates and the distribution of plants is not known, but may be related to sulfur demands in plant nutrition, osmotic pressure of the water solution, or the toxicity of magnesium usually associated with sulphates" (Moyle 1956).

The correlation observed by Moyle between wild rice occurrence and the broad trends in the chemistry of surface water has held up over time. The general trend is that wild rice tends to be present in low-sulfate waters of the state (Figure 1).

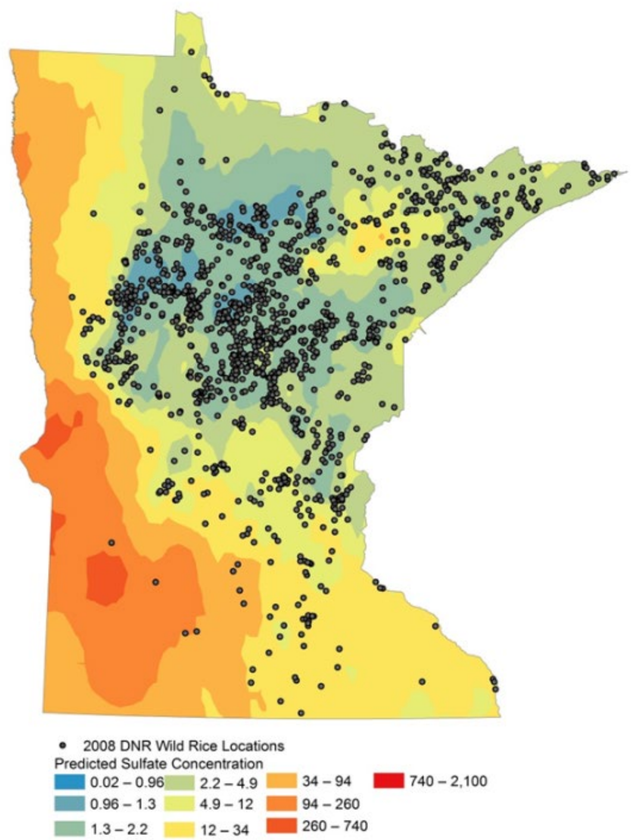


Figure 1. Locations of reported lakes with wild rice (black symbols; from DNR 2008) as compared to surface water sulfate concentrations (in mg/L). The sulfate contours were generated from 3,230 surface water sulfate values in DNR and MPCA databases (see Table 6 for summary statistics of these data).

Natural sources of sulfur in surface waters are influenced by the surficial geology of the watershed. Except for the southeastern corner of the state, Minnesota's surficial geology is dominated by its history of glaciation. Glacial lobes advanced from the northeast (Superior and Rainy lobes), north (Wadena Lobe) and northwest (Des Moines Lobe) (Figure 2). The different glacial lobes left soil parent material of varying sulfur and iron contents, which provide broad differences in sulfur concentrations in soil (Figure 3) and groundwater chemistry. The sulfur content of Minnesota's surficial soils and soil parent material do not always align with each other (Figure 3), but are both low in sulfur in north-central Minnesota, where wild rice sites are common (Figure 1).

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT P

(Cleveland Cliffs Request for Site-Specific Modification
of Sulfate Standard for Perch Lake, 2022)

CLIFFS

CLEVELAND-CLIFFS INC.
United Taconite LLC
PO Box 180, Eveleth, MN 55734
P 218.744.7800 clevelandcliffs.com

July 14, 2022

Minnesota Pollution Control Agency
Sent via email: Steven.Weiss@state.mn.us
Richard.Clark@state.mn.us

Re: Proposal for Site-Specific Modification of the Class 4A Sulfate Standard for Perch Lake

Dear Mr. Weiss and Mr. Clark:

United Taconite LLC (United) is proposing modification of the Minnesota Class 4A agricultural irrigation sulfate water quality standard for Perch Lake, located in McDavitt Township, St. Louis County, MN, consistent with the procedures described in Minnesota Rules part 7050.0220, subpart 7. This submittal provides the Minnesota Pollution Control Agency (MPCA) site-specific information to demonstrate that a modified standard is more appropriate than the existing Class 4A standard for Perch Lake. The enclosed request also shows that the beneficial use will be protected with the proposed modification to the existing standard.

Should you have any questions on the attached site-specific modification request for Perch Lake, please contact me at candice.maxwell@clevelandcliffs.com or (218) 744-7849. Thank you for your consideration on this important request.

Sincerely,

Candice Maxwell

Candice Maxwell
Area Manager – Environmental

cc: Scott Gischia, Cleveland-Cliffs
Jason Aagenes, Cleveland-Cliffs
Jason Ritter, United Taconite LLC
Nick Nelson, Barr Engineering Co.
Jennifer Fleming, Barr Engineering Co.

Request for Site-Specific Modification of the Minnesota Class 4A Sulfate Water Quality Standard Applicable to Perch Lake

Prepared for
United Taconite LLC

July 2022

4300 MarketPointe Drive, Suite 200
Minneapolis, MN 55435
952.832.2600
www.barr.com

Request for Site-Specific Modification of the Minnesota Class 4A Sulfate Water Quality Standard Applicable to Perch Lake

July 2022

Contents

List of Tables

List of Figures

List of Large Tables

List of Large Figures

List of Appendices

Abbreviations

µg/L	micrograms per liter
ALJ	Administrative Law Judge
AUID	Assessment Unit Identifier
CWA	Clean Water Act
EC	effect concentration
EC10	10% effect concentration
FDL	Fond du Lac Band
IC	inhibitory concentration
IC10	10% inhibitory concentration
IC25	25% inhibitory concentration
m^3	cubic meters
m^3/day	cubic meters per day
MBLR	multiple binary logistic regression
MDNR	Minnesota Department of Natural Resources
mg/L	milligrams per liter
MGD	million gallons per day
MPCA	Minnesota Pollution Control Agency
NWI	National Wetland Inventory
SONAR	Statement of Need and Reasonableness
TEFe	total extractable iron
TOC	total organic carbon
TSD	Technical Support Document
United	United Taconite LLC
USEPA	U.S. Environmental Protection Agency

1 Introduction and Summary

With submittal of this document to the Minnesota Pollution Control Agency (MPCA), United Taconite LLC (United) is requesting site-specific modification of the Minnesota Class 4A agricultural irrigation sulfate water quality standard (Class 4A sulfate standard) applicable to Perch Lake [Assessment Unit Identifier (AUID) 69-0688-00].[1] Perch Lake is located within the St. Louis River watershed in St. Louis County, McDavitt Township (Township 56N, Range 18W).

Minnesota Rules allow for site-specific modification of water quality standards when available information demonstrates that a site-specific modification is more appropriate than the statewide standard for a particular waterbody (Minnesota Rules, part 7050.0220, subpart 7.A). (Consistent with typical MPCA terminology, this document refers to the site-specific modification of a water quality standard as a "site-specific standard".)

This document:

- provides the site-specific information which demonstrates that a site-specific sulfate standard is more appropriate for Perch Lake than the statewide Class 4A sulfate standard; and
- proposes an appropriate site-specific sulfate standard protective of the Class 4A wild rice beneficial use in Perch Lake.

Table 1-1 provides a summary of this site-specific standard request.

---

[1] Per federal regulations, "water quality standards are provisions of State or Federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses" (40 CFR Part 131.3(i)) and water quality "criteria are elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use" (40 CFR Part 131.3(b)). Using federal terminology, United is requesting that the MPCA establish a site-specific numeric sulfate criteria for the Minnesota Class 4A designated use in Perch Lake. The MPCA generally uses the term "water quality standards" when referring to what the USEPA considers to be the numeric and narrative criteria elements of Minnesota's water quality standards (Minnesota Rules, Chapter 7050). For consistency with the MPCA's typical terminology, this document generally uses the terms "water quality standard", "standard", and "site-specific standard" rather than "water quality criteria", "criteria", and "site-specific criteria".

Table 1-1 Summary of Site-Specific Standard Request

Basin		Lake Superior
Major Watershed Name		St. Louis River
U.S. Geological Survey Cataloging Unit		04010201
County		St. Louis
Cities		McDavitt Township (Township 56N, Range 18W)
Water		Perch Lake (AUID 69-0688-00)
Beneficial Use Classifications		2B, 3, 4A, 4B, 5, and 6
Parameters		sulfate (applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels)
Rule		Minnesota Rules part 7050.0224, subpart 2
Existing Class 4A Sulfate Standard	Magnitude	10 milligrams per liter (mg/L)
	Duration	during periods when the rice may be susceptible to damage by high sulfate levels
	Frequency	(not specified)
Proposed Site-Specific Sulfate Standard	Magnitude	430 mg/L
	Duration	annual average
	Frequency	not more than once in ten years

2 Regulatory Background

This section describes regulatory background related to this request for site-specific modification of the Class 4A sulfate standard applicable to Perch Lake. Specifically:

- Section 2.1 summarizes state and federal regulations and guidance related to the development of site-specific standards.
- Section 2.2 provides an overview of Minnesota's Class 4A wild rice beneficial use.
- Section 2.3 summarizes the statewide Class 4A sulfate standard, the 2017 proposed rulemaking, and the recent listing of waters as impaired for sulfate.

2.1 Regulations and Guidance for Development of Site-Specific Standards

Minnesota Rules part 7050.0220, subpart 7 provides for the establishment of site-specific standards[2]:

A. *The standards in this part and in parts 7050.0221 to 7050.0227 are subject to review and modification as applied to a specific surface water body, reach, or segment. If site-specific information is available that shows that a site-specific modification is more appropriate than the statewide or ecoregion standard for a particular water body, reach, or segment, the site-specific information shall be applied.*

B. *The information supporting a site-specific modification can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all relevant data in support of a modified standard and determine whether a change in the standard for a specific water body or reach is justified…*

As with all state water quality standards, site-specific standards are subject to U.S. Environmental Protection Agency (USEPA) review and approval under Clean Water Act (CWA) Section 303(c) (40 CFR 131.5(a) and 40 CFR 131.20(c)). The USEPA requires that the criteria component of water quality standards[3] be developed in accordance with the following:

- *States must adopt those water quality criteria that protect the designated use. Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect*

---

[2] Minnesota Rules part 7052.0270 and 40 CFR 132 Appendix F include requirements for development of site-specific standards for aquatic life, human health, and wildlife designated uses in the Lake Superior Basin. The Class 4A sulfate standard is associated with an agricultural irrigation use and there is no sulfate water quality standard established under either Minnesota Rules Chapter 7052 (Lake Superior Basin Water Standards) or 40 CFR 132 (Water Quality Guidance for the Great Lakes System). Therefore, although Perch Lake is located in the Lake Superior Basin, the requirements for development of site-specific standards for aquatic life, human health, and wildlife designated uses in the Lake Superior Basin are not directly applicable.

[3] Refer to Footnote 1 for the federal regulatory definitions of "water quality standard" and "criteria" and discussion of the alignment of USEPA and MPCA terminology.

the designated use. For waters with multiple use designations, the criteria shall support the most sensitive use. (40 CFR 131.11(a)(1)).

- *Establish numerical values based on:*
    - *(i) 304(a) Guidance; or*
    - *(ii) 304(a) Guidance modified to reflect site-specific conditions; or*
    - *(iii) Other scientifically defensible methods* (40 CFR 131.11(b)(1)).

The CWA Section 304(a) national recommended water quality criteria for the protection of aquatic life and human health in surface water does not include guidance for sulfate; thus, numerical values for sulfate are required to be established based on other scientifically defensible methods. Chapter 3 of the USEPA's Water Quality Standards Handbook (reference (1)) provides guidance related to developing site-specific criteria for human health, recreation, and aquatic life designated uses; however, as the Class 4A sulfate standard is associated with an agricultural irrigation use, this guidance document is not directly applicable.

Overall, there is limited federal or state guidance for site-specific modification of water quality criteria or standards for the protection of non-CWA 101(a)(2) designated uses (i.e., uses other than protection and propagation of fish, shellfish, and wildlife and recreation in and on the water), such as agricultural designated uses. Resources applicable to other designated uses such as Minnesota Rules part 7052.0270, 40 CFR 132 Appendix F, and Chapter 3 of the USEPA's Water Quality Standards Handbook (reference (1)) may be used as guides but are not explicitly required. Thus, in lieu of directly applicable guidance, this request focuses on providing a scientifically defensible approach to modifying the Class 4A sulfate standard applicable to Perch Lake.

2.2 Overview of the Minnesota Class 4A Wild Rice Beneficial Use

Minnesota Rules establish eight classes of beneficial uses for which state waters may be protected (Minnesota Rules, part 7050.0140). Relevant to this request, Class 4 protects agricultural and wildlife uses and applies to "all waters of the state that are or may be used for any agricultural purposes, including stock watering and irrigation, or by waterfowl or other wildlife and for which quality control is or may be necessary to protect terrestrial life and its habitat or the public health, safety, or welfare" (Minnesota Rules, part 7050.0140, subpart 5). Class 4 is further divided into subclasses with Class 4A specifically protecting "use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area" (Minnesota Rules, part 7050.0224, subpart 2).

As noted in Section 2.1, a site-specific standard must "protect the beneficial use." Based on the plain language of Minnesota Rules, part 7050.0224, subpart 2, the "beneficial use" protected by the Class 4A sulfate standard is the use of water for "the production of wild rice." This phrase, "the production of wild rice" (which will be referred to herein as the "Class 4A wild rice beneficial use"), has been subject to varying interpretations. Some stakeholders have argued that it refers solely to waters used to irrigate wild rice grown as an agricultural crop; others have argued the phrase also encompasses the growth of natural stands of wild rice. In the Statement of Need and Reasonableness (SONAR; reference (2)) for its abandoned 2017 wild rice rulemaking, the MPCA attempted to "clarify" the beneficial use protected by the Class 4A sulfate standard by analyzing the history of the standard. As a result of this analysis, the MPCA proposed that the clarified statement of the Class 4A wild rice beneficial use should be the "use of the grain of wild rice as a food source for wildlife and humans" (reference (2)).

United does not concede that the MPCA's broad interpretation of "the production of wild rice" is the correct statement of the beneficial use protected by the Class 4A sulfate standard. Nonetheless, as explained in this request, United's proposed site-specific sulfate standard will protect the "use of the grain of wild rice as a food source for wildlife and humans" in Perch Lake. This is because United's proposed standard is based upon the peer-reviewed scientific approach of linking a sulfate standard to a protective porewater sulfide threshold that the MPCA itself concluded, in the 2017 SONAR, is protective of this articulation of the Class 4A wild rice beneficial use.

Likewise, United's proposed site-specific sulfate standard meets the requirement in Minnesota Rules, part 7050.0220, subpart 7 that it must be "more appropriate" than the Class 4A sulfate standard. The MPCA in the 2017 SONAR concluded that calculating a site-specific, porewater sulfide-based sulfate standard is more appropriate than applying the statewide standard (reference (2)). This, as explained in Section 6, is precisely the approach that United has taken with its proposed site-specific sulfate standard. In this way, United's proposed site-specific sulfate standard for Perch Lake is both protective of the Class 4A wild rice beneficial use and more appropriate than the statewide 10 milligrams per liter (mg/L) Class 4A sulfate standard.

2.3 Overview of Minnesota Class 4A Sulfate Standard

Wild rice is one of four species of grasses that are part of the genus *Zizania*. The native species of wild rice found in Minnesota is *Zizania palustris* but is referred to as "wild rice" for simplicity throughout this document.

Minnesota has adopted a sulfate water quality standard related to wild rice. This section discusses the existing standard (Section 2.3.1), the 2017 proposed rulemaking (Section 2.3.2), and the recent listing of waters as impaired for sulfate (Section 2.3.3).

2.3.1 Class 4A Sulfate Standard

As described in Section 2.2, Class 4A protects "use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area" (Minnesota Rules, part 7050.0224, subpart 2). The waters that are subject to the Class 4A standards are set forth in Minnesota Rules parts 7050.0415 and 7050.0470, and the water quality standards that these Class 4A waters must meet are set forth in Minnesota Rules part 7050.0224, subpart 2.

The Class 4A water quality standards include a numeric sulfate standard of 10 mg/L (Minnesota Rules, part 7050.0224, subpart 2). The 10 mg/L Class 4A sulfate standard was based on research completed in the 1930s and 1940s, which concluded that elevated sulfate concentrations correlated with reduced presence of wild rice (reference (3)). Observation of the presence of wild rice in waters with lower sulfate levels, and its absence in waters with elevated sulfate, led to the adoption of the Class 4A sulfate standard (references (2); (3)). The Class 4A sulfate standard does not apply in all Class 4A waters; rather, it only applies to waters "used for production of wild rice" (the Class 4A wild rice beneficial use as discussed in Section 2.2) "during periods when the rice may be susceptible to damage by high sulfate levels" (Minnesota Rules, part 7050.0224, subpart 2). However, the agency has not completed rulemaking to identify the Class 4A waters subject to the Class 4A sulfate standard. As outlined in Section 2.3.2, the MPCA, as part of an abandoned 2017 rulemaking, did propose a list of waters that would be subject to a proposed Class 4D sulfate standard (which would have replaced the Class 4A sulfate standard). Perch Lake was on this proposed list. For purposes of this site-specific standard request, United is assuming, without conceding, that Perch Lake is subject to the Class 4A sulfate standard.

2.3.2 2017 Proposed Wild Rice Rulemaking

Since the establishment of the 10 mg/L Class 4A sulfate standard in 1973, the scientific understanding of the chemistry of sulfate in the environment and the mechanisms by which it affects wild rice greatly improved. In 2011, the Minnesota legislature directed the MPCA to initiate a rulemaking process to address water quality standards for both waters containing natural beds of wild rice, as well as for irrigation waters used for the production of wild rice (reference (4)). The legislation required the MPCA to designate the specific waters to which the wild rice water quality standards would apply and the times of year during which the standards would apply. The legislation also mandated creation of an advisory group to provide input to the MPCA on a protocol for scientific research to assess the impacts of sulfates and other substances on the growth of wild rice, review research results, and provide other advice on the development of future rule amendments to protect wild rice (reference (4)). In response, the MPCA engaged with researchers, the Wild Rice Advisory Committee, and other stakeholders to develop research protocols, undertake research, complete preliminary analysis of the research, gather input on and refine the analysis, and conduct an independent scientific peer review of the studies and analysis (references (2); (3)). In March 2015, the MPCA released a *Draft Proposal for Protecting Wild Rice from Excess Sulfate* (reference (5)). This draft proposal included a new site-specific approach to establishing sulfate standards, a draft list of approximately 1,300 waters that would be subject to the new standard, and criteria for adding waters to the list over time. The MPCA requested comments on the draft proposal in late 2015 and then, in response to comments and questions received, conducted further analysis of the available research (references (2); (3)).

In July 2016, the MPCA released a draft Technical Support Document (TSD) (reference (6)) that presented the results of its research and analysis. After receiving further comments, the draft TSD was revised to address comments and consider additional research that was completed after the draft TSD was released (references (2); (3)). In August 2017, the MPCA released a revised final TSD (reference (3)), which documented the scientific support for the MPCA's proposed changes to the Class 4A sulfate standard. Specifically, the final TSD documented the MPCA's conclusions that the formation of sulfide in the porewater of the sediment where wild rice grows is the form of sulfur that directly affects wild rice populations. The MPCA also determined that porewater sulfide concentration is a function of the level of sulfate in the overlying water and the concentrations of carbon and iron in the sediment (reference (3)).

(Refer to Section 3.1 for further discussion of the relationship between surface water sulfate and porewater sulfide.)

In July 2017, the MPCA proposed amendments to Minnesota Rules Chapter 7050 (2017 proposed rules; reference (7)) and also released an associated SONAR (reference (2)). The overall intent of the 2017 proposed rulemaking was to replace the 10 mg/L Class 4A sulfate standard and clarify where the standard applies, without making changes to the beneficial use. The MPCA did propose "clarifying" the existing Class 4 beneficial use protected by the wild rice water quality standards by creating a separate use class (Class 4D) and rephrasing the description of the use; the agency's proposed revised statement of the beneficial use was "use of the grain of wild rice as a food source for wildlife and humans" (reference (2)).

The MPCA proposed to replace the existing 10 mg/L Class 4A sulfate standard with a Class 4D sulfate standard consisting of an equation that would calculate a site-specific sulfate standard protective of wild rice based on concentrations of total extractable iron (TEFe) and total organic carbon (TOC) in the sediment (reference (7)). The equation was developed based on multiple binary logistic regression (MBLR) of field data (sediment TEFe, sediment TOC, surface water sulfate, and porewater sulfide) from 107 waterbodies and a protective porewater sulfide threshold concentration of 120 micrograms per liter (µg/L). The MPCA concluded that if sulfide does not exceed the protective porewater sulfide threshold concentration, the wild rice beneficial use is protected. (Refer to Section 3.2 for further discussion of the protective porewater sulfide threshold.) The proposed equation was designed to yield waterbody-specific calculated numeric sulfate standards that would maintain sulfide below the assumed, protective porewater sulfide threshold of 120 µg/L (reference (2)). Additionally, the MPCA published a sampling and analytical methods guidance document (2017 MPCA Methods; reference (8)), which provided guidance for sediment and porewater sampling and analysis.

As part of the 2017 proposed rulemaking, the MPCA also developed a list of waters where the MPCA determined that the wild rice beneficial use has existed since November 28, 1975. The proposed rules identified these waters as "wild rice waters" where the standard applied, which was intended to replace the "water used for production of wild rice" descriptor in the existing rules (reference (2)). Perch Lake was included on MPCA's 2017 proposed list of wild rice waters (reference (7)).

However, the 2017 proposed rules, including the proposed list of wild rice waters, were never finalized. An Administrative Law Judge (ALJ) rejected the 2017 proposed rules and remanded to the MPCA (reference (9)). Importantly, the ALJ, in rejecting the rules, found no fault with the science underlying MPCA's equation-based approach. To the contrary, the ALJ rejected all science-based objections to the proposed equation and concluded:

> *[T]he MPCA presented sufficient evidence to demonstrate that there is an adequate scientific basis to conclude that the proposed equation-based sulfate standard is supported by peer-reviewed science and is needed and reasonable.* (reference (9))

Despite affirming the MPCA's scientific approach, the ALJ nonetheless determined she could not affirm the proposed rules because the implementation of the equation-based standard would require measuring

1,300 identified waters, a task that would take approximately ten years; until that is completed, no one would know exactly what standard applies and must be met in each identified body of water, rendering the rule insufficiently specific to be approved (references (9); (10)). The ALJ also cited concerns with repealing the 10 mg/L Class 4A sulfate standard without an immediate replacement for all wild rice waters.

In a letter response to the Report of the Chief ALJ (reference (11)) in March 2018, the MPCA proposed revisions to the proposed rules (2018 proposed revisions; reference (11)) and provided an updated sampling and analytical methods guidance document (2018 MPCA methods; reference (12)). Among the changes in the 2018 proposed revisions, the MPCA revised and bounded the equation for determining the new, proposed Class 4D sulfate standard. The MPCA also changed from calculating the numeric expression of the standard as the lowest value (as proposed in 2017) to the 20th percentile value to better accommodate multiple sampling events and variability in site data (reference (11)). The two iterations of the MPCA's proposed sediment sampling guidance and procedures for determining a numeric Class 4D sulfate standard based on the sediment data are compared in Table 2-1.

Table 2-1 Comparison of MPCA 2017 and 2018 Sampling Guidance and Procedures

Guidance or Procedure	2017 Final Technical Support Document (TSD)(1) and 2017 Methods(2)	2018 Proposed Revisions(3) and 2018 Methods(4)
Sediment Sampling Guidance	1. Identify 5 different locations within the highest wild rice density areas. 2. At each of the 5 locations, collect 5 samples along a transect and composite into one sample. 3. Yields 5 final composite samples.	1. Identify 100 random locations within the highest wild rice density areas. 2. Randomize the 100 locations, then collect grab samples from the first 15 locations on the randomized list. 3. If any samples fail quality control (QC), collect grab samples from the next locations on the randomized list until reaching a minimum of 15 samples with passing QC. 4. Additional samples can be collected over time (years, seasons), moving sequentially through the list of 100 random locations.
Procedure for Determining Numeric Class 4D Sulfate Standard	1. Input analytical results (sediment TEFe and TOC) from each of the 5 composite samples into the sulfate standard equation to yield 5 calculated sulfate concentrations. 2. Select the lowest calculated sulfate concentration as the numeric sulfate standard for the waterbody.	1. Input analytical results (sediment TEFe and TOC) from each of the 15 (or more) grab samples into the sulfate standard equation to yield 15 (or more) calculated sulfate concentrations. 2. Select the 20th percentile sulfate concentration as the numeric sulfate standard for the waterbody.

(1) MPCA *Final Technical Support Document: Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice*, dated August 2017 (reference (3))

(2) MPCA *Sampling and Analytical Methods for Wild Rice Waters*, dated July 2017 (reference (8))

(3) MPCA March 28, 2019 letter response to Report of the Chief Administrative Law Judge (reference (11))

(4) MPCA *Sampling and Analytical Methods for Wild Rice Waters, dated March 2018* (reference (12))

In response, the Chief ALJ did not reverse the ALJ's recommended disapproval of the proposed rules (reference (10)). Regarding the sufficiency of the MPCA's science, the Chief ALJ reemphasized that the MPCA "had met its statutory burden to show the equation-based standard to be necessary and reasonable." Regarding the MPCA's proposed revisions to the rules, the Chief ALJ conceded that "it is possible that the Agency's submitted clarifications and revisions noted above may represent improvements in the proposed rule"; however, because these changes had not been subject to public comment or discussion, they could not justify reversing the ALJ's recommendation that the rules be disapproved (reference (10)).

The MPCA withdrew the proposed rules on April 26, 2018 (reference (13)) and thus the Class 4A sulfate standard of 10 mg/L (as described in Section 2.3.1) remains in effect. Notably, however, the ALJ's disapproval and the MPCA's decision to abandon the rulemaking were unrelated to and did not affect the veracity of the underlying scientific basis for establishing site-specific sulfate standards that are protective of wild rice. As noted above, the ALJ expressly found that the MPCA's proposed equation-based sulfate standard was supported by peer-reviewed science. Moreover, the primary concerns that led the ALJ to disapprove the proposed rule—the potential adverse consequences of repealing the 10 mg/L Class 4A sulfate standard without an immediate replacement standard providing equal protection—are not implicated in the context of establishing a single site-specific sulfate standard, as United is requesting. This is because the Class 4A sulfate standard has not been repealed and remains in effect. For these reasons, United's explanation, set forth in this request, of why the requested site-specific sulfate standard for Perch Lake is scientifically defensible is based in large part upon the peer-reviewed and ALJ-affirmed scientific approach underlying the MPCA's proposed equation-based standard.

2.3.3 EPA Listing of Waters as Impaired for Sulfate

As mentioned in Section 2.3.2, the formal listing of specific wild rice waters was never completed as part of the 2017 rulemaking attempt. However, on September 1, 2021, the USEPA proposed listing of Perch Lake (AUID 69-0688-00) as impaired due to sulfate for the Class 4A wild rice beneficial use on Minnesota's 2020 List of Impaired Waters under CWA Section 303(d) (reference (14)). The next waterbody downstream of Perch Lake included on the MPCA's 2017 proposed list of wild rice waters is the St. Louis River Upper Estuary (AUID 69-1291-04). This segment of the St. Louis River Estuary is located approximately 95 river miles downstream of Perch Lake. The USEPA also proposed listing of the St. Louis River Upper Estuary as impaired due to sulfate for the Class 4A wild rice beneficial use on Minnesota's 2020 List of Impaired Waters (reference (14)).

On November 4, 2021, USEPA finalized the additions to the Minnesota 303(d) List of Impaired Waters after adding 32 waters that do not meet the Class 4A sulfate standard. Both Perch Lake and the St. Louis River Upper Estuary were included in this finalized list (reference (15)).

3 Scientific Background

Due to the importance of *Zizania palustris* (wild rice) to the state of Minnesota, a body of scientific research has been undertaken by diverse stakeholders over many years. This section focuses on a portion of this research with the goal of providing an overview of the scientific background necessary to:

- interpret the site-specific information related to wild rice in Perch Lake; and
- evaluate the appropriateness of potential approaches to determining a site-specific sulfate standard applicable to Perch Lake.

Specifically:

- Section 3.1 describes the relationship between surface water sulfate and porewater sulfide as it is relevant to wild rice.
- Section 3.2 describes determination of an appropriate porewater sulfide threshold for protection of wild rice.
- Section 3.3 describes other factors that influence the growth and abundance of wild rice, including factors that may be more influential than surface water sulfate and porewater sulfide.

3.1 Relationship between Surface Water Sulfate and Porewater Sulfide Relevant to Wild Rice

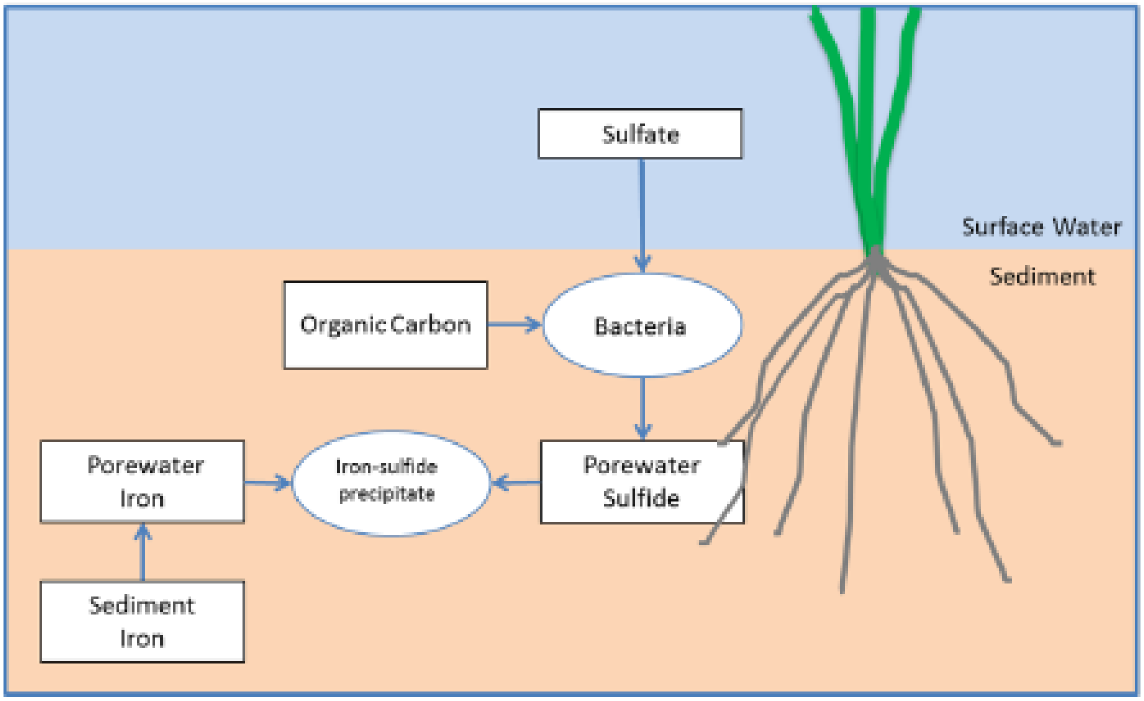
As described in Section 2.3.1, the current statewide Class 4A sulfate standard was based on observations of a perceived correlation between sulfate concentrations and the presence or absence of wild rice without any development of a positive causative relationship. Specifically, it was noted that wild rice appeared more likely to be present in waters with lower sulfate concentrations and less likely to be present in waters with higher sulfate concentrations (references (2); (3)). However, further studies have found that sulfate is not directly toxic to wild rice, even at high concentrations (up to 1,600 mg/L (reference (16)) and up to 5,000 mg/L (reference (17))). This lack of a direct toxicity relationship suggests that the conclusions from the original field observations that underpin the current rule are inherently flawed, or at least limited only to correlation and not causation, and thus limited in applicability for setting a sulfate standard and also indicates that there are variables other than surface water sulfate that effect wild rice density and presence.

Based on review and analysis of multiple peer reviewed studies (including references (16); (18); (19)) the MPCA concluded that:

- the sulfur form that adversely affects wild rice is not sulfate in the surface water, but rather sulfide in the sediment porewater;
- wild rice plants are vulnerable to accumulation of sulfide in the porewater of the sediment in which they grow;

- sulfate in overlying water can diffuse into the sediment porewater and then be converted to sulfide by reducing bacteria; and
- the level of sulfide in sediment porewater is dependent on background sediment chemistry (including concentrations of iron and TOC) and may also be mitigated by other factors such as upwelling groundwater (references (2); (3)).

Figure 3-1 illustrates the relationships between some of the primary variables affecting the relationship between surface water sulfate and porewater sulfide as they relate to wild rice growth. Specifically, "as bacteria utilize the energy in organic carbon, they respire sulfate, releasing sulfide" and "if iron is available, iron-sulfide precipitates form, which detoxifies the sulfide" (reference (3)).



excerpt from reference (3)

Figure 3-1 Conceptual Model of Primary Variables Affecting the Relationship Between Surface Water Sulfate and Porewater Sulfide

3.2 Porewater Sulfide Concentrations Protective of Wild Rice

Because multiple researchers and the MPCA have identified porewater sulfide as a primary sulfur form affecting wild rice, it is important to understand what concentrations of porewater sulfide are protective to wild rice in Perch Lake. Section 3.2.1 presents a summary of related background and research, then Section 3.2.2 discusses the selection of an appropriate porewater sulfide threshold protective of the wild rice beneficial use in Perch Lake.

3.2.1 Background

In 2017, the MPCA embarked on a rulemaking process to revise the current Class 4A sulfate standard of 10 mg/L for the protection of wild rice to incorporate more recent scientific understanding of the impacts of sulfate (Section 2.3.2). While recent research identified sediment porewater sulfide as one potential limiting factor for wild rice occurrence (Section 3.1), other habitat suitability factors were also identified including water clarity, water depth, and water temperature (reference (18)). Further, sediment composition, specifically organic matter and iron, controls the reduction of sulfate to sulfide, suggesting that the relationship between surface water sulfate concentrations and sediment porewater sulfide concentrations will vary from lake to lake. In fact, in MPCA's Response to Comments (November 22, 2017), MPCA stated, "[t]he TSD repeatedly affirms that sulfide is just one of several factors that impacts the viability of wild rice ..."

The MPCA's previously proposed Class 4D sulfate standard (Section 2.3.2) was based on the effects of porewater sulfide concentrations on wild rice determined from hydroponic, mesocosm, and field studies. Recognizing that more research was needed to better describe the impacts of surface water sulfate and sediment porewater sulfide concentrations on wild rice, numerous studies were undertaken by multiple agencies and researchers to determine protective levels of sulfate and sulfide (Table 3-1). After reviewing these studies, the MPCA considered a sediment porewater concentration of 120 µg/L sulfide as the statewide protective level for wild rice based on a 10% effect concentration (EC10) as recommended by a peer review panel during the rulemaking process (reference (3)). The 120 µg/L sediment porewater sulfide concentration was based on sulfide EC10 values calculated from:

1. MPCA sponsored hydroponic studies and mesocosm experiments (reference (16))
2. MPCA collected field surveys for wild rice and sediment porewater sulfide concentrations (reference (18))

Table 3-1 summarizes results from multiple EC10 calculations conducted by the MPCA for porewater sulfide concentrations for several endpoints including wild rice total plant weight gain, percent filled seeds, plant germination, stem density, proportion of waterbodies with wild rice, and presence/absence of wild rice. It should be noted that sulfide concentrations were log-transformed in some cases but not others.

In derivation of their proposed protective sediment porewater sulfide concentration, MPCA gave little weight to the EC10 calculated by Fort et al. in their 2017 study (reference (20)) because the plants were exposed to oxygen, which may reduce the toxicity of sulfide and only represent germination of seeds in the top 1 cm of sediment. Seeds deeper in the sediment may be exposed to high sulfide longer before reaching oxygenated water. However, Fort et al. recently addressed that critique of their experimental design by conducting hydroponic studies with low oxygen conditions in the head space (reference (21)). Results were similar to their previous studies (reference (20)). Results of the Fort et al. 2020 study are provided in Table 3-1.

The 2020 Fort study (reference (21)) employed a hydroponic design to evaluate the effect of a range of sulfide and iron concentrations on several toxicological metrics (e.g., mesocotyl emergence, root weight, root length, shoot weight, shoot length). Toxicological endpoints (10% inhibitory concentration [IC10] and 25% inhibitory concentration [IC25]) were provided for the root weight and length and the shoot weight and length metrics. The Fort study used IC (inhibitory concentration) values as the toxicological endpoints, rather than EC (effect concentration) values, but the IC10 (i.e., inhibitory concentration where there is a

10% reduction relative to the controls) was calculated the same as an EC10 (i.e., effect concentration where there is a 10% reduction relative to the controls); the terms IC10 and EC10 are interchangeable for this study.

Fort's 2020 hydroponic study, using low oxygen conditions in the headspace, documented sulfide IC10 values that are much higher than the other studies referenced in Table 3-1. The study also provides a clear indication that there is a dose-response effect with sulfide and mesocotyl emergence and that iron can be protective of the adverse effects of sulfide. The higher IC10 values derived by Fort are likely a function of the test conditions which provided conditions optimally conducive to growth without additional stressors. This does not mean this study is not of value or well executed, it simply isolates the effect of sulfide and iron from other potential environmental stressors that may be encountered with a field study evaluating sulfide and iron effects and thus gives the most direct insight to understanding the specific relationship between sulfide, iron and wild rice toxicity.

Table 3-1 Estimated EC10/IC10 Sulfide Values for the Protection of Wild Rice

		Protective Sulfide Concentration (µg/L)	
	Data Set	**Estimate**	**95% Confidence Interval**
Hydroponic experiment data from Fort et al., 2020 (reference (21)**)**[(1)]			
IC10, root weight, 0.8 mg/L Fe, 21 days[(2)]	Hydroponic	7,800	8,200
IC10, root weight, 2.8 mg/L Fe, 21 days	Hydroponic	>7,800	
IC10, root length, 0.8 mg/L Fe, 21 days[(2)]	Hydroponic	7,800	7,900
IC10, root length, 2.8 mg/L Fe, 21 days	Hydroponic	>7,800	
IC10, shoot weight, 0.8 mg/L Fe, 21 days[(2)]	Hydroponic	4,400	5,400
IC10, shoot weight, 2.8 mg/L Fe, 21 days[(2)]	Hydroponic	4,800	5,200
IC10, shoot length, 0.8 mg/L Fe, 21 days[(2)]	Hydroponic	4,800	5,400
IC10, shoot length, 2.8 mg/L Fe, 21 days[(2)]	Hydroponic	5,600	5,800
Hydroponic experiment data from Pastor et al., 2017 (reference (16)**)**[(3)]			
EC10, based on regression of total plant weight gain on average initial sulfide[(4)]	Hydroponic	251	<11 - 285
EC10, based on regression of total plant weight gain on time-weighted arithmetic mean of sulfide	Hydroponic	106	<11 – 158
EC10, based on regression of total plant weight gain on time-weighted geometric mean of sulfide[(4)]	Hydroponic	39	<11 – 66
Mesocosm experiment data from Pastor et al., 2017 (reference (16)**)**			
EC10, based on regression of percent of filled seeds	Mesocosm	228	0 – 414
EC10, based on regression of number of plants that germinated	Mesocosm	163	0 – 242
Field data set from MPCA from Myrbo et al., 2017 (reference (18)**)**			
Visual identification of reduction in proportion of waterbodies with wild rice present (N-108)	All sites	120	NA
Change-point analysis, based on wild rice density (N=67)	All sites with wild rice	112	25 – 368
EC10, based on binary logistic regression of wild rice presence (transparent sites, N=96)	Transparency > 30 cm	91	14-239
EC10, based on binary logistic regression of wild rice presence (all sites, N=108) [(4)]	All sites	58	<11-117
Equivalent threshold analysis (N=25)		370	NA

Notes(s): (adapted from reference (3))

Rows highlighted in gray indicate new data points for consideration in a weight of evidence approach compared to the data in the MPCA rulemaking

(1) MPCA gave less weight to the Fort 2017 study due to critique of the experiment design in the 2017 study. The 2020 study addressed the critique and has been included.
(2) Values interpreted from graph provided in the publication.
(3) Data from three experiments were merged for the logistic regressions
(4) Estimates identified in MPCA rule text as deserving less weight in the weighting of multiple lines of evidence

In addition to the hydroponic and mesocosm studies, the MPCA derived EC10 values from field data collected from 108 lakes and streams throughout Minnesota (referred to as the Class B dataset in the TSD). These values are included on Table 3-1. In analyses of field data, MPCA used two wild rice health metrics to derive EC10 values for porewater sulfide:

- Presence/absence of wild rice stands
- Stem density (stems/m^2)

Presence/absence data was analyzed using binary logistic regression to derive an EC10 value (p. 36 of reference (3)). MPCA noted that the EC10 derived from the binary logistic regression of presence/absence data was imprecise, because the curve of the log-transformed data does not have a flat area of "no effect." (p. 35 of reference (3)). Presence/absence data was also used in a non-statistical approach that visually identified a reduction in the proportion of sites with wild rice present for sites with sulfide concentrations greater than 120 µg/L. Stem density data was used in a change-point analysis to derive an EC10 value (p 36 of reference (3)).

3.2.2 Selection of a Protective Porewater Sulfide Threshold

The MPCA proposed a protective porewater sulfide threshold based on their assessment of the EC10 values described in Section 3.2.1. However, a new analysis of the MPCA dataset, consistent with the methods used by the MPCA, supports an alternate protective porewater threshold that shows no statistically significant differences in wild rice presence/absence or stem density compared to the MPCA proposed threshold.

3.2.2.1 MPCA Proposed Protective Porewater Sulfide Threshold – 120 µg/L

MPCA proposed 120 µg/L as the protective porewater sulfide threshold. They explain that the visual break in the proportion of sites with wild rice, at 120 µg/L, is with the range of EC10s derived from hydroponic experiments (excluding the Fort Study), and field data on wild rice presence/absence and stem density.

During the public review of MPCA's proposed standard, commenters presented evidence that a higher threshold, 300 µg/L, would be equally protective. MPCA addressed these comments using statistical analysis, grouping field data into three bins: under 120 µg/L, 120-300 µg/L, and over 300 µg/L. Results indicated "Based on wild rice presence versus absence, it is not possible to find a statistically significant difference between those sites with sulfide below 120 µg/L and those with sulfide between 120 µg/L and 300 µg/L. However, when wild rice density is examined, there is significantly higher density for those sites with sulfide below 120 µg/L compared to those with sulfide between 120 µg/L and 300 µg/L" (p. 130 of reference (3)). Based on these results, MPCA concluded that "a protective sulfide concentration of 300 µg/L would not be as protective of wild rice as a concentration of 120 µg/L" (p. 131 of reference (3)).

To analyze the presence/absence data, MPCA first performed a chi square test for independence, with a resulting p value of 0.0063, indicating there is a significant difference. To determine where the difference lies, MPCA calculated odds ratios, then calculated p values using a continuity correction. Results are shown in Table 3-2. Significant differences are in bold. The analysis indicates that based on presence/absence data it is not possible to determine whether the 120 µg/L or 300 µg/L sulfide concentration threshold is more protective. See p. 128 of reference (3) for more information on interpreting the odds ratio testing.

Table 3-2 Comparison of the Odds of Wild Rice Presence Between Any Two Sulfide Concentration Groups

Group 1	Group 2	Odds ratio	95% Confidence Interval	P value
Under 120	Between 120 & 300	1.70	(0.63, 4.59)	0.434
Under 120	**Over 300**	**5.88**	**(1.83, 18.86)**	**0.0037**
Between 120 & 300	Over 300	3.47	(0.90, 13.31)	0.1286
Under 120	**Between 120 & 300 plus Over 300**	**2.86**	**(1.26, 6.47)**	**0.0334**
Under 120 plus between 120 & 300	**Over 300**	**5.13**	**(1.65, 15.93)**	**0.0060**

Notes:
Significant differences are in **bold**.
This is MPCA Table A9-2 from p 128 of reference (3).

MPCA performed similar statistical analyses on the stem density data. They first conducted a Fisher's test (used instead of a chi square test because some groups had low numbers of observations), with a resulting p value of 0.002, indicating that at least two groups differ. Results of odds ratio testing are shown in Table 3-3. The analysis indicates that there is a significantly higher density for those sites with sulfide below 120 µg/L compared to those with sulfide between 120 µg/L and 300 µg/L. See p. 130 of reference (3) for more information on interpreting the odds ratio testing.

Table 3-3 Results of a Two-Sample Proportion Test to Find the Probability of Groups Having the Same Proportion In Each Group

Group 1	Group 2	Stem density	Odds ratio	95% Confidence Interval	P value
Under 120	Between 120 & 300	>40 vs 10-40	0.75	(0.13, 4.32)	1.0
Under 120	***Between 120 & 300***	***>40 vs <10***	***5.60***	***(1.28, 24.56)***	***0.044***
Under 120	Between 120 & 300	>40 vs no WR	2.13	(0.73, 7.46)	0.235
Under 120	Between 120 & 300	>40 vs <40	3.47	(0.90, 13.31)	0.375
Under 120	**Between 120 & 300**	**>40 vs <10 & no WR**	**3.23**	**(1.03, 10.45)**	**0.072**
Under 120	**Between 120 & 300**	**10-40 vs <10**	**7.50**	**(1.17, 48.15)**	**0.065**
Under 120	Between 120 & 300	10-40 vs no WR	3.38	(0.63, 17.97)	0.262
Under 120	***Between 120 & 300***	***10-40 vs <10 & no WR***	***3.54***	***(1.28, 9.84)***	***0.024***
Under 120	***Between 120 & 300***	***>10 vs <10***	***6.14***	***(1.54, 24.54)***	***0.018***
Under 120	Between 120 & 300	>10 vs no WR	2.76	(0.90, 8.48)	0.127
Under 120	***Between 120 & 300***	***>10 vs <10 & no WR***	***3.55***	***(1.28, 9.84)***	***0.024***
Under 120	Between 120 & 300	<10 vs no WR	0.45	(0.11, 1.79)	0.429

Notes:
Significant differences are in **bold**.
This is MPCA Table A9-4 from p. 130 of Reference (3).

3.2.2.2 Proposed Alternate Protective Porewater Sulfide Threshold – 370 µg/L

A new analysis by TIG Environmental (Appendix A) reassessed the MPCA field data on porewater sulfide, presence/absence, and stem density. This analysis differed from previous analyses as follows:

- Data were grouped into smaller bins (50 µg/L) for exploratory data analysis
- Results of exploratory data analysis indicated that data from the 200-250 µg/L bin should not be used to validate the protectiveness of alternative sulfide thresholds
- Based on the observation that high density wild rice stands are common (50% likelihood) in the 350-400 µg/L bin, an alternative threshold of 370 µg/L was tested.
- Testing for statistical differences was conducted on data in two bins: less than 120 µg/L and 250-370 µg/L.

TIG Environmental analyzed the relationship between porewater sulfide (µg/L) and two wild rice health metrics, presence/absence of wild rice stands and stem density (stems per m^2) using the MPCA 2017 dataset (the 108 sites in the Class B dataset, reference (3)). The results, presented in Figure 3-2, suggest an anomaly in the data at sulfide concentrations between 200 and 250 µg/L that could inappropriately influence statistical analyses of the relationship between sulfide and wild rice. A simulation study, documented in Appendix A, indicated that the probability of finding a low proportion of sites with high density stands is too high to reject the hypothesis that the results for the 200-250 µg/L bin arose by chance alone. Furthermore, given that two of the five sites in this concentration range had low transparency and the observation of healthy wild rice at higher sulfide concentrations (e.g., 350-400 µg/L), TIG Environmental concluded that the 200-250 µg/L bin **should not** be used to validate the protectiveness of alternative sulfide thresholds.

Based on the observation that high density wild rice stands occur in the 350-400 µg/L concentration bin, the analysis tested the hypothesis that a threshold associated with wild rice health metrics (presence/absence and stem density) that is not statistically significantly different from the MPCA proposed protective porewater sulfide threshold of 120 µg/L can be derived from within this concentration range. The highest sulfide concentration in the 350-400 bin was 368 µg/L.

Alternative thresholds were evaluated using methods consistent with the MPCA procedures in reference (3). Specifically, TIG Environmental tested for significant differences between the presence/absence and stem density metrics for sites with a sulfide concentration <120 µg/L versus sites from 250 to 370 µg/L. Figure 3-3 shows stem density boxplots and presence/absence bar charts and Table 3-4 shows the summary statistics associated with the two thresholds. The results show that the wild rice health metrics (stem densities and presence/absence) are virtually identical for both thresholds. Table 3-5 presents the results of the statistical testing. Although the stem density data are not normally distributed, violating an assumption of the t-test, the t-test is robust to violation of the normality assumption and therefore does provide an additional line of evidence that should be considered. The summary statistics were similar between the 0-120 and 250-370 µg/L sulfide populations and all three statistical tests detected no significant difference between the two populations. These analyses indicate that the alternative 370 µg/L sulfide threshold provides a level of protectiveness similar to and not statistically different from the MPCA proposed protective porewater sulfide threshold of 120 µg/L.

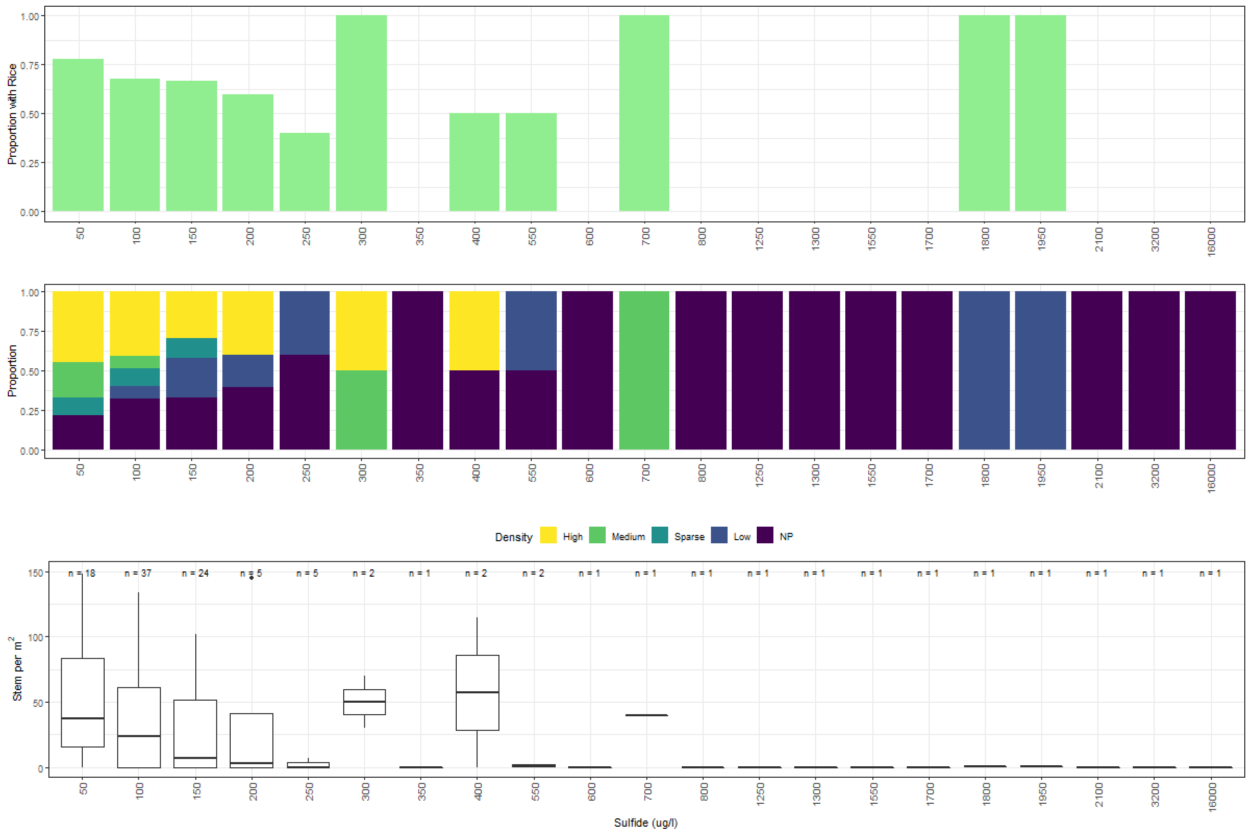


Figure 3-2 Wild Rice Health Metrics Versus Porewater Sulfide

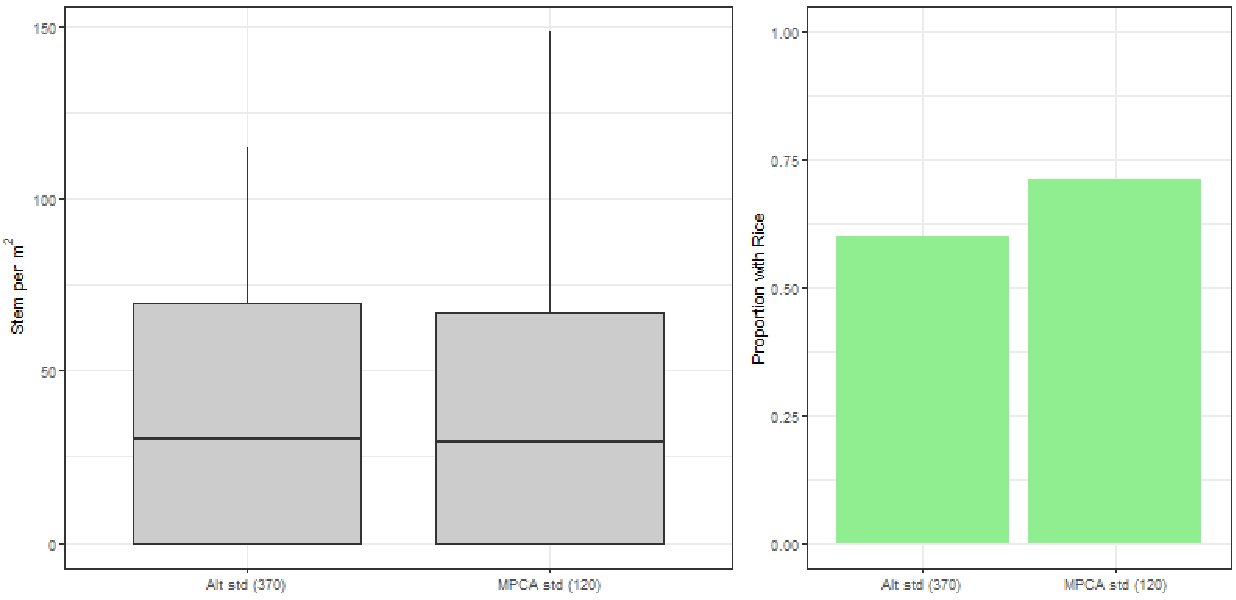


Figure 3-3 Comparisons of Stem Density and Wild Rice Presence/Absence

Table 3-4 Wild Rice Health Metric Summary Statistics, MPCA (0-120 ug/l) and Alternative (250-370 µg/L)

Sites	n	Density (per m^2) Mean	Density (per m^2) Median	Presence
MPCA 120 (0-120)	69	40.2	29.3	49 (71%)
Alternative 370 (250-370)	5	40.3	30.2	3 (60%)

Table 3-5 Statistical Testing Results, MPCA (0-120 µg/L) and Alternative (250-370 µg/L)

Parameter	Test	Result
Mean Stem Density	t-test (parametric)	$p = 0.91$, no significant difference
Median Stem Density	Wilcoxon-Mann-Whitney (non-parametric)	$p > 0.99$, no significant difference
Presence	Chi-squared test of proportions	$p = 0.98$, no significant difference

3.3 Other Factors that Influence Wild Rice

Wild rice is known to be sensitive to both physical and chemical conditions. Several factors affecting the presence and health of wild rice have been addressed by both the MPCA and peer reviewed research including:

- water flow, levels, and transparency
- water temperature
- water and sediment chemistry
- groundwater upwelling
- annual cycles of wild rice production
- shoreline and watershed development
- competitive and invasive species

The importance of the other factors that affect the presence and health of wild rice are highlighted by the Fort et al. 2020 study (reference (21)), which found little evidence of sulfide impacts on the emergence of wild rice with concentrations less than 3,100 µg/L porewater sulfide and 800 µg/L porewater iron, suggesting that there may be other mitigating factors that could reduce the toxicity of sulfide. These other factors are described in further detail in this section, and the factors that are applicable to Perch Lake are discussed further in Section 5.3.

Wild rice generally requires some moving water, with rivers, flowages, and lakes with inlets and outlets being optimal areas for growth. The MPCA has documented water depths between 30 and 120 cm (0.98 to 3.9 feet) are conducive to wild rice growth (reference (2)). Other resources provide evidence that wild rice grows well at water depths of 0.5 to 3 feet of water (reference (22)). Wild rice at depths greater than 3 feet typically have poor or no seed production and will decline in numbers and density over time (reference (23)). However, rapid increases in water levels, particularly in early summer (during its floating leaf-stage) can significantly stress the wild rice plants even if they remain rooted (reference (22)). Water transparency below 30 cm essentially excludes wild rice from growing due to light limitation (reference (18)).

Another factor impacting wild rice is water temperature. The temperature of the waterbody is negatively correlated with the presence of wild rice: warmer summer and winter temperatures likely have a negative effect on wild rice that is independent of sulfide (reference (18)). This is because elevated winter temperatures could threaten the occurrence of wild rice due to inadequate seed exposure to cold temperatures (reference (3)). Wild rice seeds are understood to need at least three months of submersion in near-freezing water in order to break dormancy (reference (24)).

Although porewater sulfide and its relationship with surface water sulfate, sediment TOC, and sediment iron was the focus of the MPCA's 2017 proposed rulemaking (reference (3)), there are other water and sediment chemical factors that interact with and/or are reactions of the sulfate-sulfide conversion process (reference (25)). Other factors that have been linked to the sulfate-sulfide conversion process include, but are not limited to: organic matter, oxidized magnesium, oxygen, dissolved metals, nitrate, and pH. Sediment with high organic matter content and a low carbon to nitrogen ratio is important to meet the nitrogen needs for plant growth (reference (26)). Organic matter also provides the energy necessary for sulfate reducing bacteria to convert sulfate into sulfide (reference (25)). If there is insufficient organic matter to supply the bacteria or there are sufficient non-sulfate electron acceptors such as oxygen, nitrates, oxidized magnesium, and oxidized iron which are preferentially converted before sulfate, then the reduction of sulfate to sulfide is unlikely to occur (references (25); (27)). Similar to the interaction between iron and sulfide (H_2S form), other dissolved metals, such as copper and zinc, also react with sulfide to form metal sulfides (references (18); (28); (29)). When dissolved metal concentrations are high relative to sulfide, sulfide may react with the dissolved metals faster than it is produced, therefore mitigating sulfide toxicity (references (25); (30)). Nitrate is generally consumed to zero if it is present; however, in some cases if the system has nitrate present it can aid the conversion of sulfide back to sulfate and therefore sulfide would not build up even if sulfide-reducing bacteria are active (reference (25)). pH determines how sulfide (S^{2-}) will speciate within the porewater, either as hydrogen sulfide (H_2S) or bisulfide (HS^-), which changes how subsequent reactions with the aquatic system will occur (reference (18)). Hydrogen sulfide is an uncharged form and can diffuse across animal cells where bisulfide is the charge form that cannot cross membranes (direct link to plant roots has not been studied) (reference (25)). While the extent of impact each of these factors have on the prevalence of wild rice has not been quantified, they do interact/react with the sulfate-sulfide conversion process and therefore could be an influencing factor in the level of sulfide present affecting wild rice growth.

Additionally, total phosphorus, total nitrogen (and its constituents), alkalinity, calcium, magnesium, potassium, and pH have been correlated with wild rice prevalence (references (31)). A recent paddy field study (reference (32)) points towards porewater sulfide, aqueous sulfate, and accumulation of potentially problematic iron-sulfide (FeS) root coatings playing a less important role in wild rice growth than previously suggested. Although aqueous sulfate in the paddies ranged from 350 mg/L to ≥1300 mg/L and porewater H_2S ranged from 0.135 mg/L to 23.5 mg/L, wild rice developed and produced seed over successive growing seasons with no adverse influence on the phenology, distribution, or production observed (reference (32)). Moreover, this recent research (reference (32)) along with a 2018/2019 mesocosm and microcosm study (reference (33)) emphasizes the potential importance of ammonia-nitrogen as a required nutrient to the health of wild rice stands indicating bioavailability of sediment ammonia-nitrogen is likely more influential than sulfide. While bioavailability of nutrients is an important factor in plant growth, excess nutrients, such as total phosphorus and nitrogen, can have adverse effects on productivity (reference (22), (26)). Elevated phosphorus likely promotes growth of phytoplankton and macrophytes that compete with wild rice for light and space (reference (18)). Elevated total nitrogen also encourages growth of phytoplankton which reduces water transparency, inhibiting wild rice growth (reference (18)). Elevated alkalinity may enhance decomposition of organic matter and is thought to be a major factor in influencing the distribution of aquatic species (references (34); (35); (36); (37)). pH is a master variable in aquatic systems (reference (38)) and determines aquatic chemistry and biota that dominate a system (references (18); (39)).

Consistent upward groundwater flow reduces the amount of downward surface water flow and thus reduces the amount of sulfate that can mobilize from the surface water to the sediment porewater. In such cases, the groundwater sulfate concentration may be more important than the surface water sulfate concentration in controlling the production of porewater sulfide (reference (3)). Therefore, areas with consistent groundwater inflow may be favorable habitat for wild rice (reference (3)).

Furthermore, wild rice growth is known to vary cyclically on a year-to-year basis. Even under ideal growing conditions, wild rice undergoes approximately three-to-five-year cycles in which productivity can naturally vary greatly (references (22); (40); (41); (42); (43)). Highly productive years are frequently followed by a year of low productivity, that is then followed by a gradual recovery in wild rice yield (references (22); (41); (44); (45); (46); (47)). Recent studies suggest that oscillations in wild rice productivity may be caused in part by the accumulation of old straw from previous growth that inhibits plant growth and seed production (references (42); (43)). In particular, the amount of wild rice straw, its stage of decay, and its tissue chemistry likely affect nutrient availability, influence wild rice productivity, and thus drive cycling of wild rice populations (reference (48)).

Shoreline and watershed development may increase loading of some constituents, such as phosphorus and sulfate, therefore reducing aquatic plant cover (reference (49)). Boat traffic may dislodge wild rice from the underlying sediment (reference (50)).

Sites with competitive or invasive species negatively impact the presence of wild rice. Wild rice populations may not be observed near populations of yellow water lily (*Nuphar variegate*) and *Utricularia vulgaris* because these species prefer environmental conditions similar to optimal rice habitat (reference (51)). Wild rice also competes with perennial plants such as cattails spp. And pickerelweed (*Pontederia cordata L.*) for shallow-water habitat. Specifically, hybrid cattail (*Typha x glauca*), a cross of native and non-native cattail (*Typha latifolia L.* and *Typha angustifolia L.*, respectively), aggressively form thick mats of roots that can float as water levels fluctuate. The common carp, a well-known invasive species, has been known to dislodge wild rice plants and reduce water clarity, both by suspending fine particles and releasing phosphorus that enhances algal growth (reference (22)).

In summary, while the Class 4A standard focuses on sulfate as a key indicator for wild rice presence and health, peer reviewed research has demonstrated there are a number of factors that can influence the presence and prevalence of wild rice.

4 Description of Perch Lake

Perch Lake (AUID 69-0688-00) is located in St. Louis County, McDavitt Township (Township 56N, Range 18W) (Large Figure 1). This section describes Perch Lake's hydrologic setting (Section 4.1) and water quality and sediment chemistry (Section 4.2).

4.1 Hydrologic Setting

Perch Lake is an approximately 65-acre lake with a maximum depth of approximately 15 feet (refer to Large Figure 2). Based on a 2020 bathymetry survey (Large Figure 2), approximately 11 acres (17%) are less than 3 feet deep, which is considered suitable water depth for wild rice growth (Section 3.3, reference (22)).

Perch Lake is located in Minnesota Department of Natural Resources (MDNR) Level 08 Subwatershed 30890000, as shown on Large Figure 1, within the St. Louis River watershed and Lake Superior basin. Subwatershed 3089000 is mainly comprised of wetlands (80%) and a chain of lakes (1%). The other 19% of land cover within subwatershed 3089000 includes a mixture of: mixed, deciduous, and evergreen forest, developed open space, shrub, barren land, low intensity developed land, herbaceous, pasture, and medium intensity developed land. From north to south the lakes within the subwatershed are Twin Lake (which includes upper and lower sections), Teal Lake, Mallard Lake, Bluebill Lake, Perch Lake, and Round Lake (Large Figure 1). The lakes are assumed to be connected by surface water flow and/or groundwater flow, at least seasonally. Flow between the lakes generally occurs from north to south, with the exception of Round Lake. Round Lake, located just east of Perch Lake, is hydrologically isolated from the chain of lakes by a topographic high between Perch Lake and Round Lake. Round Lake flows into the east side of Perch Lake via a small, channeled wetland area. Within the large wetland complex south of the chain of lakes there are a series of historic, constructed drainage ditches which flow to Whiteface River, a tributary of the St. Louis River. Some of these drainage ditches have been restored by third parties to more closely mimic natural conditions, which likely limits continuous channelized surface flow in the wetland complex to the south of Perch Lake. The nearest ditch to Perch Lake that has not been restored/filled is approximately 1 mile from the lake. Water flow through the wetland complex between Perch Lake and the ditches that have not been restored likely occurs via diffuse surface flow and/or shallow groundwater flow.

Perch Lake generally receives water inflow from Bluebill Lake, Round Lake, and the nearby wetland complex. Modeling conducted by HydroAnalysis (HAI) (reference (52)) provides some insight into the groundwater and surface water systems and transport pathways in the vicinity. This modeling included a steady-state groundwater flow and transport model and a lake mass-balance model to estimate the water budget for each of the lakes in the chain of lakes, including Perch Lake. The lake mass-balance was based on upstream surface water inflow (including wetlands), groundwater inflow, precipitation, and evapotranspiration, which equaled the outflow that was routed to the next lake in the chain. Based on this modeling, Perch Lake is estimated to receive a total inflow of approximately 1,075 cubic meters per day (m^3/day), of which 70% (761 cubic meters [m^3]) is surface water inflow, 16% (170 m^3) is net precipitation (precipitation minus evapotranspiration), and 13% (143 m^3) is groundwater inflow. Perch Lake's outflow is estimated to be 98% (1,056 m^3) surface water and 2% (19 m^3) groundwater. While the majority of water inflow and outflow from Perch Lake is estimated to be via surface water, this water balance also estimates that Perch Lake receives more groundwater inflow (approximately 143 m^3/day) than groundwater outflow (approximately 19 m^3/day) and thus indicates that groundwater inflow (via lateral inflow and/or vertical upwelling) is likely occurring in at least some parts of Perch Lake.

A single set of groundwater elevation measurements from three nested sets of wells recently installed in the area between Bluebill and Perch Lake indicate that groundwater in both the peat deposits and underlying mineral soil flows to the east-southeast toward Perch Lake, corroborating the conceptual model that Perch Lake receives groundwater inflow. Groundwater elevation measurements will be collected from these wells for a period of time to further evaluate groundwater flow directions in this area.

4.2 Water Quality and Sediment Chemistry

Sampling of Perch Lake for surface water sulfate, porewater sulfide, and sediment TEFe and TOC in accordance with the most recent MPCA recommended methods was conducted in October and November 2021. All samples were obtained in locations where wild rice had been documented during the September 2021 wild rice survey (described in Section 5.2).

As discussed in Section 2.3.2, the MPCA's 2018 *Sampling and Analytical Methods for Wild Rice Waters* (2018 MPCA Methods; reference (12)) incorporated updates related to selection of sampling locations and the type of samples collected. The basis for these updates is described in Attachment 6 of the MPCA's March 28, 2018 letter to the Chief ALJ (reference (11)) and included consideration of USEPA guidance for choosing a sampling design for environmental data collection (reference (53)). The 2018 MPCA Methods (reference (12)) specify identification of 100 random locations within the highest wild rice density areas (based on pre-sampling field reconnaissance) and collection of grab samples from the first 15 locations on the randomized list of 100 locations. Additional grab samples can be collected over time (years, seasons), moving sequentially through the list of 100 random locations, and may be collected at any time during the open water season (reference (12)). At each location, the following samples were obtained: one sediment core for TOC and TEFe analysis, one sediment core for porewater extraction and analysis, and one surface water sulfate grab sample. Appendix B includes additional details on the sampling methods and procedures associated with the water quality and sediment sampling.

Although some additional sampling was conducted in association with previous wild rice surveys in Perch Lake, this data is not included because it was not conducted in accordance with the most recent MPCA recommended methods and therefore does not provide comparative data.

4.2.1 Surface Water Sulfate and Porewater Sulfide

The analytical results for surface water sulfate and porewater sulfide from October 2021 and November 2021 Perch Lake sampling events are summarized in Table 4-1. Analytical results for each sampling location and associated lab reports are provided in Large Table 1 and Appendix C and Appendix D, respectively. Sampling locations are shown on Large Figure 3.

Table 4-1 Summary of Perch Lake Surface Water Sulfate and Porewater Sulfide Results

Sampling Month(s)	# of Samples	Surface Water Sulfate (milligrams per liter [mg/L])			Porewater Sulfide (mg/L)(1)		
		Avg	Min	Max	Avg(2)	Min	Max
October 2021	15	105	101	107	0.088	<0.014	0.39
November 2021	15	115	110	117	0.099	0.020	0.38
October & November 2021	30	110	101	117	0.094	<0.014	0.39

(1) 2021 samples were reported to method detection limit (MDL).
(2) Where results were reported as less than the MDL, the average value was calculated using the MDL.

The 2018 MPCA Methods (reference (12)) specify that at least 15 samples must be collected from the randomized list of 100 locations within the highest wild rice density areas in order to calculate a sulfate standard and that additional samples can be collected over time at any time during the open water season. The MPCA has stated that collecting more than 15 samples is "unlikely to substantially change a numeric expression of the sulfate standard calculated as the 20th percentile of 15 samples" (Attachment 6 of reference (11)). Thus, by these measures, the two sets of 15 paired porewater sulfide and surface water sulfate measurements presented in Table 4-1 should be considered to more than adequately characterize and be representative of the range of conditions within Perch Lake's wild rice habitats for purposes of developing a site-specific sulfate standard.

4.2.1.1 Porewater Sulfide Outliers

Box-and-whisker plots were used to visually evaluate the Perch Lake porewater sulfide results for outliers. These plots show data distribution statistics, including minimum as left whisker, first quartile (25th percentile) as left edge of box, median (50th percentile) within the box, third quartile (75th percentile) as right edge of box, and maximum as right whisker. When applicable, the plots also show outliers that are more than one and a half times the width of the box (the interquartile range) from the box edges. Figure 4-1 depicts the box-and-whisker plots for the October and November 2021 porewater sulfide datasets.

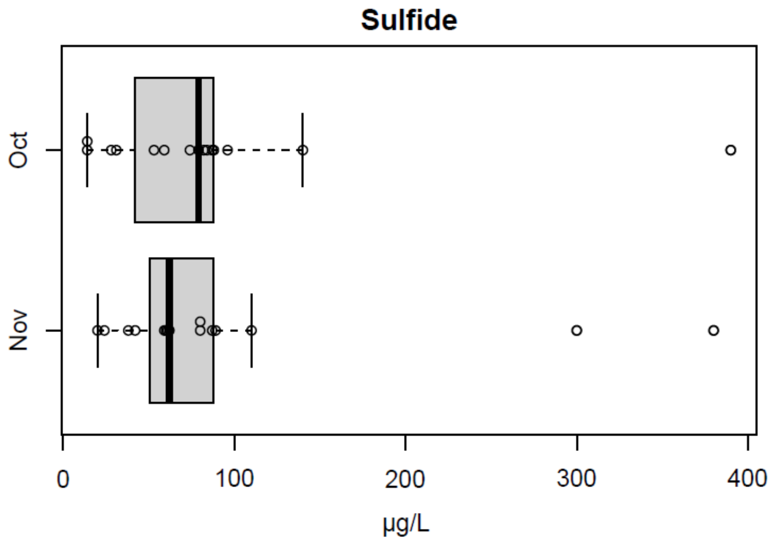


Figure 4-1 October and November 2021 Porewater Sulfide Datasets

The box-and-whisker plots show that there were three outlier porewater sulfide measurements (390 µg/L in October 2021 and 310 and 390 µg/L in November 2021). Factors that affect porewater sulfide concentrations, including sediment composition and chemistry and groundwater upwelling, are naturally variable across the bottom of a lake; thus, variation in porewater sulfide concentrations is expected. These samples were obtained within areas where wild rice was documented during pre-sampling field reconnaissance in September 2021, and they demonstrate that wild rice growth occurs in Perch Lake at porewater sulfide concentrations greater than the MPCA proposed protective porewater sulfide threshold of 120 µg/L and also at porewater sulfide concentrations greater than this request's proposed protective porewater sulfide threshold of 370 µg/L.

4.2.2 Sediment Iron and Total Organic Carbon

The analytical results for sediment TEFe and TOC from October 2021 and November 2021 Perch Lake sampling events are summarized in Table 4-2. Analytical results for each sampling location and associated lab reports are provided in Large Table 1 and Appendix E, respectively. Sampling locations are shown on Large Figure 3.

Table 4-2 Summary of Perch Lake Sediment Iron and Total Organic Carbon Results

Sampling Month(s)	# of Samples	Sediment Total Organic Carbon (TOC) (%)			Sediment Total Extractable Iron (TEFe) (milligrams per kilogram)		
		Avg	Min	Max	Avg	Min	Max
October 2021	15	14.2	0.6	28.6	27,754	5,299	56,542
November 2021	15	13.9	0.7	38.0	26,754	4,361	81,496
October & November 2021	30	14.1	0.6	38.0	27,254	4,361	81,496

The 2018 MPCA Methods (reference (12)) specify that at least 15 samples must be collected from the randomized list of 100 locations within the highest wild rice density areas in order to calculate a sulfate standard and that additional samples can be collected over time at any time during the open water season. The MPCA has stated that collecting more than 15 samples is "unlikely to substantially change a numeric expression of the sulfate standard calculated as the 20th percentile of 15 samples" (Attachment 6 of reference (11)). Thus, by these measures, the two sets of 15 paired sediment TOC and TEFe measurements presented in Table 4-2 should be considered to more than adequately characterize and be representative of the range of conditions within Perch Lake's wild rice habitats for purposes of developing a site-specific sulfate standard.

The sediment TOC and TEFe results from Perch Lake were compared visually and statistically to evaluate whether there were differences between the results of the October and November 2021 sampling events. Visual evaluation consisted of box-and-whisker plots. The structure of these plots is as described in Section 4.2.1.1. Figure 4-2 depicts the box-and-whisker plots comparing the October and November 2021 datasets. The box plots largely overlap for both sediment TOC and TEFe.

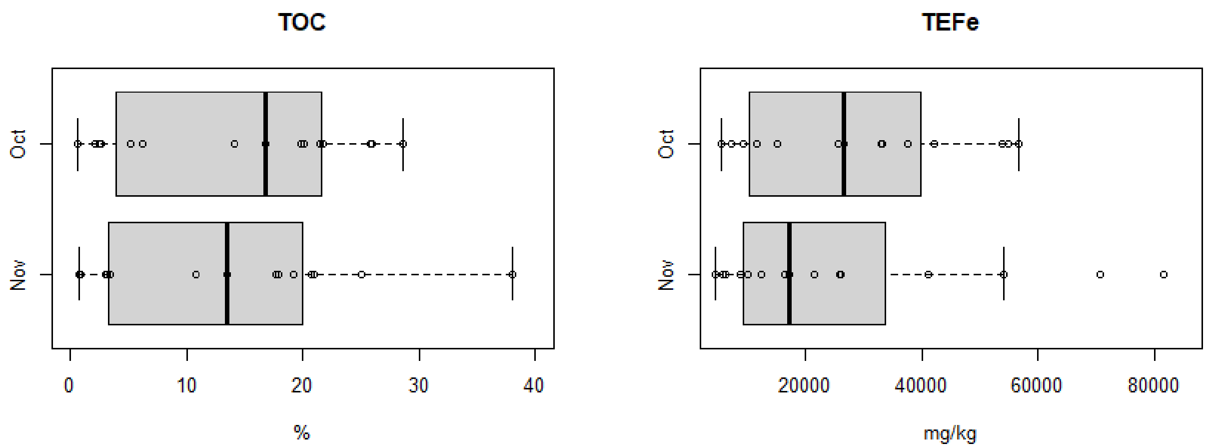


Figure 4-2 Comparison of October versus November 2021 Sediment Total Organic Carbon and Total Extractable Iron Datasets

Statistical comparison was done using Welch's two sample t-test. Shapiro-Wilk tests for normality indicated that the datasets generally fit a log-normal distribution, so data were log-transformed prior to the t-test. The results of the t-tests indicated no significant differences for sediment TOC and TEFe concentrations between the October and November 2021 datasets.

Overall, these visual and statistical evaluations indicate that the sediment results were consistent regardless of the sampling month. Thus, it can be concluded that the October and November 2021 sediment results are consistent characterizations of the sediment TEFe and TOC within Perch Lake's wild rice habitats.

Sediment is naturally spatially variable and thus sediment TOC and TEFe will vary spatially between wild rice beds (reference (3)). However, studies have shown there is no statistically significant seasonal trend in TOC and TEFe concentrations (reference (18)). TEFe will mobilize some during periods of lower oxygen (e.g., summer months) from sediment into the porewater and reabsorb into the sediment during periods of higher oxygen (e.g., fall months) but this fluctuation is minimal, and concentrations are within the same range.

5 Class 4A Wild Rice Beneficial Use

The MPCA has indicated that Perch Lake is subject to the Class 4A sulfate standard and that the Class 4A wild rice beneficial use must therefore be protected in Perch Lake. For purposes of this site-specific standard request, United is assuming, without conceding, that the Class 4A wild rice beneficial use must be protected in Perch Lake.

During the 2017 rulemaking process, the MPCA concluded that surface water sulfate concentrations are protective of the wild rice beneficial use when porewater sulfide concentrations are at or below the protective porewater sulfide threshold (reference (3)). The protectiveness of Perch Lake's existing porewater sulfide concentrations is discussed in Section 5.1.

This section also summarizes historical observations of wild rice in Perch Lake (Section 5.2) and factors other than surface water sulfate that could influence wild rice presence and health in Perch Lake (Section 5.3).

5.1 Porewater Sulfide Protective of Wild Rice

As concluded in Section 3.2.2, a protective porewater sulfide threshold of 370 µg/L represents a conservative target to protect the Class 4A wild rice beneficial use for the purposes of developing a site-specific sulfate standard for Perch Lake.

Porewater sulfide concentrations measured in Perch Lake (Large Table 1 and Large Figure 3) vary between sampling locations, as expected based on the variability of natural systems. The average porewater sulfide concentrations across Perch Lake, summarized in Table 4-1, are below both the MPCA proposed protective porewater sulfide threshold of 120 µg/L and this request's proposed protective porewater sulfide threshold of 370 µg/L. Additionally, individual porewater sulfide measurements are also predominantly below both 120 µg/L (87%; 26 of 30 measurements) and 370 µg/L (93%; 28 of 30 measurements). This demonstrates that Perch Lake's existing porewater sulfide concentrations are protective of the Class 4A wild rice beneficial use.

5.2 Wild Rice Observations

Historical observations of wild rice on Perch Lake have been documented and are summarized in Table 5-1. The exact survey methods, procedures, and quantities of wild rice are not well documented for every observation and they are likely inconsistent; however, they do indicate the ongoing presence of wild rice in Perch Lake.

Table 5-1 Summary of Documented Wild Rice Observations

Year	Conducted by	Summary of Observations [1]
1968	Minnesota Department of Natural Resources [2]	20% (approximately 18.4 acres) of Perch Lake was covered by emergent vegetation, including lush swamp horsetail almost completely surrounding the shoreline, two concentrations of scattered wild rice on the northwest shoreline, and scattered cattails and cursed crowfoot thickest in the outlet area. *(Note: The 18.4 acres of emergent vegetation is based on the MDNR fisheries lake survey report indicating that Perch Lake was 91.8 acres, which is larger than quantified by other sources.[3])*
1998	Minnesota Department of Natural Resources [4]	40% wild rice coverage yielding approximately 32 acres of wild rice. *(Note: The 32 acres of wild rice is based on the MDNR survey field notes indicating that Perch Lake was 79 acres, which is larger than quantified by other sources.[5])*
2016	Cardno [6]	Three wild rice areas were documented with total wild rice densities of 148, 244, and 172 stems/m^2. The acreage associated with these areas were not documented.
2017	Northeast Technical Services [6]	Five wild rice areas were identified as a level #1 [7] and noted rice was not very dense, only 1-2 ft above water with few seeds on the plants. The acreage associated with these areas were not documented.
2020	Barr Engineering Co. [8]	Approximately 1.6 acres of wild rice with a total stem count of 41,739 stems [9] and an approximate average density of 6 stems/m^2. The highest density, single wild rice area has an approximate average density of 58 stems/m^2. See Large Figure 4 for additional details.
2021	Barr Engineering Co. [10]	Approximately 4.5 acres of wild rice with a total stem count of 2,845 stems [9] and an approximate average density of 0.2 stems/m^2. The highest density, single wild rice area has an approximate average density of 65 stems/m^2. See Large Figure 4 for additional details.

(1) Survey methods, procedures, and quantities of wild rice are not well documented for every observation and they are likely inconsistent. In particular, few details are available for the 1968 and 1998 observations.

(2) MDNR fisheries lake survey conducted August 28-29, 1968 (reference (54))

(3) Acreage of emergent vegetation was not provided. Perch Lake was recorded on the 1968 MDNR fisheries lake survey report (reference (54)) as a 91.8-acre lake with two small ponds in the swamp as the inlet to the lake and a tributary to a swamp as the outlet; this is larger than quantified by other sources (reference (55), reference (56), and Large Figure 2). Based on recorded acreage and provided percent coverage (20%), the acreage of emergent vegetation was estimated to be approximately 18.4 acres.

(4) MDNR wild rice lake survey conducted in 1998 (reference (56))

(5) The 1998 MDNR survey field notes (reference (57)) indicated Perch Lake was 79 acres, which is larger than quantified by other sources (reference (55) and Large Figure 2). It is possible that the MDNR included some of the northwestern wetland between Perch Lake and Bluebill Lake as part of Perch Lake for a total acreage of 79 acres. Additionally, it is unlikely that there was 32 acres of wild rice in Perch Lake in 1998 based on consideration of the water depths at which wild rice has been noted to grow well, the maximum wild rice habitat in Perch Lake is approximately 11 acres that are less than 3 feet deep. (Large Figure 2)

(6) Survey completed on behalf of Cleveland Cliffs as an internal data collection exercise.

(7) MDNR's *Handbook for Collecting Vegetation Plot Data in Minnesota* (reference (58))

(8) Wild rice survey (reference (59)) conducted in accordance with MPCA's 2017 *Sampling and Analytical Methods for Wild Rice Waters* (reference (8)).

(9) Number of plants is a field estimation; individual plants may not have been individually counted during the survey.

(10) Wild rice survey (reference (59)) conducted in accordance with MPCA's 2018 *Sampling and Analytical Methods for Wild Rice Waters* (reference (12)).

These wild rice observations spanning from 1968 to 2021 indicate that conditions within portions of Perch Lake have historically supported the presence of wild rice. The observations also indicate that wild rice has fluctuated in both coverage and density, as would be expected both due to wild rice life cycles and seasonal and annual hydrological variability (refer to further discussion in Section 5.3).

The wild rice observation by the MDNR in 1998 (reference (56)) stands out as inconsistent with the other wild rice observations. This observation comes from a one page "wild rice lake survey report" containing limited information and brief handwritten notes obtained from the MDNR's files. The survey does not indicate who collected the data. Specific details on the wild rice observations are limited to percent coverage and an associated acreage of wild rice. The report and notes indicate that the lake was 79 acres in size with 40% wild rice coverage and thus approximately 32 acres of wild rice. These estimates are likely inaccurate based on the following:

- The 1981 Eveleth Mines Taconite Tailings Basin Expansion Environmental Report (reference (55)) stated that Perch Lake was a 62 acres lake and a 2020 bathymetry survey (Large Figure 2) measured Perch Lake as approximately 65 acres. Thus, it is unlikely that Perch Lake was 79 acres in 1998.
- It is unlikely that there was 32 acres of wild rice in Perch Lake in 1998. Only scattered wild rice was documented by the MDNR in 1968 (reference (54)), and as discussed in Section 5.3, based on consideration of the water depths at which wild rice has been noted to grow well, the maximum wild rice habitat in Perch Lake is approximately 11 acres that are less than 3 feet deep (Large Figure 2).

Based on the limited details available and these inconsistencies, less credence is afforded to the 1998 MDNR wild rice observation.

5.3 Other Factors Potentially Influencing Wild Rice

Available information suggestions that the following factors identified in Section 3.3 could be influencing the prevalence of wild rice in Perch Lake in addition to and possibly to a greater extent than surface water sulfate concentrations: water levels, groundwater upwelling, annual cycles of wild rice production, and water and sediment chemistry of Perch Lake. While there are several other factors mentioned in Section 3.3 and peer reviewed research, there is not enough data to derive the level of influence those factors have on the prevalence of wild rice in Perch Lake, and they are not discussed in this section.

As discussed in Section 3.3, wild rice generally requires some moving water and has been noted to grow well at water depths of 0.5 to 3 feet or 1 to 4 feet (depending on the reference). Perch Lake has some moving groundwater and surface water (as mentioned in Section 4.1). Approximately 17% of the lake (~11 acres) is less than 3 feet deep (Large Figure 2). Thus, based only on water depth, the maximum wild rice habitat in Perch Lake is approximately 11 to 24 acres.

While the full extent of groundwater upwelling occurring within Perch Lake is unknown, modeling indicates that groundwater inflow (via lateral inflow and/or vertical upwelling) is likely occurring in at least some parts of Perch Lake (Section 4.1; reference (52)). As discussed in Section 3.3, areas with consistent upward groundwater flow may be favorable habitat for wild rice because surface water sulfate is less likely to mobilize into the sediment porewater. In such cases, the groundwater sulfate concentration may be more important than the surface water sulfate concentration in controlling the production of porewater sulfide. Groundwater samples were collected from the three nested sets of wells recently installed in the area between Bluebill and Perch Lake, and sulfate concentrations were less than 1.2 mg/L (the practical quantitation limit), suggesting that groundwater flowing toward Perch Lake has lower sulfate concentrations than Perch Lake surface water. Groundwater quality monitoring will occur at these wells for a period of time to further evaluate groundwater quality in this area.

Another factor discussed in Section 3.3 and observed in Perch Lake is the variation of natural wild rice production from year-to-year. Natural wild rice production is cyclical and varies from year-to-year, generally in a three-to-five year period (references (22); (40); (41); (42); (43)) with highly productive years followed by low productivity and then a gradual recovery in natural wild rice yield (references (22); (41); (44); (45); (46); (47)). Although wild rice surveys have not been conducted frequently enough to hypothesize the typical cycle of natural wild rice growth within Perch Lake, historical wild rice surveys (Section 5.2) do demonstrate variation of wild rice presence from year-to-year.

There is potential that there are water and/or sediment chemistry parameters other than surface water sulfate, porewater sulfide, and sediment TEFe and TOC that influence porewater sulfide production and/or wild rice growth in Perch Lake. Study of the effects of other parameters has been more limited and thus there are not definitive criteria to compare against; however, some of the parameters that could be influencing wild rice are discussed in Section 3.3, including components as basic as essential nutrients such as sediment ammonia-nitrogen which recent studies have indicated may be more influential than surface water sulfate and porewater sulfide (references (32); (33)).

6 Site-Specific Sulfate Standard Approach

Based on consideration of site-specific information for Perch Lake, a site-specific sulfate standard is more appropriate for Perch Lake than the statewide Class 4A sulfate standard. This section presents site-specific justification related to:

- why a site-specific sulfate standard is more appropriate for Perch Lake than the statewide Class 4A sulfate standard (Section 6.1)
- why the MBLR equation-based approach proposed by the MPCA in 2017 and 2018 is not the most appropriate basis for a site-specific sulfate standard applicable to Perch Lake (Section 6.2)
- why a modified version of the ratio equation-based approach proposed by MPCA in 2017 is an appropriate basis for a site-specific sulfate standard applicable to Perch Lake (Section 6.3)

6.1 A Site-Specific Sulfate Standard is More Appropriate for Perch Lake than the Statewide Class 4A Sulfate Standard

As described in Section 2.3.1, the statewide Class 4A sulfate standard is 10 mg/L applicable to waters "used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels" (Minnesota Rules, part 7050.0224, subpart 2). There are multiple lines of evidence that indicate that a sulfate standard based on site-specific conditions would be more appropriate for Perch Lake than this statewide standard. Specifically, even though surface water sulfate concentrations in Perch Lake are greater than 10 mg/L (Section 4.2.1):

- Porewater sulfide concentrations in Perch Lake are predominately below both the conservative MPCA proposed protective porewater sulfide threshold of 120 µg/L and this request's proposed protective porewater sulfide threshold of 370 µg/L (Section 5.1). This demonstrates that porewater sulfide concentrations in Perch Lake are protective of the Class 4A wild rice beneficial use at sulfate concentrations greater than the statewide Class 4A sulfate standard of 10 mg/L.
- Multiple years of wild rice surveys have documented that wild rice is present in Perch Lake (Section 5.2).

This evidence that the Class 4A wild rice beneficial use is protected in Perch Lake at sulfate concentrations greater than 10 mg/L strongly indicates that the statewide Class 4A sulfate standard is unduly restrictive for Perch Lake. Thus, it is more appropriate to determine a sulfate standard applicable to Perch Lake based on site-specific conditions.

This conclusion is also supported by the MPCA's proposal in the 2017 proposed rules that sulfate standards calculated based on site-specific conditions would be more appropriate than a single statewide standard. In the SONAR for the 2017 proposed rules (reference (2)), the MPCA stated and supported that "a tailored water quality standard is designed, based on a model of the environment, to be appropriate for the specific characteristics of a given water body" and that "this results in a water quality standard that, when compared to a fixed number, more accurately identifies the level of a chemical that is protective of the beneficial use". Support for this MPCA conclusion includes:

- There are field observations of viable wild rice populations in waters where sulfate concentrations are substantially greater than 10 mg/L (reference (2)).
- MPCA's research and data analysis indicated that "the pollutant that adversely affects wild rice is not sulfate in the water, but rather sulfide in the sediment porewater" (reference (2)) and that the production of porewater sulfide from sulfate is influenced by site-specific conditions such as concentrations of iron and TOC in the sediment (references (2); (3)) along with other factors.

As discussed in Section 2.3.2, the primary concerns that led the ALJ to disapprove the 2017 proposed rule (the potential adverse consequences of repealing the 10 mg/L Class 4A sulfate standard without an immediate replacement standard providing equal protection) are not implicated in the context of establishing a single site-specific sulfate standard, which would immediately replace the statewide standard for Perch Lake.

6.2 Perch Lake Does Not Fit the MPCA Proposed MBLR Equation-Based Approach

The MBLR equation-based approach proposed by the MPCA in 2017 and 2018 was considered as a potential approach for developing a site-specific sulfate standard applicable to Perch Lake. As discussed in Section 2.3.2, the MPCA proposed MBLR equation was based on the MPCA's conceptual model that porewater sulfide concentrations of 120 µg/L or less are protective of the wild rice beneficial use, and production of porewater sulfide from sulfate is predominately influenced by site-specific conditions such as concentrations of iron and TOC in the sediment (reference (3)). The MPCA proposed its MBLR equation for use in calculating waterbody-specific sulfate standards protective of wild rice based on concentrations of sediment iron and TOC. The most recent version of the MPCA proposed MBLR equation is:

2018 MPCA proposed MBLR equation:

$$Sulfate\left(\frac{mg}{L}\right) = 0.0000854 \times \frac{Sediment\ Iron\ (\frac{mg}{kg})^{1.637}}{Sediment\ Total\ Organic\ Carbon\ (\%\ dry\ weight)^{1.041}}$$

Because the MPCA proposed MBLR equation is designed to calculate a waterbody-specific sulfate standard that would maintain porewater sulfide at or below 120 µg/L, either of the following two outcomes are expected when comparing measured porewater sulfide and surface water sulfate concentrations with the site-specific sulfate standard calculated based on the equation:

- If measured porewater sulfide concentrations are less than 120 µg/L, the calculated site-specific sulfate standard should be greater than measured surface water sulfate concentrations.
- If measured porewater sulfide concentrations are greater than 120 µg/L, the calculated site-specific sulfate standard should be less than measured surface water sulfate concentrations.

Following the MPCA's proposed procedures for determining a numeric sulfate standard using the 2018 MPCA proposed MBLR equation (as described in Table 2-1) with the sediment TEFe and TOC data from Perch Lake (October and November 2021 grab samples as summarized in Table 4-2), results in the MBLR-calculated site-specific sulfate standard of 40 mg/L. (Associated calculations are provided in Appendix F.) This potential site-specific sulfate standard is less than the measured surface water sulfate concentrations in Perch Lake (110 mg/L average in October and November 2021); however, the majority of measured porewater sulfide concentrations are less than the MPCA proposed protective porewater sulfide threshold of 120 µg/L (Section 5.1). This indicates that the Class 4A wild rice beneficial use is protected in Perch Lake at surface water sulfate concentrations greater than this potential site-specific sulfate standard and thus this approach would be unduly restrictive for Perch Lake.

The lack of correlation between the measured concentrations and the calculated potential site-specific sulfate standard from the 2018 MPCA proposed MBLR equation indicates that there are factors other than sediment TOC and iron influencing and limiting the conversion of surface water sulfate to porewater sulfide concentrations in Perch Lake. During the 2017 proposed rulemaking process, the MPCA acknowledged that, while its proposed MBLR equation was "designed for the vast majority of water bodies, where changes in the porewater sulfide concentration is proportional to changes in sulfate in surface water" (reference (2)), there would be waterbodies that do not conform "to the conceptual model on which the equation-based sulfate standard is based, and therefore an appropriate sulfate standard must be determined through an alternative method" (reference (3)).

The MPCA's specific example for why a waterbody would not conform with the conceptual model behind its proposed MBLR equation focused on the influence of upwelling groundwater with lower sulfate concentrations minimizing the influence of higher surface water sulfate concentrations on production of porewater sulfide (references (2); (3)). As discussed in Section 4.1, modeling (reference (52)) has estimated groundwater inflow into Perch Lake at approximately 143 m^3/day compared to groundwater outflow of approximately 19 m^3/day, which indicates that groundwater inflow (via lateral inflow and/or vertical upwelling) is likely occurring in at least some parts of Perch Lake. The same modeling (reference (52)) also estimated no constituent loading to Perch Lake via groundwater. Field data also indicate low sulfate concentrations in groundwater flowing toward Perch Lake (as described in Section 5.3). Thus, it is reasonable to hypothesize that upwelling groundwater with lower sulfate concentrations than surface water is influencing porewater sulfide concentrations in Perch Lake.

The MPCA also acknowledged that "there may be other reasons, in addition to the influences of groundwater flow, for why sulfide is low and wild rice is prospering despite high levels of sulfate in the surface water" (reference (2)). As discussed in Section 5.3, there are likely factors other than surface water sulfate concentrations influencing wild rice in Perch Lake.

Based on the acknowledgement that the proposed MBLR equation may not be appropriate for all waterbodies, the MPCA stated that it would be appropriate to use an alternate approach for a waterbody when:

- the ambient surface water sulfate concentration is higher than the sulfate standard calculated using the MPCA proposed MBLR equation; and
- data demonstrates that porewater sulfide concentrations are at or below the MPCA proposed protective porewater sulfide threshold of 120 µg/L (references (3); (7)).

Based on consideration of these two criteria combined with Perch Lake's alignment with the MPCA's hypotheses for why the proposed MBLR equation's conceptual model may not be appropriate for some waterbodies, the MPCA proposed MBLR equation-based approach is not the appropriate approach for developing a site-specific sulfate standard applicable to Perch Lake.

6.3 Proposed Site-Specific Sulfate Standard Approach Appropriate for Perch Lake

As discussed in Section 6.2, Perch Lake does not conform to the conceptual model upon which the MPCA proposed MBLR equation was based. In 2017, the MPCA proposed the following alternate sulfate standard equation for waterbodies where this is the case (reference (3); (60)):

2017 MPCA proposed ratio equation:

$$Sulfate\left(\frac{mg}{L}\right) = \frac{0.120\ mg/L}{Measured\ Sulfide\ (\frac{mg}{L})}\ x\ Measured\ Sulfate\ (\frac{mg}{L})$$

This equation is based on:

- The understanding that when porewater sulfide concentrations are protective of wild rice (at or below the protective porewater sulfide threshold), the ambient surface water sulfate concentration must also be sufficiently protective of the wild rice beneficial use (references (2); (3)).
- MPCA's conclusions that "it is likely that the maximum increase in porewater sulfide concentrations as a result of increased sulfate would be proportional to the increase in sulfate" (reference (3)) and thus that "a protective approach" would be to "adjust the observed ambient sulfate concentration by the factor that the protective sulfide concentration of 120 µg/L exceeds the observed ambient porewater sulfide concentration" (reference (3)).

As concluded in Section 3.2.2, a protective porewater sulfide threshold of 370 µg/L represents a conservative target to protect wild rice for the purposes of developing a site-specific sulfate standard for Perch Lake. Thus, this request proposes the following modified version of the ratio equation:

this request's proposed ratio equation:

$$Sulfate\left(\frac{mg}{L}\right) = \frac{0.370\ mg/L}{Measured\ Sulfide\ (\frac{mg}{L})}\ x\ Measured\ Sulfate\ (\frac{mg}{L})$$

A ratio equation-based approach can only be implemented when both porewater sulfide and surface water sulfate data are available. As discussed in Section 4.2.1, 30 paired porewater sulfide and surface water sulfate measurements have been collected in accordance with the most recent MPCA recommended methods to characterize the conditions within Perch Lake's wild rice habitats. The existence of these datasets allows for implementation of this approach that directly relates porewater sulfide and surface water sulfate.

The MPCA conclusion that a ratio equation-based approach would be protective of wild rice was based on consideration of the efficiency of conversion of sulfate to sulfide in surface waters (the molar ratio of sulfide to sulfate, expressed as a percentage). Specifically, the MPCA noted that:

- "In the MPCA-sponsored field survey, only 17 of the 115 different natural waterbodies had a sample with efficiency exceeding 50%. The median conversion efficiency of the natural waterbodies was 7.7%." (reference (3)).
- In the sulfate-addition experiment by Pastor et al. (reference (16)):
    - "As the sulfate concentrations increased, the efficiency of conversion declined significantly from a maximum of 4% at the lowest sulfate concentration to a maximum of about 2%" (reference (3)).
    - The experimental sulfate additions showed "a declining efficiency", thus suggesting "that the sulfide increase would be less than proportional" (reference (3)).

Site-specific measurements indicate that the efficiency of conversion of surface water sulfate to porewater sulfide in Perch Lake is lower than both the median from the MPCA-sponsored field surveys and the maximums from the Pastor sulfate-addition experiment. Sulfate-to-sulfide conversion efficiencies calculated for the 30 paired porewater sulfide and surface water sulfate measurements collected in October and November 2021 range from 0.04% to 1.1% with an average of 0.25% and median of 0.21%. Perch Lake-specific data is not available across a large enough range of sulfate values to assess whether the sulfate-to-sulfide conversion efficiency decreases as sulfate concentrations increase; however, the MPCA's analysis of Pastor's sulfate-addition experiment (reference (3)) indicates that this is likely the case.

This request's proposed ratio equation is designed to yield a protective sulfate standard based on maintenance of porewater sulfide concentrations protective of wild rice (at or below this request's proposed protective porewater sulfide threshold of 370 μg/L). Based on consideration of the design of the equation in combination with the limited efficiency of conversion of surface water sulfate to porewater sulfide in Perch Lake, this request's proposed ratio equation is an appropriate and conservative approach for determining a site-specific sulfate standard protective of the Class 4A wild rice beneficial use in Perch Lake based on measured porewater sulfide and surface water sulfate concentrations.

7 Proposed Site-Specific Sulfate Standard

This section describes the appropriate application of the proposed ratio equation to Perch Lake (Section 7.1) and then presents the details of the proposed site-specific sulfate standard (Section 7.2).

7.1 Application of Proposed Ratio Equation to Perch Lake

As described in Section 6.3, this request's proposed ratio equation is an appropriate approach to determine a site-specific sulfate standard protective of the Class 4A wild rice beneficial use in Perch Lake based on measured porewater sulfide and surface water sulfate concentrations.

7.1.1 Selection of Equation Inputs

The 2018 MPCA Methods (reference (12)) specify that at least 15 samples must be collected from the randomized list of 100 locations within the highest wild rice density areas in order to calculate a sulfate standard. As discussed in Section 4.2.1, the following porewater sulfide and surface water sulfate sampling was conducted in October and November 2021 in accordance with the most recent MPCA recommended methods:

- 15 paired porewater sulfide and surface water sulfate grab sample measurements were obtained in October 2021 from randomly selected locations within the highest wild rice density areas (as documented in September 2021)
- 15 paired porewater sulfide and surface water sulfate grab sample measurements were obtained in November 2021 from randomly selected locations within the highest wild rice density areas (as documented in September 2021)

As the MPCA noted when the agency updated its sampling methods in 2018 based on consideration of USEPA guidance for choosing a sampling design for environmental data collection (reference (53)), the 2018 probability-based sampling methods better meet the goal of objectively characterizing the range of calculated protective sulfate concentrations compared to the previously proposed sampling along transects (reference (11)). Overall, these paired porewater sulfide and surface water sulfate measurements obtained at 30 randomly selected locations within the highest wild rice density areas should be considered to more than adequately characterize and be representative of the range of conditions within Perch Lake's wild rice habitats. Thus, these porewater sulfide and surface water sulfate datasets are the most appropriate inputs to this request's proposed ratio equation for development of a site-specific sulfate standard applicable to Perch Lake.

7.1.2 Selection of Appropriate Site-Specific Sulfate Standard from Equation Outputs

To be most representative of variation throughout Perch Lake's wild rice habitats, a protective sulfate concentration should first be calculated using this request's proposed ratio equation for each paired porewater sulfide and surface water sulfate measurement. This approach produces a set of calculated protective sulfate values representative of conditions within different wild rice habitats throughout the lake from which an appropriate lake-wide protective sulfate standard can be selected. This is consistent with the MPCA's proposed approach for implementing its proposed MBLR equation (references (3); (11).

From the set of calculated protective sulfate values, the 20th percentile was selected as the site-specific sulfate standard for Perch Lake to be consistent with the MPCA's proposed approach for implementing the 2018 MPCA proposed MBLR equation (reference (11)). The MPCA's reasons for recommending a percentile approach included:

- A percentile approach works well with the randomized sampling approach as it is less susceptible to variability between sampling locations compared to selecting the lowest calculated sulfate value (reference (11)).
- With a percentile approach, "as more data is collected the calculation will converge on the 'true' values" (reference (11)). (This is advantageous compared to selection of the lowest value which becomes more vulnerable to being skewed by outliers as more data is collected.)

This percentile approach fits well with the data collected for Perch Lake, where two sets of 15 paired surface water sulfate and porewater sulfide results were collected during two sampling events in accordance with the randomized sampling approach recommended by the MPCA in 2018 (reference (12)). This is double the minimum amount of monitoring results suggested by the MPCA when using the randomized sampling approach (reference (11)). Using a percentile approach factors in natural spatial variability of porewater sulfide throughout the lake, while also minimizing the effect of outliers.

The MPCA specifically recommended selection of the 20th percentile based on its examination of "the relationship between percentile and number of samples analyzed by mimicking the random sampling of a wild rice water and calculating numeric expressions of the sulfate standards from various percentiles (10th, 20th, and 30th) based on various numbers of samples analyzed for iron and TOC (5, 10, 15, 20, or 25 samples)" (reference (11)). The details of this analysis are described further in Attachment 6 to the MPCA's 2018 response letter to the Chief Administrative Law Judge (reference (11)). From this analysis, the MPCA recommended the 20th percentile value because it resulted in more certainty than the 10th percentile and the agency concluded that there was "diminishing benefits to the use of percentiles greater than 20th" (reference (11)). Although this analysis by the MPCA focused on the proposed MBLR equation, it is reasonable to extrapolate that similar relationships between percentile and number of samples would be observed if a similar analysis was complete for the proposed ratio equation. Additionally, the MPCA noted that "the 20th percentile has a 95% confidence interval of ± 5%; so one would expect the 'true value' of the numeric expression of the sulfate standard to be ± 5% of the calculated value" (reference (11)). This indicates that selection of the 20th percentile is an accurate and appropriate method for selection of a lake-wide site-specific sulfate standard for Perch Lake.

7.2 Proposed Site-Specific Sulfate Standard

Numeric water quality standards include three components: magnitude, duration, and frequency. The magnitude is the number itself, the duration is the averaging time of the standard, and the frequency is how often the magnitude may be exceeded before the standard is considered violated (reference (2)). The three components of the site-specific sulfate standard proposed for Perch Lake are summarized in Table 7-1 and described further in Sections 7.2.1 (magnitude), 7.2.2 (duration), and 7.2.3 (frequency).

Table 7-1 Proposed Site-Specific Sulfate Standard Applicable to Perch Lake

Parameter	Magnitude	Duration	Frequency
Sulfate (applicable to water used for production of wild rice)	430 mg/L	annual average	not more than once in ten years

7.2.1 Magnitude

Applying this request's proposed ratio equation to Perch Lake as described in Section 7.1 yields a protective site-specific sulfate standard of 430 mg/L. Associated calculations are provided in Appendix G.

7.2.2 Duration

The duration of the current Class 4A sulfate standard is "during periods when the rice may be susceptible to damage by high sulfate levels" (Minnesota Rules, part 7050.0224, subpart 2). In the 2017 proposed rules (reference (7)) and associated final TSD (reference (3)) and SONAR (reference (2)), the MPCA proposed and justified implementing the duration as an annual average. For purposes of the site-specific sulfate standard applicable to Perch Lake, it is also most appropriate to apply the magnitude as an annual average.

As discussed in Section 3.1, sulfate is not directly harmful to wild rice; rather, elevated sulfate concentrations can lead to long-term buildup of porewater sulfide in the sediment in which wild rice germinates and roots. Because porewater sulfide can be produced at any time throughout the year (reference (61)), the sulfate concentration in surface water is important throughout the year, not just when wild rice is actively growing. The duration considers the timeline of impact to the Class 4A wild rice beneficial use because sulfate only causes indirect negative effects. Applying the site-specific sulfate standard as an annual average duration is therefore based on maintaining a protective porewater sulfide concentration (reference (3)).

Additionally, an annual average duration is appropriate because the conversion of surface water sulfate to porewater sulfide is a relatively slow, multi-step process. Sulfate enters the sediment from the overlying water, generally through diffusion from areas of high concentrations to areas of low concentration. The diffusion process is slowed by cold temperatures; thus, it is appropriate to apply annually to compensate for this seasonal variability (reference (2)). The annual temperature and organic matter production cycle in Minnesota strongly affect sulfide production. All wild rice plants die in the fall, producing an abundance of organic matter that drives the production of sulfide, if sulfate is available (reference (3)). An annual average duration is therefore reasonable to account for the effect of sulfate on sulfide production throughout the year.

7.2.3 Frequency

The frequency of the current Class 4A sulfate standard is not defined in Minnesota Rules Chapter 7050. In the 2017 final TSD (reference (3)), the MPCA defined frequency as "the interval between poor wild rice growth years from which wild rice has the undoubted ability to recover." In the 2017 proposed rules (reference (7)) and associated final TSD (reference (3)) and SONAR (reference (2)), the MPCA proposed and justified implementing the frequency as not to be exceeded more than once in ten years. For purposes of the site-specific sulfate standard applicable to Perch Lake, it is also most appropriate to apply the magnitude as a one in ten-year exceedance frequency.

The one in ten-year exceedance frequency is supported by natural environmental variability. A wild rice population will not be significantly harmed by an exceedance that occurs only once in ten years because the environmental chemistry and wild rice population will be able to recover between exceedances if any were to occur. It is unlikely that one year of elevated sulfate will have a long-term negative effect on wild rice growth and reproduction, so long as sulfate concentrations do not remain elevated above the allowable annual average for multiple years in a row (reference (3)). In fact, wild rice populations commonly vary on a 3- to 5-year cycle under natural conditions (reference (42)). This is because wild rice populations build up a seed bank in the sediment so that only a portion of dormant seeds germinate in any given year. The existence of the seed bank allows wild rice to recolonize a waterbody even if all growing plants were to be eliminated by an environmental disturbance in a given year (reference (22)).

As described in Section 7.2.2, the impact of sulfate on wild rice is a slow process. There is a lag time in the impacts of sulfate on surface water because porewater sulfide production requires the diffusion of sulfate into the sediment. The level of porewater sulfide is the long-term balance between production and loss of sulfide. If elevated sulfate in one year is followed by a year of lower sulfate, it is expected that porewater sulfide would re-equilibrate to the long-term average. The return to the long-term average sulfide concentration occurs because the unconverted sulfate would diffuse back to the surface water, and porewater sulfide would be oxidized by oxygen, ferric iron, and other oxidants. Temporary high concentrations of sulfate in surface water are not permanently preserved in the sediment as high sulfide (reference (3)). Therefore, it is reasonable to allow limited excursion above the standard because one year of elevated surface water sulfate will not result in a sustained increase in sulfide levels in the sediment porewater (reference (2)).

8 Protection of Downstream Beneficial Use

The site-specific sulfate standard reach begins and ends at Perch Lake, with water flowing south from Perch Lake into wetlands, which eventually reach the Whiteface River via a series of ditches (Large Figure 5). Water from Perch Lake moves laterally through the wetlands via diffuse/non-channelized flow to the series of ditches that eventually connect to the Whiteface River. The Whiteface River flows into the St. Louis River as a major tributary. The St. Louis River Estuary (WID/AUID 69-1291-04 and 04010201-501) is the only downstream waterbody included on the MPCA's 2017 proposed list of wild rice waters (to which the MPCA has indicated the Class 4A sulfate standard of 10 mg/L applies and in which the Class 4A wild rice beneficial use must therefore be protected).

Large Figure 5 shows the general flow path for water out of Perch Lake through wetlands and ditches to the Whiteface River and then to the St. Louis River Estuary. Based on this flow path, the distance from Perch Lake to the Whiteface River is 11.6 miles and the distance from there to the St. Louis River Estuary is 83.8 miles. The total distance between the Perch Lake outlet and the St. Louis River Estuary is 95.4 river miles.

The data upon which the St. Louis River Estuary was listed as impaired due to sulfate for the Class 4A sulfate standard was provided by the USEPA in Appendix 2a of Attachment 2 of the USEPA's November 5, 2021 letter to the MPCA *Re: Minnesota's 2020 List of Impaired Waters under Clean Water Act Section 303(d)* (reference (62)). The data from Stations S007-206 and S007-444 are summarized in Table 8-1.

Table 8-1 Data Referenced by the USEPA for the Impairment of the St. Louis River Estuary at Stations S007-206 and S007-444

WID	Sample Date	Station ID	Sample Fraction	Parameter	Units	Result	Analytic Method
69-1291-04	9/5/2012	S007-206	Total	Sulfate	mg/L	**16.0**	300.1
69-1291-04	5/27/2013	S007-444	Total	Sulfate	mg/L	9.4	300.1
69-1291-04	6/24/2013	S007-444	Total	Sulfate	mg/L	8.1	300.1
69-1291-04	7/22/2013	S007-444	Total	Sulfate	mg/L	6.7	300.1
69-1291-04	8/26/2013	S007-444	Total	Sulfate	mg/L	**13.9**	300.1

Sulfate measurements above 10 mg/L are **bold**

The data from Station S007-206 includes one sulfate sample at 16.0 mg/L and four sulfate samples from Station S007-444 with a minimum of 6.7 mg/L, maximum of 13.9 mg/L, and average of 9.5 mg/L.

Two major factors will influence the amount of sulfate reduction from Perch Lake to the St. Louis River Estuary: (1) the increase in water flow from the contributing watersheds causing the dilution of sulfate and (2) the reduction of sulfate from the presence of wetlands. Sections 8.1 through 8.4 outline that when these factors combine, no measurable change is estimated for sulfate at the St. Louis River Estuary from the proposed Perch Lake site-specific sulfate standard. The analyses presented in Sections 8.1 through 8.4

are for illustrative purposes and should not be confused with the process of authorizing future sulfate loading from upstream dischargers.

8.1 Reduction of Sulfate by Wetlands Downstream

Wetlands have been shown to reduce the levels of sulfate in water through multiple studies in Northern Minnesota (e.g., reference (63)). The overall reduction of sulfate by wetlands varies based on site-specific conditions including wetland residence times. In general, greater reduction of sulfate in surface water occurs with longer residence time in wetlands (where there is a small gradient or other slow flow conditions). In addition, surface water that also contains organic materials (for example, from nearby wetlands), such as is the case for portions of the Whiteface River flow, will continue to reduce sulfate.

Large Figure 5 shows the U.S. Fish & Wildlife Service National Wetland Inventory (NWI) mapped wetlands in the vicinity of flow between Perch Lake and the St. Louis River Estuary. As shown, significant portions of the flow path are through or immediately adjacent to wetlands. In the distance from Perch Lake to the Whiteface River, 30% of the distance is through areas mapped as wetlands by the NWI as shown below:

- Total distance from Perch Lake to Whiteface River: 11.6 miles
- Distance from Perch Lake to Whiteface River through NWS wetlands: 3.8 miles
- 30% of the flow distance is through NWI-mapped wetlands (Perch Lake to Whiteface River)

The influence of wetlands and watershed dilution (discussed below) is apparent by comparing sulfate data from the Whiteface River upstream and downstream of where the ditch that flows south from the wetland complex adjacent to Perch Lake enters the river. A total of ten sulfate samples were collected at upstream and downstream MPCA monitoring stations between May and September 2009. Monitoring station locations are shown on Large Figure 5. The average concentration at both the upstream station (station S005-765) and the downstream station (S005-763) was 2.6 mg/L, indicating no measurable difference between the average concentration of sulfate in the Whiteface River upstream and downstream of water from Perch Lake joining the river. Sulfate concentrations in Perch Lake (SW004) in July and September 2009 were 76.4 mg/L and 75.2 mg/L, respectively. This data shows that in 2009, the outflow from Perch Lake did not result in a measurable change in sulfate concentrations in the Whiteface River, suggesting attenuation of sulfate was occurring. The observed concentrations reflect attenuation due to wetlands and dilution and, given the available data, it is difficult to estimate the degree to which each factor contributes. However, significant presence of wetlands within the watershed downstream suggests that they likely play a key role in attenuating sulfate.

8.2 Reduction of Sulfate by Dilution Downstream

The other major process that decreases sulfate concentration is dilution. Dilution occurs as additional water from the watershed is added to the flow from the Perch Lake outfall to the St. Louis River Estuary. The surface water outflow from Perch Lake was estimated to be 0.279 million gallons per day (MGD) (Section 4.1; reference (52)). The average flow of the St. Louis River Estuary at MPCA monitoring stations

S007-206 and S007-444 was calculated using the U.S. Geological Survey's Stream Stats Program to be 1,660 MGD. Large Table 2 includes the flow information used in scenarios for dilution calculations.

8.3 Results of Scenarios

Multiple scenarios considered the effects of both dilution and sulfate reduction on downstream concentrations of sulfate. The scenarios showed no measurable change at the St. Louis River Estuary. For the analyses presented here, no measurable change is defined as a change in sulfate concentration of 0 mg/L and 0% at Station S007-444 and S007-206 in the St. Louis River Estuary. Although not considered directly in the analysis, it is important to note that the typical method variability in sulfate analytical results from a laboratory is 10%, so the definition of no measurable change being used is conservative.

For each scenario, the Perch Lake outflow sulfate concentration was first set at the conservative assumption of equaling the proposed Perch Lake site-specific sulfate standard (430 mg/L). Then, the Perch Lake concentration was adjusted so that the resulting sulfate load from Perch Lake resulted in a change in sulfate concentration of 0 mg/L and 0% at Station S007-444 and S007-206 in the St. Louis River Estuary. The concentration adjustment was applied to calculate the sulfate load from Perch Lake that would result in no measurable change at the St. Louis River Estuary. It does not indicate that the Perch Lake outflow sulfate would need to be at the calculated concentrations/load, but rather informs the degree of sulfate load reduction that would need to occur between Perch Lake and the St. Louis River Estuary to result in no measurable change. Inputs for sulfate at the St. Louis River Estuary were evaluated for the single available value at S007-206 and average and maximum measured concentration values at Station S007-444. Flow values are described in Section 8.2.

Large Table 2 includes a summary of the scenarios that were calculated and the outcomes. The scenarios illustrate that a moderate degree of sulfate load reduction of no greater than 25%, which is within the range indicated by studies in other watersheds in northern Minnesota (Section 8.1), would result in no measurable change in sulfate concentration in the St. Louis River Estuary. In summary, the scenarios estimate that there would be no measurable change in concentration at the St. Louis River Estuary even if a discharge was authorized that increased the Perch Lake outflow sulfate concentration to the proposed site-specific sulfate standard. The St. Louis River Estuary and the Class 4A wild rice beneficial use downstream will remain protected.

8.4 Other Potential Downstream Beneficial Uses

We also considered protection of other downstream uses where sulfate standards would apply:

- Drinking water (Class 1B): The proposed Perch Lake site-specific sulfate standard is lower than USEPA's secondary drinking water sulfate standard of 250 mg/L. Therefore, any downstream Class 1B use would be protected. Note that Wisconsin also has a drinking water standard for sulfate of 250 mg/L which would also be protected.

- Livestock and wildlife (Class 4B): The proposed Perch Lake site-specific sulfate standard is lower than Minnesota's Class 4B sulfate standard of 600 mg/L. Therefore, any downstream Class 4B use would be protected.
- The Fond du Lac Band (FDL) of Lake Superior Chippewa sulfate standard: The FDL of Lake Superior Chippewa Reservation is downstream of the Whiteface River confluence with the St. Louis River and has a sulfate standard that states, "Any lake or stream which supports wild rice growth shall not exceed instantaneous maximum sulfate levels of 10 milligrams per liter." Because the section of the St. Louis River that runs through the FDL is not known to have wild rice either currently or historically[4], it is unlikely to support wild rice growth and thus this standard does not apply.

[4] The segments of the St. Louis River that run through FDL (WID/AUID 04010201-506, 04010201-504, and 04010201-517) are not included on the 1854 Treaty Authority's Wild Rice List (as of March 2, 2022; reference (65)) or in Attachment 5 of the 2018 Tribal Wild Rice Task Force Report (reference (64)).

9 Conclusion

United is requesting site-specific modification of the Class 4A sulfate standard applicable to Perch Lake as allowed under Minnesota Rules part 7050.0220, subpart 7.A.

Based on consideration of site-specific information, a site-specific sulfate standard is more appropriate for Perch Lake than the statewide Class 4A sulfate standard (Section 6.1). Specifically, even though surface water sulfate concentrations in Perch Lake are greater than the 10 mg/L Class 4A sulfate standard, porewater sulfide concentrations are predominately below the porewater sulfide thresholds numerous lines of scientific evidence suggest as protective. Porewater sulfide concentrations in Perch Lake are protective of the Class 4A wild rice beneficial use at sulfate concentrations greater than 10 mg/L, therefore the statewide Class 4A sulfate standard is unduly restrictive for Perch Lake and a site-specific standard would be more appropriate.

The MBLR equation-based approach proposed by the MPCA in 2017 and 2018 is not an appropriate basis for a site-specific sulfate standard applicable to Perch Lake (Section 6.2) because Perch Lake does not conform to the conceptual model on which the MPCA proposed MBLR equation was based. Therefore, an alternate ratio equation-based approach in accordance with the MPCA's 2017 final TSD (reference (3)) is proposed (Section 6.3). This equation was based on the understanding that when porewater sulfide concentrations are protective of wild rice, the surface water sulfate concentration must also be sufficiently protective of the Class 4A wild rice beneficial use. As concluded in Section 3.2.2, a protective porewater sulfide threshold of 370 μg/L represents a conservative target to protect wild rice for the purposes of developing a site-specific sulfate standard for Perch Lake. This request's proposed ratio equation is designed to yield a protective sulfate standard based on maintenance of porewater sulfide concentrations at or below a protective porewater sulfide threshold of 370 μg/L and therefore is protective of the Class 4A wild rice beneficial use in Perch Lake.

Based on appropriate application of the proposed ratio equation to Perch Lake (Section 7.1) and consideration of the appropriate duration (Section 7.2.2) and frequency (Section 7.2.3) for the site-specific sulfate standard, the proposed site-specific sulfate standard protective of the Class 4A wild rice beneficial use in Perch Lake is summarized in Table 9-1.

Table 9-1 Proposed Site-Specific Sulfate Standard Applicable to Perch Lake

Parameter	Magnitude	Duration	Frequency
Sulfate (applicable to water used for production of wild rice)	430 mg/L	annual average	not more than once in ten years

This proposed site-specific sulfate standard is more appropriate for Perch Lake than the statewide Class 4A sulfate standard; therefore, this request for site-specific modification of the Class 4A sulfate standard applicable to Perch Lake should be granted as allowed under Minnesota Rules part 7050.0220, subpart 7.A.

10 References

1. **U.S. Environmental Protection Agency.** Chapter 3: Water Quality Criteria. *Water Quality Standards Handbook.* 2017. EPA 823 B 17 001.

2. **Minnesota Pollution Control Agency Environmental Analysis and Outcomes Division.** Statement of Need and Reasonableness: Amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters. Minn. R. chapters 7050 and 7053. July 2017.

3. **Minnesota Pollution Control Agency.** Final Technical Support Document: Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice (wq-s6-43v). August 11, 2017.

4. **State of Minnesota.** *Minnesota Session Laws - 2011, 1st Special Session.* Office of the Revisor of Statutes : s.n., July 20, 2011. Chapter 2, Article 4 Statutory Changes, Sec. 32 Wild Rice Rulemaking and Research.

5. **Minnesota Pollution Contol Agency.** Protecting wild rice from excess sulfate - Proposal (wq-s6-43k). March 24, 2015.

6. **Minnesota Pollution Control Agency.** Draft Technical Support Document: Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice (wq-s6-43v). July 18, 2016.

7. —. Proposed Permanent Rules Relating to Wild Rice Sulfate Standard and Wild Rice Waters. July 24, 2017.

8. —. Sampling and Analytical Methods for Wild Rice Waters. July 2017.

9. **State of Minnesota Office of Administrative Hearings.** *Report of the Chief Administrative Law Judge in the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers.* January 11, 2018. Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205, and 7053.0406.

10. **Chief Administrative Law Judge Tammy L. Pust.** Chief Administrative Law Judge's Order on Review of Rules Under Minn. Stat. § 14.16, Subd. 2, and Minn. R. 1400.2240, Subp. 5. April 12, 2018. In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers, Minnsota Rules parts 7050.0130, 0220, 0224, 0470, 0471, 7053.0136, 0205 & 0406.

11. **Minnesota Pollution Control Agency.** Letter to Chief Administrative Law Judge Tammy L. Pust Re: In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters. March 28, 2018. OAH Docket # 80-9003-34519, Revisor ID #4324.

12. —. Sampling and Analytical Methods for Wild Rice Waters. *Attachment 5 of Letter to Chief Administrative Law Judge Tammy L. Pust Re: In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters.* March 2018. OAH Docket # 80-9003-34519, Revisor ID #4324.

13. **State of Minnesota.** *Notice of Withdrawn Rules for Proposed Rules Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters; Revisor's ID Number 4234 (42 SR 1423).* Proposed Adopted, Emergency, Expidited, Withdrawn, Vetoed Rules; Executive Orders; Appointments; Commissioner's Orders; Revenue Notes; Official Notices; State Grants & Loans; State Contracts; Non-State Public Bids, Contracts and Grants Volume 42, No. 45, May 7, 2018.

14. **U.S. Environmental Protection Agency.** Public Notice of EPA's Additions to Minnesota's 2020 Impaired Waters List. *Impaired Waters and TMDLs.* [Online] September 1, 2021. [Cited: September 20, 2021.] https://www.epa.gov/tmdl/public-notice-epas-additions-minnesotas-2020-impaired-waters-list.

15. —. Attachment 1: Waters Added by U.S. EPA to the Minnesota 2020 Impaired Waters List. *Impaired Waters and TMDLs - EPA's Additions to Minnesota's 2020 Impaired Waters List.* [Online] November 5, 2021. https://www.epa.gov/system/files/documents/2021-11/2_attachment-1_cl_final-list-of-32-waters.pdf.

16. **Pastor, John, et al.** Effects of sulfate and sulfide on the life cycle of Zizania palustris in hydroponic and mesocosm experiments. *Ecological Applications.* 2017, Vol. 27, 1, pp. 321–336.

17. **Fort, D. J., et al.** Toxicity of sulfate and chloride to early life stages of wild rice (Zizania palustris). *Environmental Toxicology and Chemistry.* December 2014, Vol. 33, 12, pp. 2802-2809.

18. **Myrbo, A., et al.** Sulfide generated by sulfate reduction is a primary controller of the occurrence of wild rice (Zizania palustris) in shallow aquatic ecosystems. *Journal of Geophysical Research: Biogeosciences.* November 2, 2017.

19. **Pollman, Curtis D., et al.** The evolution of sulfide in shallow aquatic ecosystem sediments – an analysis of the roles of sulfate, organic carbon, iron and feedback constraints using structural equation modeling. undated.

20. **Fort, Douglas J., et al.** Toxicity Of Sulfide To Early Life Stages Of Wild Rice (Zizania Palustris). *Environmental Toxicology and Chemistry.* February 2017, Vol. 36, 8, pp. 2217–2226.

21. **Fort, Douglas J., et al.** Impact of Hydroponic Oxygen Control in Sulfide Toxicity to Early Life Stages ofWild Rice (Zizania palustris). *Environmental Toxicology and Chemistry.* 2020, pp. 1-8.

22. **Minnesota Department of Natural Resources.** Natural Wild Rice in Minnesota. A Wild Rice Study document submitted to the Minnesota Legislature by the Minnesota Department of Natural Resources. February 15, 2008.

23. **Engel, Sandy and Nichols, Stanley A.** Aquatic Macrophyte Growth in a Turbid Windswept Lake. *Journal of Freshwater Ecology.* 1994, Vol. 9, 2, pp. 97-109.

24. **Cardwell, V. B., Oelke, E. A. and Elliott, W. A.** Seed dormancy mechanism in wild rice rice(Zizania aquatica). *Agronomy Journal.* 1978, Vol. 70, 3, pp. 481-484.

25. **Minnesota Pollution Control Agency.** The Sulfate Standard to Protect Wild Rice Study Protocol (wq-s6-42b). November 8, 2011.

26. **Carson, Tara L.** The effects of sediment nutrient variation, water depth, and emergent aquatic perennials on wild rice (Zizania palustris) production at the Rice Lake National Wildlife Refuge. s.l. : The University of Minnesota, 2002. Master's Thesis.

27. **Froelich, P. N., et al.** Early oxidation of organic matter in pelagic sediments of the eastern equatorial Atlantic: suhoxic diagenesis. *Geochemica et Cosmochimica Acta.* 1979, Vol. 43, 7, pp. 1075-1090.

28. **Lamers, Leon P.M., Tomassen, Hilde B.M. and Roelofs, Jan G.M.** Sulfate-Induced Eutrophication and Phytotoxicity in Freshwater Wetlands. *Environmental Science & Technology.* 1998, Vol. 32, 2, pp. 199-205.

29. *Nutrient kinetics and availability in flooded rice soils.* **Neue, H. U. and Bloom, P. R.** Hanzhou (China) : IRRI, 1989. International Rice Research Conference (21-25 Sep 1987).

30. **van der Welle, Marlies, et al.** Detoxifying toxicants: Interactions between sulfide and iron toxicity in freshwater wetlands. *Environmental toxicology and chemistry.* 2006, Vol. 25, 6, pp. 1592-1597.

31. **Minnesota Pollution Control Agency.** Analysis of the Wild Rice Sulfate Standard Study: Draft for Scientific Peer Review. June 9, 2014. wq-s6-42z.

32. **Tedrow, O'Niell Roy.** Laboratory- and Field-Scale Bioassays for Predicting Responses of Wild Rice (Zizania palustris L.) to Exposures of Site-Specific Sediments and Waters. October 2020. PhD dissertation, Lakehead University, Thunder Bay, Ontario, Canada.

33. **Tedrow, O'Niell R. and Lee, Peter F.** Mesocosm and Microcosm Bioassays to Examine Effects of Mine-Influenced Sediments on the Growth of Wild Rice (Zizania palustris L.). *Water, Air, & Soil Pollution.* December 9, 2021, Vol. 232, 508.

34. **Vestergaard, Ole and Sand-Jensen, Kaj.** Alkalinity and trophic state regulate aquatic plant distribution in Danish lakes. *Aquatic Botany.* June 2000, Vol. 67, 2, pp. 85-107.

35. **Geurts, Jeroen J.M., et al.** Interacting effects of sulphate pollution, sulphide toxicity and eutrophication on vegetation development in fens: A mesocosm experiment. *Environmental Pollution.* July 2009, Vol. 157, 7, pp. 2072-2081.

36. **Roelofs, J. G.M.** Inlet of alkaline river water into peaty lowlands: effects on water quality and Stratiotes aloides L. stands. *Aquatic Botany.* 1991, Vol. 39, 3-4, pp. 267-293.

37. **Moyle, John B.** Some Chemical Factors Influencing the Distribution of Aquatic Plants in Minnesota. *The American Midland Naturalist.* September 1945, Vol. 34, 2, p. 19.

38. **Myrbo, A., et al.** Increase in Nutrients, Mercury, and Methylmercury as a Consequence of Elevated Sulfate Reduction to Sulfide in Experimental Wetland Mesocosms. *Journal of Geophysical Research: Biogeosciences.* November 2, 2017.

39. **Patrick, R., Roberts, N. A. and Davis, B.** The effect of changes in pH on the structure of diatom communities. *Notulae Naturae.* 1968, Vol. 416, p. 16.

40. **Jenks, Albert Ernest.** The Wild Rice Gatherers of the Upper Lakes: A Study in American Primitive Economics. n.d.

41. **Moyle, J.B.** Wild Rice in Minnesota. *Journal of Wildlife Management.* 1944, Vol. 8, 3, pp. 177-184.

42. **Pastor, J. and Walker, R.D.** Delays in nutrient cycling and plant population oscillations. *Oikos.* 2006, Vol. 112, 3, pp. 698-705.

43. **Walker, Rachel Durkee, Pastor, John, Dewey, Bradley W.** Effects of Wild Rice (Zizania palustris L.) Straw on Biomass and Seed Production in Northern Minnesota. *Canadian Journal of Botany.* June 2006, Vol. 84, 1, pp. 1019-1024.

44. **Grava, J. and Raisanen, K. A.** Growth and Nutrient Accumulation and Distribution in Wild Rice. *Agronomy Journal.* 1978, Vol. 70, 6, pp. 1077-1081.

45. **Lee, P. F.** Ecological relationships of wild rice, Zizania aquatica. 4. Environmental regions within a wild rice lake. *Canadian Journal of Botany.* September 1986, Vol. 64, 9, pp. 2037-2044.

46. **Aiken, S.G., et al.** Wild Rice in Canada. Toronto, Ontario : N.C. Press Limited, 1988. p. 130.

47. **Archibold, O W., Sutherland, J. M. and Good, A. G.** Annual Variation in Wild Rice (Zizania palustris L.) Growth and Potential Yield In Saskatchewan. *Canadian Journal of Plant Science.* July 1989, Vol. 69, 3, pp. 653-665.

48. **Durkee Walker, Rachel Elena.** Wild Rice: the Dynamics of Its Population Cycles and the Debate Over Its Control at the Minnesota Legislature. July 2008. A Dissertation Submitted to the Faculty of the Graduate School of the University of Minnesota.

49. **Radomski, Paul.** Historical Changes in Abundance of Floating-Leaf and Emergent Vegetation in Minnesota Lakes. *North American Journal of Fisheries Management.* 2006, Vol. 26, pp. 932–940.

50. **Pillsbury, R. W. and Bergey, E. A.** The effects of root mass and disturbance on wild rice (Zizania aquatica) survivorship. [ed.] L. A. Williamson, Dlutkowski and A. P. McCommon Soltis . *Wild Rice Research and Management.* 2000, pp. 206-214.

51. **Pillsbury, R. W. and McGuire, M. A.** Factors affecting the distribution of wild rice (Zizania palustris) and the associated macrophyte community. *Wetlands.* 2009, Vol. 29, 2, pp. 724-734.

52. **HydroAnalysis.** Groundwater Flow and Transport Models for United Taconite, LLC. December 1, 2020.

53. **U.S. Environmental Protection Agency.** Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan (EPA QA/G-5S). December 2002.

54. **Minnesota Department of Natural Resources.** Fisheries Lake Survey: Perch Lake; Lake Identification Number: 69-688 (T 56N, R 18W, S 25, 36). August 19, 1968.

55. **Barr Engineering Co.** Environmental Report: Eveleth Mines Taconite Tailings Basin Expansion. July 1981. Prepared for Oglebay Norton Company.

56. **Minnesota Department of Natural Resources.** Wild Rice Lake Survey Report: Perch Lake (DOW Lake ID: 69068800). 01 01, 1999.

57. **Minnesota Department of Natural Resources.** *Email to Cleveland Cliffs re: Perch Lake (#69-0688-00).* [email] October 1, 2020. Notes from the Area Wild Life Manager (attached).

58. **Minnesota Department of Natural Resources.** A handbook for collecting vegetation plot data in Minnesota: The relevé method. 2nd ed St. Paul, Minnesota : s.n., 2013. Minnesota Bilogical Survey, Minnesota Natural Heritage and Nongame Research Program, and Ecological Land Classification Program. Biological Report 92.

59. **Barr Engineering Co.** 2021 Perch Lake Wild Rice Survey, Sediment Sampling, and Water Quality Monitoring Memorandum to United Taconite LLC. December 20, 2021.

60. **Minnesota Pollution Control Agency.** MPCA Rebuttal Response to Public Comments. December 1, 2017. In the Matter of Proposed Amendment to Minnesota Rules Chapters 7050 and 7053, Relating to Minnesota Rules 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205, and 7053.0406, (OAH Docket # 80-9003-34519).

61. **DeRocher, Will and Johnson, Nathan W.** Temperature Dependent Diffusion Rates of Sulfate in Aquatic Sediments. Submitted to MPCA as a part of the Sulfate Standard Study. December 31, 2013.

62. **U.S. Environmental Protection Agrency.** Appendix 2A: Data Summaries for Individual Waters. *Impaired Waters and TMDLs - EPA's Additions to Minnesota's 2020 Impaired Waters List.* [Online] November 5, 2021. Sturgeon Lake (25-0017-01), Perch Lake (69-0688-00), St. Louis River Estuary (69-1291-04). extension://elhekieabhbkpmcefcoobjddigjcaadp/https://www.epa.gov/system/files/documents/2021-11/3f_appendix-2a_rtc.pdf.

63. **Berndt, Michael and Bavin, Travis.** Sulfate and Mercury Cycling in Five Wetlands and a Lake Receiving Sulfate from Taconite Mines in Northeastern Minnesota. s.l. : Minnesota Department of Natural Resources, December 15, 2011.

64. **Minnesota Tribal Wild Rice Task Force.** 2018 Tribal Wild Rice Task force Report. December 15, 2018.

65. **1854 Authority.** Wild Rice Waters in 1854 Ceded Territory - Wild Rice List. March 9, 2022.

Large Tables

Large Table 1 Summary of Perch Lake Sediment and Water Quality Results

Monitoring Results								
Sampling Month	Sediment Sampling Methods	Sediment Sample Type	Sample ID # for Sediment and Sulfate (1)	Sediment Total Organic Carbon (TOC)(2) (%)	Sediment Total Extractable Iron (TEFe) (milligrams per kilogram)	Water Column Sulfate (mg/L)	Sample ID # for Porewater Sulfide (3)	Porewater Sulfide (4) (mg/L)
October 2021	2018 MPCA Methods (5)	Grab	UT_PL_100	25.75	54,793	104	UT_PL_100_PW	*0.059*
			UT_PL_101	28.63	25,542	105	UT_PL_101_PW	*0.087*
			UT_PL_102	16.73	26,444	105	UT_PL_102_PW	*0.079*
			UT_PL_103	14.09	37,437	107	UT_PL_103_PW	*0.074*
			UT_PL_104	5.22	5,299	107	UT_PL_104_PW	0.39
			UT_PL_105	6.13	9,340	101	UT_PL_105_PW	*0.028*
			UT_PL_106	21.78	42,138	104	UT_PL_106_PW	*0.096*
			UT_PL_107	2.07	11,406	103	UT_PL_107_PW	*0.031*
			UT_PL_108	25.90	53,861	104	UT_PL_108_PW	0.14
			UT_PL_109	2.58	15,088	107	UT_PL_109_PW	<0.014
			UT_PL_110	0.60	5,350	105	UT_PL_110_PW	<0.014
			UT_PL_111	21.51	33,091	105	UT_PL_111_PW	*0.053*
			UT_PL_112	19.83	32,859	105	UT_PL_112_PW	*0.084*
			UT_PL_113	2.47	7,116	104	UT_PL_113_PW	*0.088*
			UT_PL_114	20.12	56,542	106	UT_PL_114_PW	*0.082*
November 2021	2018 MPCA Methods (5)	Grab	UT_PL_115	3.41	5,680	113	UT_PL_115_PW	0.11
			UT_PL_116	17.88	81,496	114	UT_PL_116_PW	*0.060*
			UT_PL_117	0.71	4,361	115	UT_PL_117_PW	*0.024*
			UT_PL_118	19.15	17,207	115	UT_PL_118_PW	*0.089*
			UT_PL_119	17.65	70,683	115	UT_PL_119_PW	*0.059*
			UT_PL_120	25.04	26,052	117	UT_PL_120_PW	*0.038*
			UT_PL_121	13.51	25,879	115	UT_PL_121_PW	*0.061*
			UT_PL_122	37.99	16,299	117	UT_PL_122_PW	0.38
			UT_PL_123	10.73	12,203	114	UT_PL_123_PW	*0.080*
			UT_PL_124	21.00	41,145	116	UT_PL_124_PW	0.30
			UT_PL_125	2.95	8,707	117	UT_PL_125_PW	*0.062*
			UT_PL_126	13.41	9,870	110	UT_PL_126_PW	*0.080*
			UT_PL_127	3.18	21,434	115	UT_PL_127_PW	*0.020*
			UT_PL_128	20.71	53,994	116	UT_PL_128_PW	*0.087*
			UT_PL_129	0.90	6,293	113	UT_PL_129_PW	*0.042*

(1) Sample ID numbers for sediment samples ended in "_SED" and for water column sulfate samples ended in "_SW".
(2) Average value of the 9060A double run total organic carbon (TOC) analysis.
(3) Two porewater sulfide samples were collected from each transect.
(4) Italics and underlining indicates an estimated concentration above the adjusted method detection limit (MDL) and below the adjusted reporting limit (RL).
(5) Reference: MPCA. Sampling and Analytical Methods for Wild Rice Waters. Attachment 5 of Letter to Chief Administrative Law Judge Tammy L. Pust Re: In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters. March 2018. OAH Docket # 80-9003-34519, Revisor ID #4324

Large Table 2 Estimated Change at the St. Louis River Estuary from Proposed Site-Specific Sulfate Standard at Perch Lake

Discharge Data						St. Louis River Estuary (Receiving Water) Data					Estimated Loading Summary				
Discharge Location	Average Flow (MGD)[1]	Sulfate (SO_4) (mg/L)[2]	Concentration Value	SO4 (lbs/day)[3]	Load Reduction[4]	Receiving Location (Monitoring Station)	Average Flow (MGD)[1]	SO_4 (mg/L)[2]	Concentration Value	SO_4 (lbs/day)[3]	Total Flow (MGD)[1]	Total SO_4 Load (lbs/day)[3]	Total SO_4 Concentration (mg/L)[2]	SO_4 Change (mg/L)	% Change
Perch Lake Outlet	0.279	430	Maximum - at SSS	1,001	25%	S007-206	1,660	16.0	Only Value	221,500	1,660	222,200	16.0	0	0%
Perch Lake Outlet	0.279	430	Maximum - at SSS	1,001	25%	S007-444	1,660	13.9	Maximum	192,400	1,660	193,100	13.9	0	0%
Perch Lake Outlet	0.279	430	Maximum - at SSS	1,001	25%	S007-444	1,660	9.5	Average	131,500	1,660	132,200	9.5	0	0%

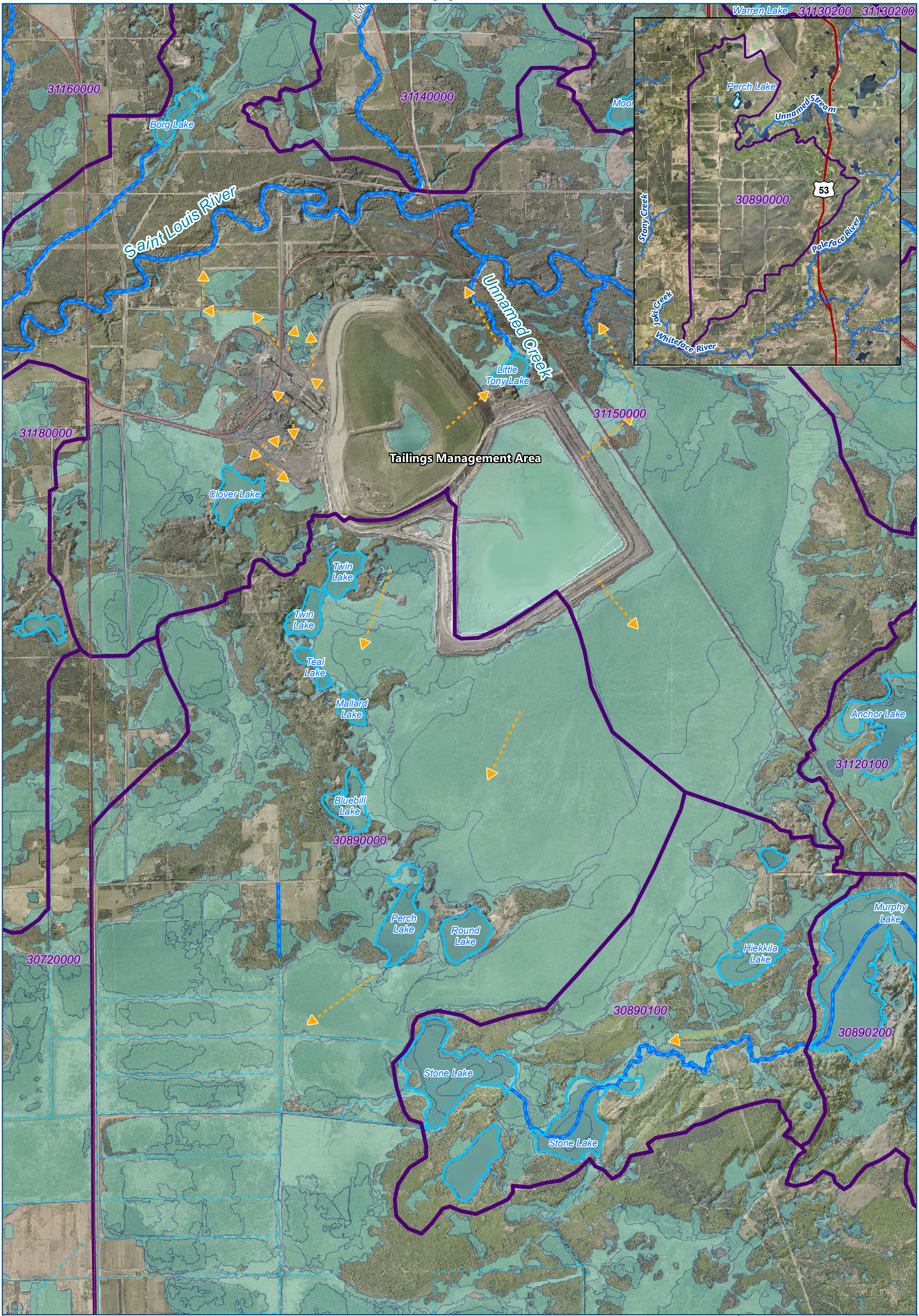
1 Flow values used three significant digits to align with the number of significant digits in the source data.

2 To align with typical laboratory reporting levels, sulfate concentrations used three significant digits, except for concentrations <10 mg/L, which were rounded to the nearest 0.1 mg/L.

3 Sulfate loads were calculated to four significant digits because the use of fewer significant digits resulted in changes that could not be resolved/detected.

4 Estimated reduction in sulfate load due to natural sulfate reduction processes in wetlands between Perch Lake and St. Louis River Estuary that results in no measurable change at the Estuary. The estimates are consistent with the range of sulfate reduction rates observed in Northern Minnesota.

Large Figures



Generalized Water Flow Direction

National Hydrography Dataset Flowline (NHD) (Dataset may not reflect restoration activities completed by third parties.)

Public Waters Inventory (PWI)

Public Water Inventory Basins

MnDNR Level 08 Subwatersheds

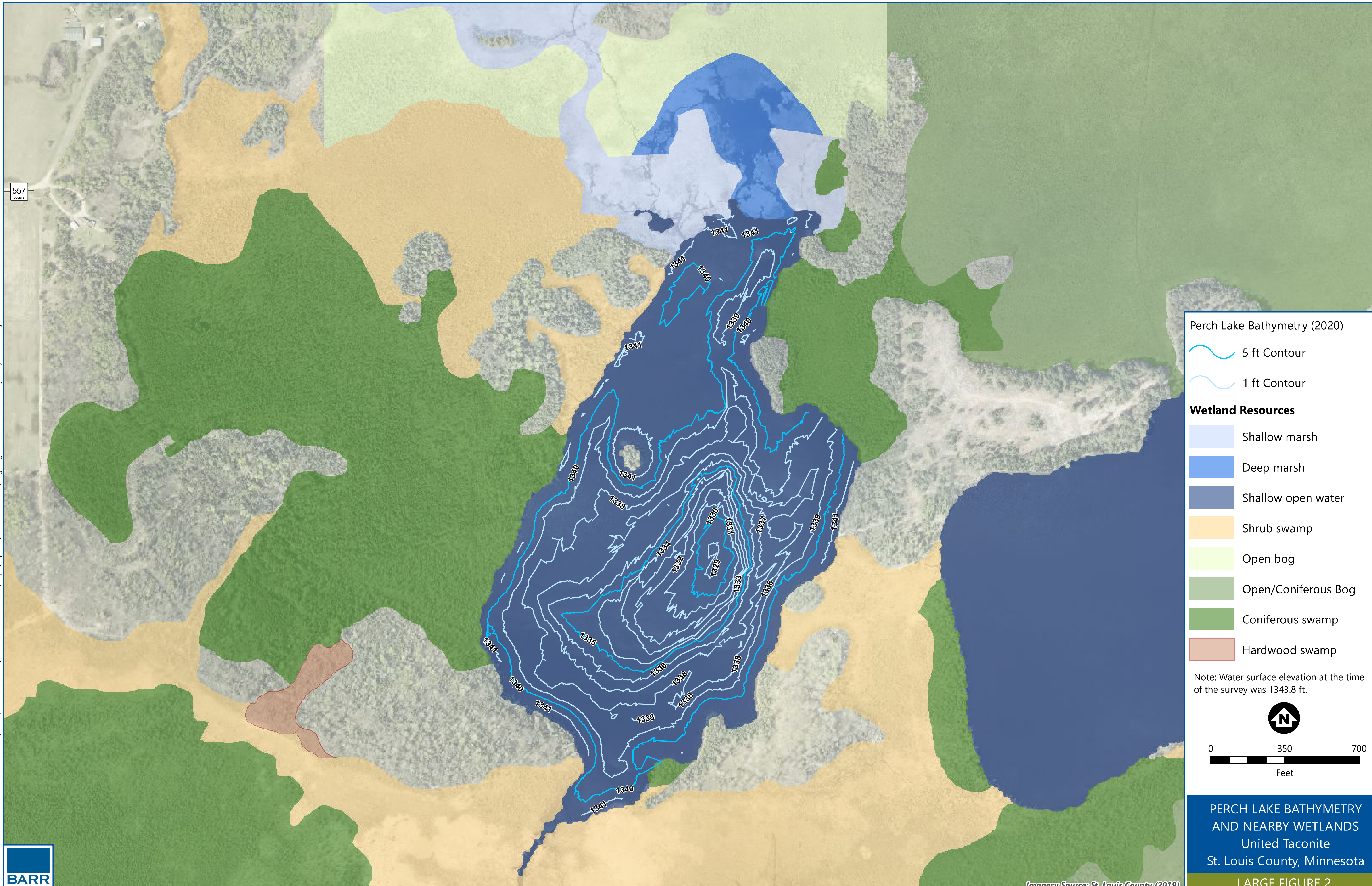
National Wetlands Inventory (NWI)

0 3,000 6,000
Feet

BARR

SITE LOCATION WITH WATERSHEDS
United Taconite
St. Louis County, Minnesota

LARGE FIGURE 1



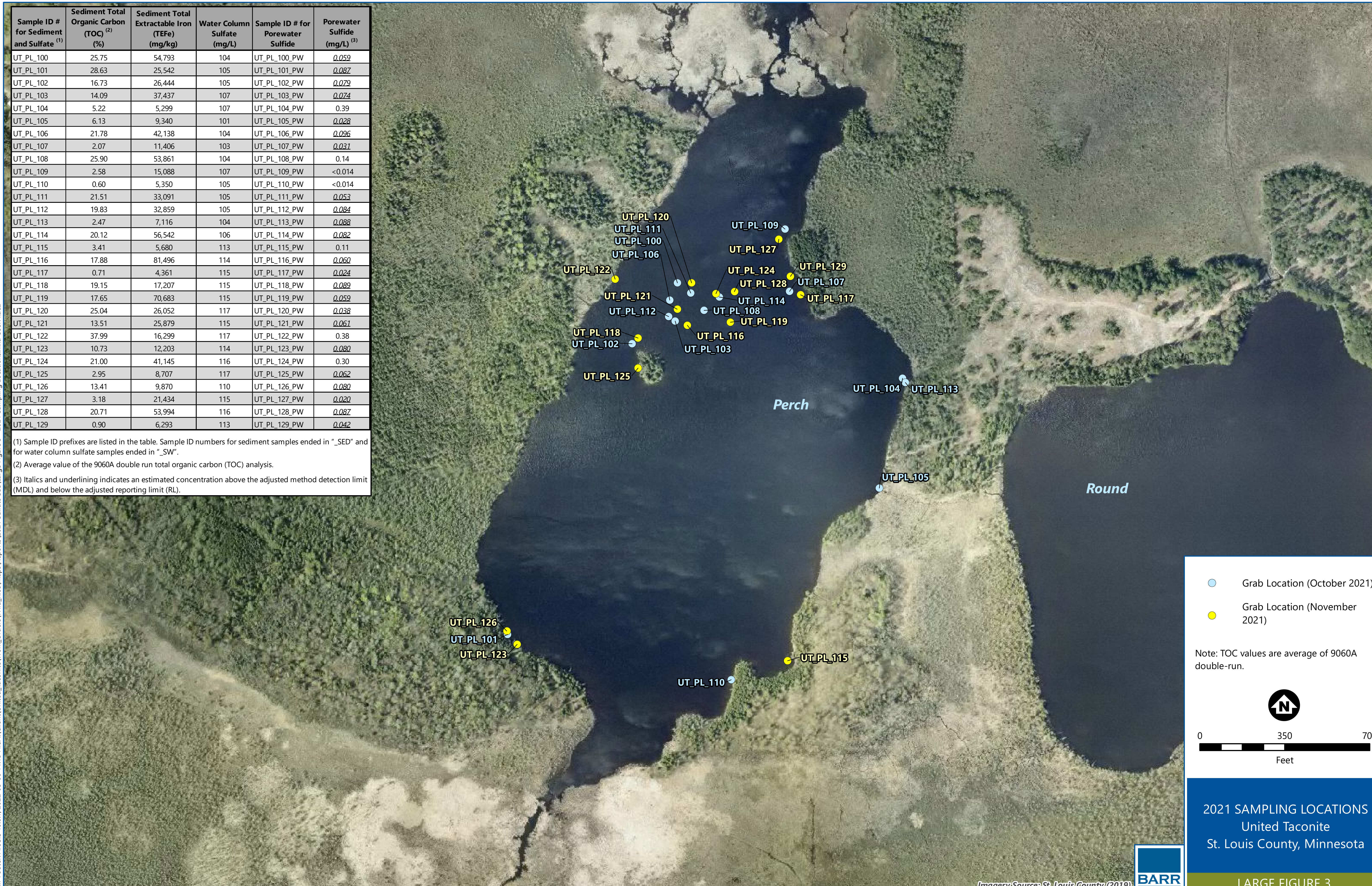
Barr Footer: ArcGIS 10.8.1, 2022-05-06 11:15 File: I:\Client\United_Taconite\Work_Orders\Wild_Rice\Maps\Reports\2021 Sulfate SSS\Large Figure 2 - Perch Lake Bathymetry and Nearby Wetlands.mxd User: kac2

Sample ID # for Sediment and Sulfate [1]	Sediment Total Organic Carbon (TOC) [2] (%)	Sediment Total Extractable Iron (TEFe) (mg/kg)	Water Column Sulfate (mg/L)	Sample ID # for Porewater Sulfide	Porewater Sulfide (mg/L) [3]
UT_PL_100	25.75	54,793	104	UT_PL_100_PW	*0.059*
UT_PL_101	28.63	25,542	105	UT_PL_101_PW	*0.087*
UT_PL_102	16.73	26,444	105	UT_PL_102_PW	*0.079*
UT_PL_103	14.09	37,437	107	UT_PL_103_PW	*0.074*
UT_PL_104	5.22	5,299	107	UT_PL_104_PW	0.39
UT_PL_105	6.13	9,340	101	UT_PL_105_PW	*0.028*
UT_PL_106	21.78	42,138	104	UT_PL_106_PW	*0.096*
UT_PL_107	2.07	11,406	103	UT_PL_107_PW	*0.031*
UT_PL_108	25.90	53,861	104	UT_PL_108_PW	0.14
UT_PL_109	2.58	15,088	107	UT_PL_109_PW	<0.014
UT_PL_110	0.60	5,350	105	UT_PL_110_PW	<0.014
UT_PL_111	21.51	33,091	105	UT_PL_111_PW	*0.053*
UT_PL_112	19.83	32,859	105	UT_PL_112_PW	*0.084*
UT_PL_113	2.47	7,116	104	UT_PL_113_PW	*0.088*
UT_PL_114	20.12	56,542	106	UT_PL_114_PW	*0.082*
UT_PL_115	3.41	5,680	113	UT_PL_115_PW	0.11
UT_PL_116	17.88	81,496	114	UT_PL_116_PW	*0.060*
UT_PL_117	0.71	4,361	115	UT_PL_117_PW	*0.024*
UT_PL_118	19.15	17,207	115	UT_PL_118_PW	*0.089*
UT_PL_119	17.65	70,683	115	UT_PL_119_PW	*0.059*
UT_PL_120	25.04	26,052	117	UT_PL_120_PW	*0.038*
UT_PL_121	13.51	25,879	115	UT_PL_121_PW	*0.061*
UT_PL_122	37.99	16,299	117	UT_PL_122_PW	0.38
UT_PL_123	10.73	12,203	114	UT_PL_123_PW	*0.080*
UT_PL_124	21.00	41,145	116	UT_PL_124_PW	0.30
UT_PL_125	2.95	8,707	117	UT_PL_125_PW	*0.062*
UT_PL_126	13.41	9,870	110	UT_PL_126_PW	*0.080*
UT_PL_127	3.18	21,434	115	UT_PL_127_PW	*0.020*
UT_PL_128	20.71	53,994	116	UT_PL_128_PW	*0.087*
UT_PL_129	0.90	6,293	113	UT_PL_129_PW	*0.042*

(1) Sample ID prefixes are listed in the table. Sample ID numbers for sediment samples ended in "_SED" and for water column sulfate samples ended in "_SW".

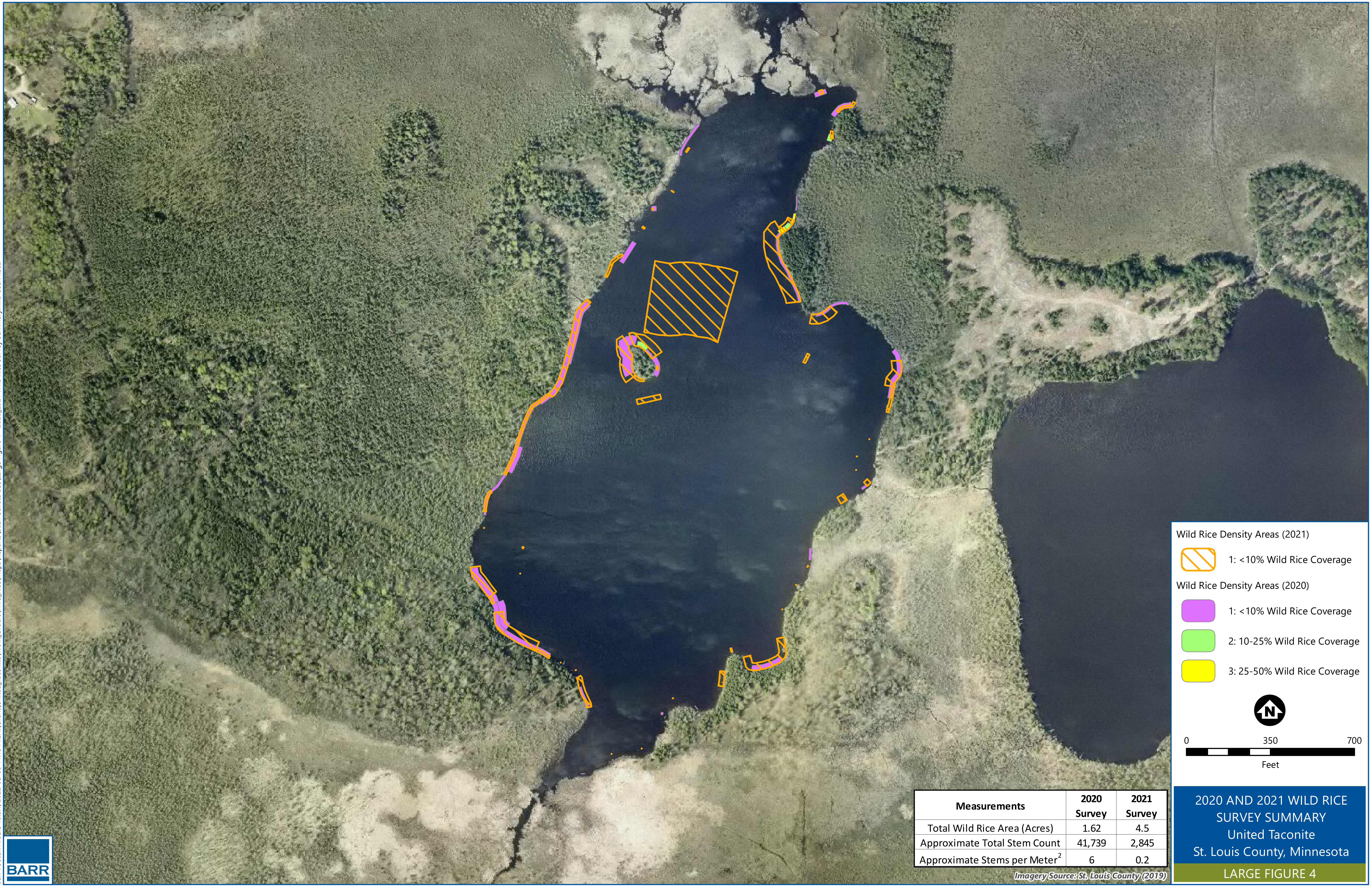
(2) Average value of the 9060A double run total organic carbon (TOC) analysis.

(3) Italics and underlining indicates an estimated concentration above the adjusted method detection limit (MDL) and below the adjusted reporting limit (RL).



2021 SAMPLING LOCATIONS
United Taconite
St. Louis County, Minnesota

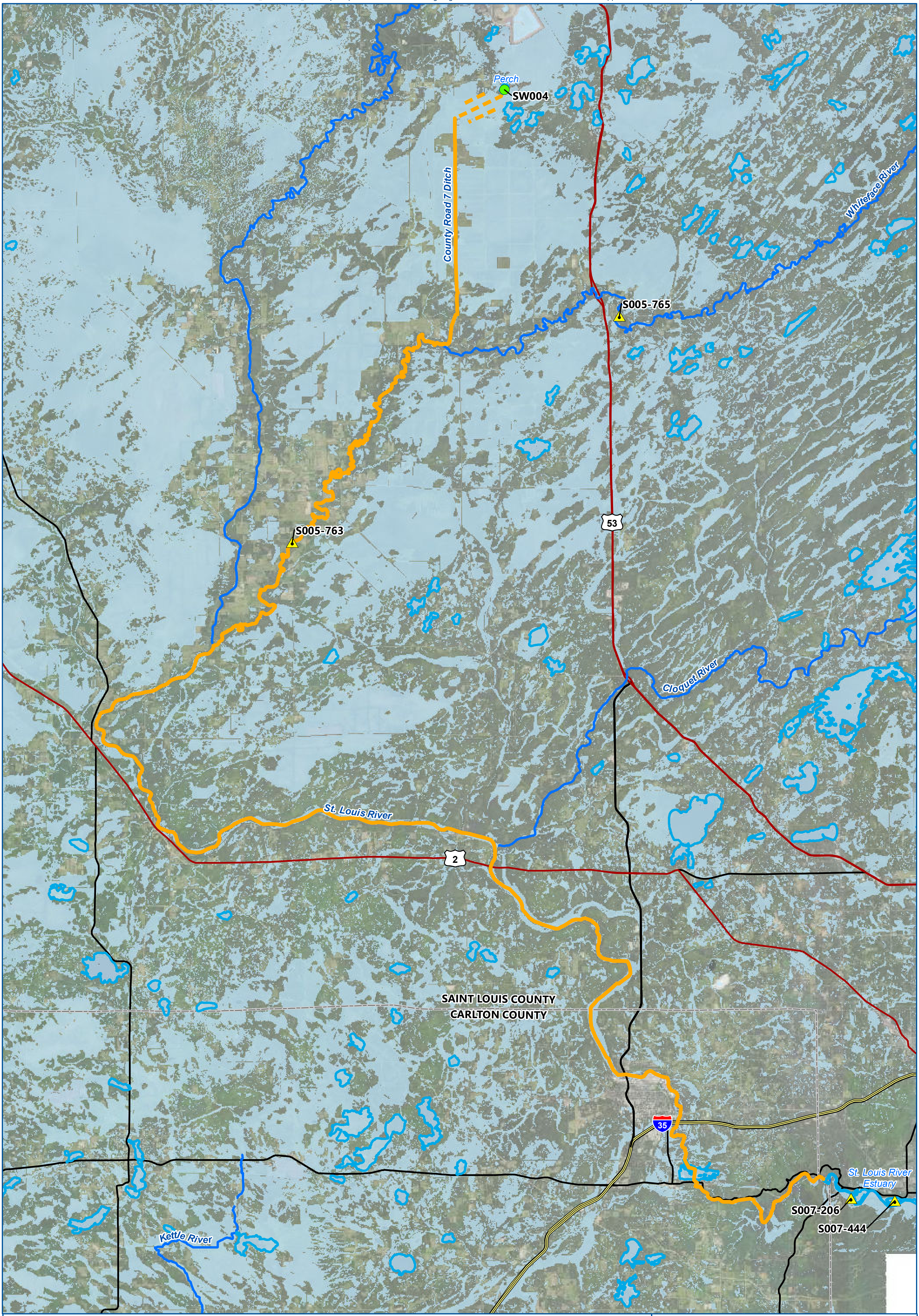
LARGE FIGURE 3



Measurements	2020 Survey	2021 Survey
Total Wild Rice Area (Acres)	1.62	4.5
Approximate Total Stem Count	41,739	2,845
Approximate Stems per Meter^2	6	0.2

2020 AND 2021 WILD RICE SURVEY SUMMARY
United Taconite
St. Louis County, Minnesota

LARGE FIGURE 4



- General Flow Path from Perch Lake to the St. Louis River
- Diffuse Flow Through Wetlands
- MPCA Surface Water Monitoring Station
- UTAC Monitoring Station
- Public Waters Inventory (PWI)
- Public Water Inventory Basins
- Wetlands (National Wetlands Inventory)
- County Boundary

0 2 4
Miles

BARR

GENERAL WATER FLOW FROM PERCH LAKE TO UPPER ST. LOUIS RIVER ESTUARY
United Taconite
St. Louis County, Minnesota

LARGE FIGURE 5

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT Q

(U.S. Steel Application for Sulfate Site-Specific Standard for Hay Lake 2022)

U. S. Steel Corporation
Minnesota Ore Operations
P.O. Box 417
Mt. Iron, MN 55768

August 17, 2022

Catherine Neuschler
Minnesota Pollution Control Agency (MPCA)
Environmental Analysis & Outcomes Division
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Re: Application for a Sulfate Site-Specific Standard for Hay Lake (AUID 31-0037-00), Located Downstream of the U. S. Steel – Keetac (Keetac)

Dear Ms. Neuschler:

Please find attached an application for a sulfate site-specific standard for Hay Lake, located downstream of the Keetac facility. This submittal is an update to the *Application for Site-Specific Sulfate Standard(s) for Hay Lake, Hay Creek, Swan Lake (including Swan Lake Southwest Bay), and Swan River (Swan Lake outlet to confluence with Snowball Creek)*, submitted in December 2014 with MPCA acknowledgement of receipt on December 29, 2014. To date, the MPCA has not acted on this application for Keetac. U. S. Steel requests the MPCA approve and implement this revised request for a sulfate site-specific standard of 79 mg/L at Hay Lake, which will replace the existing Class 4A sulfate standard of 10 mg/L. The site-specific standard is being requested in accordance with Minn Rules, part 7050.0220, subpart 7.

The application shows that the proposed sulfate site-specific standard of 79 mg/L is protective of the Class 4A narrative standard found in Minnesota Rules, part 7050.0224, subpart 2, which requires that the "quality of Class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area."

U. S. Steel developed the enclosed application in support of its conclusion that Keetac's discharges will not exceed the proposed site-specific standard and that the proposed site-specific standard will not result in inhibition or injurious effects to wild rice growth. Furthermore, no discharge limits for sulfate are necessary to protect the growth of wild rice in Hay Lake at the proposed site-specific standard in the National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permits for Keetac's mining area and tailings basin (No. MN0031879 and No. MN0055948, respectively).

A hard copy of this request will also be sent. If you have any questions or need additional information regarding this request, please feel free to contact me at (218) 749-7364 or clbartovich@uss.com.

Sincerely,

Chrissy Bartovich
Environmental Director
U. S. Steel – Minnesota Ore Operations

cc: MPCA Water Quality Submittals Center
Richard Clark, MPCA
Jeff Udd, MPCA
Eric Williams, U. S. Steel
Tom Moe, U. S. Steel

Application for Sulfate Site-Specific Standard

Hay Lake

Prepared for
United States Steel Corporation

August 2022

325 South Lake Avenue, Suite 700
Duluth, MN 55802
218.529.8200
www.barr.com

Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

cm	centimeter
CWA	Clean Water Act
CFR	Code of Federal Regulations
µg/L	micrograms per liter
µΩ/cm	microohms per centimeter
mEq/L	milliequivalent per Liter
mg/L	milligrams per Liter
MPCA	Minnesota Pollution Control Agency
MLBR120	multiple binary logistic regression at a sulfide concentration of 120 µg/L
NPDES	National Pollutant Discharge Elimination System
PEQ	projected effluent quality
S.U.	Standard Units
SDS	State Disposal System
TEFe	total extractable iron
TOC	total organic carbon
USEPA	U. S. Environmental Protection Agency
U. S. Steel	United States Steel Corporation
WPCC	Water Pollution Control Commission

Executive Summary

United States Steel Corporation (U. S. Steel) requests the Minnesota Pollution Control Agency (MPCA) to approve and implement this updated request for a sulfate site-specific standard of 79 mg/L at Hay Lake (Assessment Unit Identification (AUID) number 31-0037-00), which is downstream of U. S. Steel's Keetac facility. This report was developed to support the method for deriving the sulfate site-specific standard and to demonstrate that the sulfate site-specific standard of 79 mg/L is protective of wild rice in Hay Lake. Furthermore, because the sulfate site-specific standard of 79 mg/L is protective of wild rice in Hay Lake, and the discharges from U. S. Steel's Keetac mining area and tailings basin have no reasonable potential to exceed the proposed sulfate concentrations, no discharge limits for sulfate are necessary in the National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permits No. MN0031879 and No. MN0055948. See Figure 1 for proximities of outfalls and flow paths to Hay Lake.

The Keetac mining area and tailings basin NPDES/SDS permits MN0031879 and MN0055948 were both issued on November 15, 2011. This report shows that the proposed site-specific standard of 79 mg/L sulfate is protective of the Class 4A narrative standard found in Minnesota Rules, part 7050.0224, subpart 2, which requires that the "quality of Class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area." The rationale and scientific basis for this request include the following:

- The Administrative Law Judge (ALJ) and the Chief Administrative Law Judge (CALJ) reviewing the Class 4A rulemaking related to the proposed wild rice standard, as detailed in Section 2.3, concluded that the equation-based approach outlined in the 2017 and 2018 guidance documents, which were both titled *Sampling and Analytical Methods for Wild Rice Waters*, was scientifically sound and supported by research (reference (1)). The proposed sulfate site-specific standard of 79 mg/L was derived based on the scientific practices developed by the MPCA.

- The literature described in Section 4 indicate that the sulfate concentration of 79 mg/L contained in this site-specific standard request and 120 ug/L sulfide from the equation in the MPCA's 2018 guidance are not toxic to wild rice. Toxicity to wild rice from sulfate or sulfide occurs at concentrations far higher than these levels. This shows that using a sulfate site-specific standard of 79 mg/L will be protective of wild rice in Hay Lake.

- The Reasonable Potential Analysis (RPA) summarized in Section 5.2 concludes that there is no reasonable potential for the sulfate concentrations from the mining area and tailings basin discharges to cause or contribute to an excursion of the proposed sulfate site-specific standard of 79 mg/L in Hay Lake.

- The mass balance described in Section 5.3 indicates that there are natural reductions of sulfate prior to flows entering Hay Lake. Reservoir 2 reduced the sulfate concentration from 100.38 mg/L to 64.59 mg/L, and the Hay Creek watershed reduced the sulfate concentration to 47.63 mg/L before flows enter Hay Lake. This is further evidence that the discharges from Keetac will not impact wild rice.

Table ES-1 shows the requested sulfate site-specific standard. The proposed sulfate site-specific standard will protect the Class 4A designated use without inhibition or injurious effects to wild rice.

Table ES-1 Class 4A Site-Specific Standard Request Included in this Application

Waterbody	Current Applicable Sulfate Standard	Proposed Sulfate Site-Specific Standard
Hay Lake (AUID 31-0037-00)	*Numeric:* 10 mg/L *Narrative:* "The quality of class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area."	*Numeric:* 79 mg/L *Narrative:* No change

As alluded to above, an RPA evaluates the probability of a discharge causing an exceedance of a water quality standard, or in this case, of the proposed sulfate site-specific standard. The RPA shows that Hay Lake meets the proposed sulfate site-specific standard and that there is no reasonable potential for the discharges from Keetac to cause an excursion of the proposed sulfate site-specific standard of 79 mg/L. Table ES-2 presents the results of this analysis.

Table ES-2 Hay Lake Reasonable Potential to Exceed Sulfate Site-Specific Standard Summary

Reasonable Potential to Exceed Calculation Summary	Results
Range of Data Availability	June 23, 2009 – October 27, 2021
No. of Samples	55
Average (mg/L)	32
Maximum Observed Concentration (mg/L)	78
Standard Deviation(1)	0.35
Coefficient of Variation[1]	0.36
Reasonable Potential Multiplying Factor (99%)[2]	1
Proposed Site-Specific Standard (mg/L)	**79**
Reasonable Potential to Exceed?	**No**

[1] In accordance with the Water Quality-Based Effluent Limits derivation spreadsheet for the discharge from Mining Area SD012 that was generated by MPCA for the previous NPDES/SDS permit MN0031879 renewal, these statistical values were calculated using the natural logarithm (LN) of the raw sulfate surface water quality data for Hay Lake.

[2] The reasonable potential multiplying factor was obtained from Minnesota Rules, part 7052.0370, which aligns with MPCA's approach during the previous NPDES/SDS permit MN0031879 renewal.

1 Introduction

U. S. Steel developed this report to support its request for a sulfate site-specific standard for Hay Lake (AUID 31-0037-00), to show that current discharges will not exceed the site-specific standard and that limitations on the discharges from U. S. Steel's Keetac mining area and tailings basin are not necessary to protect the growth of wild rice in Hay Lake at the proposed sulfate site-specific standard.

Regarding the site-specific standard request, U. S. Steel developed this document in accordance with Minnesota Rules, part 7050.0220, subpart 7. A scientifically sound approach to developing the site-specific standard was used to derive a sulfate concentration of 79 mg/L. This calculated sulfate site-specific standard will apply at Hay Lake, which is located downstream of all active outfalls associated with U. S. Steel's Keetac facility, and will replace the existing Class 4A sulfate standard of 10 mg/L.

A summary of the proposed change is shown in Table 1-1. As this report details, the proposed site-specific standard will be protective of the Class 4A use and will not result in inhibition or injurious effects to wild rice growth.

Table 1-1 Site-Specific Standard Request Included in this Application

Waterbody	Current Sulfate Standard	Proposed Sulfate Site-Specific Standard
Hay Lake (AUID 31-0037-00)	*Numeric:* 10 mg/L *Narrative:* "The quality of class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area."	*Numeric:* 79 mg/L *Narrative:* No change

The Keetac facility mining area, tailings basin, and receiving waters are shown on Figure 1. The tailings basin, which receives tailings from the Keetac taconite mining and processing facility, has a footprint of approximately 6,500 acres and includes a perimeter dike surrounding the basin over a length of 8.25 miles.

Water from the mining area and from the tailings basin leaves the sites as authorized surface discharges, as shown in Figure 1. The mining area discharge from SD002 and the tailings basin discharge from SD005 flow through a series of unlisted reservoirs and creeks before entering Hay Creek, which leads to Hay Lake. The mining area discharges from SD003 and SD012 flow through the O'Brien Diversion Channel into Hay Creek and then Hay Lake. Hay Lake is unlisted and thus is classified under the default designated beneficial use Classes 2B, 3, 4A, 4B, 5, and 6 (Minnesota Rules, part 7050.0415, subpart 4).

U. S. Steel conducted RPAs using both the USEPA's statistical method and the MPCA's statistical method. These analyses show that, with respect to protecting the growth of wild rice in Hay Lake, discharges from the existing Keetac permitted outfalls will be able to maintain concentrations of sulfate below the proposed site-specific standard of 79 mg/L. Additionally, U. S. Steel evaluated sulfate data collected at a monitoring point that encompasses the combined discharge from mining area SD002 and tailings basin SD005, which are the largest contributors to sulfate concentrations in Keetac's receiving waters of all the active outfalls. This evaluation was used to support the findings from the RPAs. Based on these results, the proposed sulfate site-specific standard will be achieved and effluent limitations at the outfalls are not necessary to protect the sulfate site-specific standard for the growth of wild rice in Hay Lake.

The remainder of the report presents the regulatory background leading to this request, the scientific protocol used to develop the sulfate site-specific standard and supporting justification for the implementation of the sulfate site-specific standard of 79 mg/L. The report is divided into the following sections:

- **Section 2**: Provides the regulatory framework under which the sulfate site-specific standard may be requested.
- **Section 3**: Summarizes the Class 4A standard, the recent impairment listing, and the current water quality of Hay Lake.
- **Section 4**: Provides a literature review of several wild rice studies discussing the water and sediment chemistry related to sulfide and the physical water conditions supporting wild rice.
- **Section 5**: Provides the sulfate site-specific standard derivation and RPA using the proposed site-specific standard.
- **Section 6**: Summarizes the sulfate site-specific standard and request for no effluent limits.
- **Section 7**: Provides the references used to support the sulfate site-specific standard request.

2 Regulatory Background and Requirements

The passage of the Clean Water Act (CWA) in 1972 established the goal of restoring and maintaining the "chemical, physical, and biological integrity" of surface water "where attainable" through water quality standards. Water quality standards consist of specific designated uses linked to measurable criteria that are used as benchmarks to establish whether the designated uses of a specific waterbody are being protected. The CWA places the responsibility of adopting designated uses and corresponding water quality criteria on individual states.

In Minnesota, the classification system of beneficial uses is described in Minnesota Rules, chapter 7050. These rules define the classification system and include narrative and numeric water quality standards for the protection of the beneficial uses and thereby protect the "physical, chemical, and biological integrity of the waters of the state." The remainder of this section provides information regarding the regulatory framework under which the site-specific standard may be applied to Hay Lake and the recent Class 4 rulemaking.

2.1 USEPA Regulations for Site-Specific Standards

The USEPA does not provide applicable guidance for the derivation of site-specific standards for water quality standards for irrigation and crops or vegetation. Instead, USEPA guidance is focused on site-specific standards based upon establishing site-specific aquatic life criteria for background (reference (2)) or procedures to derive site-specific water quality criterion for aquatic life (reference (3)). USEPA describes three procedures that can be used to derive a site-specific aquatic life water quality criterion:

- The Recalculation Procedure, a taxonomic composition adjustment;
- The Indicator Species Procedure, a bioavailability adjustment now called the Water-Effect Ratio Procedure; and
- The Resident Species Procedure, a little-used approach effectively superseded by combined application of the Recalculation and Water-Effect Ratio procedures.

These procedures are not directly applicable to the derivation of site-specific standards for Class 4A because the Class 4A sulfate standard was established for the protection of wild rice, which is a crop or vegetation and not aquatic life. However, Minnesota Rules, part 7050.0220, subpart 7 provides specific information regarding the establishment of a site-specific standard. This information is discussed in more detail in Section 2.2.

2.2 Minnesota Regulations for Site-Specific Standards

Site-specific standards can be supported by the MPCA (Minnesota Rules, part 7050.0220, subpart 7) and approved by the USEPA if they are protective of the designated use and are based upon sound scientific rationales. According to the USEPA, "[a] site-specific criterion is designed to protect the current unchanged designated use, but the criterion value may be different from the statewide or otherwise applicable criterion because it is tailored to account for site-specific conditions that may cause a given chemical concentration to have a different effect on one site than another" (reference (4)). Approval and review of the site-specific criterion is required by the USEPA, whereby "the State shall submit the results of the review, any supporting analysis for the use attainability analysis, the methodologies used for site-specific criteria development, any general policies applicable to water quality standards, and any revisions of the standards to the Regional Administrator..." (40 CFR §131.20(c)).

Minnesota Rules, part 7050.0220, subpart 7 is applicable to the establishment of a site-specific standard for Class 4A water quality standards and reads as follows:

> *A. The standards in this part and in parts 7050.0221 to 7050.0227 are subject to review and modification as applied to surface water body, reach, or segment. If site-specific information is available that shows that a site-specific modification is more appropriate than the statewide or ecoregion standard for a particular water body, reach, or segment, the site-specific information shall be applied.*
>
> *B. The information supporting a site-specific modification can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all relevant data in support of a modified standard and determine whether a change in the standard for a specific water body or reach is justified.*
>
> *C. Any effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice of the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.*

Therefore, a Class 4A (Minnesota Rules, part 7050.0224, subpart 2) water quality standard can be reviewed and modified for a specific waterbody, reach, or segment provided that supporting information shows that the site-specific standard is more appropriate than the statewide water quality standard. The information supporting the site-specific standard can be provided by the MPCA or by any individual or entity. The MPCA shall evaluate that information and determine whether a change in the standard for a specific waterbody or reach is justified.

While not stated specifically in Minnesota Rules, but as specified in USEPA clarifications to the regulation of water quality standards, the proposed site-specific standard must support the designated use. However, the proposed site-specific standard must only address the designated use and is not required to consider other uses. Therefore, U. S. Steel focused this document on the Class 4A use designation applied to Hay Lake and the development of a sulfate site-specific standard to replace the Class 4A sulfate standard. The sulfate site-specific standard is protective of wild rice, as demonstrated through this report.

2.2.1 Existing Class 4A Standards

The Class 4A rule was originally published under the Water Pollution Control Commission's (WPCC) WPC-15 in 1967 prior to establishment of the MPCA. The Class 4A narrative and numeric standards specific to sulfate are included in Minnesota Rules, part 7050.0224, subpart 2, which states the following:

The quality of Class 4A waters of the state must be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area. In addition, the following standards apply:

Substance, Characteristic, or Pollutant	*Class 4A Standard*
Sulfate (SO_4)	*10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.*

The MPCA classifies all waters of the state, including unlisted waters, as Class 2B, 3, 4A, 4B, 5, and 6 in Minnesota Rules, part 7050.0415, subparts 2 and 4. However, Minnesota Rules, part 7050.0224, subpart 1 clarifies which waters are considered wild rice waters and thus are subject to the Class 4A sulfate standard. The regulation specifically states:

In recognition of the ecological importance of this resource, and in conjunction with Minnesota Indian tribes, selected wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subpart 1.

Minnesota Rules part 7050. 0470, subpart 1 lists 24 waters that are classified as wild rice waters, all of which are within the Lake Superior Basin. Hay Lake is not listed and is not in the Lake Superior Basin. The Keetac mining area and tailing basin discharges flow to the Mississippi River, not Lake Superior. Therefore, Hay Lake has not been designated as a wild rice water in Minnesota Rules.

2.3 Minnesota Class 4 Rulemaking Process

Minnesota water quality standards for Class 4 (Agricultural and Wildlife) are promulgated in Minnesota Rules part 7050.0224. First adopted on a state-wide basis in 1967, these water quality standards have remained largely unchanged since adoption. In the past decade, some mining sector industrial discharge permits have included monitoring and compliance for these parameters for discharges to low-flow receiving waters that may not provide sustainable water for irrigation purposes. Because these standards were initially implemented on a state-wide basis, and the Class 4A beneficial use was automatically assigned to unlisted Waters of the State (Minnesota Rules, part 7050.0415, subpart 2), many receiving streams were not suitable for this designated beneficial use. As a result, the MPCA underwent a process to evaluate the existing water quality standards and beneficial use designations.

The remainder of this Section 2.3 discusses the various rulemakings related to Class 4 that have occurred over the past 15 years.

2.3.1 Class 4A Wild Rice and the ALJ Decision

In 2008, the MPCA began its triennial review of water quality standards, a rulemaking process that was to include an effort to address and update the Class 4 water quality standards to reflect current science. MPCA proposed to promulgate a new designated use specific to wild rice, Class 4D. In their 2017 Statement of Need and Reasonableness (SONAR) (reference (5)), MPCA proposed to replace the numeric sulfate standard of 10 mg/L with an equation-based approach to determine the surface water sulfate standard. Justification for this change included studies supporting the science that shows the impact of total organic carbon (TOC) and total extractable iron (TEFe) on sulfide levels in sediment porewater, as outlined in Section 2.4.

As a matter of procedure, an Administrative Law Judge (ALJ) must review and approve any proposed rule to ensure that the rule and the rulemaking process comply with all state laws on rulemaking (references (1); Minnesota Statutes 2021, chapter 14; Minnesota Rules, parts 1400.2000 through 2240). On January 10, 2018, the ALJ filed the *Report of the Administrative Law Judge - In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers, Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205, and 7053.0406*. The ALJ concluded in the report that:

> *[T]he proposed rule fails to meet the definition of a rule under Minn. Stat. § 14.38 (2016) and Minn. R. 1400.2100.G (2017). In addition, the proposed equation-based sulfate standard is not rationally related to the Agency's objective in this proceeding and is unconstitutionally void for vagueness.*

Thus, the ALJ disapproved the proposed rule, which was founded on the equation-based sulfate standard (reference (6)). The MPCA noted in their March 28, 2018, response letter (reference (1)) to the ALJ's ruling that the ALJ did agree that the science the equation was based on is sound:

> *[T]he MPCA presented sufficient evidence to demonstrate that there is an adequate scientific basis to conclude that the proposed equation-based sulfate standard is supported by peer-reviewed science and is needed and reasonable.* (reference *(6)*)

The ALJ went on to state that it was rational and reasonable to use the equation-based standard because it is supported by science (reference (1)).

The previously mentioned MPCA response letter challenged the ALJ's ruling and presented a revised sulfate standard equation, referred to as the 2018 protocol, as described in Section 2.4. The disapproval of the proposed rule by the ALJ and the MPCA's response resulted in the need for the Chief Administrative Law Judge (CALJ) to review the proposed rules and accompanying documents as well as the ALJ's ruling. The CALJ ultimately agreed with the ALJ's ruling, affirming that the MPCA did not fulfill the procedural requirements listed in Minnesota Statute, sections 14.127 and 14.131 (references (1); (6)). In essence, the rulemaking package as a whole was deemed incomplete; there was not necessarily an issue with the science supporting the equation-based approach to deriving a sulfate standard.

Based on the ALJ and CALJ rulings, the 2017 and 2018 protocols are valid. Though it may not be appropriate to use these protocols to develop statewide standards since they address site-specific conditions influencing the allowance of sulfate concentrations in surface water, they are appropriate to use on a case-by-case basis for site-specific water quality and permitting decisions.

Even though the proposed rule was not promulgated, MPCA emphasized that their authority to consider a site-specific standard already exists in the state's rules (Minnesota Rules, part 7050.0220, subpart 7). The equation-based approach MPCA outlined in the SONAR is supported by science and is a sound method for developing a site-specific standard. Thus, U. S. Steel proposes to use the equation-based approach to develop a site-specific standard for sulfate in Hay Lake.

2.3.2 Class 3 and 4 Rulemaking

The MPCA conducted another rulemaking related to Class 3 and 4; however, the approved changes did not include revisions to the Class 4A sulfate standards related to wild rice. Even so, in their 2020 SONAR, the MPCA acknowledged that the cost of treating sulfate is very high, with respect to the proposed sulfate standard of 600 mg/L for Class 4B (reference (7)). The MPCA specifically stated that the sulfate is "difficult and expensive to remove from effluent" and that compliance with all of the existing Class 3 and 4 rules requires technology that is "difficult to afford" and "may lead to wider negative economic impacts in the local community." Considerations to environmental costs of treatment were not part of the evaluation in the SONAR; however, the MPCA noted that treatment technologies "have substantial environmental drawbacks most notably with regards to carbon emissions and new streams of waste products that require disposal."

These are additional substantial reasons for U. S. Steel's proposal. The costs for treatment are significant and reduced sulfate may be offset by other pollutants that could be more harmful to wild rice or could result in even more expenses, potentially impacting the local community around the Keetac facility.

In the SONAR, the MPCA also stated that they considered the development of site-specific standards for sulfate based on the waterbody and specific conditions. They cited Minnesota Rules, part 7050.0220, subpart 7, which is the bases for this request. Based on the details of the SONAR, U. S. Steel's request follows the same logic that the MPCA presented as part of this rulemaking.

2.4 Protocol for Calculating the Sulfate Site-Specific Standard

U. S. Steel developed the sulfate site-specific standard for Hay Lake using the MPCA's 2018 guidance, titled *Sampling and Analytical Methods for Wild Rice Waters* (Reference (X)). The data used in the development of the site-specific standard was collected in Hay Lake using the MPCA's 2017 guidance, titled *Sampling and Analytical Methods for Wild Rice Waters* (references (5) (8)) For the purposes of this application, the guidance documents are referred to as the 2017 protocol and the 2018 protocol.

During the development of the sulfate site-specific standard, U. S. Steel collected sediment samples in Hay Lake using the 2017 protocol. Five sample sites were identified and used in the collection of sediment samples. Subsequently, sediment samples were collected one day per month during the months of May, June, July, August, and September of 2021. This resulted in five sets of TOC and TEFe data at each sample site and a total of 25 pairs of data.

In contrast, the 2018 protocol requires the collection of one sample from at least 15 samples sites. This only results in 15 pairs of TOC and TEFe data. Thus, U. S. Steel believes it is acceptable to use the 25 pairs of data collected in Hay Lake in 2021.

The MPCA's 2018 protocol was used for calculating the sulfate site-specific standard. The MPCA improved the equation in 2018 from the 2017 equation to more accurately represent the relationship between the variables, TOC and TEFe. Therefore, it is prudent for U. S. Steel to use the most updated equation regardless of whether the paired data was collected using the 2017 protocol or 2018 protocol.

The 25 pairs of TOC and TEFe data were used in the following equation to create 25 unique sulfate concentrations. U. S. Steel then selected the 20th percentile of the 25 sulfate concentrations as the sulfate site-specific standard, per the 2018 protocol. This value was 79 mg/L. Refer to Section 5.1 for further details on the derivation of the sulfate site-specific standard. See Appendix A for the 2017 and 2018 protocols.

$$MBLR120\ Sulfate = 0.0000854\ x\ \frac{TEFe^{1.637}}{TOC^{1.041}}$$

Where:

MBLR120 = multiple binary logistic regression, sulfide concentration of 120 µg/L (0.120 mg/L)

TEFe = total extractable iron

TOC = total organic carbon

3 Existing Water Quality and Hydrology of Wild Rice in Hay Lake

This section discusses the existing sulfate water quality in Hay Lake and summarizes hydrologic and wild rice observations in Hay Lake from studies conducted by U. S. Steel.

Since Hay Lake is an unlisted lake per Minnesota Rules, part 7050.0415, the general unlisted designated beneficial uses and associated water quality standards apply to Hay Lake, including Classes 2B, 3, 4A, 4B, 5, and 6 (Minnesota Rules, part 7050.0415, subpart 4). These designated beneficial uses are the same as those general classification applied to all waters of the state in Minnesota Rules, part 7050.0415, subpart 2, which verifies that these are the correct classes to apply to Hay Lake. This request focuses on a site-specific standard for sulfate that applies to the numeric Class 4A standard of 10 mg/L (Minnesota Rules 7050.0224, subpart 2) and the numeric interpretation of the narrative standard (Minnesota Rules, part 7050.0224, subpart 2).

3.1 Hay Lake Water Quality

Sulfate water quality data for Hay Lake is summarized in Table 3-1. Hay Lake is shown in Figure 1 and Figure 2. Various sources were used to compile sulfate surface water quality data in Hay Lake, including U. S. Steel's past studies and MPCA's surface water data access tool. Based on the dataset of 55 samples collected between June 23, 2009 and October 27, 2021, the average sulfate concentration in Hay Lake is 34 mg/L. There were no instances where the sulfate concentration exceeded the proposed sulfate site-specific standard of 79 mg/L. Therefore, Hay Lake is already achieving the sulfate site-specific standard and the discharges, which were present during the time this data was collected, did not cause or contribute to sulfate concentrations greater than the proposed sulfate site-specific standard of 79 mg/L.

Table 3-1 Hay Lake Sulfate Water Quality Summary

Waterbody Name	Sulfate Concentration (mg/L)			No. of Samples
	Minimum	Average	Maximum	
Hay Lake (31-0037-00)[1]	10	32	78	55

[1] Sulfate data for Hay Lake was collected between June 23, 2009, and October 27, 2021. See references (9); (10); (11); (12); (13) for data sources.

3.2 Hydrologic and Wild Rice Observations in Hay Lake

Several studies have been conducted in Hay Lake to evaluate hydrologic conditions, wild rice presence, and wild rice density. The results of these studies, summarized in Table 3-2, have shown abundant wild rice populations in most years. See Appendix B for the complete studies.

Water depth is one factor controlling the location of the presence of wild rice in the lake. Fluctuations in water levels influence wild rice populations; well-documented beaver activity is assumed to contribute to these fluctuations in Hay Lake. Wild rice occurs primarily along the perimeter of Hay Lake, where water depth is shallow. Where the lake is deepest, from 6 to 12 feet in depth, wild rice is not present. Further, as described in Section 3.1, sulfate concentrations in Hay Lake are consistently less than the 79 mg/L sulfate site-specific standard that is protective of wild rice growth.

Table 3-2 Summary of Hay Lake Hydrologic and Wild Rice Monitoring Outcomes

Survey Date	Hydrologic Monitoring Outcome	Wild Rice Monitoring Outcome
July 2009 (conducted by Barr Engineering Co.)	• Water levels were monitored using a staff gage beginning on June 23, 2009 and continuing through the fall. • Water level increased by more than a foot as the summer progressed.	• Mature and dense wild rice with approximately one-third of Hay Lake covered with wild rice. • Density 5 wild rice (>75% coverage) observed where Hay Creek flows out of Hay Lake. • Average stem density in sampling grids were between 30 and 90 stems per 0.5 m^2.
September 2009 (conducted by Minnesota DNR)	Water level was noted to be high.	• Approximately 3 acres of wild rice present. • The density ranged from "medium" to "abundant" near the outlet to Hay Creek.
August and September 2010 (conducted by Barr Engineering Co.)	• Water levels were monitored from May 1 through November 10, 2010 using a staff gage. • Water level was consistently higher in 2010 compared to 2009. • The water elevation fluctuated from a low of 1356.0 ft above MSL on May 27, 2010 to a high of 1356.5 ft on October 4, 2010.	• Moderate total coverage of wild rice, with approximately one-quarter of Hay Lake containing wild rice. • Density 3 wild rice (25-50% coverage) observed where Hay Creek flows out of Hay Lake. • Average stem density in sampling grids were between 24.9 and 51.9 stems per 0.5 m^2.
August 2011 (conducted by Barr Engineering Co.)	• Water levels were monitored once every two weeks from May 3 through October 25, 2011 using a staff gage. • When monitoring activities began in May 2011, the water level was higher than levels observed in either 2009 or 2010. • On July 5, 2011, the water level dropped 0.92 foot from the water level recorded two weeks earlier. Two weeks later, the water level rose 1.1 feet. • Heavy rain fell in the region on August 2, 2011. On August 4, 2011, Hay Lake's elevation was the highest recorded since monitoring began in 2009. By September 16, 2011, the water level dropped 2 feet from the level recorded on August 4, 2011.	• Wild rice was identified during June and early-July water sampling events. • By August, the majority of wild rice stands were found uprooted and dead in the water. • No stems were counted.

Survey Date	Hydrologic Monitoring Outcome	Wild Rice Monitoring Outcome
August 2012 (conducted by Barr Engineering Co.)	• Water levels were monitored monthly from April 25 through October 24, 2012 using a staff gage. • When 2012 monitoring activities began, the water level was approximately one foot lower than the elevation observed in May 2011. • The elevation of the lake rose by 0.71 feet between April 26, 2012 and June 26, 2012. • Between June 26, 2012 and August 17, 2012, the water level dropped 1.45 feet.	• Density 3 wild rice (25-50% coverage) observed along northwest perimeter. • Density 2 wild rice (10-25% coverage) observed along the remaining perimeter. • Average stem density in sampling grids were between 8.0 to 20.8 stems per 0.5 m^2.
August 2014 (conducted by Barr Engineering Co.)	Not observed.	Density 5 wild rice (>75% coverage) observed along the perimeter.
May through October 2021 (conducted by NTS)	Water level increased slightly throughout the year.	• In June, early wild rice growth was noted at floating leaf stage. • In July, wild rice was found to be aerial but sparse. • No wild rice was observed after July.

The evaluation of chemical conditions at Hay Lake, as well as the historical presence of wild rice and the geomorphological conditions that encourage wild rice growth indicate that Hay Lake supports the presence of wild rice. Wild rice growth has historically been present on Hay Lake and is expected to continue to be present on Hay Lake in the future. These reasons support that a site-specific standard of 79 mg/L would be protective of the wild rice growing on Hay Lake.

4 Literature Review of Wild Rice Studies

This section includes a brief summary of recent studies conducted to determine the impacts of sulfate and sulfide concentrations on wild rice growth and development, with consideration of other potential causes of toxicity in wild rice. A study investigating the suitability of a sulfate site-specific standard for Hay Lake is also included.

Douglas J. Fort and Michael B. Mathis at Fort Environmental Laboratories, and Kurt Anderson at ALLETE, along with various other contributors (collectively referred to as Fort et al.), conducted a series of studies to determine the effects of sulfate and sulfide on wild rice. In 2014, Fort et al. treated wild rice seeds with sulfate that ranged in concentrations from 10 – 5,000 mg/L (reference (14)). After 21 days of sulfate treatment, Fort et al. found that sulfate did not cause toxic effects to wild rice at concentrations below 5,000 mg/L. This sulfate concentration is far greater than the proposed sulfate site-specific standard of 79 mg/L, showing that the proposed sulfate site-specific standard is protective of wild rice.

In 2017, Fort et al. treated wild rice seeds with sulfide and iron over a 21-day period (reference (15)). Sulfide concentrations ranged from 0.3 – 12.5 mg/L. Fort et al. found that sulfide and iron did not cause toxic effects to wild rice until concentrations reached a combination of either 3.1 mg/L sulfide with 0.8 mg/L iron or 7.8 mg/L sulfide with 2.8 or 10.8 mg/L iron. Recall that the 2018 protocol established an equation that is protective of wild rice with a sulfide concentration of 0.12 mg/L (120 µg/L). The 2018 protocol equation produces a sulfide concentration that is far less than the sulfide concentrations resulting in toxicity to wild rice found in this study.

In 2020, Fort et al. conducted a similar study to determine sulfate toxicity to wild rice under low-oxygen conditions (reference (16)). The results were nearly identical to those from 2017. Sulfide and iron did not cause toxic effects to wild rice until concentrations reached 3.1 mg/L and 0.8 mg/L, respectively. Sulfide and iron in concentrations of 7.8 mg/L and 2.8 mg/L, respectively, resulted in reduced emergence, reduced shoot weight, and reduced shoot length. Again, the concentration of sulfide that affected wild rice in this study was far greater than the sulfide concentration used in the 2018 protocol for the protection of wild rice. The proposed sulfate site-specific standard of 79 mg/L will limit concentrations of sulfide in the porewater to 120 µg/L, and therefore, will be protective of wild rice in Hay Lake.

In 2021, U. S. Steel contracted with NTS to conduct investigative work on Hay Lake with the intent of requesting a sulfate site-specific standard (reference (13)). Samples were taken for sediment, sediment pore water, water depth, and surface water quality. The TOC and TEFe concentrations in the sediment resulted in a range of sulfate values from 54 mg/L to 481 mg/L when using the 2018 protocol. The sulfide concentrations in the pore water ranged from < 0.10 mg/L, where flow from Hay Creek and Keetac's discharges enter Hay Lake and leave Hay Lake (Figure 2), to 0.568 mg/L, at the southwestern corner of Hay Lake. Depths in Hay Lake ranged from 3.34 feet to 5.46 feet. NTS noted an increase in depth over the course of the project and determined the increase was due to beaver activity in the area. NTS concluded that the low sulfate levels (21.0-27.2 mg/L) from samples in the middle portion of Hay Lake, low sulfide and sulfate levels in pore water, and high extractable iron concentrations indicate that Hay Lake is a suitable candidate for wild rice growth and a sulfate site-specific standard.

5 Site-Specific Sulfate Standard Derivation and Reasonable Potential Analysis

This section presents the results of sulfate site-specific standard calculations and reasonable potential analyses for Hay Lake.

5.1 Derivation of the Sulfate Site-Specific Standard

During the development of the sulfate site-specific standard, U. S. Steel collected TOC and TEFe data using the 2017 protocol described in Appendix A. U. S. Steel proposes to use that data in the 2018 equation to calculate a site-specific sulfate standard for Hay Lake in this application.

The NTS study conducted on behalf of U. S. Steel's in 2021 resulted in 25 pairs of TOC and TEFe data, which are summarized in Table 5-1 (reference (13)). This meets the 15 paired data minimum for the 2018 protocol. Therefore, it is reasonable to use the data collected in accordance with the 2017 protocol for the purposes of calculating a site-specific standard using the equation in the 2018 protocol. Figure 2 shows the corresponding sampling locations.

Table 5-1 Paired TOC and TEFe Data Collected in Hay Lake

Date	Sample Location	TOC (%)	TEFe (mg/kg)	Pore Water Sulfate (mg/L)	Pore Water Sulfide (mg/L)	Calculated Sulfate Standard (mg/L)
5/24/2021	HL-1	1.81	9,370	--	--	146
5/24/2021	HL-2	5.03	22,700	--	--	215
5/24/2021	HL-3	8.06	21,400	--	--	119
5/24/2021	HL-4	7.05	16,400	--	--	89
5/24/2021	HL-5	3.11	19,100	--	--	267
6/21/2021	HL-1	2.29	9,740	< 1.0	< 0.10	122
6/21/2021	HL-2	5.80	10,700	< 1.0	< 0.10	54
6/21/2021	HL-3	8.43	19,500	< 1.0	0.112	98
6/21/2021	HL-4	9.80	18,700	1.5	0.383	78
6/21/2021	HL-5	4.34	19,400	< 1.0	< 0.10	194
7/27/2021	HL-1	1.38	13,400	1.1	< 0.10	348
7/27/2021	HL-2	2.94	13,800	< 1.0	< 0.10	166
7/27/2021	HL-3	5.67	22,300	< 1.0	0.106	184
7/27/2021	HL-4	6.62	14,700	< 1.0	0.331	79
7/27/2021	HL-5	2.99	26,700	< 1.0	< 0.10	481
8/24/2021	HL-1	1.71	10,900	< 1.0	0.113	199

Date	Sample Location	TOC (%)	TEFe (mg/kg)	Pore Water Sulfate (mg/L)	Pore Water Sulfide (mg/L)	Calculated Sulfate Standard (mg/L)
8/24/2021	HL-2	2.54	9,450	24.8	< 0.10	104
8/24/2021	HL-3	6.41	13,800	5.4	< 0.10	74
8/24/2021	HL-4	6.06	10,900	< 1.0	0.568	53
8/24/2021	HL-5	3.56	20,400	< 1.0	0.124	258
9/28/2021	HL-1	1.65	10,100	< 1.0	< 0.10	182
9/28/2021	HL-2	2.78	6,800	20.0	< 0.10	55
9/28/2021	HL-3	2.79	17,400	15.7	< 0.10	257
9/28/2021	HL-4	4.75	13,900	2.8	0.141	102
9/28/2021	HL-5	2.92	19,100	< 1.0	< 0.10	285
10/27/2021	HL-1	--	--	< 1.0	< 0.10	--
10/27/2021	HL-2	--	--	1.9	0.19	--
10/27/2021	HL-3	--	--	< 1.0	< 0.10	--
10/27/2021	HL-4	--	--	< 1.0	0.316	--
10/27/2021	HL-5	--	--	< 1.0	0.133	--

The 2018 protocol described in Appendix A was used to calculate sulfate site-specific standards for Hay Lake. The sulfate concentrations listed in Table 5-1 above were calculated using the multiple binary logistic regressions formula for the prediction of a porewater sulfide concentration of 120 µg/L (MBLR 120) reference (6)):

$$Sulfate = 0.0000854 \, x \, \frac{TEFe^{1.637}}{TOCe^{1.041}}$$

Where:

TEFe = total extractable iron

TOC = total organic carbon

In accordance with the 2018 protocol, the site-specific standard is the 20th percentile of the calculated sulfate concentrations. Based on the data listed in Table 5-1 and the summary found in Table 5-2, the applicable sulfate site-specific standard for Hay Lake is 79 mg/L. See Appendix CC for the full suite of calculations.

Table 5-2 Hay Lake Sulfate Site-Specific Standards Calculations Summary

Site-Specific Standards Value Summary	Units	Hay Lake
Minimum Sediment Total Organic Carbon	%	1.38
Average Sediment Total Organic Carbon	%	4.42
Maximum Sediment Total Organic Carbon	%	9.80
Minimum Sediment Total Extractable Iron	mg/kg	6,800
Average Sediment Total Extractable Iron	mg/kg	15,626
Maximum Sediment Total Extractable Iron	mg/kg	29,700
20th Percentile Procedure [1]	**mg/L**	**79**

[1] Procedure for determining wild rice sulfate standard based on 20th percentile of calculated values as described in MPCA March 28, 2018, letter response to Report of the Chief Administrative Law Judge (reference (6)).

These sulfate site-specific standard calculations show that the current conditions of Hay Lake support the growth of wild rice at sulfate concentrations up to 79 mg/L in the water column. Based on the current water quality of Hay Lake noted in Section 3.1, which shows an average of 34 mg/L sulfate, and the projected sulfate concentration in the inflow to Hay Lake, as shown in Section 5.3, is about 48 mg/L. These values demonstrate that the discharge from the Keetac mining area and tailings basin will not cause sulfate concentrations in Hay Lake to exceed the sulfate site-specific standard of 79 mg/L; and thus, will not inhibit the growth of wild rice in Hay Lake.

5.2 Reasonable Potential Analysis

In addition to deriving the sulfate site-specific standards, an RPA was conducted to determine whether the discharges from Keetac have a reasonable potential to cause or contribute to an excursions of the calculated sulfate site-specific standard in Hay Lake. RPAs are typically performed as part of a NPDES/SDS permit writing process for point source discharges to determine whether concentrations of pollutants in a discharge will cause or contribute to an excursion of a water quality standard and, if so, implement water-quality based effluent limits (WQBELs) in the permit. However, the RPA can also be used to determine whether existing water quality in a waterbody exceeds the water quality standard.

U. S. Steel performed an RPA for Hay Lake to determine if the existing sulfate water quality exceeds the calculated sulfate site-specific standard. The statistical analysis was performed according to the USEPA's *Technical Support Document for Water Quality Based Toxics Control* (reference (17)) and Minnesota Rules, part 7052.0370. Although Minnesota Rules, part 7052.0370 is applicable to waters in the Lake Superior basin, the MPCA used the reasonable potential to exceed and WQBEL derivation approach outlined in this set of rules. Thus, U. S. Steel completed its analysis in the same manner. The steps performed are listed below:

- Compile all monitoring data for Hay Lake.

- Calculate the number of samples, maximum observed sulfate concentration, and the coefficient of variation for each data set.

- Look up the 99th percentile reasonable potential multiplying factor in Minnesota Rules, part 7052.0370 based on the number of samples and coefficient of variation for each data set.

- Multiply the maximum observed value by the coefficient of variation, resulting in the projected effluent quality (PEQ) for each data set. The PEQ represents the 99th percentile of expected concentrations based on the monitoring data available – essentially the maximum anticipated concentration.

- Compare the PEQ to the site-specific water quality standard for each waterbody. If the PEQ is less than the water quality standard, a reasonable potential to exceed the proposed site-specific water quality standard does not exist.

The results of the RPA are shown in Table 5-3. See Appendix DD for the full suite of calculations.

Table 5-3 Hay Lake Reasonable Potential to Exceed Sulfate Site-Specific Standard Summary

Reasonable Potential to Exceed Calculation Summary	Results
Range of Data Availability	June 23, 2009 – October 27, 2021
No. of Samples	55
Average (mg/L)	32
Maximum Observed Concentration (mg/L)	78
Standard Deviation[1]	0.35
Coefficient of Variation[1]	0.36
Reasonable Potential Multiplying Factor (99%)[2]	1
Proposed Sulfate Site-Specific Standard (mg/L)	**79**
Reasonable Potential to Exceed?	**No**

[1] In accordance with the Water Quality-Based Effluent Limits derivation spreadsheet for the discharge from Mining Area SD012 that was generated by MPCA for the previous NPDES/SDS permit MN0031879 renewal, these statistical values were calculated using the natural logarithm (LN) of the raw sulfate surface water quality data for Hay Lake.

[2] The reasonable potential multiplying factor was obtained from Minnesota Rules, part 7052.0370, which aligns with MPCA's approach during the previous NPDES/SDS permit MN0031879 renewal.

There is no reasonable potential for an exceedance of the proposed 79 mg/L sulfate site-specific standard in Hay Lake. The discharges from the Keetac mining area and tailings basin will not cause the sulfate concentrations in Hay Lake to exceed 79 mg/L nor will they impact the growth of wild rice in Hay Lake.

5.3 Sulfate Mass Balance and Verification of Results

U. S. Steel underwent an analysis as a check to prove that the discharges from the Keetac facilities would not result in an excursion of the 79 mg/L sulfate site-specific standard in Hay Lake; therefore, would not have an adverse effect on wild rice in Hay Lake. A mass balance calculation was conducted to determine the sulfate loading entering Reservoir 2 from the discharges at SD002 (MN0031879) and SD005 (MN0055948), which are the main contributors from Keetac's operations to sulfate in the downstream water bodies (e.g., Hay Lake) based on discharge monitoring report data. The resulting input of sulfate to Reservoir 2 was compared to the sulfate data collected at SW001, which is the discharge point from Reservoir 2. See Figure 1 for the location of SW001 in proximity to the Keetac facility and discharges. SW001 is a surface water station rather than a surface discharge station in NPDES/SDS permit MN0055948. Discharges from SW001 flow into the O'Brien Lake Diversion Channel, through Hay Creek, and into Hay Lake; thus, it is a good indicator of compliance with the proposed sulfate site-specific standard of 79 mg/L.

Monthly sulfate concentration and flow monitoring data from 2016 through 2020 were used to calculate the annual loading entering Reservoir 2 from SD002 and SD005. In turn, monthly sulfate concentration and flow monitoring data from 2017 through May 2022 were used to evaluate the annual sulfate load being discharged from SW001. To derive the annual estimates, each year's worth of data was averaged to obtain individual year annual averages (five years in the case of SD002 and SD005 and six years in the case of SW001). The individual year annual averages were then averaged to obtain a five-year and six-year average flow and sulfate concentration, respectively, for inputs to and output from Reservoir 2. The mass balance calculations estimate the sulfate concentration in Reservoir 2 from the mixed inflow waters from SD002 and SD005 is approximately 100 mg/L, while the sulfate concentration of the outflow water from Reservoir 2 is about 67 mg/L, indicating sulfate loss/removal within Reservoir 2.

Furthermore, a mass balance calculation was used to estimate the loading into Hay Lake based on sulfate and flow monitoring at all the active outfalls associated with NPDES/SDS permits MN0031879 and MN0055948, SD002, SD003 and SD012, and SD005, respectively. Similar to above, the sulfate and flow monitoring data from 2016 through 2020 were used to calculate the average annual loading from each outfall. Flow for the surrounding non-mining portion of the Hay Lake watershed (annual average) was estimated using the United States Geological Survey's StreamStats tool available online at https://streamstats.usgs.gov/ss/ and then summed together with the flows from each outfall to get a projected flow entering Hay Lake. This flow was then used with the sum of the sulfate mass loads from each outfall assumed to reach Hay Lake to calculate a sulfate concentration entering Hay Lake. The sulfate concentration entering Hay Lake was compared to the proposed sulfate site-specific standard of 79 mg/L.

Table 5-4 summarizes the results for the evaluations discussed above. See Appendix EE for the complete calculations.

Table 5-4 Estimated Sulfate Concentration in Reservoir 2, Leaving Reservoir 2, and Entering Hay Lake Based on Monitoring Data and Mass Balance Calculations

Data Set	Sulfate (mg/L)
Input into Reservoir 2 (from SD002 and SD005; mass balance approach)	100.38
SW001 2017 data (n = 12)	52.46
SW001 2018 data (n = 12)	54.34
SW001 2019 data (n = 12)	63.25
SW001 2020 data (n = 12)	50.65
SW001 2021 data (n = 5) [1]	81.52
SW001 2022 data (n = 2) [2]	68.35
Output from Reservoir 2 (Average of Annual Averages (n = 5))	**66.76**
Output from Reservoir 2 (SW001 2017-2022 data (n = 55))	**64.59**
Input into Hay Lake	**47.63**

[1] There was no outflow from Reservoir 2 from July 2021 through December 2021.
[2] There was no outflow from Reservoir 2 from January 2022 through March 2022; flow and concentration data available from April and May 2022.

For water leaving Reservoir 2, the resulting five-year sulfate averages of 66.76 mg/L (average of individual year averages) and 64.59 mg/L (average of monthly concentrations) are below the proposed sulfate site-specific standard of 79 mg/L. The results of the mass balance and results verification evaluation indicate there is some sulfate removal occurring in Reservoir 2. Sulfate inputs average 100.38 mg/L while outputs average as low as 64.59 mg/L. Sulfate loss also occurs in the Hay Creek watershed as the input to Hay Lake is estimated to be about 48 mg/L, well below the measured average sulfate concentrations at SW-001 (includes discharge from SD002 and SD005), as well as SD003 and SD012. It can be thus assumed that compliance with the proposed sulfate site-specific standard at SW001 will result in compliance with the site-specific protective value of 79 mg/L at Hay Lake. This is supported by the fact that the estimated sulfate concentration entering Hay Lake is 47.63 mg/L, even further below the proposed sulfate site-specific standard.

6 Conclusion and Request

U. S. Steel is proposing a sulfate site-specific standard for Hay Lake, which receives flow from the discharges from U. S. Steel's Keetac mining area and tailings basin. The standard U. S. Steel is proposing for Hay Lake is a Class 4A sulfate site-specific standard of 79 mg/L to replace the existing Class 4A numeric sulfate standard of 10 mg/L.

The following key points support the implementation of the sulfate site-specific standard and sulfate monitoring only requirements in the upcoming NPDES/SDS permit renewals.

- The ALJ and the CALJ reviewing the Class 4A rulemaking related to the proposed wild rice standard concluded that the equation-based approach outlined in the 2017 and 2018 protocols was scientifically sound and supported by research. The proposed sulfate site-specific standard of 79 mg/L was developed based on the scientific practices developed by the MPCA in those protocols.
- The literature described in Section 4 indicate that the sulfate concentration of 79 mg/L contained in this site-specific standard request and 120 ug/L sulfide from the equation in the MPCA's 2018 protocol are not toxic to wild rice. Toxicity to wild rice from sulfate and sulfide occurs at concentration far higher than these levels. This shows that using a sulfate site-specific standard of 79 mg/L will be protective of wild rice in Hay Lake.
- The RPA concludes that there is no reasonable potential for the sulfate concentrations from the mining area and tailings basin discharges to cause or contribute to an excursion of the proposed sulfate site-specific standard of 79 mg/L in Hay Lake.
- The mass balance indicates that natural sulfate sinks and dilution reduce the concentrations of sulfate prior to flows entering Hay Lake. Reservoir 2 reduced the sulfate concentration from 100.38 mg/L to 64.59 mg/L, and the Hay Creek watershed reduced the sulfate concentration to 47.63 mg/L before flows enter Hay Lake. This is further evidence that the discharges from Keetac will not impact wild rice.

Based on the findings summarized above, the proposed sulfate site-specific standard of 79 mg/L is protective of the growth of wild rice in Hay Lake, and U. S. Steel requests that MPCA approve the proposed sulfate site-specific standard of 79 mg/L, in which case sulfate limit are not necessary in NPDES/SDS permits MN0031879 and MN0055948.

7 References

1. **State of Minnesota Office of Administrative Hearings.** *Report of the Chief Administrative Law Judge in the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers.* January 11, 2018. Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205, and 7053.0406.

2. **U.S. Environmental Protection Agency.** Establishing Site Specific Aquatic Life Criteria Equal to Natural Background Memo. November 5, 1997.

3. —. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses (PB85-227049). 1985.

4. —. Water Quality Standards Regulatory Clarifications; Proposed Rule 40 C.F.R. Part 131. *Code of Federal Regulations.* s.l. : National Archives and Records Administration, September 4, 2013.

5. **Minnesota Pollution Control Agency Environmental Analysis and Outcomes Division.** Statement of Need and Reasonableness: Amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters. Minn. R. chapters 7050 and 7053. July 2017.

6. **Minnesota Pollution Control Agency.** Letter to Chief Administrative Law Judge Tammy L. Pust Re: In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Waters. March 28, 2018. OAH Docket # 80-9003-34519, Revisor ID #4324.

7. —. Statement of Need and Reasonableness In the Matter of Proposed Revisions of Minnesota Rule Chapters 7050 and 7053, Relating to Water Quality Standards – Use Classifications 3 and 4; Revisor ID No. 04335. December 14, 2020.

8. —. Sampling and Analytical Methods for Wild Rice Waters. July 2017.

9. **Barr Engineering Co.** 2009 Water Quality, Hydrology, and Wild Rice Monitoring: Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Hart Creek. September 14, 2009. Prepared for U. S. Steel Corporation.

10. —. 2011 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report: Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Swan River. January 2012. Prepared for United States Steel Corporation, Minnesota Ore Operations – Keetac.

11. —. 2012 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report: Swan Lake, Swan River, Hay Lake, Moose Lake, O'Brien Lake and O'Brien Creek. January 2013. Prepared for United States Steel Corporation, Minnesota Ore Operations – Keetac.

12. **Myrbo, Amy.** Wild Rice Sulfate Standard Field Surveys 2011, 2012, 2013: Final Report. December 31, 2013.

13. **Northeast Technical Services Inc.** 2021 Sediment, Pore Water and Water Quality Report: Hay Lake - Proposed Wild Rice Waters. December 2021. Prepared for U.S. Steel Minntac.

14. **Fort, D. J., et al.** Toxicity of sulfate and chloride to early life stages of wild rice (Zizania palustris). *Environmental Toxicology and Chemistry.* December 2014, Vol. 33, 12, pp. 2802-2809.

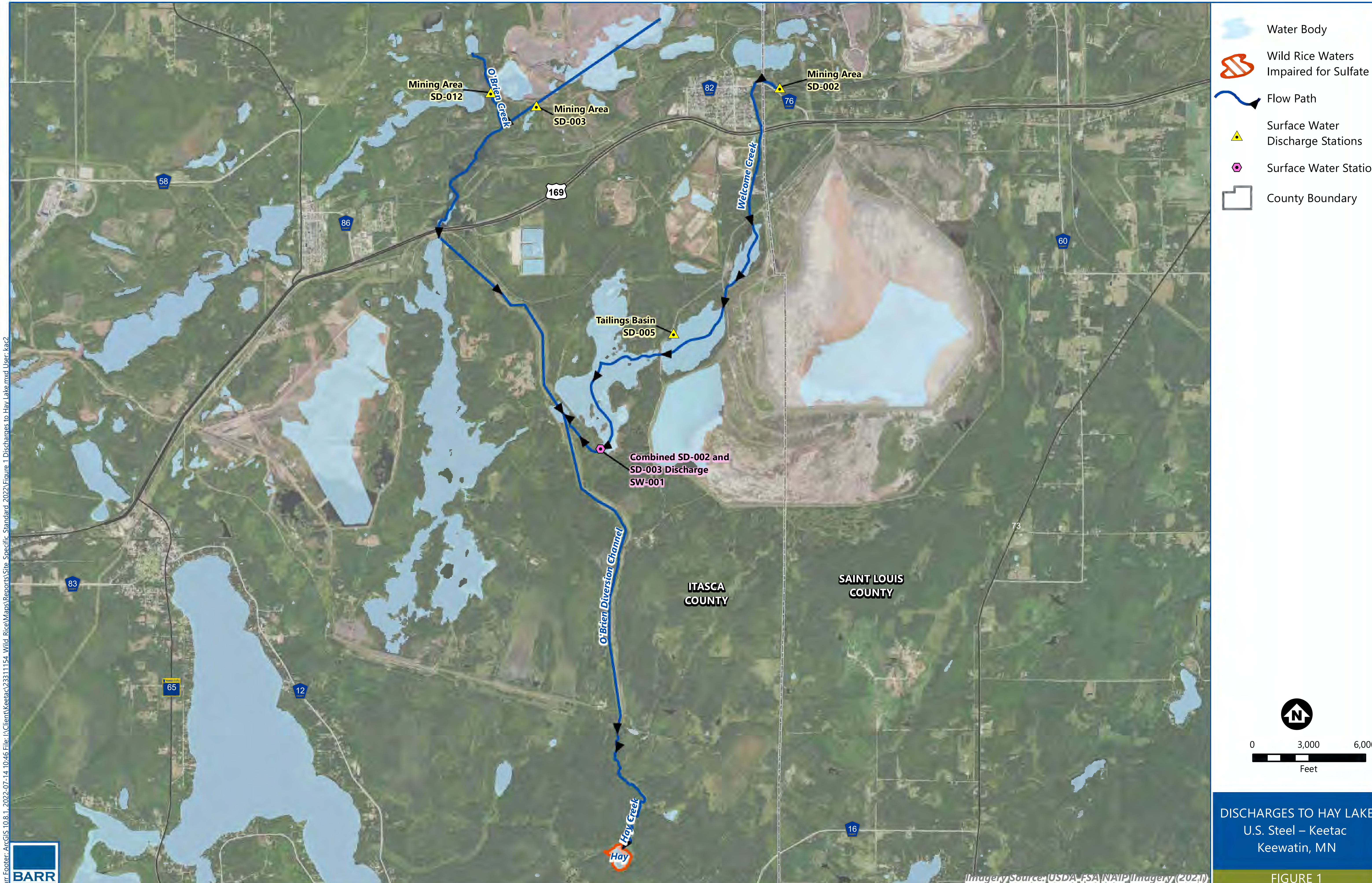
15. **Fort, Douglas J., et al.** Toxicity Of Sulfide To Early Life Stages Of Wild Rice (Zizania Palustris). *Environmental Toxicology and Chemistry.* February 2017, Vol. 36, 8, pp. 2217–2226.

16. **Fort, Douglas J., et al.** Impact of Hydroponic Oxygen Control in Sulfide Toxicity to Early Life Stages ofWild Rice (Zizania palustris). *Environmental Toxicology and Chemistry.* 2020, pp. 1-8.

17. **U.S. Environmental Protection Agency.** Technical Support Document for Water Quality Based Toxics Control. March 1991.

18. —. Public Notice of EPA's Additions to Minnesota's 2020 Impaired Waters List. *Impaired Waters and TMDLs.* [Online] September 1, 2021. [Cited: September 20, 2021.] https://www.epa.gov/tmdl/public-notice-epas-additions-minnesotas-2020-impaired-waters-list.

Figures



DISCHARGES TO HAY LAKE
U.S. Steel – Keetac
Keewatin, MN

FIGURE 1

Barr Footer: ArcGIS 10.8.1, 2022-07-14 10:46 File: I:\Client\Keetac\23311154 Wild Rice\Maps\Reports\Site Specific Standard 2022\Figure 1 Discharges to Hay Lake.mxd User: kac2

Sediment Sample Point (NTS, 2021)

N

0 75 150
Feet

HAY LAKE 2021 SEDIMENT SAMPLE SITES
U.S. Steel – Keetac
Keewatin, MN

FIGURE 2

BARR

Appendices

Appendix A

MPCA's 2017 and 2018 Protocols

MINNESOTA POLLUTION CONTROL AGENCY

Sampling and Analytical Methods for Wild Rice Waters

July 2017

Environmental Analysis and Outcomes Division

The analytical methods and sampling procedures provided in this document are incorporated by reference in Minn. R. pt. 7050.0224. They apply to the analysis and sampling of sediment and sediment porewater for purposes of implementing the sulfate water quality standard applicable to wild rice waters.

Table of Contents

Sediment sampling procedure for wild rice waters

Background

The Minnesota Pollution Control Agency has developed these procedures to ensure that samples taken for the purposes of establishing the sulfate standard to protect wild rice (Minn. R. 7050.0224) are accurate. The sulfate standard is an equation that calculates a sulfate concentration necessary to maintain a sulfide concentrations in sediment less than or equal to 120 µg/L (0.120 mg/L). The standard uses measured sediment concentrations of total organic carbon (TOC) and total extractable iron (TEFe) in the calculation of the protective sulfate concentration. This procedure establishes the methodology that must be used to collect sediment samples in wild rice waters.

The terms used in this document have the following meanings.

- Wild rice water is the entire WID identified in Minn. R. 7050.0471.
- Wild rice habitat identifier describes the type of information available to identify observed or potential wild rice habitat within a wild rice water.
- Sediment sample area is an identified portion of the wild rice water containing wild rice habitat.
- Transect is a straight line across the sediment sample area along which sediment cores are obtained.
- Core sample site is the location along a transect where an individual sediment core is taken.

1. Identify areas of wild rice habitat

The first step is to identify areas within the wild rice water where wild rice is growing or may grow. The entire wild rice water must be evaluated to determine areas of wild rice habitat.

On a map or aerial photograph of the wild rice water, outline the areas of wild rice habitat and identify them with one of the following wild rice habitat identifiers.

1. Areas where wild rice is observed or where there is evidence of wild rice, such as rooted wild rice plants that have been grazed or wild rice plant residue from previous year's growth.
2. Areas where information accurately identifies the past location of wild rice beds. Examples of acceptable information are plant surveys, sampling events, or historical records where the location of wild rice beds can be accurately determined.
3. Areas with yellow or white waterlilies (*Nuphar variegata* and *Nymphaea odorata*) where the water depth is less than 120 cm*.

* Where a depth defines a habitat, that depth is based on average conditions, i.e., where water is at or below the ordinary high water level, but not at levels typical of flood or drought conditions. If sampling occurs during high or low water conditions, the sampler must determine if the sediment sample area would normally meet the depth criteria.

4. Areas with either floating-leaved plants or emergent plants where water depth is less than 120 cm* (excluding species that form dense monocultures that exclude wild rice, such as cattails (*Typha* species), phragmites *(Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*)). Examples of the types of floating-leaved or emergent plants that will approximate the conditions for wild rice growth are pondweeds (*Potamogeton* species), watershield (*Brasenia schreberi*), pickerelweed (*Pontederia cordata*), and arrowhead (*Sagittaria latifolia*).
5. Areas where satellite or aerial photographs indicate the past presence of floating-leaved or emergent plants where the water depth is less than 120 cm*.
6. Areas where water depth is between 30 and 120 cm*.

2. Selection of sediment sample areas

The second step is to select sediment sample areas from the areas of wild rice habitat identified in section 1.

Select five representative sediment sample areas based on the following decision framework:

- If the wild rice water contains areas with wild rice habitat identifier #1, all sediment sample areas must be in the #1 areas.
    - If there are at least five separate areas with wild rice habitat identifier #1, five separate areas must be selected.
    - If there are fewer than five separate areas with wild rice habitat identifier #1, the largest areas must be divided to establish five sediment sample areas.
    - If the areas of wild rice habitat #1 are very small or of a very limited number, (e.g. one small bed) all sediment sample areas must be selected in those areas unless it is not possible to obtain the required sediment cores from those areas. In those cases, if there is documentation that wild rice was present in other areas (wild rice habitat identifier #2) those areas may be sampled to provide a total of five sediment sample areas.
- If the wild rice water does not have any areas with wild rice habitat identifier #1, all sediment sample areas must be selected based on the next highest level of wild rice habitat identifier (#s 2, 3, 4, 5, or 6).
    - If there are at least five separate areas with the highest level of wild rice habitat, those areas must be selected as sediment sample areas.
    - If there are fewer than five separate areas with the highest level of wild rice habitat identifier, the largest areas must be divided to establish five separate sample areas with the highest priority wild rice habitat identifier.
    - If the areas of the highest wild rice habitat are very small or of a very limited number, so that it is not possible to obtain the required sediment cores from those areas, additional sediment sample areas can be established in areas with the next highest priority wild rice habitat identifier.

Identify the each sample area as (A) through (E) and record the wild rice habitat number that most closely corresponds to each sampling area.

3. Identify Sampling Transects

The third step is to establish one sampling transect within each of the five identified sediment sample areas. The transect must be

- A straight line across the sediment sample area; and
- Perpendicular to the shore, unless the area is an island of habitat that is far from any shore;

Identify the approximate location of each transect within each sediment sample area on the map or aerial photograph of the wild rice water.

4. Sediment Sample Collection and Processing

The fourth step is to collect the sediment samples. Within each transect, five sediment cores must be collected and composited for analysis.

Collect and composite the sediment samples from each of the five transects using the following procedures:

1. Collect five sediment cores within each transect. To the extent possible, cores must be equally spaced across the entire transect. However, transects that cross areas that do not meet the habitat description (e.g., an area of a #1 sediment sample area where there is no wild rice or evidence of wild rice, or an area of a #3 sediment sample area that is more than 120 cm deep) should apportion the 5 sediment coring sites to the areas that correspond to the habitat description.
2. Record the latitude and longitude coordinates for the first and last core site of each transect. If the coring sites are more than 100 feet apart, record the latitude and longitude at each coring site. Record the coordinates in the format of Sediment sample area, core number (e.g., A1, A2, A3, A4, A5, B1, B2, etc.).
3. Collect each sediment core from the top 10 centimeters of the sediment. Use the same diameter core tube for all cores collected.
4. Place the 10-cm long core into a clean container.
5. Repeat for each of the five cores collected from the transect.
6. Thoroughly mix all five sediment cores together. Discard any large plant or rock material.
7. After mixing, remove a sample of approximately 0.2 L and place into an appropriately labelled sample container.

5. Data Reporting

In the report of the sample data, include:

1. The map or aerial photograph of the wild rice water, marked with the areas of wild rice habitat (required in Step 1), location of the sample areas (required in Step 2) and transects (required in Step 3);
2. The latitude and longitude of the ends of each transect, or the core site if the core sites are more than 100 feet apart; and
3. The wild rice habitat number that most closely corresponds to each sediment sample area.

Example Data Report of sediment samples

Wild Rice Water: Sediment samples and analysis

Sediment sampling date:

Field crew names:

Name of Wild Rice Water:

State of Minnesota ID for the waterbody:

		Location of transect ends, or each core site (if > 100 feet apart)			Sediment sample analytical results	
Sediment Sample Area (A-E)	Wild Rice Habitat Identifier (1-6)	Core Identifier	Latitude	Longitude	TOC	TEFe
A	#	A1				
		A2				
		A3				
		A4				
		A5				
B	#	B1				
		B2				
		B3				
		B4				
		B5				
C	#	C1				
		C2				
		C3				
		C4				
		C5				
D	#	D1				
		D2				
		D3				
		D4				
		D5				

Sediment Sample Area (A-E)	Wild Rice Habitat Identifier (1-6)	Location of transect ends, or each core site (if > 100 feet apart)			Sediment sample analytical results	
		Core Identifier	Latitude	Longitude	TOC	TEFe
E	#	E1				
		E2				
		E3				
		E4				
		E5				

Analytical method for the determination of total extractable iron in sediment

This document describes the methods for the preparation and analysis of sediment samples for total extractable iron (TEFe) for analysis by Inductively Coupled Plasma-Atomic Emission Spectrometry Spectroscopy.

1. Prior to analysis, store the samples at ≤ 6° C to minimize biological activity. Samples must be analyzed within 180 days of collection date.
2. Dry and prepare the sample using either procedure 2a or 2b:
   - 2a.
     - Manually remove large materials such as rocks, shells, and sticks
     - Dry the sample in an oven at 50° C until constant weight is achieved.
     - Manually break the dried sample into pieces.
     - Pulverize the dry sample using a mill.
   - 2b.
     - Freeze-dry the sample.
     - Homogenize the sample using a stainless steel spatula.
     - Remove remaining large materials such as rocks, shells, and sticks.
3. After the sample has been prepared, digest a small aliquot of the sample (0.25 +/- 0.02 grams) and all necessary QC samples by adding 25 mL of 0.5 N hydrochloric acid to all digestion tubes. Digest samples (and all necessary QC samples) on a hot block at 80-85° C or in a water bath at 80-85° C. Once samples reach 80° C, digest samples for 30 additional minutes. After 30 minutes, remove samples immediately and cool to room temperature, and bring to a constant volume. Immediately either centrifuge the tubes at 1000 rpm for 10 minutes or filter using a 0.45 µm PES-type filter. Remove an aliquot and dilute with reagent water to known volume for iron analysis. Determine iron in the diluted aliquot using Inductively Coupled Plasma-Atomic Emission Spectrometry. Report the results in mg/kg (dry weight).
4. Acceptable performance must be demonstrated on an ongoing basis. With every digestion batch, the laboratory must perform the following:
   - Low Background: At the beginning of each batch, analyze a blank (BLK) to determine reagent or laboratory contamination. The background level of the BLK must be below the report level before samples are analyzed.
   - Accuracy: With every batch of 20 samples processed as a group, analyze a Laboratory Control Sample (LCS). The LCS should be prepared at concentrations similar to those expected in the field samples and ideally at the same concentration used to prepare the matrix spike (MS). The acceptance criteria for recovery of the analyte in the LCS is 80 – 120%.
   - A MS must be prepared and analyzed with each batch of 20 samples processed as a group, or a minimum of 10% of the field samples analyzed, whichever is greater. The same solution used to

fortify the LCS is used to fortify the MS. The acceptance criteria for recovery of the analyte in the MS is 80 – 120%.

- Precision: Analyze a Laboratory Duplicate (DUP) with each batch of field samples processed as a group, or 10% of the field samples analyzed, whichever is greater. The acceptance criteria for the relative percent difference is ≤ 20%.

Analytical method for the determination of total organic carbon in sediment

This document describes the methods for the preparation and analysis of sediment samples for the analysis of Total Organic Carbon (TOC) by Non-Dispersive Infrared Detection.

1. Prior to analysis, store the samples at ≤ 6° C to minimize biological activity. Samples must be analyzed within 28 days of collection date.
2. Dry and prepare the sample using either procedure 2a or 2b:
    - 2a. Manually remove large materials such as rocks, shells, and sticks.
        - Dry the sediment sample in an oven at 50° C until sample is completely dried.
        - Manually break the dried sample into pieces.
        - Pulverize the remaining dry sediment using a mill.
    - 2b. Freeze-dry the sample.
        - Homogenize the material using a stainless steel spatula,
        - Remove remaining large materials such as rocks, shells and sticks.
3. After the sample has been prepared:
    - Treat an aliquot of the homogenized sample with a 5% solution of H_3PO_4 to remove any inorganic carbon.
    - Either air-dry or oven-dry (at 105°C) the sample until constant weight is achieved.
    - Analyze the sample (and all necessary QC samples) for Total Organic Carbon content using a Standard Operating Procedure based on EPA Method 9060A.
    - Analyze all environmental samples in duplicate.
    - Report the results in mg C/kg dry sediment, and as percent C in dry sediment.
4. Acceptable performance must be determined for every digestion batch by performing the following activities:
    - Low Background: At the beginning of each batch, analyze a blank (BLK) to determine reagent or laboratory contamination. The background level of the BLK must be below the report level before analyzing samples.
    - Accuracy: With every batch of 20 samples processed, analyze a Laboratory Control Sample (LCS). The LCS must prepared at the same concentrations as the field samples and at the same concentration used to prepare the matrix spike (MS). The acceptance criteria for recovery of the analyte in the LCS is 70 – 130%.

      Prepare and analyze a MS with every 20 samples processed as a group, or a minimum of 10% of the field samples analyzed, whichever is greater. The same solution used to fortify the LCS is used to fortify the MS. The acceptance criteria for recovery of the analyte in the MS is 70 – 130%.

- Precision: Analyze a Laboratory Duplicate or a MS duplicate with every 20 samples processed as a group, or 10% of the field samples analyzed, whichever is greater. The acceptance criteria for the relative percent difference (RPD) is ≤ 30%.
- Analyze every sample in duplicate. The RPD between duplicates must be ≤ 30%.

Porewater sampling and analytical method for the determination of sulfide

This document describes the methods for the sampling and analysis of sediment porewater samples for total dissolved sulfide in sediment porewater samples for analysis by the automated methylene blue method (Standard Methods 4500-S2 E. Gas Dialysis, Automated Methylene Blue Method).

1. Sample Locations:

Before conducting porewater analysis to determine an alternate sulfate standard, sediment in the water body must have been sampled as described in Sediment Sampling Procedure for Wild Rice Waters. Using the same locational data used for the previous sediment sampling, take ten sediment cores for porewater analysis as close as possible to the sediment sample points within each of the five previously established transects, according to the following table (which was established using a random number generator so that the porewater samples would represent the wild rice water).

Transect (a-e)	Sediment Composite sample #1	Sediment Composite sample #2	Sediment Composite sample #3	Sediment Composite sample #4	Sediment Composite sample #5
a	porewater		porewater		
b		porewater		porewater	
c	porewater			porewater	
d		porewater			porewater
e	porewater		porewater		

2. Sample Collection:

Sediment samples for porewater analysis must be taken from undisturbed sediment, preferably from a boat, with a sediment coring device with a 7 cm diameter core barrel.

- Obtain a 15-50 cm long sediment core with at least 10 cm of overlying water. Insert a piston at the bottom end of each core as it is retrieved.
- Keep the core upright and shaded prior to porewater sampling.
- Immobilize the core tube in a rack while on shore or on a suitable stable surface.

3. Porewater sampling:

- Porewater sampling must begin within 4 hours of collecting the sediment sample.
- Shortly before beginning porewater collection, extrude the overlying water from the top of the core sample.
- Extract porewater using a 10-cm long, 2.5 mm diameter, Rhizon™ filter with a mean pore size of 0.15 µm (Rhizon™ filter is available from Rhizosphere.com, Netherlands). Insert the Rhizon™ filter vertically into the core top and connect with a stainless steel needle and either PVC or

polyethylene tubing to a 125-mL evacuated serum bottle that had been capped with a 20-mm thick butyl rubber septum. Obtain a sample of no less than 15 mL of porewater, although 50 mL is preferable.

Before the needle is inserted into the sulfide sample bottle, using a second evacuated bottle, flush air from the Rhizon-tubing assembly with a small amount of sample porewater. As the porewater sample is collected, keep the top of the Rhizon within the wet sediment as the core subsides. The serum bottle must be preloaded with 0.2 mL of 2.0 N zinc acetate, 0.5 mL of 15 M sodium hydroxide, and a stir bar, flushed with a nitrogen atmosphere, evacuated, and preweighed.

4. Sample Analysis:

- Samples must be analyzed within 14 days of the collection date and must be stored at ≤ 6° C to minimize biological activity. At the laboratory, inject 5-6 mL of alkaline antioxidant reagent into each sample bottle through the septum with a Safety-Lok syringe and stir for at least 1 hour prior to subsampling for analysis.
- Sub-samples for analysis of sulfide should be withdrawn from the serum bottle without removing the septum, which preserves the sample for possible re-analysis. Analyze sulfide colorimetrically using a gas dialysis automated methylene blue method, with in-line acid distillation and NaOH trapping method (Standard Methods 4500-$S2^-$ Sulfide).
- Express the results as milligrams sulfide, as sulfur, per liter of porewater (with three significant figures).

5. Acceptable Performance:

Acceptable performance must be demonstrated on an ongoing basis. With every digestion batch, the laboratory must perform the following:

- Demonstration of Low Background: At the beginning of each batch, analyze a blank (BLK) to determine reagent or laboratory contamination. The background level of the BLK must be below the report level; otherwise, investigate and eliminate the source of the contamination before samples are analyzed.
- Accuracy: With every batch of 20 samples processed as a group, analyze a Laboratory Control Sample (LCS). Prepare the LCS at concentrations similar to those expected in the field samples and at the same concentration used to prepare the matrix spike (MS). The acceptance criteria for recovery of the analyte in the LCS is 80 – 120%.
- Prepare a MS is and analyze with each batch of 20 samples processed as a group, or a minimum of 10% of the field samples analyzed, whichever is greater. Use the same solution used to fortify the LCS to fortify the MS. The acceptance criteria for recovery of the analyte in the MS is 80 – 120%.
- Precision: Analyze a Laboratory Duplicate with each batch of field samples processed as a group, or 10% of the field samples analyzed, whichever is greater. The acceptance criteria for the relative percent difference (RPD) is ≤ 20%.

Minnesota Pollution Control Agency

Sampling and Analytical Methods for Wild Rice Waters

March 2018

Environmental Analysis and Outcomes Division

The analytical methods and sampling procedures provided in this document are incorporated by reference in Minn. R. pt. 7050.0224. They apply to the analysis and sampling of sediment for purposes of implementing the sulfate water quality standard applicable to wild rice waters.

Table of Contents

Background

The Minnesota Pollution Control Agency developed this procedure to ensure that samples taken for the purposes of calculating the numeric expression of the sulfate standard to protect wild rice (Minn. R. 7050.0224) are scientifically defensible and protective of the Class 4D wild rice use. The numeric expression of the sulfate standard is derived from the output of an equation that calculates a sulfate concentration necessary to maintain sulfide concentrations in sediment porewater less than or equal to 0.120 mg/L. The standard is derived using measured concentrations of total organic carbon (TOC) and total extractable iron (TEFe) in a sediment sample to calculate a protective sulfate concentration for each sediment sample. Due to natural processes, TOC and TEFe concentrations vary in the sediment of aquatic ecosystems, which means that the analysis of multiple sediment samples will produce a range of calculated sulfate concentrations that could serve as the numeric expression of the standard.

In order to protect the majority of wild rice habitat in a wild rice water, the numeric sulfate standard for a wild rice water is defined as the 20th percentile of at least 15 protective sulfate concentrations calculated from sediment samples randomly selected from the wild rice habitat. Sediment is only sampled from areas of wild rice habitat, since wild rice does not grow at all locations within a wild rice water.

This document establishes the methodology that must be used to collect sediment samples from wild rice habitat in wild rice waters, analyze the samples, apply the equation, and determine the numeric sulfate standard.

The terms used in this document have the following meanings.

- Wild rice water is the entire WID identifying a Class 4D wild rice water as shown in Minn. R. 7050.0471.
- Wild Rice Habitat (WRH) are the area(s) of the wild rice water that (1) support or have supported wild rice, or (2) are identified as likely to support wild rice. Once the referencing period has ended, WRH has been delineated, and sediment samples have been taken, the WRH areas defined for a wild rice water do not change. The MPCA will post on its website maps for each wild rice water that has had WRH delineated.
- Each Candidate Sample Site (CSS) is a point randomly selected from within the WRH, identified by its spatial coordinate. At least 100 CSS points must be identified for each wild rice water prior to obtaining sediment samples that will be analyzed for the determination of a numeric sulfate standard. Sediment samples must be taken from at least 15 of the candidate sample sites.
- Referencing period identifies the time within which desktop review and on-site reconnaissance occurs in preparation for the final delineation of WRH and sampling of sediment. The referencing period ends when the first complete set of sediment samples is collected.
- The numeric sulfate standard of a wild rice water is defined as the 20th percentile of the 15 or more protective calculated sulfate concentrations.

Section 1. Sediment sampling procedure for wild rice waters

A. Identifying wild rice habitat areas

Before sediments are sampled, WRH must be delineated within the wild rice water. The entire wild rice water (WID) must be evaluated to determine WRH. The process of identifying WRH in a wild rice water must be completed in two steps: (1) a desktop review of available information prior to any field reconnaissance, and (2) a pre-sampling field reconnaissance of the wild rice water. The intent of these two steps is to produce a map of WRH within the wild rice water. The map produced from this survey must be in a format that is compatible with performing a random selection of candidate sample sites as described in part B.

Delineation of Areas of Potential WRH

Step 1. Desktop review: On a map or aerial photograph of the wild rice water, outline the areas of potential WRH based on the following information:

- Areas where existing information identifies the past location of wild rice plants. Examples of acceptable information are annotated maps, documented plant surveys, sampling events, or historical records from which the areas containing wild rice plants can be determined.
- Areas where satellite or aerial photographs indicate the past presence of floating-leaved or emergent plants.

Step 2. Pre-sampling field reconnaissance:

After conducting the desktop review, the map of potential WRH must be compared to direct observation by conducting a field survey during the growing season of wild rice. This field survey must be done at a time when wild rice plants can be effectively identified; the best time period is when the growth of wild rice is at least at the tiller stage (July through September).

Areas identified as potential WRH in the desktop review must be examined in the field for evidence of wild rice plants. The survey must include visual observation of all areas of potential WRH. The wild rice water must also be surveyed for evidence of wild rice plants outside of the areas identified in the desktop review. Available information must also be gathered about possible phenomena that may have reduced that year's wild rice population, such as unusually high water levels. If the available information show a likelihood that the year's wild rice population has been significantly impacted by such phenomena, the referencing period must be extended by performing additional field reconnaissance in a following year.

Information on each area of potential WRH must be recorded, including which hierarchy level each site falls into, as described here:

Level 1 – Areas that Support or Have Supported Wild Rice

#1a. Areas where wild rice is observed growing or where there is evidence of recent growth, such as rooted wild rice plants that have been grazed, or wild rice plant residue from previous year's growth.

#1b. Areas that have supported wild rice in the past, as identified from evidence included in the desktop review.

Level 2 – Areas Likely to Support Wild Rice

#2a. Areas with either floating-leaved plants or emergent plants where water depth is less than 120 cm. Examples of floating-leaved or emergent plants whose presence approximates the conditions for wild rice growth are yellow or white waterlilies (*Nuphar variegata* and *Nymphaea odorata*), pondweeds (*Potamogeton* species), watershield (*Brasenia schreberi*), pickerelweed (*Pontederia cordata*), and arrowhead (*Sagittaria latifolia*). WRH does not include areas dominated by species that form dense monocultures that exclude wild rice, such as cattails

(*Typha* species), phragmites *(Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*).

#2b. Areas where water depth is between 30 and 120 cm.

Delineating Final WRH

If any Level 1 area is identified, then the entirety of the Level 1 areas (both 1a and 1b) represent the final WRH for that wild rice water. If no Level 1 area is identified, then any Level 2a areas are the WRH. If no Level 2a areas are identified, then the Level 2b areas are the WRH. The map of the final delineated WRH must be used to define at least 100 random candidate sample sites, as described below in Part B.

B. Selecting sediment core sample sites

All sediment sampling must occur within the delineated WRH. Using the map of the delineated WRH within the wild rice water, identify the randomly located 100 candidate sample sites as potential locations for sediment sampling. Each candidate sample site must be geo-referenced, specifying latitude and longitude to 5 decimal places.

The CSS sites may be identified by laying a grid over the WRH and randomly locating potential sites where the gridlines overlap, or through the use of geographic information system (GIS) software that randomly selects points within the WRH layer.

Once at least 100 points of the CSS are randomly established within the WRH, the CSS points must be tabulated and randomly numbered. Sort the sites by the random numbers and number them in order from 1 to 100.

The candidate sample sites must be selected in order as sites for the collection of sediment samples for analysis. At least the first 15 samples must be collected. Additional samples may be collected, moving sequentially through the random number list, to ensure that sufficient samples are available in case the analysis of some samples fail the QA/QC procedures specified in Sections 2 and 3 of this document. At least 15 pairs of acceptable total organic carbon (TOC) and total extractable iron (TEFe) concentrations must be available from laboratory analysis in order to calculate the numeric expression of the standard, as specified in part 4 of this document.

A map showing WRH and the sites selected for sampling must be submitted to the MPCA and placed on the website that houses information on the Class 4D wild rice waters.

C. Conducting Sediment Sampling

The selected sample locations may be visited in any order and at any time during the open water season. Sampling can take place the same year as the WRH was delineated, or at a later date. For instance, sediment can be collected early the following summer, before emergent wild rice becomes dense. Sampling before the wild rice population is dense has the potential advantage of allowing navigation across the wild rice water without damaging emergent plants.

A global positioning system (GPS) receiver must be used to locate the position of the site in the field, and accuracy of the receiver must be at least 3 meters. Sediment must be collected in a place with overlying water that is within 3 meters of the predetermined location.

At each of the selected sampling points, use the following methods to collect a sediment core sample:

1. Each sediment sample is the top 10 centimeters of a sediment core after the overlying water has been removed.
2. Place the sediment sample into a clean container that is clearly labeled with an identification number associated with the table of random numbers, water body, collection date, latitude, and longitude.
3. Store the samples on ice in the field and keep the samples at ≤ 6° C until delivered to an analytical lab for analysis.

D. Data Reporting

Document and report to the MPCA the following information about the sediment sampling:

1. Name and WID of the wild rice water
2. Name of person responsible for desktop review, and summary of findings.
3. Reconnaissance date and names of field crew.
4. Sediment sampling date(s) and names of field crew.
5. Description of coring device and diameter of coring tube.

6. The map or aerial photograph of the wild rice water, marked with the areas of wild rice habitat delineated in part A, steps 1 and 2, and the location of the final sample points determined in part B.
7. A table of the CSS that gives the latitude and longitude of at least the first 100 randomly selected sites and identifies the final sample sites;

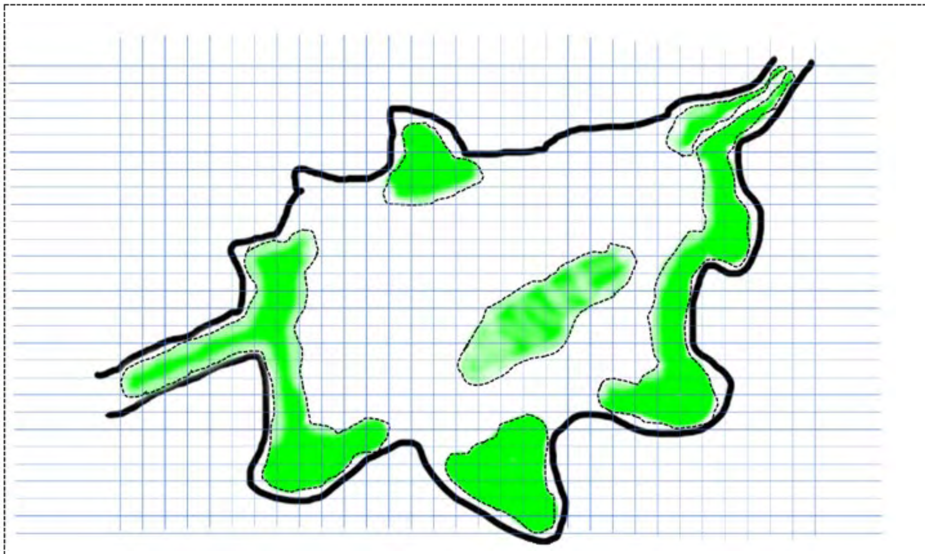


Figure 1. Example of grid overlay on a base map of a wild rice water with areas of wild rice habitat delineated. Potential sampling points are the grid intersections within areas of wild rice habitat. Alternatively, random sites within wild rice habitat can be randomly selected by GIS software.

Section 2. Analytical method for the determination of total extractable iron in sediment

This document describes the methods for the preparation and analysis of sediment samples for total extractable iron (TEFe) for analysis by Inductively Coupled Plasma-Atomic Emission Spectrometry Spectroscopy.

1. Prior to analysis, store the samples at ≤ 6° C to minimize biological activity. Samples must be analyzed within 180 days of collection date.
2. Dry and prepare the sample using either procedure 2a or 2b:

   2a.

   - Manually remove large materials such as rocks, shells, and sticks, and add a description of removed materials to the lab report.
   - Dry the sample in an oven at 50° C until constant weight is achieved.
   - Manually break the dried sample into pieces.
   - Pulverize the dry sample using a mill.

   2b.

   - Freeze-dry the sample.
   - Homogenize the sample using a stainless steel spatula.
   - Manually remove r~~emaining~~ large materials such as rocks, shells, and sticks, and add a description of removed materials to the lab report.

3. After the sample has been prepared, digest a small aliquot of the sample (0.25 +/- 0.02 grams) and all necessary QA/QC samples by adding 25 mL of 0.5 N hydrochloric acid to all digestion tubes. Digest samples (and all necessary QA/QC samples) on a hot block at 80-85° C or in a water bath at 80-85° C. Once samples reach 80° C, digest samples for 30 additional minutes. After 30 minutes, remove samples immediately and cool to room temperature, and bring to a constant volume. Immediately either centrifuge the tubes at 1000 rpm for 10 minutes or filter using a 0.45 µm PES-type filter. Remove an aliquot and dilute with reagent water to known volume for iron analysis. Determine iron in the diluted aliquot using Inductively Coupled Plasma-Atomic Emission Spectrometry. Report the results in mg/kg (dry weight).
4. Acceptable performance must be demonstrated on an ongoing basis. With every digestion batch, the laboratory must perform the following:

   - Low Background: At the beginning of each batch, analyze a blank (BLK) to determine reagent or laboratory contamination. The background level of the BLK must be below the report level before samples are analyzed.
   - Accuracy: With every batch of 20 samples processed as a group, analyze a Laboratory Control Sample (LCS). The LCS should be prepared at concentrations similar to those expected in the field samples and ideally at the same concentration used to prepare the matrix spike (MS). The acceptance criteria for recovery of the analyte in the LCS is 80 – 120%.

- Matrix spike. A MS must be prepared and analyzed with each batch of 20 samples processed as a group, or a minimum of 10% of the field samples analyzed, whichever is greater. The same solution used to fortify the LCS is used to fortify the MS. The acceptance criteria for recovery of the analyte in the MS is 80 – 120%.

- Precision: Analyze a Laboratory Duplicate (DUP) with each batch of field samples processed as a group, or 10% of the field samples analyzed, whichever is greater. The acceptance criteria for the relative percent difference (RPD) is ≤ 20%.

  RPD is a measure of precision, calculated as: RPD = (X1 – X2)/Xave x 100, where X1 and X2 are the concentrations of duplicates. Xave is the average of the two concentrations, calculated as: Xave = (X1 + X2)/2.

Section 3.Analytical method for the determination of total organic carbon in sediment

This document describes the methods for the preparation and analysis of sediment samples for the analysis of Total Organic Carbon (TOC) by Non-Dispersive Infrared Detection.

1. Prior to analysis, store the samples at ≤ 6° C to minimize biological activity. Samples must be analyzed within 28 days of collection date.

2. Dry and prepare the sample using either procedure 2a or 2b:

   2a.

   - Manually remove large materials such as rocks, shells, and sticks, and add a description of removed materials to the lab report.
   - Dry the sediment sample in an oven at 50° C until constant weight is achieved.
   - Manually break the dried sample into pieces.
   - Pulverize the remaining dry sediment using a mill.

   2b.

   - Freeze-dry the sample.
   - Homogenize the material using a stainless steel spatula,
   - Remove remaining large materials such as rocks, shells and sticks, and add a description of removed materials to the lab report .

3. After the sample has been prepared:

- Treat an aliquot of the homogenized sample with a 5% solution of H_3PO_4 to remove any inorganic carbon.
- Either air-dry or oven-dry (at 105°C) the sample until constant weight is achieved.
- Analyze the sample (and all necessary QA/QC samples) for Total Organic Carbon content using a Standard Operating Procedure based on EPA Method 9060A.
- Analyze all environmental samples in duplicate.
- Report the results in mg C/kg dry sediment, and as percent C in dry sediment.

4. Acceptable performance must be determined for every digestion batch by performing the following activities:

   - Low Background: At the beginning of each batch, analyze a blank (BLK) to determine reagent or laboratory contamination. The background level of the BLK must be below the report level before analyzing samples.
   - Accuracy: With every batch of 20 samples processed, analyze a Laboratory Control Sample (LCS). The LCS must prepared at the same concentrations as the field samples and at the same concentration used to prepare the matrix spike (MS). The acceptance criteria for recovery of the analyte in the LCS is 70 – 130%.

- Matrix spike: Prepare and analyze a MS with every 20 samples processed as a group, or a minimum of 10% of the field samples analyzed, whichever is greater. The same solution used to fortify the LCS is used to fortify the MS. The acceptance criteria for recovery of the analyte in the MS is 70 – 130%.
- Precision: Analyze a Laboratory Duplicate or a MS duplicate with every 20 samples processed as a group, or 10% of the field samples analyzed, whichever is greater. The acceptance criteria for the relative percent difference (RPD) is ≤ 30%.

  Analyze every environmental sample in duplicate. The RPD between duplicates must be ≤ 30%.

  RPD is a measure of precision, calculated as: RPD = (X1 – X2)/Xave x 100, where X1 and X2 are the concentrations of duplicates. Xave is the average of the two concentrations, calculated as: Xave = (X1 + X2)/2.

Section 4. Calculating the numeric sulfate standard using the equation.

A protective sulfate concentration (mg/L) is computed based on each sediment sample using the following equation:

$$MBLR120\,Sulfate = 0.0000854 \times \frac{TEFe^{1.637}}{TOC^{1.041}}$$

If any sample has an organic carbon concentration that is lower than 0.20 percent carbon, then the concentration of 0.20 percent carbon must be substituted for the lower concentration. If any sample has an iron concentration greater than 83,421 micrograms/gram, then the concentration of 83,421 micrograms/gram must be substituted for the higher concentration.

The numeric expression of the sulfate standard is the 20th percentile of all calculated sulfate concentrations resulting from the application of the equation to each pair of organic carbon and iron concentrations (including any substituted concentrations).

There are several different ways to calculate percentiles; for this purpose, 20th percentile can be calculated through the use of the Microsoft Excel function PERCENTILE.INC, or through the following procedure:

1. Sort all calculated sulfate concentrations, ranked from low to high (e.g., 1st, 2nd, 3rd, 4th, etc.).
2. Calculate values for x and y in the following expression: x.y=0.2(N-1)+1 (N is the total number of calculated sulfate concentrations; if there are 15 samples, x.y = 3.8).
3. Calculate the 20th percentile as xth sulfate concentration plus [0.y times (value of xth+1 sulfate concentration minus the value of xth sulfate concentration)]. For instance, if there were 15 samples, the 20th percentile sulfate concentration would be:

   [value of 3rd + 0.8(value of 4th – value of 3rd)].

At least 15 pairs of TOC and TEFe concentrations must be used to calculate the numeric expression of the sulfate standard. All acceptable (based on Sections 2 and 3) concentrations of TOC and TEFe must be used to calculate the numeric expression of the sulfate standard, even if those concentrations were gathered from different sampling events.

If the numeric sulfate concentration is above 335 mg/L sulfate, then the numeric expression of the sulfate standard for the wild rice water from which the sediment samples were taken is 335 mg/L. If the numeric sulfate concentration is below 0.5 mg/L sulfate, then the numeric expression of the sulfate standard for the wild rice water from which the sediment samples were taken is 0.5 mg/L.

Attachment 6: Technical Discussion of Proposed Equation Related Changes to the Rule.

Revision to the Equation

The MPCA is proposing to revise proposed Minn. R. 7050.0224, Subp. 5, B (1). The proposed revision is to change the equation that serves as the standard to protect wild rice from adverse impacts of sulfate.

Upwelling Groundwater – Second Creek

During the comment and hearing process, the MPCA heard several comments that sulfate in surface water may not be controlling sulfate availability to the bacteria in the sediment that convert sulfate to sulfide. In particular, it was suggested that sulfide in sediment porewater where wild rice grows may be controlled by the sulfate content of upwelling groundwater rather than the sulfate content of the surface water.

Pollman et al., 2017[1] (Response Exhibit N.4) showed that there is a significant and quantifiable impact of sulfate in surface water on porewater sulfide in Minnesota waterbodies. Since discharged sulfate would increase sulfate concentrations in surface water, it is therefore reasonable to conclude that discharged sulfate has the potential to affect wild rice via increased porewater sulfide. However, the Technical Support Document[2] ("TSD") did consider the potential effects of upwelling groundwater in some detail. It noted that waterbodies with upwelling groundwater could be favorable sites for wild rice growth, and that such sites would not conform to the conceptual model underlying the proposed equation (TSD, pp. 23-24). Groundwater upwelling is discussed in the TSD as a likely reason for some of the observed false positives in the MPCA data set (false positives are waterbodies for which the equation predicts that sulfide should exceed 120 micrograms per liter, but the sulfide is less than 120).

On further review of the concerns about the equation, the MPCA determined that it would be appropriate to reconsider the standard without the inclusion of data from Second Creek – the single site where groundwater upwelling is fully documented. The MPCA does not believe this is a substantial change because there is no change to the fundamental relationships that define the equation-based standard, and the proposed change is a logical outgrowth of the comments received during the public comment period.

MPCA developed the equation in the 2017 proposal using data from all 108 different waterbodies that had been sampled during the MPCA-sponsored 2011-2013 field survey. The use of all of the waterbodies assumed that most of the sites conformed to the conceptual model that porewater sulfide is derived from sulfate that moves downward into the sediment from the overlying surface water. MPCA staff were aware that it was possible that at some study sites groundwater may have been moving upward into the overlying water, which would have not been consistent with the assumption that surface water was the source of sulfate. The equation would not be materially affected if sulfate concentrations were similar between groundwater and surface water, but the equation would potentially be made inaccurate if the concentrations were significantly different. All sites were used because it was not possible to collect or find data that would reveal groundwater flow at each site.

The MPCA identified four waterbodies, out of the 108 waterbodies sampled, that were potentially affected by upwelling groundwater low in sulfate compared to surface water sulfate concentrations

[1] See MPCA Post-Hearing Response to Public Comments, November 22, 2017, Exhibit N.4

[2] See SONAR, Exhibit S-1

(TSD, Table 2-1, p. 72). The only evidence of this possibility was that the four waterbodies did not conform to the equation; based on the equation, porewater sulfide was expected to be above 120 µg/L, but observed concentrations were below 120 µg/L (i.e., these sites had a preponderance of false positive predictions). The lack of conformance could be the result of (a) upward groundwater movement, as suggested, (b) random deviation, or (c) inhibition of sulfide production caused by variables not quantified by the MPCA model.

If it had been known that upward groundwater movement was responsible for the observed level of sulfide being lower than predicted than the equation (false positives), the MPCA would have had a defensible rationale for excluding such sites from the development of the equation. This would have enhanced the accuracy of the predictions. However, given the lack of specific knowledge as to the mechanism producing the false positive predictions, MPCA did not exclude any of these four sites from the development of the equation. If MPCA had excluded any of the false positive sites without any knowledge of the specific mechanism, MPCA would justifiably have been vulnerable to criticism for increasing the accuracy of the equation by arbitrarily excluding sites that happened to not conform to the hypothesis.

The state of knowledge of waterbodies included in the MPCA equation changed upon the publication of a detailed study of Second Creek, which was one of the four sites identified by the MPCA as possibly affected by upwelling groundwater because sulfide levels were much lower than predicted,. The four waterbodies were:

Waterbody	**Identifier**	**Observed Sulfate (mg/L)**
Second Creek	S007-220	838
Ox Hide Creek	31-0106-00-203	25.9
Turtle River (North Dakota)	S007-662	198
Big Swan Lake	77-0023-00-207	5.5

On August 21, 2017, the day that the Notice of Hearing for the wild rice sulfate rule was published in the State Register, a journal posted online a peer-reviewed paper by Dr. Crystal Ng and her team containing their findings on a 2015 study of the relationship between groundwater and surface water in the area where wild rice grows in Second Creek (Ng et al. 2017[3]). Dr. Ng is a professor in the Earth Sciences Department at the University of Minnesota-Twin Cities. Dr. Ng studied Second Creek at the suggestion of MPCA staff, given that MPCA staff were aware of the site's lack of conformance to the conceptual model for sulfide development. Dr. Ng obtained financial support for the study from the University's Water Resources Center. The MPCA arranged for the installation of local groundwater monitoring wells that Dr. Ng needed for the study, but the MPCA was otherwise not involved in the study or preparation of the published paper.

Ng et al. (2017) concluded that under usual conditions groundwater upwells in Second Creek in the area that wild rice grows, and that the groundwater has much lower sulfate concentrations than the surface water. The upwelling, combined with the mismatch between groundwater and surface water sulfate

[3] See Hearing Exhibit L.2, Ng et al., 2017

concentrations, is evidence that it is inappropriate to include Second Creek in the dataset used to develop the equation. The site does not match the conceptual model that the equation is designed to capture.

The Second Creek data point therefore had inappropriate influence on the coefficients of the equation. This influence was likely particularly strong, considering that Second Creek had the highest sulfate concentration observed, at 838 mg/L.

After removing Second Creek from the dataset, MPCA staff updated the equation and observed the effect on the resulting numeric expression of the sulfate standard. The MPCA retained the other three waterbodies in the dataset due to a continued lack of information about why these sites have lower porewater sulfide than expected.

The original equation, developed using multiple binary logistic regression (MBLR) for the prediction of a porewater sulfide concentration of 120 µg/L, was:

$$MBLR120\ Sulfate\ =\ 0.0000121\ \times\ \frac{TEFe^{1.956}}{TOC^{1.197}}$$

The revised equation, using the same methodology but excluding Second Creek, is:

$$MBLR120\ Sulfate\ =\ 0.0000854\ \times\ \frac{TEFe^{1.637}}{TOC^{1.041}}$$

The revised equation produces numeric expressions of the standard (sulfate values) that are highly correlated with those from the original equation (R^2=0.99 [4]). However, the revised equation reduces the spread of the sulfate concentrations, resulting in sulfate concentrations that are higher at very low concentrations and progressively lower the higher they were.

The difference at the very low concentrations is minor in absolute terms; for instance, the lowest concentration increased from 0.4 mg/L under the original equation to 0.5 mg/L under the revised equation. On the other hand, sulfate values above 4.0 mg/L decreased progressively more the higher they were; the maximum decreased from 1,821 mg/L to 790 mg/L, a 57% decrease. This significant decrease of high values is understandable, given that the Second Creek data (the highest sulfate value in the whole data set, 838 mg/L, coupled with a low porewater sulfide concentration of 45 µg/L) exerted strong influence on the equation when it was included in the dataset. The effect of that single data point was to cause the equation to underestimate the effect of elevated sulfate. The sulfate concentration in Second Creek (838 mg/L) was more than twice as high as the next-highest concentration in the 108-waterbody dataset (335 mg/L, observed in Lady Slipper Lake in southwestern Minnesota, a region naturally high in sulfate). Lady Slipper Lake had a very high porewater sulfide concentration of 1,680 µg/L, which is consistent with the MPCA conceptual model, given that its sulfate concentration is over ten times greater than the calculated numeric expression of the standard, which is a sulfate value of 30 mg/L.

The MPCA finds that this change to the standard follows the science and data analysis that was used to develop the proposed standard, and is therefore reasonable. It is also a direct outgrowth of comments raising concerns about upwelling groundwater.

[4] A correlation coefficient or R^2 value of 0.99 indicates that the original and revised equations agree with each other as to which predictions should be relatively low and which relatively high, but not necessarily of the same magnitude. An R^2 value of 1 indicates perfect correlation.

Bounding the Equation

The MPCA noted in its rebuttal response that it agreed with commenter concerns about the fact that the equation is of unknown validity outside of the range of data used to develop it. As noted in the rebuttal response,

> "The MPCA believes it is appropriate to respond to this concern by setting constraints on the implementation of the equation that would ensure that the equation is protective. The MPCA is proposing that input values of carbon cannot be lower than the minimum value in the range of data used to develop the equation, because carbon enhances sulfide production. The MPCA is proposing that input values of iron cannot be higher than the maximum value in the range of data used to develop the equation because iron removes sulfide from porewater.
>
> The MPCA is proposing that output values of sulfate cannot be higher than the maximum value in the range of data used to develop the equation, 838 mg/L."[5]

The MPCA continues to believe that such bounding on the sulfate output is reasonable, and the ALJ agreed in finding 298 of her report. The proposed change to the equation based on the removal of the data from Second Creek results in a different upper bound to the sulfate values calculated as the numeric expression of the standard. Although a sulfate value of 790 mg/L was *calculated* for a waterbody in the dataset, the MPCA is proposing to bound the calculated sulfate concentrations at the highest *observed* sulfate concentration in the dataset that produces the equation. When the 838 mg/L value from Second Creek is not used to develop the equation, the upper sulfate bound would be 335 mg/L, which was observed in Lady Slipper Lake. The MPCA proposes to utilize the Lady Slipper Lake data point as the highest sulfate concentration used in the development of the equation because its relationship between sulfate and sulfide conform to the expectations of the conceptual model.

The MPCA is proposing to add rule language that notes that the numeric expression of the standard/calculated sulfate standard may not be below 0.5 mg/L and may not be above 335 mg/L sulfate. In Finding 298, the ALJ indicated that doing so was needed and reasonable.

The MPCA is also proposing to bound the iron and carbon inputs to the equation. In Finding 299, the ALJ notes that unspecified bounds on carbon or iron are not reasonable; the MPCA always intended to specify these numeric values but was not able to do so in the time constraints of the rebuttal period. The finding implies that specific numeric values would be acceptable.

In order to be protective of wild rice, the MPCA is proposing to set a minimum value for carbon and a maximum value for iron as inputs to the equation. The MPCA is only proposing to bound the inputs on the sides that would result in a higher calculated sulfate value as the numeric expression of the standard. The MPCA is proposing that calculations of the numeric expression of the standard should use any iron concentrations that are lower than the minimum in the field data set (895 µg/g), and any TOC concentrations that are greater than the maximum value in the field data set (33.3%). Doing so will calculate lower sulfate standards than the use of the minimum and maximum (respectively), but doing so will ensure protection of unusual waterbodies that don't fit in the broad ranges found in the MPCA field survey.

The removal of the Second Creek data does not change the minimum carbon or maximum iron input values for the equation. Those values are 0.20 percent carbon (TOC) and 83,431 micrograms/gram iron (TEFe). If any composite sample has an organic carbon value that is lower than 0.20 percent carbon,

[5] MPCA Rebuttal Response to Public Comments, December 1, 2017, pp 3-4

then the value of 0.20 percent carbon would be substituted for the lower value in performing the calculation. If any composite sample has an iron value greater than 83,421 micrograms/gram, then the value of 83,421 micrograms/gram would be substituted in doing the calculation.

The MPCA is proposing to implement these bounds through the addition of language in the incorporated by reference document "Sampling and Analytical Methods for Wild Rice Waters". The MPCA is proposing to remove subitems (a) – (d) from proposed Minn. R. 7050.0224, subp. 5, B (1) and to place these requirements in the methods document. This will result in a new section of the Sampling and Analytical Methods for Wild Rice Waters that covers how to calculate the numeric expression of the sulfate standard using the equation. That section will include the information about the inputs and how they are expressed, and include language about how to bound the input values. The methods document will also include the upper sulfate bound, but the MPCA felt it was also appropriate to put the maximum calculated sulfate value directly in the rule for clarity.

Sediment Sampling Methods

The MPCA is also proposing changes to the way that sediment sampling is conducted to derive the numeric expression of the standard based on the sediment's iron and carbon content. The MPCA does not believe that this is a substantial change because the rule continues to require sediment sampling and analysis to determine iron and carbon levels. The changes are responsive to concerns raised during the public comment period about how wild rice habitat will be located within wild rice waters, the need for more specificity in selecting wild rice beds for sampling, and concerns about how the MPCA might deal with additional sampling and the resulting data.

As originally proposed, sediment sampling would be conducted in five identified representative areas of wild rice habitat, with five samples collected on a transect across each area. One composite sample would be produced from each transect by mixing the sediment from the five equally spaced sampling locations. Then a potential sulfate concentration would be calculated from each of the five composite sediment samples. MPCA proposed that the lowest sulfate concentration of the five would be adopted as the numeric expression of the sulfate standard for that wild rice water.

Concerns about this proposal included:

- The difficulty and potential subjectivity of identifying five areas of wild rice habitat and ensuring they are representative of the wild rice water (especially if there are more than five areas where wild rice is growing).
- How to orient the transect within the area (e.g. orthogonal to the shore, or parallel to the shore).
- How to identify the numeric expression of the sulfate standard if MPCA or other entities sampled more than five transects.

The MPCA re-examined the original proposal, keeping in mind the following goals:

- To produce a reproducible calculated numeric expression of the sulfate standard that is protective of wild rice.
- To reduce or remove the subjectivity in selecting sampling sites.
- To ensure that the samples (and resulting numeric expression of the standard) accurately represent all the sediment within the wild rice habitat of the wild rice water
- To accommodate the analysis of additional samples.

- To be practical, in terms of the time spent obtaining the sediment samples and the money spent analyzing the samples.

Based on these goals, the MPCA is proposing to move to a stratified random sampling methodology, in which the areas of wild rice habitat within each WID designated as a Class 4D wild rice water are delineated and then randomly sampled.

The U.S. Environmental Protection Agency (EPA) has published guidance on how to choose a sampling design for environmental data collection.[6] The guidance differentiates between probability-based designs, where sample sites are randomly chosen, and judgmental sampling designs, where subjective expert judgment is employed to choose sample sites. Judgmental sampling can be easier to implement than a probability-based design. Although often requiring more work and more steps, a great advantage of probability-based designs is that they allow statistical inferences to be made about the system being sampled. In other words, random design ensures that you can draw conclusions about the whole system or whole population based on the sample population. Because the goal is to objectively characterize the range of calculated protective sulfate concentrations, a probability-based approach better meets the MPCA's goals than to a judgmental approach.

The first step in the process now described in the sampling and analytical methods incorporated by reference is to delineate the areas of wild rice habitat within the wild rice water. Potential wild rice habitat is defined at two key levels: 1) areas where there is observed evidence of present or past support of wild rice growth; 2) areas that are likely to support wild rice. These levels are further subdivided as follows:

Level 1 – Areas that Support or Have Supported Wild Rice

#1a. Areas where wild rice is observed growing or where there is evidence of recent growth, such as rooted wild rice plants that have been grazed, or wild rice plant residue from previous year's growth.

#1b. Areas that have supported wild rice in the past, as identified from evidence included in the desktop review.

Level 2 – Areas Likely to Support Wild Rice

#2a. Areas with either floating-leaved plants or emergent plants where water depth is less than 120 cm. Examples of floating-leaved or emergent plants whose presence approximates the conditions for wild rice growth are yellow or white waterlilies (*Nuphar variegata* and *Nymphaea odorata*), pondweeds (*Potamogeton* species), watershield (*Brasenia schreberi*), pickerelweed (*Pontederia cordata*), and arrowhead (*Sagittaria latifolia*). WRH does not include areas dominated by species that form dense monocultures that exclude wild rice, such as cattails (*Typha* species), phragmites *(Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*).

#2b. Areas where water depth is between 30 and 120 cm.

[6] See Guidance on Choosing a Sampling Design for Environmental Data Collection. 2002. (https://www.epa.gov/sites/production/files/2015-06/documents/g5s-final.pdf)

Those doing sampling will start with a desktop review of available data that will help determine the location of potential wild rice habitat within the wild rice water. Desktop review could include information such as aerial photos, past plant surveys, historical records, satellite bathymetry, and similar.

The next step will be on-site field surveys to delineate the areas of wild rice habitat. This field survey needs to occur at a time when wild rice can be easily identified. Field crews would travel the wild rice water and document areas of potential wild rice habitat in the three categories described above. That would produce a map of potential wild rice habitat.

If there are Level 1 areas – those where wild rice has been observed in the past (based on the desktop review) or is observed during the field reconnaissance, those areas become the final delineated wild rice habitat. If areas of specific wild rice growth cannot be identified, the delineated habitat is defined moving down the hierarchy – first to areas where similar aquatic plants grow and then to water of appropriate depth.

Once documented, the wild rice habitat would not change, and the MPCA envisions that we would make maps of the wild rice habitat within each wild rice water available on the website. All sediment sampling, whether by the MPCA or others, must be done within the delineated area of wild rice habitat.

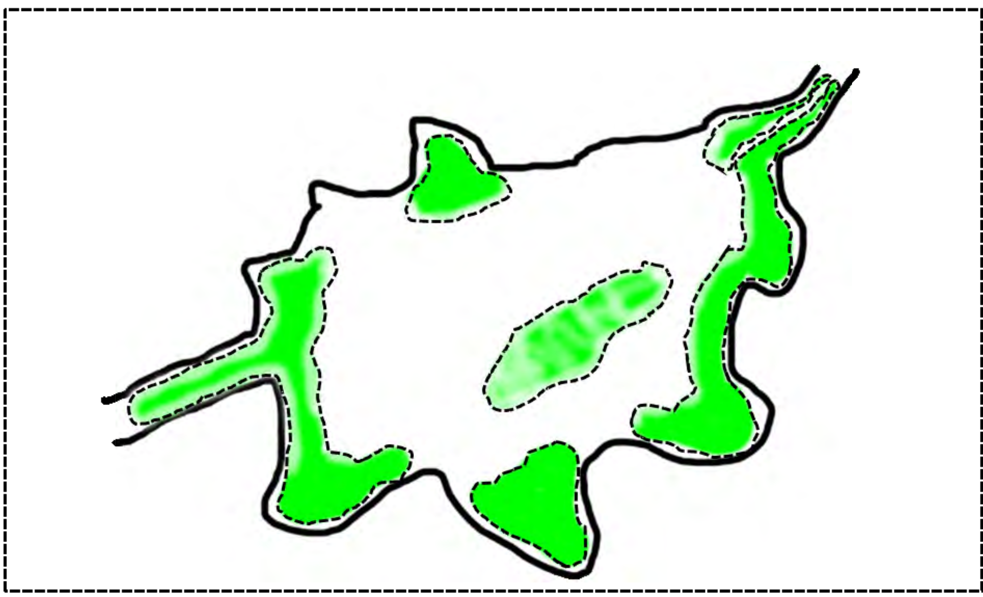


Figure 1. Example of wild rice habitat (green areas) identified in a wild rice water.

Next, 100 random locations would be identified within the wild rice habitat – either using a grid based system or a GIS tool that generates random locations within the wild rice habitat. The first 15 randomly selected sites would be selected for sampling and analysis to develop the numeric expression of the sulfate standard based on the equation. One sediment core would be taken at each site. (More than 15 samples could be taken if desired, in case of errors during analysis.) That sediment core could then be taken at any time, such as the following spring or early summer before wild rice is dense. Sediment cores would not need to all be taken on the same day, but should be completed in a single summer.

The MPCA originally proposed using composite samples largely in order to reduce the analytical costs. As noted in the SONAR, composite samples provide a way to integrate the conditions in the sediment where wild rice grows. Because of this property, the use of composite samples makes more sense with a sampling design that involves transects or similar closely spaced samples – when the samples are intended to approximate a similar area. Composite samples also tend to even out the differences between extreme values, which is appropriate when characterizing a relatively homogenous area. With a random sampling design, sediment samples may be taken from very diverse locations and it is important to preserve the differences among the locations.

Therefore, the MPCA finds it appropriate to move to analysis of individual samples rather than composite samples, because analyzing individual samples offers more clarity, accuracy, and precision regarding the level of protection being calculated.

Although this revision to the procedure specifies an initial field survey that was not in the proposed version, MPCA's monitoring staff have indicated that an initial field reconnaissance would already have been necessary. Therefore, the changes do not increase field costs. Splitting the field work into a habitat survey and sampling will enable crews to focus more specifically on each task. Analyzing 15 cores will increase analytical costs compared to analyzing five composites, but reduces field time compared to collecting 25 cores.

Analysis to Develop the Numeric Expression of the Standard

The MPCA is also proposing to move from using the lowest sulfate value to a percentile approach to determining the numeric expression of the standard. The MPCA is proposing to use the 20th percentile value. The MPCA believes this is a logical outgrowth of the comments, as several commenters suggested different approaches rather than the lowest sulfate value.

The MPCA is now proposing to use a percentile approach. The percentile approach works well with the random sampling design and analysis of individual sediment cores – each individual core may be more different from another core, but the percentile approach evens out the variability. In addition, as more data is collected the calculation will converge on the "true" values that exist in the sediment.

The choice of the percentile is interrelated with the number of samples that are needed to characterize the sediment. The MPCA examined the relationship between percentile and number of samples analyzed by mimicking the random sampling of a wild rice water and calculating numeric expressions of the sulfate standards from various percentiles (10th, 20th, and 30th) based on various numbers of samples analyzed for iron and TOC (5, 10, 15, 20, or 25 samples). This was done through analysis of the pilot sediment sampling project described in the TSD, in which six different wild rice waters were each sampled for 25 sediment cores and each core was analyzed for iron and TOC. A larger, synthetic, data set of 100 samples was created using the data from each of the six wild rice waters. A synthetic data set of 100 protective sulfate concentrations was created for each wild rice water with the same mean and standard deviation (original data sets were transformed when necessary to achieve a normal distribution prior to calculating mean and standard deviation). Then the synthetic data sets were randomly sampled 10,000 times to create average standard deviations and associated normalized measures of variation (coefficient of variation, CV). The CV values were then averaged in order to characterize the effect of given percentiles and number of samples analyzed.

These calculations were done so that the consequences of choosing particular percentiles and number of samples to analyze would be clear. Use of a percentile to identify a numeric sulfate standard would allow additional data to be collected without affecting the theoretical standard being identified. But, the certainty around that percentile calculation is affected by both the percentile level being used, and the number of samples being analyzed.

The MPCA is proposing to use the 20th percentile value. The 10th percentile estimates of sulfate concentrations have significantly more variation (i.e., less certainty) than either the 20th or 30th percentile estimates (Figure 2). Once the number of samples exceeds 5, the benefit of using the 20th percentile, compared to the 10th percentile, is roughly twice the benefit of using the 30th percentile rather than the 20th percentile. In other words, there are diminishing benefits to the use of percentiles greater than 20th.

The benefit (reduction in CV) of increasing the number of samples analyzed is greatest when increasing from 5 to 10 samples. There are diminishing benefits when more than 15 samples are analyzed.

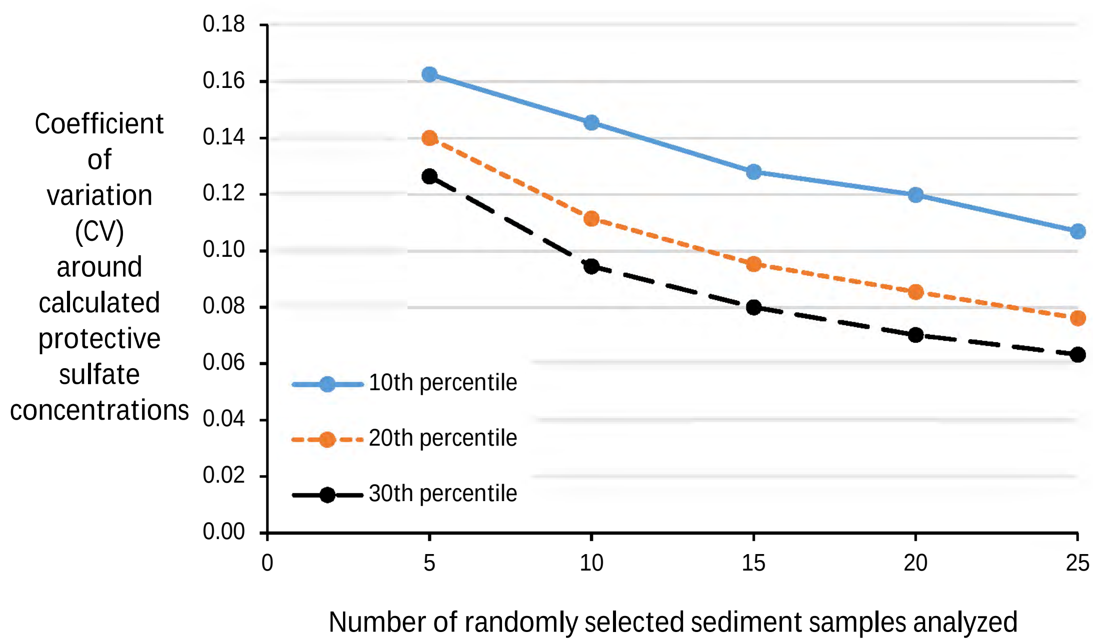


Figure 2. Relationship between percentile and number of sediment samples analyzed.

The previously proposed lowest sulfate value is more susceptible to variability. As noted above, the use of composite samples would even out some variability – somewhat compensating for the increase in variability from using the lowest value. In the SONAR, pg 89, the MPCA discussed the relationship between using the lower calculated sulfate value from composite samples and a percentile value derived from analysis of individual cores. At the six waterbodies where pilot sediment sampling was conducted, the lowest calculated value was always between the 10^{th} and 30^{th} percentile.

Therefore, the MPCA concludes that it is reasonable to identify a numeric sulfate standard for a wild rice water as the 20^{th} percentile sulfate concentration after sampling and analyzing at least 15 sediment samples. The outcome of this calculation will be similar to the outcome produced by the originally proposed rule, but the sampling design is more clear and the outcome will be much more consistent.

The analysis indicates that the analysis of additional sediment samples is unlikely to substantially change a numeric expression of the sulfate standard calculated as the 20^{th} percentile of 15 samples. The 20^{th} percentile has a 95% confidence interval of ± 5%; so one would expect the “true value” of the numeric expression of the sulfate standard to be ± 5% of the calculated value.

All data collected in a wild rice water would be used to set the numeric expression of the standard for that wild rice water. If MPCA has already collected and analyzed 15 (or more) values, then the next 15 (or more) values would be added to the calculation. Moving to a percentile approach will provide greater stability in the numeric expression of the standard – as more data is collected, the numeric expression will converge on the “true” value. This will reduce the likelihood of major changes in the calculated numeric expression of the standard.

Appendix B

Hay Lake Hydrologic and Wild Rice Studies

Field Report

Hay Lake/Hay Creek Wild Rice and Stream Conditions Survey

Date: 15 September 2009

Staff: Michael Crotteau, DNR-Water/L&M, Grand Rapids

Purpose: To verify the occurrence, density and health of wild rice in Hay Creek and determine geomorphic or other controls (i.e. beaver dams) that affect water level in Hay Lake.

Location: Hay Lake (31-37W) (UTMX 492455, UTMY 5236990) and outlet of Hay Lake and Hay Creek downstream to Swan Lake.

Description: Traveled from the east-southeast side of Hay Lake to the outlet of the lake where Hay Creek exits. Observations were made from an inflatable kayak for approximately 1.4 miles downstream of Hay Lake.

Hay Lake – Water level was high. Water level elevation equipment was not available; therefore, no elevation was recorded. A loon and bald eagle were present as well as a 14-foot boat on the south side of the lake. A beaver lodge was present on the south side of the lake. Approximately 3 acres of wild rice was present in medium to abundant density. However, the crop was severely damaged (rotten) and appeared to be un-harvestable (see photos 1-12). This is more than likely due primarily to an increase in water level in the lake due to beaver activity (see below). The outside edge of the wild rice (lake-side) was 4 - 5 feet in depth.

Hay Creek – Water level was very high, though no elevation was captured. Wild rice was abundant at the outlet of the lake (mid-channel) with cattails bounding the shore margins (see photo 13). The crop, like the lake, was very un-healthy and had virtually no seeds. From the outlet to approximately 0.6 miles downstream, wild rice was present, but sparse and unhealthy (see photo 14). At 0.6 miles downstream of the outlet, an area of moderate wild rice density was encountered that was approximately 200 feet in channel length (see photo 16). Wild rice abundance dropped off to sparse after this section.

A beaver dam (BD 1) was encountered 0.66 miles downstream from the lake outlet; however, the dam was nearly at grade and created virtually no head drop from upstream to downstream (see photo 17). Approximately 0.84 miles downstream from the lake outlet, another beaver dam (BD 2) was encountered (see photo 20). This beaver dam was the controlling factor of stream and lake levels in Hay upstream and created a two to three foot head drop from upstream to downstream (see photo 21). Two meanders downstream (0.1 from BD2, 0.94 miles from lake), another beaver dam (BD 3) was encountered creating another one foot head drop in the stream (see photos 22). The last full stream width beaver dam (BD 4) was 1.08 miles downstream of the lake outlet and created an approximate 1.5 foot head drop in the creek water level (see photos 23 and 24). Between BD 2 and BD 4, the total head drop between these dams was between 4.5 to 5.5 feet over that 0.24 mile stretch of creek.

Wild rice was sparsely present between BD 1 and the beaver lodge (see lodge photo 19), just upstream (250 feet) of BD2. This distance from the lake to the beaver lodge above BD2 is approximately 0.83 miles. Below BD2, wild rice was not present in any visible amount in Hay Creek to the point where I exited at mile 1.4 below Hay Lake. Spot checks at various point from mile 1.4 to County Road 12 (nearly at Swan Lake) revealed no wild rice present. However, wild rice could be present directly below the confluence with Moose Lake outlet, which was another 0.58 miles downstream from where I exited. I was able to conduct a spot check 0.15 miles below the Moose Lake outlet confluence and no wild rice was present (see photo 28). Due to time constraints and access, I did not survey this stretch of creek directly below Moose.

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Hay Lake from east access looking across to Hay Creek outlet

Wild rice near Hay Lake outlet

Hay Lake looking northwest at inlet of upper Hay Creek

Hay Lake from east access

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Wild rice and lily pads approaching Hay Creek outlet

Unhealthy wild rice stalk

Hay Lake wild rice

Hay Lake wild rice looking northwest to Hay Creek inlet

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Hay Lake wild rice - very unhealthy/rotten

Hay Lake wild rice

Hay Lake wild rice - very unhealthy/rotten

Wild rice and cattails approaching Hay Creek outlet

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Hay Creek looking downstream from outlet

Moderate wild rice density in Hay Creek 0.6 miles downstream from outlet

Outlet of Hay Creek looking downstream

Typical Hay Creek before first flow-restricting beaver dam (BD2) - sparse WR

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Sparse wild rice immediately below BD1

Beaver dam (BD2) (0.84 miles downstream fr outlet) creating 2-3' head drop

Beaver dam (BD1) which was flooded out due to BD2 downstream

Beaver lodge and sparse wild rice upstream of BD2 (0.83 miles fr outlet)

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Beaver dam (BD3) 0.94 miles downstream of Hay Lake (1 foot head drop)

Beaver dam (BD4) 1.08 miles downstream of Hay Lake (~1.5' head drop)

Close-up of BD2 and head drop (2-3')

Approaching another beaver dam (BD4); notice lodge in background (it has been around a while with little roof work - nice landscaping)

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Older beaver dam with flow through at river left (1.3 miles fr outlet)

Hay Creek 0.15 miles below confluence with Moose Lake outlet

Hay Creek at BD4 looking downstream

Log jams at 1.4 miles downstream of Hay Lake outlet

HAY LAKE - HAY CREEK WILD RICE SURVEY, 15 SEPT 2009

Hay Creek 0.69 miles upstream of Co Rd 12, looking upstream

Hay Creek 0.69 miles upstream of Co Rd 12, looking downstream

Hay Creek 0.37 miles below confluence with Moose Lake outlet

2009 Water Quality, Hydrology, and Wild Rice Monitoring

Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Hart Creek

Prepared for
U. S. Steel Corporation

September 14, 2009

2009 Water Quality, Hydrology, and Wild Rice Monitoring

Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Hart Creek

Prepared for
U. S. Steel Corporation

September 14, 2009

BARR

4700 West 77th Street
Minneapolis, MN 55435-4803
Phone: (952) 832-2600
Fax: (952) 832-2601

2009 Water Quality, Hydrology, and Wild Rice Monitoring
September 14, 2009

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Background

The purpose of this report is to provide information in response to the data request sent to U.S. Steel by the MPCA requesting additional information as part of a NPDES permit application for a discharge of mine pit dewatering from the Perry Pit at the Keetac facility. In addition, the information in this report will be used by the DNR in preparation of the Environmental Impact Statement (EIS) for the Keetac Expansion project.

The MPCA requested the following information:

1.0 A literature review to determine the potential location of wild rice in the downstream receiving waters,

2.0 A cooperative information gathering/exchange process with Bands of Chippewa potentially affected by the project and the 1854 Authority,

3.0 A field survey of wild rice, and

4.0 Information on current sulfate concentrations in the bodies of water where wild rice was located.

The information for items 1, 3 and 4 is provided in the following sections. A summary of item 2 is provided in the remainder of this section.

As part of the cooperative information exchange with the Bands of the Chippewa (Bands), U. S. Steel held a meeting at the Keetac facility on September 8, 2009. Invitations were sent to representatives of all of the Bands, and representatives from Bois Forte, 1854 Treaty Authority, and Leech Lake attended the meeting. As part of the meeting, a boat tour was taken to observe the wild rice in the southwest bay of Swan Lake and a presentation was made summarizing the sulfate and wild rice data collected to date. This same information is summarized in this report.

One purpose of the meeting was to determine if the Bands had any additional information regarding the cultural and historical use of the wild rice or sulfate or water level information for the water bodies included in the study. The MPCA data request asked that U. S. Steel try to ascertain historic uses for wild rice beds potentially affected by Keetac's discharge. A Bois Forte representative helped the group understand the difficulty of determining historic use of wild rice beds because tribal groups, or groups of families, may have moved as many as six times in a year to various villages to harvest various natural resources as they came into season, including but not limited to wild rice, maple sugar, fish, game, etc. There is historic evidence that tribes started harvesting in the southern part of the state, where seasons begin earlier, and moved northward. Identifying relatively recent history would require interviewing tribal elders on reservations, in Duluth, and in the Twin Cities about their recollections of harvesting with their parents and grandparents. This would be a time-intensive undertaking. An existing Trygg map indicates one village in the area on Swan River at the outlet of Swan Lake. However, it is possible that there could have been more villages, because such maps tend to under-represent the villages that were present according to the Bois Forte representative. In addition, recent DNR wild rice harvest reports indicate that wild rice is harvested from Swan Lake. Given this information, it is likely that wild rice was historically harvested in the area.

None of the representatives present at the meeting were aware of any additional information regarding historical sulfate, water level, or wild rice data for the water bodies in this study. The remainder of this report discusses the sulfate, hydrologic, and wild rice data that has been recently collected.

2.0 Water Quality and Hydrologic Monitoring

Water quality and hydrologic monitoring are currently ongoing for 2009. Results of measurements collected to date are presented in this report. A final water quality and hydrologic monitoring report will be generated after 2009 monitoring activities are completed.

2.1 Water Quality Monitoring

The purpose of water quality monitoring is to evaluate the concentration of sulfate and corresponding basic water quality parameters (e.g., pH) in water bodies that contain wild rice, and to continue characterizing sulfate levels in Swan Lake. Water quality monitoring activities for 2009 commenced on June 23, 2009, and are scheduled to continue until fall turnover of Swan Lake occurs (typically September or October).

2.1.1 Water Quality Monitoring Locations

The water quality monitoring locations are identified in Figure 1. The water discharges from the Keetac facility all end up flowing into Hay Creek upstream of Hay Lake. Hay Creek flows through Hay Lake and eventually discharges to the southeast corner of Swan Lake. Swan Lake discharges to the Swan River west of monitoring location KSW6. Monitoring location KSW7 is located in a shallow (approximately 2- to 3-feet deep) unnamed bay at the southwest corner of Swan Lake near the outlet to the Swan River. The bay, further referred to in this report as Swan Lake Southwest Bay, is attached to the main body of Swan Lake by a small channel. There are no other substantial inlets or outlets to Swan Lake Southwest Bay.

Neither Hart Creek (KSW8) nor Moose Lake (KSW2) receive any direct discharges related to mining activities, and are therefore considered control sites.

2.1.2 Water Quality Monitoring Methodology

Water quality samples were collected from the surface of Hay Creek, Hart Creek, Hay Lake, Moose Lake, and Swan Lake. In addition, water quality samples were collected from 2-meter depth intervals at two locations in Swan Lake (KSW4 and KSW5). Lake water quality samples were collected with a stainless steel Kemmerer sampler. Water quality samples collected from streams were collected by directly filling sample bottles while facing upstream. Samples were placed on ice and shipped to Braun Intertec laboratories for sulfate and total iron analyses. Water quality analyses consisted of unfiltered sulfate analysis by ion chromatography method (EPA 9056) and unfiltered total iron analysis (EPA 6010B). Select samples were analyzed for comparison to historical data for sulfate by turbidimetric method (EPA 9038) in addition to ion chromatography method.

Field measurements of pH, specific conductivity, temperature, dissolved oxygen, and oxidation-reduction potential (ORP) were collected using an YSI® model 556 multiprobe. Depth profiles of field parameters were collected at 1-meter intervals in Hay Lake (KSW1B), Moose Lake (KSW3), and Swan Lake (KSW4 and KSW5).

2.1.3 Water Quality Monitoring Results

Results of sulfate (ion chromatography method) and total iron analyses are summarized in Table 1. Field parameter measurements are included as Appendix A. Sulfate concentrations (ion chromatography method) for Hay Lake and Hay Creek ranged from 41 mg/L to 84 mg/L, while sulfate concentrations for Hart Creek and Moose Lake were 8.4 mg/L or less (Figure 2). Sulfate concentrations (ion chromatography method) in surface samples collected from the main body of Swan Lake (KSW4, KSW5, and KSW6) ranged from 23 mg/L to 51 mg/L, and concentrations in Swan Lake Southwest Bay (KSW7) ranged from 6.9 mg/L to 48 mg/L (Figure 3). The ion chromatography analytical method has an error range of 20 percent according to the method documentation. Error bars representing this are also shown for each data point in Figures 2 and 3. Over lapping error bars between data points indicates that results are not significantly different. As can be seen in Figures 2 and 3, although there is a wide range in the results, many of the values are not significantly different when considering the method error.

2.1.3.1 Sulfate Analysis by Turbidimetric Method

Upon reviewing results of the June and July 2009 sulfate analyses by ion chromatography method, it was observed that sulfate concentrations in Swan Lake were higher and more variable than in data collected previously as part of the Minnesota Steel EIS. Additionally, sulfate concentrations at KSW7 increased unexpectedly compared to the first sampling event. It was identified that the turbidimetric method had been used on the historical analysis rather than ion chromatography. The turbidimetric method is no longer an approved CWA method and therefore was not used for this study. Select samples from the June sampling events were reanalyzed for sulfate by turbidimetric method for comparison. Select samples from August sampling events were also analyzed for sulfate by both ion chromatography and turbidimetric methods.

Table 2 summarizes the results of samples analyzed for sulfate by both ion chromatography and turbidimetric method. No clear trend was found between the two analytical methods. Results for Hay

Lake were generally in good agreement for all samples collected and analyzed using both methods. However, the results for the July samples for Swan Lake were markedly different when comparing analytical methods, while those for the August samples were very similar. The turbidimetric method is known to have interferences and is subject to human interpretation. These are two of the reasons that this method was dropped from the list of approved CWA analytical methods. It is possible that something was present in the July 2009 Swan Lake samples that caused interference with one or both of the laboratory methods, resulting in the difference between the sulfate concentrations reported by the two methods. It is possible that these same interferences may have been present in the historical results as well.

2.1.4 Historic Sulfate Concentrations for Swan Lake

Swan Lake has been monitored for sulfate concentrations in previous years by Minnesota Steel/Essar Steel. Historic sulfate data collected from the surface of Swan are included in Appendix B. Sulfate concentrations in surface water samples collected in the center of Swan Lake from 2005 to current are plotted in Figure 4.

2.2 Hydrologic Monitoring

Hydrologic monitoring commenced on June 23, 2009 and will proceed into fall 2009. As hydrologic monitoring is still ongoing, the results presented in this report should be considered preliminary. A report updating the 2009 hydrologic monitoring results will be generated after 2009 monitoring activities are completed.

2.2.1 Hydrologic Monitoring Locations

Hydrologic monitoring was conducted in Hay Creek upstream of Hay Lake (KSW1A) and Hay Creek upstream of Swan Lake (KSW3), as identified on Figure 1. Additionally, water levels in Hay Lake were monitored.

2.2.2 Hydrologic Monitoring Methodology

Staff gages were installed in Hay Creek at locations KSW1A and KSW3. A staff gage was also installed in Hay Lake. An In-Situ® Level Troll® water level logging device was attached to each staff gage for continuous recording of water levels. Flow was measured in Hay Creek at locations KSW1A and KSW3 during each water quality monitoring field visit. Flow was measured following USGS methodology (i.e., measuring stream velocity at 0.6 of water depth and multiplying by cross-sectional area). Water velocities were measured with a Marsh-McBirney Flo-Mate™ Model 2000 portable velocity flow meter.

2.2.3 Hydrologic Monitoring Results

Results of flow monitoring data collected to date for Hay Creek are presented in Table 3. Updated results will be presented in a later report after 2009 hydrologic monitoring activities are completed. Beaver activity was observed to be prevalent in Hay Creek, and a beaver dam was observed at the outlet of Moose Lake. As a result, the water level of Moose Lake is maintained at a higher level than nearby Hay Creek, and Moose Lake does not receive water from Hay Creek under typical hydrologic conditions. It was also observed that the water level in Hay Lake increased by more than a foot as the summer progressed, suggesting a beaver dam is present on Hay Creek downstream of Hay Lake.

The water level of Swan Lake is controlled by a manmade structure on the Swan River. Therefore, the water level of Swan Lake does not change substantially.

3.0 Wild Rice Survey

The purpose of the Wild Rice Survey is to determine the presence of wild rice (*Zizania palustris L,* known as *Manoomin* in Ojibwe), an annual grass, on Hay Lake (KWR1), Moose Lake (KWR2), and the Swan Lake Southwest Bay (KWR3) (Figure 1). Since wild rice populations oscillate over an approximate 4- to 6-year period, the following analyses and ground surveys were performed to determine past and current presence of wild rice.

1. Literature search to identify waterbodies potentially affected by the Keetac Project.
2. Analysis of historic aerial photographic imagery of the study area.
3. On-the-ground verification of the presence of wild rice and sampling of the density of select wild rice stands.
4. Acquire current aerial photographic imagery to verify information obtained from the cultural data, historic aerial photographic imagery analysis, and ground surveys.

3.1 Wild Rice Survey Methodology

The following section describes the methodologies used in obtaining information and data on wild rice.

3.1.1 Methodology of Literature Search for Wild Rice in Downstream Receiving Waters from the Project

To determine which waterbodies downstream of the Keetac Project might potentially contain wild rice, a literature review of historic and cultural information was conducted. Information examined included the 2008 DNR "Natural Wild Rice in Minnesota" Report, U.S. Department of Interior Geological Survey maps (Topo maps), Trygg maps, and the 1854 Treaty Authority List. The Trygg maps were developed by J. William Trygg (1966) utilizing data from the original Government Land Surveys along with other historical surveys and sources (http://www.trygglandoffice.com/maps.html).

3.1.2 Methodology of Historic Aerial Photographic Imagery Analysis

Staff from the Geospatial Sciences and Technologies Branch USGS-BRD-Upper Midwest Environmental Sciences Center in La Crosse, WI analyzed 2004 and 2008 1-meter resolution NAIP (National Agricultural Imagery Program) natural color and color infrared aerial photographic imagery for the presence of wild rice on Hay, Moose and Swan Lakes. These photos are the best publicly available aerial images from which to identify areas with the potential for the presence of wild rice. The USGS staff has over a decade of experience analyzing NAIP aerial images for the presence of wild rice, mostly along the backwaters and bays of the Mississippi River in southeastern Minnesota and southwestern Wisconsin. The quality of the analysis is influenced by several factors, including the date of acquisition, weather conditions, light conditions, and the quality of the "wild rice photographic signature". While the wild rice signature is considered distinct at the end of the growing season, it can be difficult to distinguish the signature of wild rice from the signature of other emergent plants.

3.1.3 Methodology of Ground Verification and Density/Acreage Calculations

Surveys to estimate wild rice density and crop acreage were carried out the week of July 27, 2009. Qualitative estimates of wild rice coverage were carried out by canoeing along the perimeter of the wild rice beds and recording bed locations using a Trimble® GPS Pathfinder® ProXH™ receiver. Quantitative estimates of wild rice coverage were determined from representative sampling grids 10-meter x 10-meter size. Three grids were sampled on Moose Lake, three grids were sampled on Hay Lake, and four grids were sampled on Swan Lake Southwest Bay. Within each grid, 20 1-meter by 1-meter plots were randomly selected using a computer random number generator. Each randomly selected plot was sampled using a 0.5 m^2 sampling square made from PVC piping (0.71 m on each side). The square was placed on the water surface at each randomly selected plot and the rice stems within 0.5 m^2 the square were counted. Height above the water surface was measured for five plants within each 0.5 m^2 plot. Height was measured to the plant's highest point (seed head or flag leaf depending on stage of plant growth). Stem count sum, mean, median, and standard deviation were calculated based on the stem count for 20 plots. The total stem count for each grid comprises 10 percent of the grid area. The total area sampled for each grid was 10 m^2 (20 plots x 0.5 m^2 each). Grid zero sampled on Moose Lake was sampled using an *in situ* randomization.

3.1.4 Methodology for Acquisition of 2009 Aerial Photographs

Aerial photographic images of the study area were acquired the first week of September 2009. The aerial photographs are color digital imagery with a 1.9 feet/pixel resolution. The sky conditions were less than 2 percent cloud interference with a sun angle of 30 degrees or higher. Due to the recent acquisition of the imagery, rectification and analysis of 2009 imagery are still ongoing.

3.2 Wild Rice Survey Results

The following details the results of the wild rice survey and analyses that have been conducted for Swan Lake Southwest Bay, Hay Lake, and Moose Lake.

3.2.1 Methodology for Acquisition of 2009 Aerial Photographs

The Trygg map of Swan Lake identifies an area on the northern shore of the bay leading to Swan Lake Southwest Bay as a location of an "Indian Village" (1966). A "Chippewa Indian House" is also identified at this location. It is likely the camp was used as a "Ricing Camp", traditionally used by bands to camp during the ricing season, as well as a location for other hunting/gathering activities during other parts of the year (Vennum 1986, follow up discussion with tribal biologists from Leech Lake Band, Bois Forte and 1854 Authority, September 2009). From that investigation Hay Lake, Swan Lake, and Moose Lake were identified as potential wild rice waterbodies.

3.2.2 Results of Historic Aerial Photographic Imagery Analysis

The potential presence of wild rice identified from the historic aerial photographic imagery analysis is marked with red dots (2008 photos) and pink squares (2004 photos) (Figure 5). This method of identification did not include any estimates for bed size, overall acreage, or density. The 2004 NAIP aerial imagery for Swan Lake, Moose Lake, and Hay Lake were acquired during the period of June 10-19, 2004. The 2008 NAIP aerial imagery for Swan Lake was taken August 9, 2008, while the imagery for Moose Lake and Hay Lake were taken June 1, 2008. Wild rice does not typically begin to emerge above the water level until July in the project area. Therefore, only the 2008 NAIP aerial image for Swan Lake was suitable for identifying wild rice. Upon analyzing the 2008 NAIP imagery, the USGS identified wild rice along much of the perimeter of the Swan Lake Southwest Bay as well as along the channel connecting the bay to the main body of Swan Lake and Swan River flowing out of Swan Lake (Figure 5). Wild rice was not identified on either Moose or Hay Lakes in the aerial photography. Since the aerial imagery for Moose and Hay Lakes were acquired in early June in both 2004 and 2008, wild rice could not be identified by analysis of historic aerial imagery.

3.2.3 Results of Ground Verification and Density/Acreage Calculations

Wild rice was identified from ground surveys performed on Moose Lake, Hay Lake, and the Swan Lake Southwest Bay the week of July 27, 2009 (Figure 6). The aerial photography information was not obtained until after the field survey work was completed; therefore, the wild rice on the Swan River, which had not previously been identified in the other information sources, was not field surveyed. The presence of wild rice on Swan River was verified at a road leading to the dam on the Swan River. No wild rice was found in the south bay shown to potentially contain wild rice in the aerial photography (see Figure 5). Swan Lake Southwest Bay had the largest overall acreage of wild rice, while both Hay Lake and Moose Lake had less acreage but denser stands of wild rice (greater than 80 percent coverage). Wild rice stands were identified along most of the perimeter of Moose Lake with approximately 30 percent coverage; the area located at the southern end near the outlet had the densest stands (greater than 80 percent coverage). Hay Lake had the most mature and dense wild rice of the three lakes with approximately one-third of the lake covered with wild rice near the outlet to Swan Lake (greater than 90 percent coverage). Swan Lake Southwest Bay had many patchy areas of wild rice throughout most of its extent. The density of those areas ranged from approximately 20 to 50 percent coverage. The USGS analysis of 2008 NAIP aerial imagery of Swan Lake identified wild rice along the perimeter of Swan Lake Southwest Bay, but not within the center of Southwest Bay. It is possible that wild rice beds on Swan Lake in 2008 were not present or dense enough to be captured by aerial photographs. It is also possible that the method of analysis does not distinguish between wild rice and other emergent vegetation in some cases. One example might be the case of lily pads (*Nymphaea odorata*) comprising a significant portion of the wild rice bed and making it difficult to identify the wild rice signature from aerial photographic imagery. Many of the wild rice beds observed within Swan Lake Southwest Bay in 2009 were populated with between 30 to 50 percent lily pads. Detailed information on results of the on-the-ground wild rice survey is included in Appendix C. Photographs of wild rice taken from Hay Lake, Moose Lake, and Swan Lake Southwest Bay are included in Appendix D.

3.2.4 Results of 2009 Aerial Photographs

Rectification and analysis of aerial photographic imagery acquired in September 2009 is ongoing. Results will be included in a future report.

3.3 Wild Rice Survey Discussion

Results from the historic aerial imagery analysis and 2009 ground surveys identified the presence of wild rice on Moose Lake, Hay Lake, and the Swan Lake Southwest Bay. Although several dense stands of wild rice were identified on Moose Lake and Hay Lake, it is difficult to determine the health and history of wild rice in these lakes without a multi-year combined analysis of ground surveys and aerial photographic imagery, as wild rice populations oscillate over an approximate 4 to 6 year period. Delays in plant nutrient uptake and wild rice tissue chemistry influence wild rice growth and production from year to year (Walker et al., 2006; Walker et al., submitted for publication 2009). Other factors such as water level may also play a role, but no data has been collected over multiple years and published. Given that wild rice populations fluctuate over 4 to 6 years, studies carried out over a shorter time frame may not provide adequate information regarding the growth and production of wild rice.

Hay Lake had the densest stands of wild rice (between 30 and 90 stems / 0.5 m^2) with sulfate levels ranging from 47 mg/L to 78 mg/L. Moose Lake had less dense stands than Hay Lake (between 33 and

43 stems / 0.5 m^2) and sulfate levels ranged from 4.9 mg/L to 8.4 mg/L. From one year's data examining wild rice density data and water sulfate levels, it is not possible to determine the effects of sulfate on wild rice growth and production.

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice
Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific
Sulfate Standards for the Protection of Wild Rice

ATTACHMENT R

(MPCA Citizens' Board Materials for Authorization to Issue
NPDES/SDS Permits MN0031879 and MN0055948 for Keetac Mine and Tailings Basin, 2011)

Minnesota Pollution Control Agency
520 Lafayette Road North | St. Paul, Minnesota 55155-4194 | 651-296-6300
800-657-3864 | 651-282-5332 TTY | www.pca.state.mn.us | Equal Opportunity Employer

October 14, 2011

RE: United States Steel Corporation, Minnesota Ore Operations, Keetac - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948

TO: INTERESTED PARTIES

Enclosed for your information is a copy of the Minnesota Pollution Control Agency (MPCA) Citizens' Board (Board) Item documents for the proposed United States Steel Corporation, Minnesota Ore Operations – Keetac National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948 (Permits), Itasca County, and a copy of the Board Agenda. The Board packet includes:

- Proposed Findings of Fact, Conclusions of Law, and Order for the National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permits
- Comment letters received on the Draft Permits
- Responses to written comments received on the draft permits
- Table of changes to draft Permits
- Proposed Permits
- Statement of Basis for the Proposed Permits
- Map of the facility

The United States Steel Corporation, Minnesota Ore Operations – Keetac - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Request and Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948 Board Packet may also be viewed at the MPCA St. Paul Office and on our MPCA Web site at http://www.pca.state.mn.us/about/board/bdagenda.html.

The draft Permits and Statement of Basis documents are very lengthy. In an effort to save postage and resources, the draft Permit and Statement of Basis will not be included in this mailing. All Board Item documents, including the draft Permit and Statement of Basis may be reviewed at the MPCA offices in St. Paul and on the MPCA Web site at http://www.pca.state.mn.us/about/board/bdagenda.html. Requests for copies of these documents may be made by contacting the St. Paul office at 651-757-2084.

The Board Item will be presented at the MPCA Board Meeting on October 25, 2011. Please refer to the enclosed Board Agenda for specific location, dates, and times. We encourage your attendance at the Board Meeting. If you have any questions regarding the enclosed Board Item or the specifics of the meeting, feel free to contact Brandon Smith of our staff at 651-757-2740.

Sincerely,

Ann Foss

Ann M. Foss
Director
Strategic Projects Sector
Industrial Division

AMF:rm

Enclosures

MINNESOTA POLLUTION CONTROL AGENCY

Industrial Division
Strategic Projects Sector

Board Item Cover Sheet

MEETING DATE:	October 25, 2011	**DATE MAILED:**	October 14, 2011
Presenter(s):	Brandon Smith BES	**Phone Number:**	651-757-2740
Project Manager:	Brian Timerson BT	**Phone Number:**	651-757-2785
Sector Director:	Ann Foss AMF	**Phone Number:**	651-757-2366
Division Director:	Jeff Smith	**Phone Number:**	651-757-2735
Asst. Co.: (if issue applies to water or air issue)	Rebecca Flood	**Phone Number:**	651-757-2022
Deputy Commissioner:	John Stine	**Phone Number:**	651-757-2014
Attorney:	Robert Roche	**Phone Number:**	651-757-1372

TITLE OF BOARD ITEM: United States Steel Corporation, Minnesota Ore Operations - Keetac, Keewatin, Minnesota - Request for Approval of Findings of Fact, Conclusions of Law, and Order and Request for Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948.

LOCATION: Keewatin (City/Township) Itasca (County)

TYPE OF ACTION: Permit Issuance

RECOMMENDED ACTION: Authorization to Issue National Pollutant Discharge Elimination System/State Disposal System Permits MN0031879 and MN0055948.

ISSUE STATEMENT:

The Minnesota Pollution Control Agency (MPCA) staff requests that the MPCA Citizens' Board (Board) approve reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System(SDS) Permits MN0031879 and MN0055948 (Permits) for the United States Steel Corporation – Minnesota Ore Operations (Permittee) – Keetac Mining Area facility. The MPCA staff prepared the draft Permits for the Keetac Mining Area facility, and submitted the draft Permits for public comments on June 27, 2011. The public comment period for the Permits was extended twice, closing on August 19, 2011. Prior to extending the public comment period to end on August 19, 2011, the MPCA received 179 requests for extension of the public comment period, 177 were received in substantially identical e-mails. In addition to the requests for extension of the public comment period, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails. Comments received on the draft Permits centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters. In response to comments received, the MPCA staff has modified the draft Permits to clarify and improve enforceability of compliance schedule requirements. The MPCA staff recommends that the Board approve the reissuance of each of the Permits.

Printed on recycled paper containing at least 30% fibers from paper recycled by consumers.
Telephone Device for Deaf (TDD): 1-800-657-3864; Local 651-282-5332
This material can be made available in other formats, including Braille, large type or audio tape, upon request.

ATTACHMENTS:

1. Proposed Findings of Fact, Conclusions of Law, and Order Permit No. MN0031879
2. Proposed Findings of Fact, Conclusions of law and Order Permit No. MN0055948
   - Appendix A – Comment Letters received on the Draft Permits
   - Appendix B – Responses to Comments Received on the Draft Permits
   - Appendix C – Table of Changes to Draft NPDES/SDS Permits
3. Proposed NPDES/SDS Permit No. MN0031879
4. Proposed NPDES/SDS Permit No. MN0055948
5. Statement of Basis Permit No. MN0031879
6. Statement of Basis Permit No. MN0031879
7. Map of Facility

Printed on recycled paper containing at least 30% fibers from paper recycled by consumers.
Telephone Device for Deaf (TDD): 1-800-657-3864; Local 651-282-5332
This material can be made available in other formats, including Braille, large type or audio tape, upon request.

MINNESOTA POLLUTION CONTROL AGENCY
Industrial Division
Land and Water Quality Permits Section

United States Steel Corporation, Minnesota Ore Operations, Keetac
National Pollutant Discharge Elimination System/State Disposal System
Permits MN0031879 and MN0055948

October 25, 2011

ISSUE STATEMENT

The Minnesota Pollution Control Agency (MPCA) staff requests that the MPCA Citizens' Board (Board) approve reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System(SDS) Permits MN0031879 and MN0055948 (Permits) for the United States Steel Corporation – Minnesota Ore Operations (Permittee) – Keetac facility. The MPCA staff prepared the draft Permits for the Keetac facility, and submitted the draft Permits for public comments on June 27, 2011. The public comment periods for the Permits were extended twice, closing on August 19, 2011. Prior to extending the public comments period to end on August 19, 2011, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permits, 106 of which were received in substantially identical e-mails. Comments received on the draft Permits centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters. In response to comments received, the MPCA staff has modified the draft Permits to clarify and improve enforceability of compliance schedule requirements. The MPCA staff recommends that the Board approve the reissuance of each of the Permits.

I. <u>BACKGROUND</u>:

A. Facility Description

The principal activity at the Keetac facility is the open pit mining of taconite from the Biwabik Iron Formation for processing into taconite pellets. The Keetac facility is currently subject to NPDES/SDS Permits MN0031879 and MN0055948, which regulate discharges from the mining/processing facility and the tailings basin system, respectively. The permitted activities under NPDES/SDS Permit MN0031879 consist of discharges from the Permittee's Keetac plant area, all mine excavations, mining waste disposal areas, plant areas, materials and equipment storage areas, and wastewater disposal facilities. The permitted activities under NPDES/SDS Permit MN0055948 consist of discharges of process and dewatering wastewaters associated with the Keetac tailings basin system.

The Permittee has proposed an expansion to its mining and pellet production operations at the Keetac facility, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. A short ton equals 2,000 pounds. The proposed expansion exceeded the threshold for requiring mandatory environmental review. Pursuant to Minn. R. 4410.2000, subp. 3.B., the Permittee and the Minnesota Department of Natural Resources (DNR) agreed that a discretionary Environmental Impact Statement should be prepared pursuant to Minn. R. 4410.4400 subp. 8, and the DNR would be the Responsible Governmental Unit for the State of Minnesota.

B. Procedural History

On January 11, 2010, the MPCA received applications for modification of both of the Permits to address proposed mining expansion. The proposed expansion does not change the operation of the previously permitted disposal systems associated with the Keetac mine area and processing plant or the discharge of wastewater associated with the previously permitted disposal systems.

In February, 2010, the MPCA determined waters downstream from the discharges authorized by the Permits to be waters used for the production of wild rice.

In August, 2010, the MPCA staff determined that the requested modifications to the Permits should be included with the upcoming reissuance of each of the Permits.

On December 30, 2010, the DNR determined the final EIS for the proposed Keetac mine expansion to be adequate.

On June 27, 2011, the MPCA staff public noticed the draft Permits for reissuance.

On July 27, 2011, the MPCA staff extended the public comment period for the Permits to end on August 12, 2011, to account for business days lost due to the Minnesota State government service interruption that occurred in July.

On August 12, 2011, the US Environmental Protection Agency (EPA) formally requested a 30 day review of the draft Permits, starting from August 2, 2011, and ending on September 2, 2011.

On August 12, 2011, the MPCA staff extended the public comment period for the Permits to end on August 19, 2011, in response to requests for additional time to submit public comments.

On August 19, 2011, the public comment period for the draft Permits ended.

On September 2, 2011, the MPCA staff received comments from the EPA review of the draft Permits. The comments requested corrections and clarifications to the language in the draft Permits regarding the compliance schedule for sulfate.

II. DISCUSSION:

The draft permits do not authorize, and the permittee had not requested expansion of any of the permitted discharges above the volumes and mass loadings authorized under the previous permits. The substantial changes to the Permits, as compared to previous permits issued to this facility, occurred as a result of the determination that discharges from the facility impact downstream waters, which are used for the production of wild rice.

As required by federal Clean Water Act regulations, the MPCA staff performed an analysis to determine whether the discharge would have the reasonable potential to cause or contribute to a violation of any water quality standards in the receiving waters. Under the regulation, where the MPCA determines that a discharge of a particular pollutant has the reasonable potential to cause or contribute to a violation of an applicable water quality standard in a receiving water, the permit must include a water quality based effluent limit for that pollutant. This “reasonable potential” analysis results in water quality based effluent limit recommendations, which are included in the draft permits.

On February 2, 2010, the MPCA staff completed the effluent limit recommendations and associated nondegradation review for NPDES/SDS Permit MN0031879, in accordance with all state and federal regulations, as well as MPCA policies governing such reviews.

On April 7, 2011, the MPCA staff completed the effluent limits recommendations and associated nondegradation review for NPDES/SDS Permit MN0055948, in accordance with all state and federal regulations, as well as the MPCA policies governing such reviews.

Minnesota's water quality standards include a 10 mg/L sulfate limit for waters used for the production of wild rice when the rice may be susceptible to damage by high sulfate levels. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on that standard. The sulfate effluent limits are 14 mg/L calendar month average and a 24 mg/L daily maximum. These effluent limits were calculated utilizing the same statistical procedures that are used to determine water quality-based effluent limitations for NPDES/SDS permits throughout Minnesota.

Because U. S. Steel is currently unable to comply with the sulfate effluent limits, the MPCA staff developed a compliance schedule based on the time required for the completion of evaluations and implementation of the final plans to attain compliance with the sulfate effluent limits. The compliance schedule was developed in accordance with the requirements of 40 CFR § 122.47, and Minn. R. 7001.0150, subp. 2 (A).

Commentors expressed a variety of concerns regarding the topics identified above. These comments are addressed in the Response to Comments document (Appendix B of Attachment 2). In response to comments made by EPA, changes were made to the draft permit, which are defined in Appendix C of Attachment 2. The following is a summary of the changes made to the draft permit: (1) the MPCA modified the tailings basin permit to include reference to the compliance schedule for non-tailings basin discharges found in the mining operations permit. (2) Interim effluent limits for sulfate were added to the permit for outfalls where full-scale treatment evaluation is approved. (3) Full-scale treatment evaluation is required for outfalls representative of wastewater type. (4) Additional monitoring requirements for selenium added to the permit.

Many of the other comments received from environmental groups and concerned citizens related to the effluent limits for sulfate, including whether the effluent limits were calculated appropriately and the assumptions used in the calculations, as well as concerns regarding the appropriate length of the compliance schedule to achieve the sulfate limits. Comments also included requests to increase the frequency of sulfate monitoring and to include additional monitoring and effluent limits for hardness and other parameters.

The issue before the Board is whether to reissue each of the two Permits as prepared by the MPCA staff. The MPCA's decision to reissue Permits is governed by Minn. R. 7001.0140 subp. 1, which states:

> *Subpart 1.Agency action. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D, and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.*

The MPCA staff believes that the requirements of Minn. R. 7001.0140 subp. 1 have been fulfilled.

III. <u>CONCLUSIONS</u>:

For the reasons discussed above and more fully described in the Findings of Fact, Conclusions of Law and Order, in the staff's response to comments, and in the Statement of Basis for the Mining Operations, the MPCA staff believes that Permit No. MN0031879 should be issued.

For the reasons discussed above and more fully described in the Findings of Fact, Conclusions of Law and Order, in the staff's response to comments, and in the Statement of Basis for the Tailings Basin, the MPCA staff believes that Permit No. MN0055948 should be issued.

IV. <u>RECOMMENDATION</u>:

The MPCA staff recommends that, in accordance with the standard and criteria set forth in Minn. R. 4410.1700, the Board vote to approve issuance of NPDES/SDS Permits MN0031879 and MN0055948 for the United States Steel Corporation, Minnesota Ore Operations – Keetac facility.

SUGGESTED STAFF RESOLUTION

Authorization to Issue NPDES/SDS Permits MN0031879 and MN0055948

BE IT RESOLVED, that the Minnesota Pollution Control Agency (MPCA) approves and adopts the attached Findings of Fact, Conclusions of Law, and Order (Attachment 1 and Attachment 2) in support of its approval of issuance of the NPDES/SDS Permits for United States Steel Corporation, Minnesota Ore Operations - Keetac Project.

BE IT FURTHER RESOLVED, that the Commissioner is authorized to do the following: (1) execute the Findings of Fact, Conclusions of Law, and Order (Attachment 1 and Attachment 2) on behalf of the MPCA; (2) issue NPDES/SDS Permits MN0031879 and MN0055948 on behalf of the MPCA; and (3) undertake all actions necessary for issuance and effectiveness of the water permit.

ATTACHMENT 1

STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

IN THE MATTER OF THE PROPOSAL TO
REISSUE THE NPDES/SDS
PERMIT NO. MN0031879
FOR UNITED STATES STEEL – MINNESOTA ORE OPERATIONS - KEETAC
MINING
KEEWATIN, MINNESOTA

FINDINGS OF FACT
CONCLUSIONS OF LAW
AND ORDER

The above-entitled matter came before the Minnesota Pollution Control Agency (MPCA) Citizens' Board at a regular meeting held in St. Paul, Minnesota on October 25, 2011. Based on the MPCA staff review, comments and information received during the comment period, and other information in the record of the MPCA, the MPCA hereby makes the following Findings of Fact, Conclusions of Law, and Order:

FINDINGS OF FACT

This matter involves the application of United States Steel Corporation for reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit No. MN0031879 for the Minnesota Ore Operations - Keetac – Mining Facility. For the purposes of these Findings, Conclusions of Law and Order, the United States Steel Corporation is referred to as U. S. Steel or the Permittee and the Minnesota Ore Operations Keetac – Mining Facility is referred to as Keetac. The permit reissuance includes: 1) a description of the proposed expansion of the taconite processing plant with which the permitted operations are associated; 2) effluent limitations based on the 10 mg/L sulfate water quality standard for "waters used for the production of wild rice;" and 3) continuation of the currently effective compliance schedule for the sulfate effluent limitations, which was added as part of a major permit modification issued on June 17, 2010. The MPCA must decide whether, under applicable statutes and rules, it should reissue the permit.

DESCRIPTION OF THE PROJECT

1. United States Steel Corporation ("U. S. Steel Corp.") owns and operates a taconite (iron ore) mine and processing plant in Keewatin, Minnesota. The facility, U. S. Steel Corporation, Minnesota Ore Operations - Keetac ("Keetac"), produces taconite pellets for use as a primary raw ingredient at iron and steel mills.

2. Iron ore mining and taconite pellet production have been on-going at the Keetac facility since 1967. The original Phase I taconite processing plant began operation in 1969. At that time, the Keetac facility included one operating taconite production line.

3. In 1977, the Phase II expansion added a second operating line. The Phase I line was idled in December 1980 under the ownership of National Steel Pellet Corporation. U. S. Steel Corp. purchased the National Steel Corporation in 2003, including the Keetac facility.

4. Currently, there is one operational pellet producing line (Phase II) with annual production of approximately 6.0 million tons of taconite pellets per year (MTPY). The facility has proposed an expansion to its mining and pellet production operations, which will increase production from 6.0 MTPY to 9.6 MTPY. A joint state and federal Environmental Impact Statement (EIS) was completed for the proposed expansion, and was determined to be adequate by the Minnesota Department of Natural Resources on December 30, 2010.

5. The reissuance of NPDES/SDS Permit No. MN0031879 is requested to authorize continued operation of permitted disposal systems associated with the Keetac mine area and processing plant, and the discharge of wastewater associated with the permitted disposal systems.

6. The current mining facility has four surface water discharge points. The proposed expansion does not change the operation of currently permitted disposal systems associated with the Keetac mine area and processing plant, or the discharge of wastewater associated with the currently permitted disposal systems, each of which is described below.

7. The water supply treatment plant, located just north of Welcome Lake, currently discharges backwash wastewater from the sand filters on a periodic basis through culvert outfall SD001, at a rate of less than 0.010 million gallons per day (MGD), to Welcome Lake.

8. A Diversion Ditch System consisting of a series of sedimentation basins and a conveyance channel, currently discharges treated runoff from the Keetac plant area and stockpile areas, as well as overflow discharges of mine pit dewatering and runoff from a holding and treatment basin identified as Reservoir 5, at an average rate of 2.3 MGD to Welcome Creek via weir outfall SD001.

9. Mine pit dewatering from the Mesabi Chief Pit may be pumped and discharged through pipe outfall SD003, at an average rate of 5.85 MGD, to O'Brien Creek, which flows to the O'Brien Reservoir.

10. Discharges of mine pit dewatering from the Perry Pit, which includes stormwater from stripping and stockpiling activities west of the Mesabi Chief mining area, are directed through pipe outfall SD012 at rate of up to 4.32 MGD to O'Brien Creek.

APPLICABLE STANDARDS

Technology-based Treatment Standards

11. Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category.

12. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit.

13. The applicable BPT and BAT standards for mining area discharges are for Total Suspended Solids (TSS) and Total Iron, as limited in the currently effective Permit.

14. The applicable standards for the discharge of water supply treatment plant backwash water are based on the State Discharge Restrictions for pH and TSS pursuant to Minn. R. 7053.0225, as limited in the currently effective Permit.

Water Quality Standards

15. The immediate receiving waters affected by this permit reissuance include: Welcome Lake, Welcome Creek, O'Brien Creek, and the O'Brien Reservoir.

16. All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek and O'Brien Creek are classified as Class 2C waters as listed in 7050.0470 subp. 4.A. items (127) and (236), respectively. According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water. Welcome Lake and O'Brien Reservoir are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

17. Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

18. In addition, the MPCA staff has made the determination that discharges from the facility reach downstream waters, which are "used for the production of wild rice" as stated in Minn. R. 7050.0224 subp. 2. The wild rice determination was made prior to the permit modification dated June 17, 2010, and no revisions to the determination were made during the permit reissuance process.

19. As required by 40 C.F.R. § 122.44(d)(1), the MPCA evaluated the proposed discharge to determine whether it has a reasonable potential to cause or contribute to an excursion above applicable water quality standards.

20. Effluent limitations have been included in the draft Permit for total sulfate based on the results of the reasonable potential analysis.

21. In addition to the numeric water quality standards for applicable use classifications, Minn. R. 7050.0185 governs nondegradation for all waters. Nondegradation review is required by the MPCA for significant new and expanding discharges as defined in Minn. R. 7050.0185 to determine whether additional controls beyond compliance with water quality standards are warranted to prevent degradation of waters of the state. For this Permit, a significant new or expanded discharge would be defined as one in which the maximum design flow expands by more than 200,000 gallons per day above the existing baseline flow, or would increase the concentration of a toxic pollutant in the receiving water by greater than one percent. No expansion of the maximum

daily design flows above the currently permitted levels is authorized by the Permit. Additionally, the EIS for the proposed Keetac expansion project indicates that water chemistry in the discharges authorized by the Permit is not anticipated to change due to continuation of similar mining and dewatering activity following the expansion. Therefore, the discharges authorized by the Permit do not constitute significant new or expanded discharges, and nondegradation review is not required for the proposed reissuance of the Permit.

22. Minn. R. 7050.0180 governs nondegradation for Outstanding Resource Value Waters (ORVWs). None of the discharges authorized by the Permit are directly to ORVWs, therefore nondegradation with regard to ORVWs under the Permit is limited to verifying that new or expanding flows are controlled to prevent degradation of downstream ORVWs. As previously discussed, permitted flows are required to remain within the range currently permitted, and changes to the chemistry of the permitted discharges are not expected to occur. Therefore, degradation of downstream ORVWs is not anticipated, and additional controls are not required pursuant to Minn. R. 7050.0180.

PROTECTION OF WATERS USED FOR THE PRODUCTION OF WILD RICE

23. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on the 10 mg/L stated applicable to "waters used for the production of wild rice." The sulfate effluent limits are 14 mg/L calendar month average and 24 mg/L daily maximum.

24. The effluent limitations for sulfate have been calculated utilizing statistical methods derived from the EPA Technical Support Document for Water Quality-Based Toxics Control. The limits are calculated assuming no dilution capacity in the receiving waters, maximum flow from the permitted discharges, and a waste load allocation of 10 mg/L sulfate based on the ambient water quality standard for waters used for the production of wild rice. Compliance with the calculated effluent limitations provides reasonable assurance that the Permittee's discharges are not causing or contributing to excursions above the water quality standard within the water bodies where the standard applies.

25. U. S. Steel is currently unable to comply with the sulfate effluent limits. Due to the complex nature of the wastewater disposal systems at the Keetac facility, a facility-wide compliance solution must be investigated that incorporates both water management and treatment solutions. The MPCA staff determined that inclusion of a compliance schedule in the permit is appropriate. Therefore, the permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate on a facility-wide basis.

26. The compliance schedule in the draft Permit requires the completion of a Water Management Study and a Sulfate Reduction Strategy Study, which are required to inform the development and implementation of a Sulfate Reduction Plan. The implementation of the Sulfate Reduction Plan is required to lead to compliance with the final effluent limitations for sulfate as soon as possible. The Sulfate Reduction Plan must provide justification for the proposed timeframe for attaining compliance.

27. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2018. The maximum term of the compliance schedule is based on potential time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The schedule does not automatically grant the maximum timeframe, but requires the MPCA approval at interim steps and requires that all interim steps proceed to compliance with final effluent limitations as soon as possible. The schedule requires the Permittee to make reductions in sulfate concentration to the extent practical prior to the end of the compliance schedule.

28. Interim requirements for the compliance schedule prior to the final attainment of compliance include completion of the Water Management Study and Sulfate Reduction Strategy Study currently underway, preparation and submittal of the Sulfate Reduction Plan, implementation of the Sulfate Reduction Plan following MPCA approval of the plan, and progress reporting. The Permit specifies maximum timeframes for completion of interim requirements. Implementation of the actions contained in the Sulfate Reduction Plan following the MPCA approval will also be enforceable actions due to implementation of the approved plan being an enforceable condition of the Permit.

29. Additional enforceable interim requirements are built into the schedule contingent upon the proposals in the Sulfate Reduction Plan. Distinct timeframes for the attainment of compliance following MPCA approval of the plan are required, and are dependent on whether or not the MPCA approves full-scale testing of treatment technology on representative outfalls prior to final implementation on all discharges. The Permit allows time for completion of such testing in the event that such a proposal is approved by the MPCA, but specifies maximum timeframes for completion of the testing, and requires that interim effluent limitations for sulfate be met at the representative outfalls following treatment evaluations. If full-scale treatment evaluation is not approved by the MPCA, the Permit requires compliance to be attained in a shorter timeframe.

REVISIONS TO THE SULFATE COMPLIANCE SCHEDULE FOLLOWING PUBLIC COMMENT PERIOD

30. The U.S. Environmental Protection Agency (EPA) requested to review the draft permit, outside of the public comment period, under federal oversight authority. The EPA submitted a comment letter to the MPCA dated September 2, 2011. Specific comments and the MPCA responses regarding the sulfate compliance schedule are discussed below. These changes were made following public notice of the Permit.

31. The EPA requested the MPCA to revise draft NPDES/SDS Permit No. MN0055948 either to incorporate by reference the compliance schedule in draft NPDES/SDS Permit No. MN0031879, or provide the same level of detail as is included in draft NPDES/SDS Permit No. MN0031879.

32. The MPCA staff modified draft NPDES/SDS Permit No. MN0055948 to include the compliance schedule contained in draft NPDES/SDS Permit No. MN0031879 by reference.

33. The EPA requested the MPCA to revise the compliance schedule so that the different paths within the compliance schedule following the MPCA approval or disapproval of treatment technology pilot studies are independent, and contain distinct enforceable actions leading to compliance with the effluent limits for sulfate.

34. The MPCA staff modified the language in draft NPDES/SDS Permit No. MN0031879 to indicate two distinct schedules, with distinct requirements for attainment of compliance with final effluent limitations for each case regarding the MPCA approval or disapproval of a request for full-scale treatment evaluation on representative outfalls.

35. The EPA requested the MPCA to revise the compliance schedule so that it is clear that the full scale treatment technology pilot studies are required for a representative outfall of each type of discharge, specifically tailings basin, dewatering pit, and Reservoir 5/sedimentation basins. The EPA asked that the MPCA staff specify that the representative dewatering pit outfall will be one included in draft NPDES/SDS Permit No. MN0031879 and therefore fall under that schedule.

36. The MPCA staff modified the compliance schedule in draft NPDES/SDS Permit No. MN0031879 to require evaluation of full-scale treatment evaluation for outfalls representative of wastewater type. The MPCA did not specify the three waste types contained in the EPA comments, due to the possibility of these waste types changing due to operational modifications, dependent on the results of the Water Management Study that is currently in progress. As an equivalent measure, the MPCA is requiring the Permittee to base any request for testing on representative outfalls on consideration of physical condition of the wastewater, wastewater chemistry, and the size/frequency of the discharge within the Sulfate Reduction Plan. The permit language has also been modified to specify compliance dates based on the type of wastewater discharged as requested.

37. The EPA stated that the schedules of compliance require successful full-scale pilot treatment of outfalls representing the various types of discharges at the facility. The EPA requested the MPCA to require interim limits for sulfate at each outfall selected for the full-scale pilot studies, effective upon completion of the testing phases specified in paragraphs 1.11, 1.12 and 1.13 of draft NPDES/SDS Permit No. MN0031879.

38. The MPCA staff modified the language to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

39. The EPA requested the MPCA to correct the dates specified in the draft NPDES/SDS permits to reflect that the sulfate effluent limits shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019 date specified in the draft NPDES/SDS Permit No. MN0031879.

40. The MPCA staff corrected the final compliance date to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges.

41. The revised compliance schedule language, based on EPA comments, is included in the permit document found in Attachment 3. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150, subp. 2 (A) and 40 CFR § 122.47. The Permit requires that compliance with final effluent limitations be attained as soon as possible, and that completion of

interim steps result in continued progress toward compliance with final effluent limitations. Where the time between specific interim steps exceeds one year, the compliance schedule requires progress reports to be submitted to the MPCA at a minimum of every 6 months to provide details regarding the implementation of the requirements of the schedule and verify continued progress toward achieving compliance as soon as possible.

PROCEDURAL HISTORY

42. Pursuant to Minn. R. 7001.0100, a draft permit was prepared by the MPCA staff for the proposed permit reissuance.

43. The public comment period for the draft permit began on June 27, 2011, and ended on August 19, 2011. The initial 30-day comment period ended on July 27, 2011. Due to circumstances with the state government shutdown, which ran from July 1, 2011, to July 21, 2011, the comment period was extended to August 12, 2011, and a second extension was granted until August 19, 2011.

44. During the comment period, the MPCA received 2 comment letters from government agencies and received 11 comment letters from citizens.

45. The MPCA reviewed each of the comments and prepared responses to all comments received during the public comment period. Comment letters received have been hereby incorporated by reference as Appendix A to these findings. The MPCA responses to comments received are hereby incorporated by reference as Appendix B to these findings.

46. The MPCA concurs with the reasoning of MPCA staff in its Responses to Comments document (Attachment B) and adopts the reasoning by reference on these findings. The EPA comments and MPCA responses to those comments are also included in the Appendix A and Appendix B, respectively.

SELECTED COMMENTS AND MPCA RESPONSES

47. During the public comment period for the Permit, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails.

48. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails.

49. Comments received on the draft Permit centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters.

50. In response to comments received, the MPCA staff has modified the draft Permit to clarify and improve enforceability of compliance schedule requirements.

51. The comments received on this Permit and NPDES/SDS Permit MN0055948, as well as the MPCA responses to the comments, are detailed in Appendix B.

FINAL DETERMINATION OF WHETHER TO REISSUE PERMIT

52. The MPCA finds there is jurisdiction for U. S Steel's NPDES/SDS permit reissuance in accordance with Minn. R. 7001.0100, subp. 1 which states:

Subpart 1. After a permit application is complete, the commissioner shall make a preliminary determination as to whether the permit should be issued or denied.

53. The MPCA has followed the procedures for the reissuance of the NPDES/SDS Permit according to the provisions in Minn. R. ch. 7001.

54. The MPCA's decision to reissue the NPDES/SDS Permit is governed by its permit rule, Minn. R. 7001.0140, which in part, states:

Subpart 1. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D, and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.

CONCLUSIONS OF LAW

55. The MPCA is authorized and required to administer and enforce all laws relating to the pollution of the air and water of the state. Minn. Stat. chs. 115 and 116.

56. The MPCA has authority to reissuance this NPDES/SDS Permit. Minn. Stat. chs. 115 and 116 and Minn. R. chs. 7000, 7001, 7009, and 7020.

57. Under the federal Clean Water Act, the MPCA is delegated the authority from the EPA to issue NPDES permits. 33 U.S.C. §1342; Minn. Stat. § 115.03, subd. 5.

58. A draft permit for the facility was prepared and public noticed in accordance with the requirements of Minn. R. 7001.0100 and public comments on the draft permit were addressed in accordance with the MPCA rule requirements.

59. The requirements of Minn. R. ch. 7001, including Minn. R. 7001.0100 reissuance of a NPDES/SDS Permit, have been met including all applicable provisions of Minn. Stat. ch. 116D and Minn. R. ch. 4410. The MPCA determines that the Permittee will comply and will undertake the schedule of

compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA, and conditions of the reissued NPDES/SDS Permit.

60. The NPDES/SDS Permit contains effluent limitations and requirements that are protective of the environment and human health.

61. The findings of the MPCA justify reissuance of the NPDES/SDS Permit and do not support denial of the permit.

62. Areas where the potential for significant environmental effects may have existed have been identified and appropriate mitigation measures have been incorporated into the project design and permits. The project is expected to comply with all the MPCA standards.

63. Any findings that might properly be termed conclusions and any conclusions that might properly be termed findings are hereby adopted as such.

ORDER

The Minnesota Pollution Control Agency approves the reissuance of the National Pollutant Discharge Elimination System/State Disposal System Permit No. MN0031879 to U.S. Steel Corporation for the Minnesota Ore Operations Keetac - Mining Facility.

IT IS SO ORDERED

____
Commissioner Paul W. Aasen
Chair, Citizens' Board
Minnesota Pollution Control Agency

____
Date

STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

IN THE MATTER OF THE PROPOSAL TO REISSUE THE NPDES/SDS PERMIT NO. MN0055948 FOR UNITED STATES STEEL – MINNESOTA ORE OPERATIONS – KEETAC TAILINGS BASIN KEEWATIN, MINNESOTA

FINDINGS OF FACT CONCLUSIONS OF LAW AND ORDER

The above-entitled matter came before the Minnesota Pollution Control Agency (MPCA) Citizens' Board at a regular meeting held in St. Paul, Minnesota on October 25, 2011. Based on the MPCA staff review, comments and information received during the comment period, and other information in the record of the MPCA, the MPCA hereby makes the following Findings of Fact, Conclusions of Law, and Order:

FINDINGS OF FACT

This matter involves the application of United States Steel Corporation for reissuance of National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit No. MN0055948 for the Minnesota Ore Operations - Keetac Tailings Basin. For the purposes of these Findings, Conclusions of Law and Order, the United States Steel Corporation is referred to as U. S. Steel or the Permittee and the Minnesota Ore Operations - Keetac Tailings Basin Facility is referred to as Keetac. The permit reissuance includes: 1) a description of the proposed expansion of the taconite processing plant with which the permitted operations are associated; 2) a new outfall constructed to facilitate direct discharge of Sargent Pit dewatering, which is currently directed to other outfalls that are covered under NPDES/SDS Permit No. MN0031879; and 3) a compliance schedule to meet the sulfate effluent limits based on the 10 mg/L sulfate water quality standard for "waters used for the production of wild rice."

DESCRIPTION OF THE PROJECT

1. United States Steel Corporation ("U. S. Steel Corp.") owns and operates a taconite (iron ore) mine and processing plant in Keewatin, Minnesota. The facility, U. S. Steel Corporation, Minnesota Ore Operations - Keetac ("Keetac"), produces taconite pellets for use as a primary raw ingredient at iron and steel mills.

2. Iron ore mining and taconite pellet production have been on-going at the Keetac facility since 1967. The original Phase I taconite processing plant began operation in 1969. At that time, the Keetac facility included one operating taconite production line.

3. In 1977, the Phase II expansion added a second operating line. The Phase I line was idled in December 1980 under the ownership of National Steel Pellet Corporation. U. S. Steel Corp. purchased the National Steel Corporation in 2003, including the Keetac facility.

4. Currently, there is one operational pellet producing line (Phase II) with annual production of approximately 6.0 million tons of taconite pellets per year (MTPY). The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 MTPY to 9.6 MTPY. A joint state and federal Environmental Impact Statement (EIS) was completed for the proposed expansion, and was determined to be adequate by the Minnesota Department of Natural Resources on December 30, 2010.

5. The current facility has two surface water discharge points. The proposed expansion does not change the operation of previously permitted disposal systems associated with the Keetac mine area and processing plant, or the discharge of wastewater associated with the previously permitted disposal systems as described below.

6. Reservoir 6 is a holding and treatment basin used for water storage, and contains water decanted from the tailings basin. Return water for the plant water supply is pumped from a station on Reservoir 6. This reservoir discharges through siphon outfall SD001, at a combined maximum rate of 9.4 million gallons per day (MGD), to Reservoir 2, which is a water of the state that flows to the O'Brien Diversion Channel.

7. Outfall SD005 was established to discharge water from the tailings basin to Reservoir 2 North and Welcome Creek, to Reservoir 2, at a maximum flow of approximately 23 MGD. The proposed expansion to the mining and pellet manufacturing process will result in a vertical expansion of the tailings basin, and changes to the volumes discharged to and from the tailings basin. Discharges to surface water from the tailings basin following the expansion will not exceed the pre-expansion volumes.

8. The reissuance of NPDES/SDS Permit No. MN0055948 (Permit) is requested to authorize continued operation of permitted disposal systems associated with the Keetac tailings basin and the discharge of wastewater associated with the permitted disposal systems.

9. In order to better meet the operational needs of the facility, the Permittee requested a new outfall for dewatering the Sargent Pit, which is an existing mine pit where the dewatering water is currently directed to outfall SD003 authorized under NPDES/SDS Permit No. MN0031879 (Keetac Mining).

10. While the dewatering activity is similar to other mine pit dewatering operations authorized in NPDES/SDS Permit MN0031879, due to the proposed discharge location, MPCA staff determined that the direct discharge of mine pit dewatering from the Sargent Pit to an unnamed ditch should be included in NPDES/SDS Permit No. MN0055948.

11. The immediate receiving waters affected by this permit reissuance include: Reservoir 2, Reservoir 2 North, Welcome Creek, and an unnamed ditch, which discharges to Welcome Creek.

APPLICABLE STANDARDS

Technology-based Treatment Standards

12. Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category.

13. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit.

14. The applicable BPT and BAT standards for mining area and tailings basin discharges are total Suspended Solids (TSS) and Total Iron, as limited in the currently effective Permit.

Water Quality Standards

15. All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek is classified as Class 2C waters as listed in 7050.0470 subp. 4.A. item (236). According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water. Reservoir 2, Reservoir 2 North, and the unnamed ditch leading to Welcome Creek are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

16. Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

17. In addition, the MPCA staff has made the determination that discharges from the facility reaches downstream waters, which are "used for the production of wild rice" as stated in Minn. R. 7050.0224 subp. 2. The determination was made prior to the permit modification dated June 17, 2010, and no revisions to the determination were made during the permit reissuance process.

18. As resquired by 40 C.F.R. § 122.44(d)(1), MPCA evaluated the proposed discharge to determine whether the discharge has a reasonable potential to cause or contribute to a violation of applicable water quality standards.

19. Effluent limitations have been included in the draft Permit for total sulfate based on the results of the reasonable potential analysis.

20. In addition to the numeric water quality standards for applicable use classifications, Minn. R. 7050.0185 governs nondegradation for all waters. Nondegradation review is required by the MPCA for significant new and expanding discharges as defined in Minn. R. 7050.0185 to determine whether additional controls beyond compliance with water quality standards are warranted to prevent degradation of waters of the state. For this Permit, a significant new or expanded discharge would be defined as one in which the maximum design flow expands by more than 200,000 gallons per day above the existing baseline flow, or would increase the concentration of a toxic pollutant in the receiving water by greater than one percent. Nondegradation review has been completed for this Permit as detailed below.

21. Given that the new discharge location for Sargent Pit dewatering to the unnamed ditch represents an expansion of the facility's permitted discharge to this receiving water by more than 0.2 mgd, and an increased loading of one or more pollutants over the baseline quality in the receiving water, the discharge of dewatering effluent has been reviewed in accordance with Minn. R. 7050.0185. The review includes consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water. The statistical reasonable potential analysis shows that the proposed project will not impair the designated beneficial uses of the receiving waters. Sargent Pit dewatering effluent is currently directed to other pits, and discharged via outfalls permitted under NPDES/SDS Permit MN0031879, therefore the new outfall only constitutes a new or expanded discharge to the extent that it discharges to waters that do not currently receive Sargent Pit dewatering effluent. The O'Brien Diversion Channel was determined to be a water of the state that already receives the proposed discharge, therefore nondegradation review was limited to waters of the state upstream from that water body. The proposed discharge has been permitted to protect water quality standards in the water bodies upstream of the O'Brien Diversion Channel. The EIS for the proposed Keetac expansion project indicates that water chemistry in the discharge is not anticipated to change due to continuation of similar mining and dewatering activity following the expansion, therefore degradation of the O'Brien Diversion Channel and its downstream waters is not expected. Additional controls to prevent degradation in the immediate receiving waters upstream of the O'Brien Diversion Channel have not been determined to be warranted pursuant to Minn. R. 7050.0185.

22. No expansion of the maximum daily design flows above the currently permitted levels is authorized by the Permit for stations SD001 or SD005. Additionally, the water chemistry in these discharges is not anticipated to change because the Permittee has committed to install additional treatment technology on internal waste streams to maintain baseline quality as defined in Minn. R. 7050.0185. Therefore, discharges via SD001 and SD005 authorized by the Permit do not constitute significant new or expanded discharges, and nondegradation review is not required for these discharges for the proposed reissuance of the Permit.

PROTECTION OF WATERS USED FOR THE PRODUCTION OF WILD RICE

23. The reasonable potential analysis for sulfate in the mine area discharges resulted in the inclusion of an effluent limit based on the 10 mg/L stated applicable to "waters used for the production of wild rice." The sulfate effluent limits are 14 mg/L calendar month average and 24 mg/L daily maximum.

24. The effluent limitations for sulfate have been calculated utilizing statistical methods derived from the U.S. Environmental Protection Agency (EPA) Technical Support Document for Water Quality-Based Toxics Control. The limits are calculated assuming no dilution capacity in the receiving waters, maximum flow from the permitted discharges, and a waste load allocation of 10 mg/L sulfate based on the ambient water quality standard for waters used for the production of wild rice. Compliance with the calculated effluent limitations provides reasonable assurance that the Permittee's discharges are not causing or contributing to excursions above the water quality standard within the water bodies where the standard applies.

25. U. S. Steel is currently unable to comply with the sulfate effluent limits. Due to the complex nature of the wastewater disposal systems at the Keetac facility, a facility-wide compliance solution must be investigated that incorporates both water management and treatment solutions. The MPCA staff determined that inclusion of a compliance schedule in the Permit is appropriate. Therefore, the Permit reissuance includes by reference a schedule contained in NPDES/SDS Permit MN0031879 for attaining compliance with the final effluent limitations for total sulfate on a facility-wide basis.

26. The compliance schedule in the draft Permit requires the completion of a Water Management Study and a Sulfate Reduction Strategy Study, which are required to inform the development and implementation of a Sulfate Reduction Plan. The implementation of the Sulfate Reduction Plan is required to lead to compliance with the final effluent limitations for sulfate as soon as possible. The Sulfate Reduction Plan must provide justification for the proposed timeframe for attaining compliance.

27. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2018. The maximum term of the compliance schedule is based on potential time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The schedule does not automatically grant the maximum timeframe, but requires MPCA approval at interim steps and requires that all interim steps proceed to compliance with final effluent limitations as soon as possible. The schedule requires the Permittee to make reductions in sulfate concentration to the extent practical prior to the end of the compliance schedule.

28. Interim requirements for the compliance schedule prior to the final attainment of compliance include completion of the Water Management Study and Sulfate Reduction Strategy Study currently underway, preparation and submittal of the Sulfate Reduction Plan, implementation of the Sulfate Reduction Plan following the MPCA approval of the plan, and progress reporting. The Permit specifies maximum timeframes for completion of interim requirements. Implementation of the actions contained in the Sulfate Reduction Plan following MPCA approval will also be enforceable actions due to implementation of the approved plan being an enforceable condition of the Permit.

29. Additional enforceable interim requirements are built into the schedule contingent upon the proposals in the Sulfate Reduction Plan. Distinct timeframes for the attainment of compliance following the MPCA approval of the plan are required, and are dependent on whether or not the the MPCA approves full-scale testing of treatment technology on representative outfalls prior to final implementation on all discharges. The Permit allows time for completion of such testing in

the event that such a proposal is approved by the MPCA, but specifies maximum timeframes for completion of the testing, and requires that interim effluent limitations for sulfate be met at the representative outfalls following treatment evaluations. If full-scale treatment evaluation is not approved by the MPCA, the Permit requires compliance to be attained in a shorter timeframe.

REVISIONS TO THE SULFATE COMPLIANCE SCHEDULE

30. The EPA requested to review the draft permits, outside of the public comment period, under federal authority. The EPA submitted a comment letter to the MPCA dated September 2, 2011. Specific comments and the MPCA responses regarding the sulfate compliance schedule are discussed below.

31. The EPA requested the MPCA to revise draft NPDES/SDS Permit No. MN0055948 either to incorporate by reference the compliance schedule in draft NPDES/SDS Permit No. MN0031879, or provide the same level of detail as is included in draft NPDES/SDS Permit No. MN0031879.

32. The MPCA staff modified draft NPDES/SDS Permit No. MN0055948 to include the compliance schedule contained in draft NPDES/SDS Permit No. MN0031879 by reference.

33. The EPA requested the MPCA to revise the compliance schedule so that the different paths outlined in the compliance schedule following the MPCA approval or disapproval of treatment technology pilot studies are independent, and contain distinct enforceable actions leading to compliance with the effluent limits for sulfate.

34. The MPCA staff modified the language in draft NPDES/SDS Permit No. MN0059948 to indicate two distinct schedules, with distinct requirements for attainment of compliance with final effluent limitations for each case regarding MPCA approval or disapproval of a request for full-scale treatment evaluation on representative outfalls.

35. The EPA requested the MPCA to revise the compliance schedules so that it is clear that the full scale treatment technology pilot studies are required for a representative outfall of each type of discharge, specifically tailings basin, dewatering pit, and Reservoir 5/sedimentation basins. The EPA asked that the MPCA specify that the representative dewatering pit outfall will be one included in draft NPDES/SDS Permit No. MN0031879 and therefore fall under that schedule.

36. The MPCA staff modified the compliance schedule in draft NPDES/SDS Permit No. MN0031879 to require evaluation of full-scale treatment evaluation for outfalls representative of wastewater type. The MPCA has not specified the three waste types contained in the EPA comments, due to the possibility of these waste types changing due to operational modifications, dependent on the results of the Water Management Study that is currently in progress. As an equivalent measure, the MPCA is requiring the Permittee to base any request for testing on representative outfalls on consideration of physical condition of the wastewater, wastewater chemistry, and the size/frequency of the discharge within the Sulfate Reduction Plan. The permit language has also been modified to specify compliance dates based on the type of wastewater discharged as requested.

37. The EPA stated that the schedules of compliance require successful full-scale pilot treatment of outfalls representing the various types of discharges at the facility. The EPA requested the MPCA to require interim limits for sulfate at each outfall selected for the full-scale pilot studies, effective upon

completion of the testing phases specified in paragraphs 1.5, 1.6, and 1.7 of draft NPDES/SDS Permit No. MN0055948.

38. The MPCA staff modified the language to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

39. The EPA requested the MPCA to correct the dates specified in the draft NPDES/SDS permits to reflect that the sulfate effluent limits shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019, date specified in the draft NPDES/SDS Permit No. MN0031879. Draft NPDES/SDS Permit No. MN0055948 also appears to specify the incorrect date. Please revise the dates specified in both draft permits to correct the discrepancy.

40. The MPCA staff corrected the final compliance dates to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges.

41. The revised compliance schedule language, based on EPA comments, is included in the permit documents found in Appendix XX. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150, subp. 2 (A) and 40 CFR § 122.47. The Permit requires that compliance with final effluent limitations be attained as soon as possible, and that completion of interim steps result in continued progress toward compliance with final effluent limitations. Where the time between specific interim steps exceeds one year, the compliance schedule requires progress reports to be submitted to the MPCA at a minimum of every 6 months to provide details regarding the implementation of the requirements of the schedule and verify continued progress toward achieving compliance as soon as possible.

PROCEDURAL HISTORY

42. Pursuant to Minn. R. 7001.0100, a draft permit was prepared by the MPCA staff for the proposed permit reissuance.

43. The public comment period for the draft permit began on June 27, 2011, and ended on August 19,2011. The initial 30-day comment period ended on July 27, 2011. Due to circumstances with the state government shutdown, which ran from July 1, 2011 to July 21, 2011, the comment period was extended to August 12, 2011, and a second extension was granted until August 19, 2011.

44. During the comment period, the MPCA received 2 comment letters from government agencies and received 11 comment letters from citizens.

45. The MPCA reviewed each of the comments and prepared responses to all comments received during the public comment period. Comment letters received have been hereby incorporated by reference as Appendix A to these findings. The MPCA responses to comments received are hereby incorporated by reference as Appendix B to these findings.

46. The MPCA concurs with the reasoning of the MPCA staff in its Responses to Comments document (Attachment B) and adopts the reasoning by reference on these findings. The EPA comments and the MPCA responses to those comments are also included in the Appendix A and Appendix B, respectively.

SELECTED COMMENTS AND MPCA RESPONSES

47. During the public comment period for the Permit, the MPCA received 179 requests for extension of the public comments period, 177 were received in substantially identical e-mails.

48. In addition to the requests for extension of the public comment periods, the MPCA received 117 comment letters regarding the Permit, 106 of which were received in substantially identical e-mails.

49. Comments received on the draft Permit centered primarily on the relationship between the Permits and a proposed expansion on mining at the Keetac facility, water quality-based effluent limitations, and a compliance schedule in the draft Permits for the application of final effluent limitations for sulfate, which are based on an ambient water quality standard for wild rice production waters.

50. In response to comments received, the MPCA staff has modified the draft Permit to clarify and improve enforceability of compliance schedule requirements.

51. The comments received on this Permit and NPDES/SDS Permit MN0031879, as well as the MPCA responses to the comments, are detailed in Appendix B.

FINAL DETERMINATION OF WHETHER TO REISSUE PERMIT

52. The MPCA finds there is jurisdiction for U. S. Steel's NPDES/SDS permit reissuance in accordance with Minn. R. 7001.0100, subp. 1 which states:

Subpart 1. After a permit application is complete, the commissioner shall make a preliminary determination as to whether the permit should be issued or denied.

53. The MPCA has followed the procedures for the reissuance of the NPDES/SDS Permit according to the provisions in Minn. R. ch. 7001.

54. The MPCA's decision to reissue the NPDES/SDS Permit is governed by its permit rule, Minn. R.7001.0140, which in part, states:

Subpart 1. Except as provided in subpart 2, the agency shall issue, reissue, revoke and reissue, or modify a permit if the agency determines that the proposed permittee or permittees will, with respect to the facility or activity to be permitted, comply or will undertake a schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the agency, and conditions of the permit and that all applicable requirements of Minnesota Statutes, chapter 116D, *and the rules adopted under Minnesota Statutes, chapter 116D, have been fulfilled. For solid waste facilities, the requirements of Minnesota Statutes, section 473.823, subdivisions 3 and 6, must also be fulfilled.*

CONCLUSIONS OF LAW

55. The MPCA is authorized and required to administer and enforce all laws relating to the pollution of the air and water of the state. Minn. Stat. chs. 115 and 116.

56. The MPCA has authority to reissuance this NPDES/SDS Permit. Minn. Stat. chs. 115 and 116 and Minn. R. chs. 7000, 7001, 7009, and 7020.

57. Under the federal Clean Water Act, the MPCA is delegated the authority from EPA to issue NPDES permits. 33 U.S.C. §1342; Minn. Stat. § 115.03, subd. 5.

58. A draft permit for the facility was prepared and public noticed in accordance with the requirements of Minn. R. 7001.0100 and public comments on the draft permit were addressed in accordance with MPCA rule requirements.

59. The requirements of Minn. R. ch. 7001, including Minn. R. 7001.0100 reissuance of a NPDES/SDS Permit, have been met including all applicable provisions of Minn. Stat. ch. 116D and Minn. R. ch. 4410. The MPCA determines that the Permittee will comply and will undertake the schedule of compliance to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA, and conditions of the reissued NPDES/SDS Permit.

60. The NPDES/SDS Permit contains effluent limitations and requirements that are protective of the environment and human health.

61. The findings of the MPCA justify reissuance of the NPDES/SDS Permit and do not support denial of the permit.

62. Areas where the potential for significant environmental effects may have existed have been identified and appropriate mitigation measures have been incorporated into the project design and permits. The project is expected to comply with all MPCA standards.

63. Any findings that might properly be termed conclusions and any conclusions that might properly be termed findings are hereby adopted as such.

ORDER

The Minnesota Pollution Control Agency approves the reissuance of the National Pollutant Discharge Elimination System/State Disposal System Permit No. MN0055948 to U. S. Steel Corporation for the Minnesota Ore Operations – Keetac Tailings Basin.

IT IS SO ORDERED

____
Commissioner Paul W. Aasen
Chair, Citizens' Board
Minnesota Pollution Control Agency

____
Date

APPENDIX A

Minnesota Pollution Control Agency

United States Steel Corporation, Minnesota Ore Operations, Keetac
National Pollutant Discharge Elimination System/State Disposal System
Permits MN0031879 and MN0055948

LIST OF COMMENT LETTERS RECEIVED

1. Lenard Anderson, Cloquet Citizen. Letter received electronically August 12, 2011.
2. Larry Dolphin, Izaak Walton League of America. Letter received August 19, 2011.
3. Lotti Matkovits, Golden Valley Citizen, Letter received electronically August 11, 2011.
4. Kathryn Hoffman, Minnesota Center for Environmental Advocacy (MCEA), Letter received electronically August 19, 2011.
5. Kevin M. Pierard, U. S. EPA Region 5. Letter received September 2, 2011.
6. Paula Goodman Maccabee, Esq., Just Change Law Offices, WaterLegacy. Letter received electronically August 18, 2011.
7. Nick Axtell, 1854 Treaty Authority. Letter received electronically August 12, 2011.
8. Mason C and Gwen S Myers, Minnetonka Citizens, Letter received electronically August 19, 2011.
9. Susan Stewart, Mahtomedi Citizen, Letter received electronically August 18, 2011.
10. Christine Hoffman, Alexandria Citizen, Letter received electronically August 14, 2011.
11. Gale Havrilla, Silver Bay Citizen, Letter received electronically August 12, 2011.
12. Comments from Group of Concerned Citizens – Extension Request. Letters received electronically August 10, 2011, to August 20, 2011.
13. Comments from Group of Concerned Citizens. Letters received electronically August 15, 2011 to September 8, 2011.

Comments from Group of Concerned Citizens – Extension Request:

Greg Overlid, Tracy Napp, Jean Ross, Michele Nihipali, Mary Dosch, Harriet Mccleary, Stephen Rossitter, Elizabeth Mullen, William Herzberg, Mikanuk "Larry D. Adams," Kim Clymer Kelly, Diane Jankord, Rose Ramsey, Maxene Linehand, Cary Anderson, Beth Lewis, Ryan Anderson, Stephen Jay, Rebecca Lucking, Jacquelin Bartosh, Steven Koschak, Jane Koschak, Jamie Hoerter, Linville Doan, Steven Tracy, Amy Gardner, Lawrence Krantz, Melinda Sueflow, Stuart Knappmiller, Frank Moe, Kay Hempel, Ann Galbraith Miller, James Dushane, Pat Stevesand, Judith Rosenblatt, Paul Schollmeier, Carolyn Clements, Kay Labanca, Sue and Mike Prom, Guy Bateman, Elinor Ogden, Brian Major, Christine Hoffman, Christopher Boldt, Nathaniel Mordal, Paulette Anholm, Roger Michael, Jim Bambenek, Kay Koelkerwestby, Madelynn Frazier, Verba Weaver, Jamie Kaiser, Jan Scofield, Margaret Klette, Robert Robbings, Jayne Johnson, Judith Stoltzfus, William Dustin, Robert Davis, Frank Verderame, Colles Larkin, Terry Hokenson, Honor Schauland, Will Tajibnapis, Andy Pearson, Margie and David Back, Leslie Limberg, Lewsi Kuhlman, Amy Rus, Matt Johansen, Patricia Liquard, Sandra Keller, Anne Uehling, Gavin Sparby, Roger Muellner, Ann Marie, Mike Conrad, Betsey Porter, Mollie Schierman, David Howd, Susan Stewart, Jeanne Piehl, Karen Brugger, Kimberly Nieman, Martin Makinen, Kim Fishburn, Jim Carlen, Carol Mockovak, Dan Iverson, Kristi Kraling, Terry McCarthy, Sharon Meister, Jane Jasperson, John Paul Roy, Marie Digatono, James and Sara Conway, Alexander Heid, Jeffrey Kirst, Jim Scheidt, Mark Sulander, Dick Bently, Barbara Janssen, Alex Barbeau, John Schmitt, Jesse Lucking, Christopher Loch, Allan Hancock, Nan Corliss, Elizabeth Merz, Annie Gardner, Diadra Decker, Kurt Seaberg, Glady's Schmitz, SSND, Christopher Norbury, Seymour Gross, Kevin Koschak, John Viacrucis, Donald Janes, Ann Beane, Krissy Hughes, Chad Oness, Peter Veits, Mary Moriarty, Ordell Vee, David Higgins, Corinne Livesay, Rosemary Welch, Art Wilkinson, Susan Scherer, Michael Kinney, Tony Doom, Karen Matthew, Erin Strauss, Ann Mikkelsen, Mark Kassal, Sue Halligan, Elisabeth Johnson, Robert Bullis, Erik Roth, Candice Mohammad, Janice Hallman, Janice Greenfield, Gail Grabow, Alma Ronningen, Judy Nelson, Gary Rost, Mimi Gngold, Katherine Doerr, Brian Thornbjornsen, Barb Knoth, Robert Desjarlait, Sharon Fortunak, Walk Gordon, Andrea Heier, John Pegg, Kathleen Moraski, Brent Gurtek, Carol Schaaf, Loren Stoner, Karrie Vrabel, Marie Nickell, Kate Ford, Michael Rice, Rebecca Stoner, Jeffrey Masco, A Bonvouloir, Jon Damon, Catherine Chayka, Ann Herdna, Martha Krikava, Douglas Limon, Lynn Lang, Kathy Kormanik, Bryan Hansel, Sandy Dvorsky, Mark Jepson, Lotti Matkovits

Comments from Group of Concerned Citizens:

A. Bonvouloir, Allan Hancock, Analiese Miller, Ann Chemin, Ann Marie, Annie Gardner, Arnie Roos, Art Wilkinson, Barbara Janssen, Barbara Stamp, Betsey Porter, Bruce McKay, Carlos Zhingre, Carolyn Clemnts, Cheryl Dannenbring, Chris Burda, Christine Hoffman, Christopher Carlson, Corinne Livesay, David Higgins, Deborah Huskins, Diane Tuff, Dorie Reisenweber, Edjee Jonson, Edward Bouril, Erik Roth, Gail Grabow, Greg Klave, Gregory King, Guy Bateman, Harriet Mccleary, Herbert Davis, Honor Schauland, Ian Johnson, Jacqueline Bartosh, James Merkling, Jan Karon, Janice Greenfield, Jenna Conley, Jim Hart, Jim Hawkins, Jody Slocum, Joe Thorne, Johann Chemin, John Bussjaeger, John Schmitt, John Viacrucis, Karen Brugger, Karen Raccio, Kay Hempel, Kay Koelkerwestby, Krissy Hughes, Kristi Kraling, Kristin Olson, Lawrence Krantz, Lea Foushee, Lewis Kuhlman, Linda Morris, Lois Norrgard, Loren Stoner, Louis Asher, Lynn Lang, M. Richardson, Margie and David Back, Mark Kowaliw, Mark Salamon, Mary Lou Wilm, Mary Smith, Mary Suelflow, Mary Thompson, Mary Zink, Mikanuk "Larry D. Adams," Mike Ferguson, Mike Link, Mike Mjelde, Nan Corliss, Nancy Conger, Ordell Vee, Paul Thompson, Retha Dooley, Robert Davis, Roberta Avidor, Robin Poppe, Roger Muellner, Rosie Neher, Ryan Anderson, Sally Fineday, Sandra Keller, Saraphine Metis, Sharon Fortunak, Terry Hokenson, Terry Williams, Tony Doom, Tracy Napp, Tyler Henkels, Verba Weaver, Vikki Howard, Wanda Ballentine, Wendy Robertson, Will Tajibnapis, William Barton, William Dustin, William Herzberg

APPENDIX B

Minnesota Pollution Control Agency

United States Steel, Minnesota Ore Operations
Keetac – Tailings Basin NPDES/SDS Permit No. MN0055948
Keetac – Mining Operations NPDES/SDS Permit No. MN0031879

RESPONSES TO COMMENTS ON THE DRAFT PERMITS

1. <u>Comments by Leonard Anderson, Cloquet Citizen. Letter received electronically August 12, 2011.</u>

Comment 1-1: The sulfate limit allowed in this permit is in violation of the Minnesota standard for sulfate in wild rice.

Response: The comment indicates that the final effluent limitations contained in the draft permits are not consistent with the ambient water quality standard of 10 milligrams per liter (mg/L) sulfate for the protection of wild rice production waters, and that the maximum daily effluent limitation of 24 mg/L total sulfate is simply based on the highest observed value. The effluent limitations contained in the permit are based directly on the 10 mg/L total sulfate standard, and were calculated utilizing the same statistical procedures that are used to determine water quality-based effluent limitations (WQBEL) for National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) permits throughout Minnesota. The maximum measured value of 23.4 mg/L was not used in any way to determine the appropriate effluent limitations, but rather was used as a basis for comparison to determine whether or not the discharges authorized by the permits exhibited reasonable potential to cause or contribute to an excursion above the applicable water quality standard in the receiving water body. Based on the statistical analyses that were completed, the Minnesota Pollution Control Agency (MPCA) technical staff have determined that compliance with the effluent limitations contained in the draft permits will ensure that the permittee is not causing or contributing to excursions above 10 mg/L total sulfate in the receiving waters.

Comment 1-2: It is wrong to write an agreement between United States Steel Corporation (USS). and the State of Minnesota that allows them to violate the 10 mg/L standard until August 17, 2019.

Response: The MPCA disagrees with the characterization of the permits as agreements. The permits are regulatory instruments that require compliance with applicable environmental protection requirements. MPCA also disagrees with the assertion that the permits allow U.S. Steel Corporation to violate the 10 mg/L water quality standard until 2019. This statement is incorrect, as the permits are regulatory documents that contain a schedule of compliance that requires the Permittee to comply with the final effluent limitations for sulfate as soon as possible. The permits require progress toward compliance throughout the duration of the compliance schedule, and do not automatically grant the maximum amount of time allowed by the schedule, but instead require continual progress toward compliance, and require approval of proposed timeframes by the Minnesota Pollution Control Agency (MPCA).

Comment 1-3: Fish tissue mercury should also be considered. Increased sulfate discharges will in turn increase mercury methylation and therefore increase the fish tissue mercury.

Response: The permits do not authorize discharge of additional sulfate above the nondegradation baseline under the current permits for the referenced waters. The sulfate and mercury monitoring requirements in the permits during the interim period prior to the attainment of compliance with the final effluent limitations are consistent with the MPCA policy for addressing mercury impairments, including fish tissue impairments affected by mercury methylation. The effluent limitations of 14 mg/L as a calendar month average and 24 mg/L as a daily maximum represent decreases from the current discharge concentrations; therefore it is incorrect to state that they will result in any additional degradation beyond currently observed levels. Furthermore, the compliance schedules in the draft permits require the Permittee to take actions to reduce sulfate concentrations to the extent practical as soon as possible during the interim period.

Comment 1-4: The sulfate limit in the permit should be 10 mg/L.

Response: The final effluent limitations in the draft Permits have been calculated based on a waste load allocation of 10 mg/L total sulfate, and are applied to ensure that the Permittee's discharges do not cause or contribute to excursions above the applicable ambient water quality standard for sulfate, thereby ensuring that the Permits are protective of waters used for the production of wild rice. The limits are applied with a schedule of compliance in accordance with all state and federal regulations. Therefore, the Permits have not been modified as requested in your letter.

2. Comments by Larry Dolphin, Izaak Walton League of America. Letter received August 19, 2011.

Comment 2-1: The Minnesota Division Izaak Walton League of America opposes the issuance of a permit that allows a 10 mg/L sulfate standard until August 17, 2019 and supports the comments of member Len Anderson.

Response: See responses to comment 1-1 through 1-4.

3. Comments by Lotti Matkovits, Golden Valley Citizen, Letter received electronically August 11, 2011.

Comment 3-1: The commenter opposes the issuance of the permits without imposing limits on mercury and other toxic metals.

Response: The MPCA has reviewed site-specific data from the permit applications, including effluent data for mercury and metals, and determined that the discharges do not exhibit reasonable potential to cause or contribute to an excursion above the applicable water quality standards in the receiving water body for those pollutants. This reasonable potential evaluation was completed consistent with applicable state and federal requirements and is detailed in the statement of basis documents supporting the draft permits. Furthermore, the mercury monitoring requirements in the draft permits are consistent with MPCA policy for addressing mercury impairments in receiving and downstream waters.

Comment 3-2: The commenter also requests more time to comment on the permits.

Response: The MPCA extended the original public comment period for the permits, with the final comment period closing on August 19, 2011. The information related to the Keetac expansion has previously been available for public review during the public notice of intent to major modify

NPDES/SDS Permit MN0031879, which was open from May 14, 2010, to June 14, 2010; the public comment period for the Environmental Impact Statement (EIS) scoping process, which was open from September 8, 2008 to October 8, 2008; the public comment period for the draft EIS, which was open for 45 days, ending on January 26, 2010; the public comment period for the final EIS, which was open from November 12, 2010, to December 20, 2010; and public meetings regarding the EIS on October 1, 2008, and January 11, 2010. Additionally, the public will have the opportunity to present comments regarding the proposed reissuance of the permits at the MPCA Citizens Board meeting on October 25, 2011, where the permits will be presented for final determination on the reissuance. Additional information regarding the meeting can be found on the MPCA website, at the following address: http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/mpca-citizens-board/mpca-citizens-board.html

4. Comments by Kathryn Hoffman, Minnesota Center for Environmental Advocacy (MCEA), Letter received electronically August 19, 2011.

Comment 4-1: MCEA requests that the MPCA Citizens Board consider the issuance of the NPDES permits.

Response: The MPCA has agreed to present the permits to the Citizens Board for final determination on the proposed reissuances, pursuant to requests received during the public comment period.

Comment 4-2: MCEA requests that changes be made to Permit MN0055948 to clarify the location and limit derivation for SD008.

Response: Page 6 of the permit lists SD008 as the sum of the outfalls associated with SD001 and SD005. This is not an additional outfall, but simply a mathematical summation of the discharge flows associated with SD001 and SD005 to ensure that the total volume discharged from the tailings basin meets federal regulations. Given that the interim and final periods referenced in the permit are associated with effluent limitations for sulfate at individual outfalls, the permit has been corrected to reflect that the monitoring and reporting requirements for SD008 are applicable during both the interim and final periods.

Comment 4-3: The compliance schedule is contrary to Minnesota law. It exceeds the maximum time period for compliance, and does not meet the statutory or regulatory definitions of a compliance schedule.

Response: The comments indicate that the compliance schedules contained in the draft permits exceed the maximum timeframe of five years allowed under Minn. R. 7052.0260 subp. 3. Please note that Minn. R. ch. 7052 applies specifically to the Lake Superior Basin. Given that the compliance schedule in the permits regulates point source discharges to the Mississippi River basin, the rules regarding compliance schedules under Minn. R. 7052.0260 are not applicable in this case. The compliance schedule has been developed in accordance with the requirements of Minn. R. 7001.0150 subp. 2.A.

The comments additionally state that the compliance schedules contained in the permits do not meet the requirements for a compliance schedule by failing to lead to compliance with applicable Minnesota Rules. The comment also states that the compliance schedules do not lead to compliance, as the schedule does not specify the means by which the limitations must be met, or require interim benchmarks other than further study. These statements are incorrect, as the requirements of the compliance schedules are explicitly written with the requirement to attain compliance with the final effluent limitations for total sulfate contained in the permits. The requirements to complete the Water Management Study and the Sulfate Reduction Strategy Study, both currently in progress pursuant to NPDES/SDS Permit MN0031879, have the express purpose of informing the development of a Sulfate Reduction Plan that the Permittee is required to implement following MPCA review and approval to attain compliance with the final effluent limitations contained in the permits. The permits have been modified to clarify how the actions required by the compliance schedules must lead to compliance with the final effluent limitations for total sulfate.

The comments indicate that the compliance schedules in the permits fail to require interim measures that lead to compliance with the final effluent limitations, specifically stating that the interim requirements do not lead to compliance within five years, that interim reductions in pollutant load or concentration must be made to achieve compliance with final effluent limitations as soon as possible, and that the interim requirements of the schedules fail to meet the intent of the federal regulations governing compliance schedules in NDPES permits. As previously discussed, the five year maximum timeframe referenced in your comments is not applicable to the compliance schedules contained in the permits, and the schedules meet the applicable requirements under Minn. R. 7001.0150. Please note that the compliance schedules require the Permittee to continue minimizing sulfate concentrations in the discharge to the extent possible prior to the compliance date, a requirement which will be informed by the completion of the required Water Management Study and Sulfate Reduction Strategy Study currently in progress. Additionally, in response to comments received following public notice of the intent to reissue the permits, the MPCA has added requirements to comply with interim effluent limitations following completion of any approved treatment evaluations to ensure that continued progress is made toward compliance with the final effluent limitations prior to the end of the compliance schedules. Following completion of the required Water Management Study and Sulfate Reduction Strategy Study, the permits require the Permittee to implement the actions contained in an approved Sulfate Reduction Plan, which is required by permit language to lead to compliance with final effluent limitations as soon as possible. The language in the permits has been modified to clarify how implementation of the Sulfate Reduction Plan will lead to compliance with final effluent limitations.

The comments raise concern that no progress has been made toward compliance with effluent limitations based on the ambient water quality standard for sulfate in wild rice production waters. It should be noted that, as stated in the permits, the Permittee submitted plans for the Water Management Study and the Sulfate Reduction Strategy Study following modification of NPDES/SDS Permit MN0031879 on June 17, 2010, and both plans were approved by the MPCA on October 6, 2010. Both of the studies are currently in progress, as indicated by the first progress report, which was submitted in accordance with the requirements of NPDES/SDS Permit MN0031879 on April 6, 2011.

Additionally the comments correctly note that 40 CFR 122.47(a)(1) requires that compliance schedules must be written to require compliance as soon as possible. It should also be noted that the permits have been drafted to explicitly require that "Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges, unless the permit is modified pursuant to 40 CFR 122.62." Additionally, the permits do not automatically grant the maximum amount of time, but rather require approval by the MPCA of proposed timeframes for the attainment of compliance, and ongoing demonstration by the Permittee through progress reports on the implementation of the Sulfate Reduction Plan that compliance is being attained as soon as possible.

The comments further state that the schedules in the draft permits fail to lead to compliance with the applicable effluent limitations because the compliance schedules do not mandate specific solutions that must be evaluated and implemented to lead to compliance with final effluent limitations. Please note that this is the express purpose of the required Water Management Study and Sulfate Reduction Strategy, and the implementation of solutions that will result in compliance with final effluent limitations for sulfate as soon as possible is the express purpose of the required Sulfate Reduction Plan. The language in the permits has been modified to clarify the intent of these actions.

Comment 4-4: The compliance schedule is contrary to federal law.

Response: The comments indicate that MPCA has violated federal regulation by failing to enforce the ambient water quality standard for sulfate in wild rice production waters, and has exercised authority in violation of federal law by failing to require compliance as soon as possible. As previously discussed, the draft permits include schedules, which specifically require the reduction of sulfate concentrations in the permitted discharges to the extent practical prior to achieving compliance with the final effluent limitations, and require the Permittee to evaluate and implement facility-wide water management strategies and sulfate reduction options with the explicit requirement to comply with final effluent limitations based on the applicable water quality standard as soon as possible. The schedule of compliance contained in the Permits requires that compliance be attained in accordance with all federal regulations. Comments further suggest that the inclusion of language regarding collection of data and research implies that the Permittee may select this as an alternative to compliance with final effluent limitations as required by the permits. Language included in Chapter 1, Section 2 of NPDES/SDS Permit MN0031879 in no way allows the Permittee to select an alternative to compliance with the final effluent limitations in the permits unless the permits are modified in accordance with all state and federal regulations. The language has not been removed at this time.

Comment 4-5: The permits do not reflect the additional pollution burden of the proposed expansion of Keetac mining operations.

Response: The comment indicates that the permits do not require mitigation of impacts on wastewater discharges resulting from the proposed increase in mining and taconite processing activities at the Keetac facility. Please note that the draft Permits do not authorize discharge of sulfate above the nondegradation baseline established by the currently effective Permits, and the Permittee has proposed to implement the mitigation for pollutant increases indicated in the final EIS for the proposed Keetac expansion project in order to prevent the unmitigated impacts predicted by the EIS, as indicated in the applications for the permits. Although the draft permits do not require the Permittee to implement specific mitigation actions, the Permittee is required to implement actions as necessary to prevent degradation of downstream waters and comply with all rules governing nondegradation. The permits do not authorize expansion or change to the characteristics of wastewater discharges that conflict with the requirements of Minn. R.

7050.0180 and Minn. R. 7050.0185 regarding nondegradation for waters of the state, therefore the Permittee must implement mitigation to prevent degradation above currently permitted levels. Furthermore, the compliance schedules previously discussed require the Permittee to further reduce sulfate-related impacts from existing levels. Therefore the impacts on wastewater discharges from the Keetac facility as a result of the proposed mining expansion are not expected to increase from the currently permitted levels. The permits have not been changed to require additional mitigation.

Comment 4-6: The commenter states that "reasonable potential" and WQBEL calculations should be done for all receiving waters, not just immediate receiving waters.

Response: The comment states that the calculations used to determine whether or not the Keetac discharges exhibit reasonable potential to cause or contribute to an excursion above the water quality standards are incomplete, as they have not evaluated the potential to exceed water quality standards in the receiving waters downstream from those immediately receiving the discharge. This statement is incorrect, as the MPCA does evaluate the potential to exceed water quality standards in downstream water bodies. This review is the basis for inclusion of effluent limitations for total sulfate in the draft permits. The immediate receiving waters have not been determined to be waters used for the production of wild rice, however the reasonable potential to cause or contribute to excursions above the ambient water quality standard for the protection of wild rice has been evaluated specifically because of the fact that downstream receiving waters have been determined by the MPCA to be waters used for the production of wild rice. Additionally, the comments state that the reasonable potential calculations do not take into account the higher flows for the downstream receiving waters where the ambient water quality standard for the protection of wild rice would actually apply. The MPCA has taken a conservative approach by applying the effluent limitations as calculated for the immediate receiving water, as the critical low flow rate of zero in the receiving water requires the Permittee to meet the water quality standard without any allowance for dilution in the receiving water, as reflected by the waste load allocation of 10 mg/L used in the reasonable potential calculations for sulfate.

Comment 4-7: When calculating the sulfate effluent limits, MPCA should use the actual coefficient of variation (CV) from the Keetac facility, not a hypothetical CV of 0.6.

Response: The comment indicates that effluent limitations for total sulfate should be calculated utilizing a CV of 0.106 based on the current variability observed in discharges via SD005, instead of an assumed CV of 0.6, as it results in a lower effluent limitation, which MCEA believes to be more conservative. The CV is a statistical value, which describes the variability associated with treatment operations, and the default value of 0.6 taken from U.S. Environmental Protection Agency (EPA) guidance is based on typical variability of effluent concentrations when treatment processes are utilized prior to discharge. Given the likelihood that some form of treatment will be necessary in order to comply with the final effluent limitations for the outfalls currently authorized by the permits, the assumption that the variability of effluent concentrations will remain the same as observed under current operations, in which there is no treatment process in operation specifically for the reduction of sulfate, is not justified. Additionally, the assumption of higher effluent variability is a more conservative assumption, as this assumes that a lower long-term average effluent concentration must be targeted in order to ensure that the effluent waste load allocation of 10 mg/L is met. The effluent limitations for the draft permits have not been recalculated.

Comment 4-8: Based on USS's history, MPCA should require USS to monitor its outfall effluent daily, rather than twice a month. This will result in more accurate testing and more stringent limits.

Response: The permits require that a minimum of two samples per month be collected to demonstrate compliance with sulfate limitations. This sampling frequency is consistent with the MPCA practice for water quality-based effluent limitations in NPDES/SDS permits throughout Minnesota. Although the use of a higher sampling frequency in the statistical reasonable potential calculations does result in lower effluent limitations, the lower effluent limitation does not correlate to a better environmental impact, as the waste load allocation for the discharge of pollutants and the long term average pollutant concentration following treatment do not change. Given that the additional sampling is not believed to be necessary to ensure compliance with environmental standards, the monitoring frequencies required by the draft permits have not been changed.

5. <u>Comment by Kevin M. Pierard, U. S. EPA Region 5. Letter received September 2, 2011.</u>

Comment 5-1: Please revise draft NPDES/SDS Permit MN0055948 either to incorporate by reference the schedule in draft NPDES/SDS Permit MN0031879, or provide the same level of detail as is included in draft Permit MN0031879.

Response: NPDES/SDS Permit MN0055948 has been modified to include the compliance schedule contained in NPDES/SDS Permit MN0031879 by reference.

Comment 5-2: Please revise the schedules so that the different compliance schedules following MPCA approval or disapproval of treatment technology pilot studies are independent, and contain distinct enforceable actions leading to compliance with the WQBEL for sulfate.

Response: The language in NPDES/SDS Permit MN0031879 has been modified to indicate two distinct schedules, with distinct requirements for attainment of compliance with final effluent limitations for each case regarding the MPCA approval or disapproval of a request for full-scale treatment evaluation on representative outfalls.

Comment 5-3: Please revise the schedules so that it is clear that the full scale treatment technology pilot studies are required for a representative outfall of each type of discharge, specifically tailings basin, dewatering pit, and Reservoir 5/sedimentation basins. Please specify that the representative dewatering pit outfall will be one included in draft NPDES/SDS Permit MN0031879 and therefore fall under that schedule.

Response: The compliance schedule has been modified in NPDES/SDS Permit MN0031879 to require evaluation of full-scale treatment evaluation for outfalls representative of wastewater type. The MPCA has not specified the three waste types contained in your comments, due to the possibility of these waste types changing due to operational modifications, dependent on the results of the Water Management Study that is currently in progress. As an equivalent measure, the MPCA is requiring the Permittee to base any request for testing on representative outfalls on consideration of physical condition of the wastewater, wastewater chemistry, and the size/frequency of the discharge within the Sulfate Reduction Plan. The permit language has also been modified to specify compliance dates based on the type of wastewater discharged as requested.

Comment 5-4: The schedules of compliance require successful full-scale pilot treatment of outfalls representing the various types of discharges at the facility. The schedules should require interim limits for sulfate at each outfall selected for the full-scale pilot studies, effective upon completion of the testing phases specified in paragraphs 1.11, 1.12, and 1.13 of draft NPDES/SDS Permit MN0031879 and paragraphs 1.5, 1.6, and 1.7 of draft NPDES/SDS Permit MN0055948.

Response: The language has been modified to require compliance with an interim effluent limitation for total sulfate of 14 mg/L as a calendar quarter average. This effluent limitation will be applied on any outfalls for which full scale treatment evaluation is approved, following the completion of those evaluations, to ensure continued progress toward compliance with final effluent limitations.

Comment 5-5: Please correct the dates specified in the draft permits to reflect that the sulfate WQBELs shall be attained as soon as possible but no later than August 17, 2018, as opposed to the August 2019 date specified in draft NPDES/SDS Permit MN0031879 permit. Draft NPDES/SDS Permit MN0055948 also appears to specify the incorrect date. Please revise the dates specified in both draft permits to correct the discrepancy.

Response: The final compliance dates have been corrected to require compliance with final effluent limitations as soon as possible and in no case later than August 17, 2018, for non-tailings basin discharges, and August 17, 2019, for tailings basin discharges.

Comment 5-6: There is significant public interest in this facility and both of these permits. MPCA should upload the facility discharge monitoring reports (DMRs) and permit compliance status and history for both permits to EPA's Integrated Compliance Information System (ICIS) database.

Response: At this time, the MPCA is not uploading the Permittee's DMRs and compliance status to the ICIS database. The MPCA recognizes the public interest in this facility, and the associated NPDES/SDS permits, and has noted EPA's comments regarding this issue. Please note that all public information regarding NPDES/SDS Permits MN0031879 and MN0055948, as well as the Permittee's compliance with these permits, is available for inspection and copying by any person pursuant to Minn. R. 7000.1200.

Comment 5-7: The data provided with the applications indicate that selenium has been detected at several outfalls. Selenium monitoring requirements are included in the draft permits for SD009 only. At a minimum, please add a monitoring requirement for selenium at SD005 in accordance with 40 CFR §§ 122.44 and 122.48.

Response: The MPCA has added a monitoring requirement for selenium at SD005 as requested.

6. Comment by Paula Goodman Maccabee, Esq., Just Change Law Offices, WaterLegacy. Letter received electronically August 18, 2011.

Comment 6-1: The draft permits for the Keetac Mine Area and Keetac Tailings Basin result from a major expansion of mining activity requiring a comprehensive nondegradation analysis.

Response: As a point of clarification, note that expansion of industrial activity does not trigger a requirement for a nondegradation analysis. The requirement to complete a nondegradation analysis is based on an increase in permitted discharge flow. Although the Permittee has proposed an expansion to the industrial activity conducted at the Keetac facility, the MPCA has determined that a nondegradation analysis is not required for most of the changes to the operation of the permitted disposal systems and the wastewater discharges associated with those systems as a result of the proposed expansion.

The comments correctly note that the applications, which were used for the reissuance of the permits, were originally submitted with the intent to address changes to the permitted operations at the Keetac facility as a result of the proposed mining expansion. It is also correct to state that there will be an increase in the area used for stockpiling, the volume of tailings and associated process wastewater sent from the processing facility to the tailings basin, wastewater discharges from the tailings basin system and dewatering waste streams, and chemical usage associated with taconite processing. However, the proposed changes to operations regulated by permits are primarily within the range currently allowed by the permits, and therefore would not require nondegradation review. In accordance with Minnesota Rules, nondegradation review was completed to the extent that the discharges authorized by the draft Permits constitute significant new or expanded discharges, as discussed in greater detail below.

As indicated in the comments, Minn. R. 7050.0185 subp. 4 require a nondegradation analysis for any new or expanded discharge that is a significant discharge as defined in Minn. R. 7050.0185 subp. 2.G. in order for the MPCA to determine whether additional control measures can reasonably be taken to minimize the impact of the discharge on the receiving water. As detailed in Minn. R. 7050.0185 subp. 5, for discharges of industrial and other wastes, the flow rate to be used to determine whether the discharge is significant is the design maximum daily flow rate. With the exception of the Permittee's proposal to discharge dewatering effluent from the Sargent Pit directly to an unnamed ditch flowing to Reservoir 2, the maximum design discharge flow rates anticipated for this permitting action are equivalent to or lower than the currently permitted flow rates, as indicated in the applications for the permits. For that reason, nondegradation analysis was not completed for the permitted wastewater outfalls that do not meet the definition of significant new or expanded discharges. Pursuant to Minn. R. 7050.0185, a nondegradation analysis was completed for the new discharge of Sargent Pit dewatering effluent to the unnamed ditch to the extent that the new discharge will impact the receiving water bodies, as indicated in the Statement of Basis for NPDES/SDS Permit MN0055948.

The comments further indicate that WaterLegacy believes that the draft Permits will result in degradation of downstream receiving waters, including ORVWs. As discussed in greater detail in the response to Comments 6-2 and 6-3, the MPCA has verified that the draft Permits prevent degradation of downstream receiving waters as required by the provisions of Minn. R. 7050.0180-7050.0185.

Comment 6-2: The Keetac mine expansion nondegradation review should analyze potential impacts to downstream waters of outstanding resource value and Lake Superior Basin waters.

Response: As previously discussed, a nondegradation review was completed for the new discharge of Sargent Pit dewatering effluent to an unnamed ditch leading to Reservoir 2, in accordance with Minn. R. 7050.0185, and that nondegradation review for the other permitted discharges was determined by the MPCA not to be necessary as they do not meet the definition of a significant discharge. The comment indicates that additional nondegradation review is required to address impacts to water bodies downstream of the immediate water body that are Outstanding Resource Value Waters (ORVWs) as defined in Minn. R. 7050.0180.

The comments correctly state that the MPCA is required to control new and expanded discharges upstream of an ORVW to assure no deterioration in the quality of the downstream ORVW, pursuant to Minn. R. 7050.0180 subp. 9. The comments indicate that the MPCA has failed to apply this requirement based on a discretionary decision for the permits, citing a statement from the application for NPDES/SDS Permit MN0055948 reading "MPCA personnel indicated that for the purposes of this application, the MPCA would not apply ORVW nondegradation review, but would rely on the "all waters" classification of the water bodies discharged into and nearby downstream points." This statement should not be interpreted to mean that the MPCA has elected to selectively apply only Minn. R. 7050.0185 for nondegradation requirements applying to all waters, but rather that the MPCA has determined that the water bodies to which the nondegradation review must apply are limited to non-ORVW water bodies, specifically those between the immediate discharge and the O'Brien Diversion Channel, as discussed below.

As documented in the final EIS for the proposed Keetac mining expansion, and as indicated by the wastewater flow diagram in Appendix A, Figure 2 of the permit application for NPDES/SDS Permit MN0055948 illustrating current conditions, dewatering effluent from the Sargent Pit is currently discharged to O'Brien Creek via the Mesabi Chief Pit, as authorized by NPDES/SDS Permit MN0031879. Wastewater discharged via this outfall flows through the O'Brien Reservoir to the O'Brien Diversion Channel. The proposed direct discharge of Sargent Pit dewatering under NPDES/SDS Permit MN0055948 will also eventually discharge to the O'Brien Diversion Channel after flowing through Reservoir 2. Therefore, given that the effluent from this dewatering operation already reaches the proposed receiving waters downstream of Reservoir 2, the discharge does not constitute a new or expanded discharge to the O'Brien Diversion Channel, or any of the receiving waters downstream from that point, including the downstream ORVW water bodies. Therefore, the nondegradation analysis has been completed for the unnamed ditch to which Sargent Pit dewatering effluent will be discharged, as well as Reservoir 2, as they are the only water bodies that will be receiving a new or expanded discharge. Minn. R. 7050.0185 for Nondegradation for All Waters is the applicable rule governing nondegradation for these water bodies. Given that the proposed discharge is not a new or expanded discharge to water bodies downstream of the O'Brien Diversion Channel, the discharge is not expected to affect the water quality of downstream ORVWs, therefore additional controls to prevent degradation of downstream ORVWs pursuant to Minn. R. 7050.0180 subp. 9 are not warranted.

The comments further indicate that nondegradation analysis should be completed to determine impacts resulting from the expansion on Outstanding International Resource Waters (OIRWs) in the Lake Superior Basin due to some portions of the Keetac facility's operations being located within the Lake Superior watershed. As discussed in the EIS for the Keetac expansion, water transfers between basins and rerouting of surface runoff as a result of mining activity are regulated by the Department of Natural Resources, and are outside the scope of the permits. Furthermore, the additional runoff to the Lake Superior Basin resulting from the additional stockpiling activities meets the definition of an expanded discharge of industrial stormwater as described in Minn. R. 7052.0310. Therefore, the MPCA has determined that the requirements to maintain best management practices for the control of industrial stormwater as detailed in the permits are adequate to protect the water quality of the Lake Superior Basin, and further analysis beyond the potential impacts evaluated in the EIS for the proposed Keetac expansion is not required.

Comment 6-3: The Keetac Mine and Tailings Basin permits should set maximum discharge loading limits and require conditions for treatment efficacy needed to prevent degradation of Minnesota Waters.

Response: The comments indicate that the permits should require mass loading limits and internal treatment improvements in order to ensure compliance with nondegradation requirements for hardness and sulfate. The baseline flows and associated pollutant loadings described in Minn. R. 7050.0185 are not intended to be effluent limitations, but instead are triggers for the evaluation of the need for additional requirements in the event that the Permittee proposes to expand their permitted discharge in such a way that it becomes a significant discharge as defined in the rule. The draft Permits do not authorize increased pollutant loading in the permitted discharges in such a way that the permitted discharge flows and baseline effluent quality as defined under Minn. R. 7050.0185 subp. 2.C. would be exceeded, and failure to maintain discharge loading below these values is a violation of the Permits due to incorporation of nondegradation rules by reference. The Permittee has proposed installation of treatment technology to ensure compliance with nondegradation rules, and the MPCA believes that the monitoring requirements for sulfate and hardness related parameters in the draft Permits are sufficient to verify that nondegradation rules are not violated following the operational changes associated with the proposed expansion of mining activity, therefore additional limitations and monitoring requirements have not been added.

Additionally, the comments identify the requirement to comply with final effluent limitations as an outcome following additional sulfate loading. As a point of clarification, the schedules for compliance with final effluent limitations for sulfate are not related to the Permittee's proposal to install additional treatment equipment to reduce sulfate loading to the tailings basin. The Permittee will be required to maintain sulfate loading in the tailings basin discharge below the baseline quality established by Minn. R. 7050.0185 immediately, and must manage water quality in the discharge as necessary to ensure compliance with the nondegradation requirements that are incorporated by reference in the permits. The schedules of compliance included in the permits are for additional reductions that the Permittee is required to make in order to comply with final effluent limitations for sulfate that are based on ambient water quality standards for the protection of wild rice.

The comments also request evaluation of the potential for iron and mercury to degrade water quality, and indicate a request for the inclusion of effluent limitations to restrict mass loading for these parameters to ensure compliance with nondegradation rules. As previously discussed, a nondegradation review was completed in accordance with Minn. R. 7050.0185 for the proposed new direct discharge of Sargent Pit dewatering effluent, in which the MPCA determined that the monitoring requirements for mercury, and the effluent limitations and related monitoring requirements for iron, are adequate to ensure that the water quality standards for the receiving waters will be met in accordance with Minn. R. 7050.0185 subp. 3, and that additional controls to prevent degradation of the receiving waters pursuant to Minn. R. 7050.0185 subp. 4 are not warranted. For the remaining Keetac discharges, as discussed on page 4-52 of the EIS for the proposed mining expansion, water quality associated with wastewater discharges is not anticipated to change for typical parameters of concern with the exception of the impacts associated with the scrubber blowdown waste stream and the treatment of that waste stream. Given that the pollutant concentrations for iron and mercury are expected to remain within the ranges currently observed under the Keetac facility's existing operations, and, as previously discussed, the proposed changes to wastewater flows do not trigger nondegradation review for any discharges other than the Sargent Pit dewatering outfall, the MPCA has determined that the effluent limitations for iron and the monitoring requirements for mercury are sufficient to ensure compliance with the nondegradation requirements that are incorporated by reference in the permits.

Comment 6-4: The Keetac Mine and Tailings Basin permits should impose current effluent limits for sulfate. The schedules of compliance in the draft permits are inconsistent with applicable law.

Response: The comments correctly note the rule citations describing the requirements for schedules of compliance contained in NPDES/SDS permits. The MPCA has applied the state rules and federal regulations that are detailed in the comments in the permits.

The comments indicate that there is not necessarily a connection between the Water Management Study and the Sulfate Reduction Strategy Study (Studies) that are currently in progress pursuant to the requirements of the current NPDES/SDS Permit MN0031879 and a change in sulfate effluent. This is incorrect, as the express purpose of the Studies is to inform the required development of a Sulfate Reduction Plan, which the Permittee is required to implement following MPCA review and approval. The Sulfate Reduction Plan must identify the actions that will be taken by the Permittee with the specific purpose of complying with the final effluent limitations for sulfate. The comments further indicate that the permits do not meet the requirements of state and federal law by failing to require compliance as soon as possible. Please note that the language in the permits explicitly states that "compliance with final effluent limitations shall be attained as soon as possible…" The Permits are structured to require compliance based on a series of actions that could potentially last through August of 2018 for non-tailings basin discharges, and 2019 for tailings basin discharges; however the Permittee is required to comply with the final limitations more expeditiously if possible.

The comments indicate that the MPCA must require immediate compliance with effluent limitations that are based on water quality standards adopted before July 1, 1977. However, EPA precedent indicates that compliance schedules may be allowed for discharges subject to water quality-based effluent limitations derived from standards that are new, revised, or reinterpreted after July 1, 1977. The waters downstream from the Keetac facility's discharges are not specifically named in Minnesota Rules as waters used for the production of wild rice. Based on case-specific review of the information currently available, the MPCA newly interpreted the 10 mg/L sulfate standard in Minn. R. 7050.0224 subp. 2 to be applicable to water bodies downstream from the Keetac discharges in 2010. Therefore, compliance schedules have been determined to be allowed pursuant to Minn. R. 7001.0150.

Comment 6-5: Permits for the Keetac Mine and Tailings Basin should contain WQBELs for selenium, specific conductance, hardness and mercury.

Response: The comment correctly notes that the statement of basis for NPDES/SDS Permit MN0055948 indicates that limits are included in the draft permit for selenium and specific conductance. This statement was included in error, as the MPCA policy is not to include effluent limitations based on limited data. The MPCA has reviewed the data from the permit application for NPDES/SDS Permit MN0055948, and determined that additional monitoring is warranted for selenium and specific conductance at outfall SD009, however there is not sufficient data to determine whether or not reasonable potential exists to exceed water quality standards to warrant an effluent limitation for either of these parameters.

The comments indicate that the MPCA has maximized the potential for dilution in evaluating the reasonable potential to exceed water quality standards by applying maximum design flow in the analysis. In fact, by applying the maximum design flow for the facility's discharge, and the 7Q10 low flow condition for the receiving stream, the MPCA has maximized the potential impact of the discharge on the receiving water concentration as required for these analyses. The critical conditions utilized in these analyses effectively model the reasonable potential to exceed water quality standards in the receiving stream assuming the highest predicted pollutant concentration in the effluent, the highest flow of effluent from the outfall, and the lowest dilution potential in the receiving stream.

The comments regarding hardness indicate that the reasonable potential analysis for this parameter is inadequate due to use of maximum dilution and an incorrect water quality standard. Please note that the water quality standard of 250 mg/L for hardness referenced in the comments is not a Class 2B water quality standard, but is a Class 3B water quality standard as detailed in Minn. R. 7050.0223 subp. 3, and is one of three standards referenced in Minn. R. 7050.0220 subp. 5a.A.(8). This standard is not applicable to the receiving waters for the Keetac discharges, as all of the applicable receiving waters have a Class 3C designation, for which the applicable ambient water quality standard for hardness is 500 mg/L, as utilized in the reasonable potential calculations. As previously discussed, the reasonable potential calculations assume critical conditions that model the minimum dilution; therefore the proper conditions have been evaluated.

The comments regarding mercury suggest that effluent limitations for mercury must be included in the Permits, and recommend an effluent limitation of 6.9 ng/L for the permitted discharges, and 1.3 ng/L for any discharges to the Lake Superior Basin. Please note that reasonable potential analyses have been completed for total mercury at all outfalls authorized by the Permits utilizing a waste load allocation of 6.9 ng/L based on the applicable water quality standards for the water bodies receiving the permitted discharges. None of the permitted discharges are to the Lake Superior Basin, therefore the 1.3 ng/L standard is not applicable. As previously discussed, the critical flow conditions used in the reasonable potential analyses do not maximize dilution potential, but rather account for minimal receiving water dilution. Given that the procedures used to account for mercury water quality standards in the Permits, as described in the final EIS, have not shown reasonable potential, effluent limitations have not been included in the draft Permits. Effluent monitoring requirements have been applied in the Permits, consistent with MPCA policy and the implementation plan for the state-wide mercury Total Maximum Daily Loads.

Comment 6-6: Permits for the Keetac Mine and Tailings Basin should require additional monitoring for hardness (calcium and magnesium), aluminum and manganese and multiple monitoring sites should be required to identify impacts of mine expansion.

Response: The comments indicate that monitoring requirements should be required for calcium in the tailings basin based on nondegradation concerns as previously discussed. As previously noted, the MPCA has included monitoring requirements on the influent waste stream to the tailings basin that is anticipated to contribute to additional hardness, which is believed to be adequate to ensure that nondegradation requirements are met for discharges from the tailings basin. Therefore, additional monitoring requirements have not been included.

The comments further indicate that hardness monitoring should be required on discharges from the Keetac mining area due to anticipated increased use of magnesium chloride as a dust suppressant as a result of the increased footprint of the mine following the proposed expansion. Please note that the mechanism by which this additive contributes to hardness is from precipitation runoff. The increase in the amount of the dust suppressant applied based is anticipated to be accompanied by an equivalent increase in runoff volume, therefore the hardness concentrations observed in the currently discharges are not anticipated to be affected by the proposed expansion, therefore additional monitoring requirements have not been included in the draft Permits.

The comments indicate that aluminum monitoring must be required due to the use of aluminum chlorhydrate in the turbidity treatment system that is used for discharges via SD002. Due to the use of this additive as a flocculent, the aluminum associated with the product becomes bound to the suspended solids from the wastewater. Due to the high removal of solids associated with the turbidity treatment system, aluminum concentrations are not anticipated to increase appreciably, therefore additional monitoring has not been required.

The comments request ongoing monitoring for manganese due to measured concentrations for that parameter in the Keetac tailings basin in excess of the Minnesota Health Risk Limit (HRL), and monitoring data from other mine facilities. Please note that the HRL referenced in the comments is not a water quality standard applicable to the discharges authorized by the Permits, therefore monitoring requirements have not been included in the draft Permits based on this comparison.

The comments express concerns regarding the monitoring frequency required for the permitted discharges. Monitoring requirements have been assigned consistent with MPCA practices for NPDES/SDS permits throughout Minnesota based on consideration of the detention times for the wastewater discharges authorized by the Permits, and the variability in concentrations associated with the industrial activities at the Keetac facility. Additionally, with regard to the comments on the sampling frequency required for mercury, the quarterly sampling requirement is included based on MPCA policy for mercury monitoring for industrial discharges.

Based on review of site-specific information from the Keetac expansion EIS and the data received to support the permit reissuance process, the MPCA has determined that the monitoring requirements are sufficient to characterize the permitted disposal systems and the associated discharges.

Comment 6-7: The permit review process should address additional concerns: mercury methylation, rating of mine expansion permits as "minor," and accessibility of public information.

Response: Your comments indicate concern that sulfate discharges from the Keetac facility will result in additional mercury methylation in receiving waters. Please note that, as previously discussed, the levels of sulfate in the permitted discharges are not authorized to exceed the currently permitted levels due to rules governing nondegradation. Futhermore, the compliance schedule for sulfate in the draft Permits requires that the Permittee further reduce sulfate loading to receiving waters, thereby further reducing the impact of sulfate on mercury methylation over the long-term. The ongoing monitoring requirements for both mercury and sulfate are consistent with MPCA policies for reducing mercury impacts in waters of the state.

Your comments regarding the process for rating NPDES permits as "major" or "minor" have been noted. Please note that the rating worksheet used by the MPCA is the same used for NPDES permits issued by the U.S. Environmental Protection Agency (EPA), and that the EPA's ability to review NPDES/SDS permits issued by the MPCA is not affected by the permit rating.

Your comments regarding public process have been noted. Please note that all public information regarding NPDES/SDS Permits MN0031879 and MN0055948, as well as the Permittee's compliance with these permits, is available for inspection and copying by any person pursuant Minn. R. 7000.1200. Information regarding the presentation of the draft permits for final determination by the MPCA Citizens Board will be made available online at the following address: http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/mpca-citizens-board/mpca-citizens-board.html.

7. Comment by Nick Axtell, 1854 Treaty Authority. Letter received electronically August 12, 2011.

Comment 7-1: The 1854 Treaty Authority would like to see the reasonable potential analysis that was used to determine this average concentration level rather than the standard of 10 mg/L sulfate.

Response: Refer to the response to comment 1-1. In addition, the statement of basis supporting documents for each permit presents information on the reasonable potential analyses for sulfate.

Comment 7-2: The 1854 Treaty Authority is concerned with the length of time the compliance schedules will take and would like to see limitations on sulfate levels prior to the final effluent limits in 2019.

Response: Please refer to the response to comment 5-4.

8. Comment by Mason C and Gwen S Myers, Minnetonka Citizens, Letter received electronically August 19, 2011.

Comment 8-1: The permit will exceed air quality standards without treating wastewater.

Response: Comments have been noted by the MPCA, however, please note that air related comments do not pertain to the Keetac Mine and Keetac Tailings Basin permits identified in your e-mail, and the comments were received following completion of the public comment period for the air emissions permit.

Comment 8-2: The proposed permits are discouraging, given the mercury-related fish consumption restrictions on Minnesota lakes and rivers.

Response: Please refer to the responses to comments 1-3 and 3-1.

9. Comment by Susan Stewart, Mahtomedi Citizen, Letter received electronically August 18, 2011.

Comment 9-1: The commenter voices concern regarding water quality and the fragile nature of wild rice and the impact that mining operations have on these resources.

Response: Comment noted.

10. Comment by Christine Hoffman, Alexandria Citizen, Letter received electronically August 14, 2011.

Comment 10-1: The commenter voiced concerns regarding the natural resources of the area and the impact that mining activities have on the area.

Response: Comment noted.

11. Comment by Gale Havrilla, Silver Bay Citizen, Letter received electronically August 12, 2011.

Comment 11-1: Limits on mercury and other toxic metals should be set in accordance with existing regulations.

Response: Please refer to the response to comment 3-1.

Comment 11-2: The commenter is concerned about the levels of pollution in fish and wild rice in the area.

Response: Please refer to the response to comment 1-3.

12. Comments from Group of Concerned Citizens – Extension Request, Letters received electronically August 10, 2011, to August 20, 2011.

Comment 12-1: The public notices do not explain the proposed mining expansion at the Keetac facility.

Response: The Public Notice of Intent documents for each of the Permits that were distributed in accordance with Minnesota Rules on June 27, 2011, and again on July 27, 2011, when the public comment period was extended to August 12, 2011, to account for business days lost due to the Minnesota government shutdown, explicitly state "The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. The conditions of this permit reflect the changes associated with that expansion." Further, the permits and the statements of basis identify the changes in permitted activities that are anticipated for each of the permits as a result of the proposed mining expansion. As a point of clarification, it should be noted that the permits do not authorize an expansion of mining, but rather authorize the operation of disposal systems and the wastewater discharges associated with those systems. The expected changes associated with the permitted wastewater operations at the Keetac facility following the mining expansion have been well documented in the EIS for the Keetac expansion project, and the conditions in the draft permits are reflective of those changes, as detailed the statements of basis.

Comment 12-2: The draft permits do not explain how the effluent limitations that have been set will be protective of water quality following the proposed mining expansion.

Response: It is not common practice to include the specific details for setting effluent limitations within the text of NPDES/SDS permits, but rather to document this information in the associated statement of basis documents. The effluent limitations that have been included in the draft permits have been calculated in consideration of water quality impacts, consistent with state and federal requirements, as well as MPCA policy for all point source discharge permits in Minnesota.

The effluent limitations have been calculated using the methodology developed from the EPA "Technical Support Document for Water Quality-based Toxics Control," based on consideration of effluent data from the Keetac facility, the applicable ambient water quality standards for the water bodies receiving the Keetac discharges, and expected changes resulting from the Keetac expansion. The water quality considerations documented in the EIS and the statements of basis illustrate how the permits will be protective of water quality. Additionally, these documents address the basis for not including effluent limitations and monitoring requirements for the mining-related pollutants listed in your comments, based on site-specific data for the Keetac facility.

Comment 12-3: Comments were made relating to legislative action associated with the ambient water quality standard for total sulfate applicable to waters used for the production of wild rice.

Response: The MPCA wishes to clarify that the bill referenced in your comments did not result in any changes to the applicability of the current ambient water quality standards. Therefore, the draft permits do include the appropriate final effluent limitations for total sulfate based on all current state and federal regulations, and do require the Permittee to comply with the final effluent limitations based on the existing standard as soon as possible in accordance with the regulations governing compliance schedules in NPDES/SDS permits.

Comment 12-4: The commenter requested additional time to comment on the draft permits.

Response: The MPCA extended the public comment period to end on August 19, 2011, in order to allow for review of the information contained in this response. Please note that much of the information related to your comments has previously been available for public review during the public notice of intent to major modify NPDES/SDS Permit MN0031879, which was open from May 14, 2010, to June 14, 2010; the public comment period for the EIS scoping process, which was open from September 8, 2008, to October 8, 2008; the public comment period for the draft EIS, which was open for 45 days, ending on January 26, 2010; the public comment period for the final EIS, which was open from November 12, 2010, to December 20, 2010; and public meetings regarding the EIS on October 1, 2008, and January 11, 2010.

13. <u>Comments from Group of Concerned Citizens. Letters received electronically August 15, 2011 to September 8, 2011.</u>

Comment 13-1: The comments indicate that the draft permits does not explain how the effluent limitations that have been set will be protective of water quality following the proposed mining expansion.

Response: It is not common practice to include the specific details for setting effluent limitations within the text of NPDES/SDS permits, but rather to document this information in the associated statement of basis documents. As detailed in the statement of basis documents, the effluent limitations that have been included in the draft permits have been calculated in consideration of water quality impacts, consistent with state and federal requirements, as well as the MPCA policy for all point source discharge permits in Minnesota. The effluent limitations have been calculated using the methodology developed from the EPA "Technical Support Document for Water Quality-based Toxics Control," based on consideration of effluent data from the Keetac facility, the applicable ambient water quality standards for the water bodies receiving the Keetac discharges, and expected changes resulting from the Keetac expansion. The water quality considerations documented in the EIS and the statements of basis illustrate how the permits will be protective of water quality. Additionally, these documents address the basis for not including effluent limitations and monitoring requirements for the mining-related pollutants listed in the comments, based on site-specific data for the Keetac facility. Additionally, the comments indicate that the draft permits do not set limits on the total amount of pollutants that will be discharged from the Keetac facility. This is incorrect, as both the water quality and technology-based effluent limitations contained in the permits restrict the concentrations for specific pollutants that can be discharged. These limitations on effluent concentration work in conjunction with Minnesota Rules regarding nondegradation, which are included by reference in the permits, ensure that the total loading of pollutants in the discharges authorized by the permits meets all applicable state and federal regulations.

Comment 13-2: The Keetac Air Emissions permit will allow more than 75 pounds of additional mercury to be emitted into the air.

Response: Comments have been noted by the MPCA, however, please note that these comments have no bearing on the Keetac Mine and Keetac Tailings Basin permits identified in your e-mail, and the comments were received following completion of the public comment period for the air emissions permit. As for mercury discharges associated with the discharges in the permits, please note that the mercury concentrations in the Keetac facility's wastewater discharges have not been shown to exhibit reasonable potential to cause or contribute to excursions above the ambient water quality standard for this pollutant.

Comment 13-3: The permits do not set any limits on the amount of sulfate allowed to be discharged as the Keetac facility expands.

Response: This is incorrect, due to the fact that the rules governing nondegradation incorporated in the permits require the Permittee to maintain discharge loading consistent the baseline quality authorized under the current Permits given that the Permits do not authorize expansion of discharge beyond this level. The Permittee is required to restrict sulfate loading in accordance with nondegradation requirements. Additionally, the permits require further reductions of sulfate loads in the permitted discharges in accordance with schedules of compliance, which specifically require the Permittee to make reductions in sulfate discharge concentrations to the extent practical prior to attaining compliance with final effluent limitations. It is important to note that the compliance schedules are not limited to studies, but require implementation of a Sulfate Reduction Plan, which is specifically required to result in compliance with final effluent limitations for total sulfate as soon as possible. The language in the permits has been updated to more clearly reflect the means by which the compliance schedules will lead to compliance with final effluent limitations.

APPENDIX C

Permit	Location	Original Permit Condition	Change	Comment
MN0031879	Compliance Schedule	Pilot studies use the same schedule	Two distinct schedules with requirements for attainment of compliance written into MN0031879	Performed upon request of USEPA
MN0031879	Compliance Schedule	Proposes treatment evaluation of multiple outfalls	Require full-scale treatment evaluation for outfalls representative of wastewater type	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 36 months of approval of the Sulfate Reduction Plan for non-tailings basin discharges	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 42 months of approval of the Sulfate Reduction Plan for representative tailings basin discharges	Performed upon request of USEPA
MN0031879	Compliance Schedule	No interim effluent limits	Interim sulfate limit for total sulfate of 14 mg/L as a calendar quarter average for outfalls where full scale treatment evaluation is approved	Performed upon request of USEPA
MN0031879	Compliance Schedule	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2019	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2018 for non-tailings basin discharges	Performed upon request of USEPA
MN0055948	Compliance Schedule	Compliance schedule only in MN0031879	Include compliance schedule from MN0031879 by reference in to MN0055948	Performed upon request of USEPA
MN0055948	Compliance Schedule	Pilot studies use the same schedule	Two distinct schedules with requirements for attainment of compliance written into MN0031879	Performed upon request of USEPA
MN0055948	Compliance Schedule	Proposes treatment evaluation of multiple outfalls	Require full-scale treatment evaluation for outfalls representative of wastewater type	Performed upon request of USEPA
MN0055948	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 36 months of approval of the Sulfate Reduction Plan for non-tailings basin discharges	Performed upon request of USEPA
MN0055948	Compliance Schedule	No interim effluent limits	Addition of interim effluent limits within 42 months of approval of the Sulfate Reduction Plan for representative tailings basin discharges	Performed upon request of USEPA

MN0055948	Compliance Schedule	No interim effluent limits	Interim sulfate limit for total sulfate of 14 mg/L as a calendar quarter average for outfalls where full scale treatment evaluation is approved	Performed upon request of USEPA
MN0055948	Compliance Schedule	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2019	Sulfate effluent limits to be attained as soon as possible but no later than August 17, 2018 for non-tailings basin discharges	Performed upon request of USEPA
MN0055948 MN0031879	Monitoring		Additional Monitoring for selenium	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

STATE OF MINNESOTA

Minnesota Pollution Control Agency

Industrial Division

**National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS) Permit MN0031879**

PERMITTEE:	United States Steel Corporation
FACILITY NAME:	Minnesota Ore Operations – Keetac – Mining
RECEIVING WATER:	Welcome Lake; Welcome Creek to Reservoir 2 North; Unnamed wetlands and creeks tributary to O'Brien Reservoir

CITY OR TOWNSHIP:	Keewatin	**COUNTY:**	Itasca
ISSUANCE DATE:		**EXPIRATION DATE:**	

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to construct, install and operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to reduce pollutant levels in point source discharges and protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7050, 7053, 7060, 7090.3000 through 7090.3080, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, and supersedes the previous permit that was issued for this facility on June 15, 2006. This permit expires at midnight on the expiration date identified above.

Signature: ____

Jeff Udd, P.E. *for* The Minnesota Pollution Control Agency
Acting Supervisor, Water Quality Permits Unit
Land and Water Quality Permits Section
Industrial Division

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Questions on this permit?

- For DMR and other permit reporting issues, contact: Belinda Nicholas, 651-757-2613.
- For specific permit requirements or permit compliance status, contact: John Thomas, 218-302-6616.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

Table of Contents

Facility Description

The principal activity at this facility is the open pit mining of taconite (Biwabik Iron Formation) for processing into taconite pellets. The facility consists of the United States Steel Corporation, Minnesota Ore Operations – Keetac plant area, all mine excavations, mining waste disposal areas, plant areas, materials and equipment storage areas, and wastewater disposal facilities. The facility has proposed an expansion to their mining and pellet production operations, which will increase production from 6.0 million short tons of pellets per year to 9.6 million short tons per year. The conditions of this permit reflect the changes associated with that expansion.

The plant area includes the above-mentioned shops as well as several equipment storage buildings, the general office building, the water supply treatment plant, fuel storage area, crude ore storage building, concentrator, pellet plant, various processing thickeners, laboratory, power substation, coal, concentrate and pellet stockpile areas, and the pellet rail load-out area. Yard and roof run-off from the plant area is routed either to the Bennett Pit, Welcome Lake, or to the Diversion Ditch System. The water supply treatment plant, located just north of Welcome Lake, uses potassium permanganate and potassium hydroxide for iron removal. The water treatment plant backwash wastewater from the sand filters currently discharges on a periodic basis through culvert outfall SD001, at a rate of less than 0.010 MGD, to Welcome Lake (class 2B, 3B, 4A, 4B, 5 and 6 waters). Filter backwash solids from the water treatment plant are land applied on a site within the inactive Bennett tailings basin (SW ¼ of Section 17, T57N, R21W).

Most surface drainage from mining waste disposal and excavation areas in the facility is collected in mine pit sumps and then pumped to Reservoir 5. The Bennett Pit water overflows to the Russell Pit, which is pumped at an average rate of 4.0 million gallons per day (MGD) to Reservoir 5. This treatment basin also receives surface flow from inactive stockpiles and tailings basins. Reservoir 5 also provides some make-up water for processing in the Keewatin Taconite plant. Reservoir 5 outflows through a decant control structure to the Diversion Ditch System, constructed as a series of sedimentation basins and a conveyance channel. These basins help to treat run-off from the Keewatin Taconite plant area, as well as some active and inactive stockpile areas. The ditch system discharges through weir outfall SD002 at an average rate of 2.3 MGD to Welcome Creek (class 2C, 3C, 4A, 4B, 5 and 6 waters).

Mine pit dewatering from the Mesabi Chief Pit may be pumped and discharged through pipe outfall SD003, at an average rate of 5.85 MGD, to O'Brien Creek (2C, 3C, 4A, 4B, 5 and 6 water) which flows to the O'Brien Reservoir (class 2B, 3B, 4A, 4B, 5 and 6 water). Some mining waste stockpile drainage from the northwestern side of the facility flows to unnamed wetlands and creeks tributary to O'Brien Reservoir.

Stormwater from stripping and stockpiling activities west of the Mesabi Chief mining area flows into the Perry Pit. This permit authorizes discharges of mine pit dewatering from the Perry Pit through pipe outfall SD012 at rate of up to 4.32 MGD to O'Brien Creek.

Wastewater drainage is collected in the bottom of the two coarse crushers located in the Section 18 Pit. Crusher #1 wastewater is pumped at an average rate of 2.6 MGD to Sump #1, then to Reservoir 5. Crusher #2 wastewater is pumped to the Section 18 Pit, then to Reservoir 5. A septic tank/drainfield system handles the sanitary wastewater generated at the two coarse crushers, at a rate of less than 10,000 gallons per day (gpd). Dry storage buildings, which generate no process or sanitary wastewaters, are located at the facility north of Reservoir 5, south of the coarse crushers and east of the main plant area. A shovel repair area located on the northwest side of the Russell Pit, in the NW ¼, Section 13, T57N, R22W, also generates no process or sanitary wastewaters.

The combined floor drain overflow from the concentrator and the pellet plant is routed to the Bennett Pit. This overflow may include emergency overflow process wastewater from the concentrator if a power failure occurs. All steam cleaning and floor drain wastewater from the truck shops and the plant/machine/welding shops is treated by an oil/water separator and sedimentation tank before overflowing to a drainage pipe to the Bennett Pit. Sludge from the shop areas are taken off-site for treatment or disposal. Oils removed by the oil/water separator are reclaimed for reuse.

Two recirculating wet scrubbers treat waste gas from the Phase II indurating grate-kiln. Blowdown water from these wet scrubbers is sent to a wastewater treatment system. The treatment system is used when the indurating grate-kiln is using coal as a fuel source. The wastewater treatment system includes lime addition to promote calcium sulfate (gypsum) precipitation and solids settling in an existing thickener (old indurating thickener). Solids from the thickener are dewatered using two filter presses and disposed off-site. Overflow from the thickener and filtrate from the filter presses are sent to the tailings basin. Waste station WS011 is located at the plant water make-up to the scrubber system and waste station WS012 is located on the overflow from the indurating thickener prior to being sent to the tailings basin.

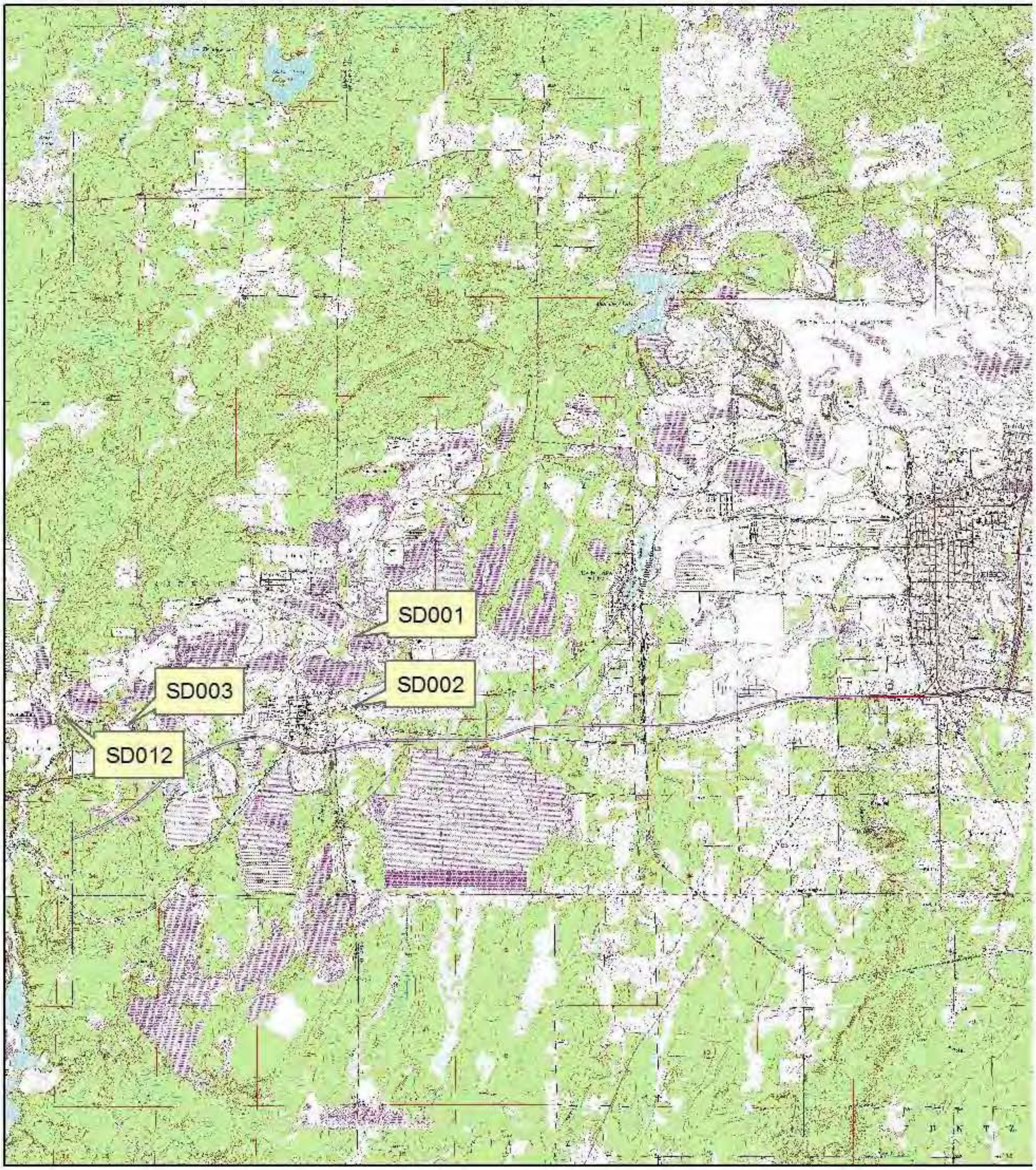
An activated sludge package plant consisting of a bar screen, comminutor, diffused aeration tank, sludge holding tank, and chlorination contact tank is used for the treatment of domestic wastewater. The sewage plant is designed to treat an average flow of 0.040 MGD with five-day carbonaceous biochemical oxygen demand (CBOD5) strength of 140 milligrams per liter (mg/l). No active dechlorination treatment is provided. The treated sanitary wastewater effluent is routed through weir station WS005 to Reservoir 5. The biosolids are transferred off-site to a permitted wastewater treatment facility.

Parallel tailings pipelines exit the north side of the concentrator and approximately follow the Diversion Ditch System east and south before crossing Highway 169 toward the Keewatin Taconite Tailings Basin Area. Segments of these pipelines do not have spill containment berms, and some leaks from pipelines north of Highway 169 may flow toward the Diversion Ditch. The tailings are pumped through the pipelines, which include three dump valve drainage points north of Highway 169. These dump valve points include detention basins and ponds used to contain tailings and process wastewater that is drained during normal maintenance and emergency shutdown situations. Dump Points 1 and 2 overflow to the Diversion Ditch System, while Dump Point 3 drains to a non-discharging infiltration basin. The tailings that do accumulate in these detention basins and ponds are typically removed every two years and hauled by truck for disposal in the Keewatin Taconite Tailings Basin, which is covered by permit MN0055948.

Chemical dust suppressants are occasionally applied on roads in the immediate plant area. Currently, magnesium chloride and lignosulfanate are used at a maximum rate of 11,000 gallons per year. This does not restrict the use of other acceptable dust suppressants at the facility.

Topographic Map of Permitted Facility

MN003189, US Steel - Keewatin Taconite Operations, Mining
St. Louis County & Itasca County, Minnesota



Map produced by: MPCA Staff, 4/15/2010
Source: USGS Nashwauk, Keewatin, Hibbing, Pengilly, Silica, Riley Quads
Scale: 1:24,000

0 0.5 1 2 Miles

N

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS302	Solids to Land Treatment/Application	Shop wastewater treatment sludges	
WS303	Solids to Land Treatment/Application	WTP filter backwash treatment sludges	SW Quarter of the NW Quarter of the Section 19, Township 57 North, Range 21 West

Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD001	Effluent To Surface Water	WTP Backwash Outfall 040	SE Quarter of the SW Quarter of the NW Quarter of Section 19, Township 57 North, Range 21 West
SD002	Effluent To Surface Water	Weir Outfall 050	NE Quarter of the NW Quarter of the NW Quarter of Section 30, Township 57 North, Range 21 West
SD003	Effluent To Surface Water	Pipe Outfall 080	SW Quarter of the NE Quarter of the NE Quarter of Section 27, Township 57 North, Range 22 West
SD012	Effluent To Surface Water	Perry Pit Dewatering	

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS005	Internal Waste Stream	Station 901	NW Quarter of the NW Quarter of Section 19, Township 57 North, Range 21 West
WS011	Internal Waste Stream	Plant water to scrubber system	NW Quarter of Section 19, Township 57 North, Range 21 West
WS012	Internal Waste Stream	Scrubber blowdown after treatment	NW Quarter of Section 19, Township 57 North, Range 21 West

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Quarter Average	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
Flow	Monitor Only	MG	Calendar Quarter Total	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1

SD 002

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	2 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Nitrogen, Ammonia, Un-ionized (as N)	0.04	mg/L	Calendar Month Average	Mar-Oct	Calculation	1 x Month	
Nitrogen, Ammonia, Un-ionized (as N)	Monitor Only	mg/L	Daily Maximum	Mar-Oct	Calculation	1 x Month	
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Mar-Oct	Estimate, Instantaneous	1 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Mar-Oct	Estimate, Instantaneous	1 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Turbidity	Monitor Only	NTU	Daily Maximum	Jan-Dec	Grab	2 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	Grab	2 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

WS 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	3.8	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	6.0	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	2 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	mgd	Maximum Calendar Week Average	Jan-Dec	Measurement, Continuous	1 x Day	
Nitrogen, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	2 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	4.5	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	6.8	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

WS 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Quarter Average	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
Flow	Monitor Only	MG	Calendar Quarter Total	Jan-Dec	Measurement, Instantaneous	1 x Quarter	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 002

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	2 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
Nitrogen, Ammonia, Un-ionized (as N)	0.04	mg/L	Calendar Month Average	Mar-Oct	Calculation	1 x Month	
Nitrogen, Ammonia, Un-ionized (as N)	Monitor Only	mg/L	Daily Maximum	Mar-Oct	Calculation	1 x Month	
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Mar-Oct	Estimate, Instantaneous	1 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Mar-Oct	Estimate, Instantaneous	1 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Turbidity	Monitor Only	NTU	Daily Maximum	Jan-Dec	Grab	2 x Month	

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 003

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Oil & Grease, Total Recoverable (Hexane Extraction)	0.5	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Oil & Grease, Total Recoverable (Hexane Extraction)	5.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
pH	8.5	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.5	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	20	mg/L	Calendar Quarter Average	Jan-Dec	Grab	1 x Quarter	1
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Quarter	1
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Quarter	1
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	
Turbidity	25	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

SD 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

WS 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	3.8	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	6.0	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	2 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Day	
Flow	Monitor Only	mgd	Maximum Calendar Week Average	Jan-Dec	Measurement, Continuous	1 x Day	
Nitrogen, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	2 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Phosphorus, Total (as P)	Monitor Only	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	4.5	kg/day	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	6.8	kg/day	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	8-Hour Flow Composite	2 x Month	

WS 011

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

WS 012

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Calcium, Total (as Ca)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Fluoride, Total (as F)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	Monitor Only	SU	Single Value	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Single Value	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	1 x Month	

Notes:
1 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR).
2 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisionsto this methods.
3 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). The permittee may request to modify this permit after 12 months of monitoring data have been submitted to MPCA, in order to remove or modify limits or monitoring requirements.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 1. Special Requirements

1. Compliance Schedule

Compliance Schedule for Sulfate

1.1 The Permittee shall meet the terms of the compliance schedule detailed below in order to attain compliance with the final effluent limitations contained in this permit and NPDES/SDS Permit MN0055948 for total sulfate.

The Permittee shall continue to work toward minimizing sulfate in the discharges to the extent practical prior to the compliance date. Compliance with the final effluent limitations shall be attained as soon as possible, and in no case shall compliance be attained later than August 17, 2018 for non-tailings basin discharges, and August 17, 2019 for tailings basin discharges, unless the permit is modified pursuant to 40 CFR 122.62.

Water Management Study

1.2 The Permittee has submitted a Water Management Study Plan to refine the water mass balance, and evaluate water discharge and water consumption alternatives that may lead to compliance. The Water Management Study Plan was approved by the MPCA on October 6, 2010.

1.3 The Water Management Study shall be completed within 18 months of MPCA approval of the Water Management Study Plan. The Permittee, upon approval from the MPCA, may make revisions to the Water Management Study Plan as new alternatives and information emerge and as deemed appropriate. The Permittee shall notify the MPCA within 14 days of completion of the Water Management Study.

1.4 The Permittee shall provide written progress updates on the Water Management Study to the MPCA every six months, at minimum, following MPCA approval of the Water Management Study Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.5 The Permittee shall provide the results of the Water Management Study to the MPCA within three months of completion of the Water Management Study.

Sulfate Reduction Strategy Study

1.6 The Permittee has submitted a Sulfate Reduction Strategy Study Plan for water quantity and quality data review, and evaluation of source control strategies and sulfate treatment technologies that may lead to compliance. The Sulfate Reduction Strategy Study Plan was approved by the MPCA on October 6, 2010.

1.7 The Sulfate Reduction Strategy Study shall be completed within 18 months of MPCA approval of the Sulfate Reduction Strategy Study Plan. The Permittee, upon approval from the MPCA, may make revisions to the Sulfate Reduction Strategy Study Plan as new alternatives and information emerge and as deemed appropriate. The Permittee shall notify the MPCA within 14 days of completion of the Sulfate Reduction Strategy Study.

1.8 The Permittee shall provide written progress updates on the Sulfate Reduction Strategy Study to the MPCA every six months, at minimum, following MPCA approval of the Sulfate Reduction Strategy Study Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.9 The Permittee shall provide the results of the Sulfate Reduction Strategy Study to the MPCA within three months of completion of the study.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 1. Special Requirements

1. Compliance Schedule

Sulfate Reduction Plan

1.10 Based on the results of the Water Management Study and the Sulfate Reduction Strategy Study, and within three months of submittal of the results of both studies, the Permittee shall provide a Sulfate Reduction Plan for MPCA review and approval. The Sulfate Reduction Plan shall, at minimum, detail the actions the Permittee proposes to take in order to comply with the final effluent limitations for total sulfate at each outfall under this permit and NPDES/SDS Permit MN0055948. The actions proposed in the Sulfate Reduction Plan must lead to compliance with final effluent limitations as soon as possible, and the plan must include a schedule for implementation of the proposed actions, as well as a justification for the proposed schedule that addresses the timing associated with each of the specific actions proposed in the plan. If treatment technology for sulfate is proposed in the Sulfate Reduction Plan, applications for any necessary permit modifications, as well as plans and specifications for the proposed treatment technology shall be submitted to the MPCA along with the Plan.

1.11 The Sulfate Reduction Plan may include a request for evaluation of treatment effectiveness at full scale on representative outfalls prior to installation of the same technology on similar outfalls if the following conditions are met:
1. The request categorizes all permitted outfalls into groups based on similar wastewater chemistry and physical conditions.
2. The results of the Water Management Study and Sulfate Reduction Strategy Study indicate that additional evaluation is necessary to determine treatment effectiveness at full scale for one or more of the outfall groups.
3. The treatment technology proposed in the Sulfate Reduction Plan is the same for the representative outfalls selected as the technology proposed for the other outfalls in the same waste group, and the results of the Sulfate Reduction Strategy Study do not show a significant difference in treatment effectiveness between the representative waste stream and the other waste streams of its type.
4. The representative outfall for each waste group has the highest volume and/or highest frequency of discharge of all outfalls in that group, and is therefore the most beneficial for evaluation.

1.12 Following approval of the Sulfate Reduction Plan by the MPCA, the Permittee shall complete the actions proposed in the Sulfate Reduction Plan and attain compliance with the final effluent limitations as detailed in Parts 1.13 and 1.14 of this Chapter, whichever is applicable.

1.13 If the approved Sulfate Reduction Plan includes approval of a request for full scale treatment evaluation pursuant to Part 1.11 of this Chapter, the Permittee shall attain compliance with final effluent limitations according to the following schedule:
1. The permitting, installation of equipment, and evaluation of treatment effectiveness on representative outfalls shall be completed within 36 months of MPCA approval of the Sulfate Reduction Plan for representative non-tailings basin discharges. The Permittee shall notify the MPCA within 14 days of completing this evaluation.
2. The permitting, installation of equipment, and evaluation of treatment effectiveness on representative outfalls shall be completed within 42 months of MPCA approval of the Sulfate Reduction Plan for representative tailings basin discharges. The Permittee shall notify the MPCA within 14 days of completing this evaluation.
3. Following completion of the full-scale treatment evaluation on the approved representative outfalls, the Permittee shall comply with an interim calendar quarter average effluent limitation of 14 mg/L total sulfate for all of the representative outfalls to ensure continued progress toward compliance with final effluent limitations.
4. The Permittee shall attain compliance with final effluent limitations for total sulfate on all non-tailings basin outfalls within 30 months of completing treatment evaluations on the representative outfalls for those waste types.
5. The Permittee shall attain compliance with final effluent limitations for total sulfate on all tailings basin outfalls within 36 months of completing treatment evaluations on the representative outfalls for those waste types.

Chapter 1. Special Requirements

1. Compliance Schedule

1.14 If the approved Sulfate Reduction Plan does not include approval of a request for full scale treatment evaluation pursuant to Part 1.11 of this Chapter, the Permittee shall attain compliance with final effluent limitations according to the following schedule:
1. The Permittee shall attain compliance with final effluent limitations for total sulfate on all non-tailings basin outfalls within 30 months of MPCA approval of the Sulfate Reduction Plan.
2. The Permittee shall attain compliance with final effluent limitations for total sulfate on all tailings basin outfalls within 36 months of MPCA approval of the Sulfate Reduction Plan.

1.15 The Permittee shall provide written progress reports on the implementation of the Sulfate Reduction Plan to the MPCA every six months, at minimum, following MPCA approval of the Sulfate Reduction Plan. Additional updates can be provided in the form of electronic transmittals, conference calls or meetings.

1.16 The Permittee shall submit written notification of compliance to the MPCA within 14 days of completing all of the actions required for the attainment of compliance with final effluent limitations. The notification of compliance shall include a notification that installation and startup of treatment equipment has been completed, or shall include a submission of a representative effluent monitoring data set if equipment is not determined to be necessary. The MPCA will submit notification to the Permittee that final effluent limitations apply.

2. Special Requirements

Effluent Limit Study

2.1 The Permittee may opt to conduct a study to gather data and information that would support a total sulfate limit other than the final limitations included in this permit.

2.2 When cause exists according to state and federal law regarding modification of permits, this permit may be reopened for modification of effluent limitations, discharge restrictions, monitoring requirements, and or conditions of a schedule of compliance. Any modified permit conditions shall be consistent with all applicable state and federal requirements. MPCA shall comply with all procedural requirements under state and federal law prior to reopening and modifying this permit.

Chapter 2. Industrial Process Wastewater

1. Prohibited Discharges

1.1 This permit does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

1.2 The Permittee shall prevent the routing of pollutants from the facility to a municipal wastewater treatment system in any manner unless authorized by the pretreatment standards of the MPCA and the municipal authority.

1.3 The Permittee shall not transport pollutants to a municipal wastewater treatment system that will interfere with the operation of the treatment system or cause pass-through violations of effluent limits or water quality standards.

Chapter 2. Industrial Process Wastewater

2. Toxic Substance Reporting

2.1 The Permittee shall notify the MPCA immediately of any knowledge or reason to believe that an activity has occurred that would result in the discharge of a toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10 or listed below that is not limited in the permit, if the discharge of this toxic pollutant has exceeded or is expected to exceed the following levels:

a. for acrolein and acrylonitrile, 200 ug/L;

b. for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, 500 ug/L;

c. for antimony, 1mg/L;

d. for any other toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10, 100 ug/L; or

e. five times the maximum concentration value identified and reported for that pollutant in the permit application. (Minnesota Rules, pt. 7001.1090, subp. 2.A)

2.2 The Permittee shall notify the MPCA immediately if the Permittee has begun or expects to begin to use or manufacture as an intermediate or final by-product a toxic pollutant that was not reported in the permit application under Minnesota Rules, pt. 7001.1050, subp. 2.J. (Minnesota Rules, pt. 7001.1090, subp. 2.B)

3. Hydrotest Discharges

3.1 The Permittee shall notify the MPCA prior to discharging hydrostatic test waters. The Permittee shall provide information necessary to evaluate the potential impact of this discharge and to ensure compliance with this permit. This information shall include:

a. the proposed discharge dates;

b. the name and location of receiving waters, including city or township, county, and township/range location;

c. an evaluation of the impact of the discharge on the receiving waters in relation to the water quality standards;

d. a map identifying discharge location(s) and monitoring point(s);

e. the estimated average and maximum discharge rates;

f. the estimated total flow volume of discharge;

g. the water supply for the test water, with a copy of the appropriate Minnesota Department of Natural Resources (DNR) water appropriation permit;

h. water quality data for the water supply;

i. proposed treatment method(s) before discharge; and

j. methods to be used to prevent scouring and erosion due to the discharge.

3.2 This permit does not authorize the construction or installation of pipeline facilities.

4. Polychlorinated Biphenyls (PCBs)

4.1 PCBs, including but not limited to those used in electrical transformers and capacitors, shall not be discharged or released to the environment.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 2. Industrial Process Wastewater

5. New Proposed Dewatering

5.1 The Permittee shall obtain a permit modification before discharging from a new dewatering outfall.

5.2 In addition to the requirements in the Permit Modifications section of this permit, the Permittee shall submit to the MPCA detailed plans and specifications for the proposed methods of achieving discharge limits for turbidity and total suspended solids, based in part upon representative water quality data for untreated wastewater and a detailed map and diagram description of the proposed design for the flow control structures, and route of the discharge to receiving waters.

6. Application for Permit Reissuance

6.1 The permit application shall include analytical data as part of the application for reissuance of this permit. These analyses shall be done on individual samples taken during the twelve-month period before the reissuance application is submitted.

6.2 The permit application shall include analytical data for at least the following parameters at monitoring station SD002:

a. biochemical oxygen demand, chemical oxygen demand, total organic carbon, gasoline range organics, diesel range organics, fecal coliform, ammonia, temperature;

b. color, fluoride, nitrate-nitrite (as nitrogen), total organic nitrogen, oil and grease, total phosphorus, chloride, sulfate, sulfide (as sulfur), surfactants, bicarbonates, alkalinity, total salinity, total dissolved solids, specific conductance;

c. aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, vanadium, zinc (all in total form) using atomic absorption (AA) furnace methods according to 40 CFR Part 136.3;

d. total mercury using EPA Method 1631;

e. gross alpha particles, radium-226, radium-228, radon-222, uranium;

f. PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260; and

g. a scan of constituents using EPA Methods 624 and 625, in 40 CFR Part 136.

The Permittee shall identify, in addition to those pollutants noted in Methods 624 and 625 (Appendix D, Table II), the concentrations of at least ten of the most abundant constituents of the acid and base/neutral organic fractions shown to be present by peaks on the total ion plots (reconstructed gas chromatograms) within ten percent of the nearest internal standard. Identification shall be through the use of U.S. EPA/NIH computerized library of mass spectra, with visual confirmation and potential quantification.

Chapter 3. Domestic Wastewater (non-POTW)

1. Authorization

1.1 The sanitary wastewater generated at the facility shall be disposed of:

a. Through the activated sludge sewage treatment plant at the facility monitored by station WS005;

b. To portable units, and then transported from the facility for proper disposal; and/or

c. To permitted septic tank-drainfield systems that treat sanitary wastewater only, at a rate of less than 10,000 gallons/day each.

1.2 The Permittee shall prevent the introduction of the following to its domestic wastewater treatment system:

a. pollutants which create a fire or explosion hazard, including any discharge with a flash point less than 60 degrees C (140 degrees F);

b. pollutants which would cause corrosive structural damage, including any waste stream with a pH of less than 5.0;

c. solid or viscous pollutants which would obstruct flow;

d. heat that would inhibit biological activity, including any introduction of wastewater that would cause the temperature of the waste stream at the domestic wastewater treatment system to exceed 40 degrees C (104 degrees F);

e. pollutants which produce toxic gases, vapors, or fumes that may endanger the health or safety of workers;

f. non-contact cooling waters, unless there are no cost-effective alternatives; and

g. hazardous wastes.

The flushing or disposal of solvents and petroleum products is prohibited. Employee training shall be provided on the proper disposal of solvents and petroleum products.

2. Operator Certification

2.1 The Permittee shall provide a Class C state certified operator who is in direct responsible charge of the operation, maintenance and testing functions required to ensure compliance with the terms and conditions of this permit.

2.2 If applicable, the Permittee shall provide the appropriate number of operators with a Type IV certification to be responsible for the land application of the biosolids generated by the facility.

2.3 If the Permittee chooses to meet operator certification requirements through a contractual agreement, the Permittee shall provide a copy of the contract to the MPCA. The contract shall include the certified operator's name, certificate number, company name if appropriate, and evidence that the operation is being adequately supervised by a properly certified operator.

2.4 The Permittee shall notify the MPCA within 30 days of a change in operator certification or contract status.

3. Sanitary Sewer Extension Permit

3.1 The Permittee is required to obtain a Sanitary Sewer Extension Permit from the MPCA before the start of construction of any addition, extension or replacement to the sanitary sewer.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 3. Domestic Wastewater (non-POTW)

4. Solids Management

Septage

4.1 Any accumulation of solids in pump stations, distribution devices, valve boxes or drop boxes shall be considered septage.

4.2 Septage shall be disposed of according to state, federal and local requirements.

Domestic Biosolids

4.3 The Permittee shall provide the information needed to comply with the biosolids requirements of Minn. R. ch. 7041 to others who treat, store, prepare or use the biosolids.

4.4 The Permittee shall keep records of the information necessary to show compliance with pollutant concentrations and loadings, pathogen reduction requirements, vector attraction reduction requirements and management practices as specified in Minn. R. 7041.1600, subp. 3.

Chapter 4. Metallic Mining

1. Mobile and Rail Equipment Service Areas

1.1 Mobile equipment and rail equipment service areas in the facility shall be operated in compliance with the following:

a. The Permittee shall collect and dispose of locomotive traction sand, degreasing wastes, motor oil, oil filters, oil sorbent pads and booms, transmission fluids, power steering fluids, brake fluids, coolant/antifreeze, radiator flush wastewater and spent solvents in accordance with applicable solid and hazardous waste management rules. These materials shall not be discharged to surface or ground waters of the state.

b. The steam-cleaning of mobile equipment and rail equipment, except for limited outdoor cleaning of large drills and shovels, shall be conducted in wash bays that drain to wastewater treatment systems that include the removal of suspended solids and flammable liquids. The only washing of mobile equipment done in outside areas shall be to remove mud and dirt that has accumulated during outside work.

c. The Permittee shall not use solvent-based cleaners, such as those available for brake cleaning and degreasing, to wash mobile and rail equipment unless the cleaning fluids are completely contained and not allowed to flow to surface or ground waters of the state. Soaps and detergents used in washing shall be biodegradable.

d. Mobile and rail equipment maintenance and repairs shall not be conducted in wash bays.

e. Hazardous materials shall not be stored or handled in wash bays.

f. The Permittee shall inspect wastewater containment systems regularly, and repair any leaks that are detected immediately.

g. If the Permittee discovers that recoverable amounts of petroleum products have entered wastewater containment systems, they shall be recovered immediately and reported to the MPCA.

h. Spill cleanup procedures shall be posted in mobile and rail equipment maintenance and repair areas.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 5. Water Treatment

1. Residual Solids Management

1.1 The Permittee shall provide for the effective management and/or disposal of residual solids, or other substances resulting from treatment of potable water.

1.2 The Permittee shall dispose of residual solids in such a manner and at such locations that disposal practices shall not result in unlawful pollution of the air, surface water or ground water, or create nuisance conditions.

2. Waste Materials - Stockpiling

2.1 Stockpiling residual solids is prohibited unless authorized by the MPCA. If the Permittee proposes to stockpile residual solids, the Permittee shall submit a description of the type and amount of solids to be stockpiled and the proposed location of the stockpiles for review and approval.

3. Waste Materials - Nuisance Conditions

3.1 The Permittee shall notify the MPCA of any nuisance conditions, such as wind blown lime residual solids dust, immediately and take necessary actions to control and abate these conditions. (Minnesota Statutes, section 115.061)

4. Waste Materials - Land Application Restrictions

4.1 The Permittee shall not apply residual solids within 200 feet of any place of habitation or recreational area or within 100 feet of intermittent streams.

4.2 The Permittee shall apply residual solids uniformly over the entire site.

4.3 The Permittee shall regulate surface application rates to prevent surface runoff from the land application site.

4.4 The residual solids application rate shall be based on the University of Minnesota, College of Agriculture recommended application rates for Agricultural Liming Material (ALM).

4.5 Land application is not allowed when radium concentration in the waste product exceeds 50 pci per gram on a dry weight basis. Wastes with radium concentrations not exceeding 50 pci per gram may be land applied if the resulting radium concentration of the soil can be shown to not exceed 5 pci per gram. Testing shall be done according to nationally accepted laboratory procedures, such as the U.S. Department of Energy procedures manual.

4.6 Residual solids shall not be applied on any land without the owner's permission.

Chapter 6. Stormwater Management

1. Authorization

1.1 This chapter authorizes the Permittee to discharge stormwater associated with industrial activity in accordance with the terms and conditions of this chapter. The MPCA may initiate modification of this chapter in accordance with Minn. R. 7001.0170 and Minn. R. 7001.0190 Subp. 1 to incorporate revised requirements in response to the reissuance or modification of the General Stormwater Permit for Industrial Activity (MNG611000).

2. Prohibited Discharges

2.1 This permit, unless specifically authorized by another chapter, does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

2.2 This permit does not authorize discharges from sites for which Environmental Assessment Worksheets or Environmental Impact Statements are required, in accordance with Minn. R. ch. 4410, until that environmental review is completed.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

3. Water Quality Standards

3.1 The Permittee shall operate and maintain the facility and shall control runoff, including stormwater, from the facility to prevent the exceedance of water quality standards specified in Minnesota Rules, chs. 7050 and 7060.

3.2 The Permittee shall limit and control the use of materials at the facility that may cause exceedances of ground water standards specified in Minnesota Rules, ch. 7060. These materials include, but are not limited to, detergents and cleaning agents, solvents, chemical dust suppressants, lubricants, fuels, drilling fluids, oils, fertilizers, explosives and blasting agents.

4. Stormwater Pollution Prevention Plan

4.1 The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff. If contact cannot be eliminated or reduced, stormwater that has contacted significant material should be treated before it is discharged from the site. The Plan shall apply to those areas of the facility where industrial activities occur or significant materials are stored, and stormwater runoff does not receive treatment prior to discharge via a permitted surface discharge station. In addition, the Plan should indentify all areas of the facility where the necessary treatment of stormwater is addressed by a permitted surface discharge station.

4.2 The Plan shall be implemented at the site before the Permittee is covered under this permit.

4.3 The Stormwater Pollution Prevention Plan shall include a description of appropriate Best Management Practices for protection of surface and ground water quality at the facility, and a schedule for implementing the practices. The Plan shall also include the procedures to be followed by designated staff employed by the Permittee to implement the plan.

4.4 The Permittee shall comply with its Stormwater Pollution Prevention Plan.

4.5 The Permittee shall submit the Stormwater Pollution Prevention Plan to MPCA upon request.

Plan Contents

4.6 Complete a drainage map. The map should indicate the following items at or adjacent to the facility:

a. drainage areas and directions of stormwater runoff (indicated by arrows);

b. discharge outfalls from the site (structures that carry stormwater runoff from the facility such as ditches or storm sewers);

c. the name and location of waters of the state that receive facility stormwater runoff (if waters of the state are too distant from the facility to be indicated on the site map, indicate the name, direction and shortest distance to the lake, river, stream or wetland that receives runoff from your site);

d. areas where significant materials are exposed to stormwater;

e. locations of storm sewer inlets and an indication of which, if any, structures have floor drains or loading dock drains that are connected to storm sewers; and

f. locations and types of Best Management Practices (BMPs) currently installed at the facility to reduce or eliminate pollutants to stormwater.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.7 Complete an inventory of exposed significant materials. Indicate the types of significant materials handled or stored at the site that may potentially contact stormwater. The following are examples of materials that, if exposed to stormwater, must be included in the inventory:

a. raw materials, such as fuels; solvents; petroleum products; detergents; plastic pellets; materials used in food processing or production; stockpiled sand, salt or coal;

b. by-products or intermediate products, such as wood dust, chips or bark; screened limestone, taconite or gravel by-product, recycled blacktop;

c. finished materials, such as metallic products, including scrap metal and recycled or scrap motor vehicle parts, old process equipment/machinery, taconite pellets;

d. waste products, such as ashes, sludge, solid and liquid waste, slag;

e. hazardous substances designated under section 101(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA);

f. any chemical the facility is required to report under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

4.8 Evaluate facility areas for exposure of significant materials to stormwater. In creating the inventory of exposed significant materials, the Permittee must, at a minimum, evaluate the following areas at the industrial site (as well as other areas where appropriate) to determine whether or not significant materials are exposed in these areas:

a. vehicle and equipment maintenance, parking and storage areas including fueling and washing/cleaning areas, to determine if there is discolored soil in these areas as a result of fuel and lubricant leaks and spills;

b. liquid storage tanks and other bulk material stockpile areas;

c. loading and unloading areas;

d. outdoor manufacturing, processing or storage areas and industrial plant yards, to determine if there is discolored soil in these areas as a result of leaked or spilled solvents, fuels, or lubricants;

e. dust or particulate generating areas including dust collection devices that may release dust;

f. rooftops contaminated by industrial activity or operation of a pollution control device;

g. on-site waste disposal areas, such as waste ponds, dumpsters, solid waste storage or management areas; and

h. exposed (non-vegetated) soil areas where there is a potential for erosion to occur.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.9 Describe appropriate BMPs, including structural and non-structural BMPs, that will be used at the facility to minimize or eliminate pollution of stormwater at the site. The description must include an objective for each BMP, as well as a description of how to evaluate proper functioning of the BMP and any maintenance requirements of the BMP. BMPs should target significant materials and areas identified in subparts 7 and 8 of this part. The following general categories of BMPs shall be considered and one or more shall be incorporated into the facility's Plan if significant materials are exposed to stormwater on-site:

a. Source reduction: reduce or eliminate the significant materials that are exposed to stormwater. Materials management practices should be evaluated to determine whether inventories of exposed materials can be reduced or eliminated. This can include clean-up of equipment yards, periodic checking of dust control equipment to ensure minimal accumulation of dust in the area of control equipment, removal and treatment of petroleum contaminated soil, consolidation of materials from multiple areas into one area, and training employees regarding proper handling and disposal of materials. Significant materials may also be moved indoors or covered with a tarp or structure to eliminate contact with precipitation.

b. Diversion: divert stormwater drainage away from exposed significant materials through use of curbing, berms, sewers or other forms of drainage control or elevate exposed significant material above surrounding drainage.

c. Treatment: where contact of stormwater with significant materials is unavoidable, use treatment devices to reduce the concentration and amount of pollutants in the discharge. Such devices include oil/water separators, stormwater detention/retention ponds, and vegetative swales.

4.10 Evaluate all discharge conveyances from the site (storm sewers, pipes, tile lines, ditches, etc.) to determine if liquids other than stormwater are being discharged from these devices. This should be done during dry weather when stormwater discharge is not occurring. The evaluation should cover sewer inlets and floor drains to determine which inlets/drains are connected to sanitary sewer lines, storm sewer lines, or septic tanks/drainage fields; appropriate methods such as dye or smoke testing or video imaging should be used to determine the source of discharges.

The Plan must certify that discharges from the site have been evaluated for the presence of non-stormwater discharges. The certification shall indicate the date of testing, location of testing, describe the method used to determine the source of discharges and the results of testing. Discharge of non-stormwater (such as sanitary sewer or floor drain connections to storm sewers) is not authorized by this permit; before such discharge may continue, authorization under an appropriate NPDES permit must be obtained.

4.11 Develop a preventive maintenance program. The program must require regular inspection and maintenance of stormwater management devices (e.g. cleaning oil/water separators and catch basins), as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants (e.g. hydraulic leaks, torn bag-house filters) to surface waters.

4.12 Develop a spill prevention and response procedure. In order to develop this procedure, Permittees should evaluate where spills have occurred and where they have the potential to occur. Determine drainage points for potential spill areas and develop appropriate spill prevention and containment measures, should a spill occur. Detailed procedures for cleaning-up spills shall be identified and made available to appropriate personnel. If your facility has any other spill contingency plan that satisfies the above requirements, that plan may be incorporated by reference into this Plan to satisfy this requirement.

4.13 Develop and implement an employee training program to inform appropriate personnel of the components and goals of the Plan. Training shall address spill response, good housekeeping and materials management practices. The Plan shall identify periodic dates for such training.

4.14 Identify personnel responsible for managing and implementing the Plan as well as those responsible for the reporting requirements of this permit. This should include the facility contact person as indicated on the permit application. Identified personnel must be available at reasonable times of operation.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

5. Temporary Protection and Permanent Cover

5.1 The Permittee shall provide and maintain temporary protection or permanent cover for the exposed areas at the facility.

5.2 Temporary protection methods are used to prevent erosion on a short-term basis, such as the placement of mulching straw, wood fiber blankets, wood chips, erosion control netting, or temporary seeding.

5.3 Permanent cover or final stabilization methods are used to prevent erosion, such as the placement of rip rap, sodding, or permanent seeding or planting. Permanent seeding and planting must have a uniform perennial vegetation cover of at least 70 percent density to constitute final stabilization.

6. Inspection and Maintenance

6.1 Site inspections shall be conducted at least once every two months throughout the calendar year. During winter months, the inspections shall be conducted during non-frozen conditions. Inspections shall be conducted by an appropriately trained personnel at the facility site, as identified in part 4.13 of this chapter. The purpose of inspections is to: 1) determine whether structural and non-structural BMPs require maintenance or changes, and 2) evaluate the completeness and accuracy of the Plan.

At least one inspection during a reporting period shall be conducted while stormwater is discharging from the facility. Inspections may be documented using an inspection form provided by the MPCA. A Storm Water Site Inspection Form is provided in the appendices section of this permit.

6.2 Inspections shall be documented and a copy of all documentation shall remain on the permitted site whenever Permittee staff are availbale on the site, and be available upon request. The inspection form developed for the General Storm Water Permit for Industrial Activity may be used for recording inspection results, and is included in the appendices section of this permit.

6.3 The following compliance items will be inspected, and documented where appropriate:

a. evaluate the facility to determine that the Plan accurately reflects site conditions as described in subpart 6 of this part, and document any inaccuracies;

b. evaluate the facility to determine whether new exposed materials have been added to the site since completion of the Plan, and document any new significant materials;

c. during the inspection conducted during the runoff event, observe the runoff to determine if it is discolored or otherwise visibly contaminated, and document observations; and,

d. determine if the non-structural and structural BMPs as indicated in the Plan are installed and functioning properly.

6.4 The Permittee shall ensure that temporary protection and permanent cover for the exposed areas at the site are maintained.

6.5 Indicate the date and time of the inspection as well as the name of the inspector on the inspection form.

6.6 When the depth of sediment collected in the final sedimentation basin above the outfall reaches one-half of the riser height, or one-half of the basin design hydraulic storage volume, the Permittee shall drain the basin and remove the sediment within sixty (60) days of discovery. No outflow from the sedimentation basin shall occur while sediment is being removed from that basin. The sediment removed from the basin shall be disposed of at a site which drains to sedimentation basin(s) at the facility.

6.7 If conditions are observed at the site that require changes in the Plan, such changes shall be made to the Plan prior to submission of the annual report for that calendar year.

6.8 The Permittee shall minimize vehicle tracking of gravel, soil or mud onto paved surfaces at the facility.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

6. Inspection and Maintenance

6.9 If the findings of a site inspection indicate that BMPs are not meeting the objectives as identified in subpart 9 of this part, corrective actions must be initiated within 30 days and the BMP restored to full operation as soon as field conditions allow.

6.10 The Permittee shall remove tracked material from the road surface and return it to the facility within one (1) day of discovery so that the materials drain to sedimentation basin(s) at the facility.

7. Sedimentation Basin Design and Construction

New Sedimentation Basins

7.1 Sedimentation basins shall be designed by a registered professional engineer, and installed under the direct supervision of a registered professional engineer.

7.2 The basin shall provide at least 1800 cubic feet, per acre drained, of hydraulic storage volume below the top of the outlet riser pipe.

7.3 Inlet(s) and outlet(s) shall be designed to prevent short circuiting and the discharge of floating debris.

7.4 The inlet(s) shall be placed at an elevation at least above one-half of the basin design hydraulic storage volume.

7.5 The outlet(s) shall consist of a perforated riser pipe wrapped with filter fabric and covered with crushed gravel. The perforated riser pipe shall be designed to allow complete drawdown of the basin(s).

7.6 Permanent erosion control, such as rip rap, splash pads or gabions shall be installed at the outlet(s) to prevent downstream erosion.

7.7 The basins shall be designed to allow for regular removal of accumulated sediment by a backhoe or other suitable equipment.

8. Application of Chemical Dust Suppressants

8.1 If chemical dust suppressants are applied, the Permittee shall submit a Chemical Dust Suppressant Annual Report due 31 days after the end of each calendar year following the application of a chemical dust suppressant.

8.2 The Chemical Dust Suppressant Annual Report shall include:

a. a record of the dates, methods, locations and amounts by volume of chemical application at the facility;

b. whether the product was applied in the preceding year; and,

c. the results of a chemical analysis of the materials applied each year.

8.3 If a material applied is mixed with water or another solvent before application, the chemical analysis shall be done on the aqueous or other mixture that is representative of the solution applied. This analysis shall be conducted during the same calendar year of application. This analysis shall include the parameters that may be determined by U.S. Environmental Protection Agency (EPA) Methods 624 and 625 which are described in 40 CFR Part 136.

8.4 Chemical dust suppressants, if used, shall not be applied within 100 feet of the surface receiving waters identified in the 'Facility Description' section of this permit. These materials also shall not be applied within 100 feet of ditches that conduct surface flow to the surface receiving waters identified on Page 1 of this permit.

9. Reporting

9.1 Submit a Stormwater Annual Report by March 31 of each year following permit issuance. A copy of the Stormwater Annual Report Form is provided in the appendices section of this permit.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

9. Reporting

9.2 The Permittee shall, upon request of the Agency, submit within a reasonable time the information and reports that are relevant to compliance with this Chapter, including the Plan, inspection reports, annual reports, original laboratory sheets from analyses conducted on the waste stream, and BMP plans and specifications.

10. Records

10.1 The Plan shall be retained for the duration of the permit. A copy of the Plan shall remain on the permitted site whenever Permittee staff are available on the site, and be available upon request. The Permittee shall maintain the following records for the period of permit coverage:

a. dates of inspections;

b. findings of inspections;

c. corrective actions taken;

d. documentation of all changes to the Plan; and,

e. a copy of annual reports.

11. Notification

11.1 If the Permittee discharges stormwater into a municipal storm sewer, the Permittee shall notify the operator of the municipal storm sewer of the existence of this permit.

12. Request for Termination of Stormwater Permit Coverage

12.1 All Permittees regulated by 40 CFR 122.26(b)(14)(i) through (ix) and (xi) may request termination of permit coverage by applying for the no exposure exclusion from permitting. The Permittee must submit (form provided by the Agency) a written certification that a condition of no exposure exists at the facility and that the facility meets the definition of no exposure of industrial activities and materials to storm water.

The application for the no exposure exclusion must be completed by the Permittee and sent to: MPCA, Industrial Storm Water Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

Failure to complete an accurate application will result in the facility being denied the no exposure exclusion from permitting. The facility must submit the application to the Agency once every five years.

12.2 The no exposure exclusion is conditional. The Permittee must maintain a condition of no exposure at the facility in order for the no exposure exclusion to remain applicable. In the event of any change or circumstance that causes exposure of industrial activities or materials to stormwater, the Permittee must comply with the stormwater requirements of this chapter.

12.3 The no exposure certification is non-transferrable. In the event that the facility operator changes, then the new operator must submit a new no exposure certification to the MPCA, Industrial Stormwater Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

12.4 The MPCA retains the authority to require the facility operator to comply with the requirements of this chapter, even when an industrial operator certifies no exposure, if the MPCA has determined that the discharge is contributing to the violation of, or interfering with the attainment or maintenance of water quality standards, including designated uses.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Stormwater Management

13. Definitions

13.1 "No exposure" means all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snow melt, and/or runoff. Industrial activities or materials include, but are not limited to, material handling equipment or activities, industrial machinery, raw materials, intermediate products, by-products, final products, or waste products.

13.2 "Non-stormwater discharge" means any discharge not comprised entirely of stormwater discharges authorized by a NPDES permit.

13.3 "Runoff" means any liquid that drains over land from any part of a facility.

Chapter 7. Surface Discharge Stations

1. Requirements for Specific Stations

1.1 SD 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.2 SD 002: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.3 SD 003: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.4 SD 012: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

Elimination of SD001

2.1 The Permittee currently discharges filter backwash from the Potable Water Plant via SD001. The filter backwash flows west through a ditch alongside the north side of the railroad tracks and ultimately into Welcome Lake, located on the south side of the railroad tracks, via a culvert. It is the Permittee's intent to re-route the filter backwash so that it does not discharge into Welcome Lake, if possible, by directing the waste stream to an alternative location within the facility's water system.

The Permittee shall notify the MPCA within 14 days of completing any rerouting the filter backwash stream currently discharged via SD001. The notification shall include a description of the new route for the backwash wastewater, and the final point of discharge for this wastewater. Following this notification, the MPCA may minor modify the permit to eliminate SD001 from the regulated outfalls.

During the interim period between completing the rerouting of SD001 wastewater and minor modification of the permit, the Permittee shall report No Discharge for SD001.

3. Sampling Location

3.1 Samples for Station SD001 shall be taken at the culvert flowing south under the railroad tracks towards Welcome Lake during a period of discharge. If a discharge from the culvert occurs at any time during the sampling quarter, a sample must be obtained for analysis.

3.2 Samples for Station SD002 shall be taken at the weir outfall at the old Highway 169 road crossing in the NW 1/4 of the NW 1/4 of Section 30, T57N, R21W.

3.3 Samples for Station SD003 shall be taken at the pipe outfall southwest of the Mesabi Chief Mine Pit.

3.4 Samples for SD012 shall be taken at the outfall of Perry Pit dewatering to O'Brien Creek.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 7. Surface Discharge Stations

3. Sampling Location

3.5 Samples and measurements required by this permit shall be representative of the monitored activity.

4. Surface Discharges

4.1 Floating solids or visible foam shall not be discharged in other than trace amounts.

4.2 Oil or other substances shall not be discharged in amounts that create a visible color film.

4.3 The Permittee shall install and maintain outlet protection measures at the discharge stations to prevent erosion.

5. Winter Sampling Conditions

5.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

6. Discharge Monitoring Reports

6.1 The Permittee shall submit monitoring results for discharges in accordance with the limits and monitoring requirements for this station. If no discharge occurred during the reporting period, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR).

Chapter 8. Waste Stream Stations

1. Requirements for Specific Stations

1.1 WS 005: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.2 WS 011: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

1.3 WS 012: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Samples for Stations WS005 shall be taken at weir station 901 following the chlorination tank.

2.2 Samples for Station WS011 shall be representative of the plant water to the scrubber system. Samples for Station WS012 shall be taken at a point representative of the treated scrubber blowdown flow to the tailings basin.

3. Sampling Frequency

3.1 Monitoring frequency for WS011 and WS012 shall be taken in accordance with the limits and montioring requirements of this permit, including when coal is not being used as a fuel source in the Phase II indurating grate-kiln.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

General Requirements

1.1 Incorporation by Reference. The following applicable federal and state laws are incorporated by reference in this permit, are applicable to the Permittee, and are enforceable parts of this permit: 40 CFR pts. 122.41, 122.42, 136, 403 and 503; Minn. R. pts. 7001, 7041, 7045, 7050, 7052, 7053, 7060, and 7080; and Minn. Stat. Sec. 115 and 116.

1.2 Permittee Responsibility. The Permittee shall perform the actions or conduct the activity authorized by the permit in compliance with the conditions of the permit and, if required, in accordance with the plans and specifications approved by the Agency. (Minn. R. 7001.0150, subp. 3, item E)

1.3 Toxic Discharges Prohibited. Whether or not this permit includes effluent limitations for toxic pollutants, the Permittee shall not discharge a toxic pollutant except according to Code of Federal Regulations, Title 40, sections 400 to 460 and Minnesota Rules 7050, 7052, 7053 and any other applicable MPCA rules. (Minn. R. 7001.1090, subp.1, item A)

1.4 Nuisance Conditions Prohibited. The Permittee's discharge shall not cause any nuisance conditions including, but not limited to: floating solids, scum and visible oil film, acutely toxic conditions to aquatic life, or other adverse impact on the receiving water. (Minn. R. 7050.0210 subp. 2)

1.5 Property Rights. This permit does not convey a property right or an exclusive privilege. (Minn. R. 7001.0150, subp. 3, item C)

1.6 Liability Exemption. In issuing this permit, the state and the MPCA assume no responsibility for damage to persons, property, or the environment caused by the activities of the Permittee in the conduct of its actions, including those activities authorized, directed, or undertaken under this permit. To the extent the state and the MPCA may be liable for the activities of its employees, that liability is explicitly limited to that provided in the Tort Claims Act. (Minn. R. 7001.0150, subp. 3, item O)

1.7 The MPCA's issuance of this permit does not obligate the MPCA to enforce local laws, rules, or plans beyond what is authorized by Minnesota Statutes. (Minn. R. 7001.0150, subp.3, item D)

1.8 Liabilities. The MPCA's issuance of this permit does not release the Permittee from any liability, penalty or duty imposed by Minnesota or federal statutes or rules or local ordinances, except the obligation to obtain the permit. (Minn. R. 7001.0150, subp.3, item A)

1.9 The issuance of this permit does not prevent the future adoption by the MPCA of pollution control rules, standards, or orders more stringent than those now in existence and does not prevent the enforcement of these rules, standards, or orders against the Permittee. (Minn. R. 7001.0150, subp.3, item B)

1.10 Severability. The provisions of this permit are severable and, if any provisions of this permit or the application of any provision of this permit to any circumstance are held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

1.11 Compliance with Other Rules and Statutes. The Permittee shall comply with all applicable air quality, solid waste, and hazardous waste statutes and rules in the operation and maintenance of the facility.

1.12 Inspection and Entry. When authorized by Minn. Stat. Sec. 115.04; 115B.17, subd. 4; and 116.091, and upon presentation of proper credentials, the agency, or an authorized employee or agent of the agency, shall be allowed by the Permittee to enter at reasonable times upon the property of the Permittee to examine and copy books, papers, records, or memoranda pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit; and to conduct surveys and investigations, including sampling or monitoring, pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit. (Minn. R. 7001.0150, subp.3, item I)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

1.13 Control Users. The Permittee shall regulate the users of its wastewater treatment facility so as to prevent the introduction of pollutants or materials that may result in the inhibition or disruption of the conveyance system, treatment facility or processes, or disposal system that would contribute to the violation of the conditions of this permit or any federal, state or local law or regulation.

Sampling

1.14 Representative Sampling. Samples and measurements required by this permit shall be conducted as specified in this permit and shall be representative of the discharge or monitored activity. (40 CFR 122.41 (j)(1))

1.15 Additional Sampling. If the Permittee monitors more frequently than required, the results and the frequency of monitoring shall be reported on the Discharge Monitoring Report (DMR) or another MPCA-approved form for that reporting period. (Minn. R. 7001.1090, subp. 1, item E)

1.16 Certified Laboratory. A laboratory certified by the Minnesota Department of Health shall conduct analyses required by this permit. Analyses of dissolved oxygen, pH, temperature and total residual oxidants (chlorine, bromine) do not need to be completed by a certified laboratory but shall comply with manufacturers specifications for equipment calibration and use. (Minn. Stat. Sec. 144.97 through 144.98 and Minn. R. 4740.2010 and 4740.2050 through 4740.2120) (Minn. R. 4740.2010 and 4740.2050 through 2120)

1.17 Sample Preservation and Procedure. Sample preservation and test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and Minn. R. 7041.3200.

1.18 Equipment Calibration: Flow meters, pumps, flumes, lift stations or other flow monitoring equipment used for purposes of determining compliance with permit shall be checked and/or calibrated for accuracy at least twice annually. (Minn. R. 7001.0150, subp. 2, items B and C)

1.19 Maintain Records. The Permittee shall keep the records required by this permit for at least three years, including any calculations, original recordings from automatic monitoring instruments, and laboratory sheets. The Permittee shall extend these record retention periods upon request of the MPCA. The Permittee shall maintain records for each sample and measurement. The records shall include the following information (Minn. R. 7001.0150, subp. 2, item C):

a. The exact place, date, and time of the sample or measurement;

b. The date of analysis;

c. The name of the person who performed the sample collection, measurement, analysis, or calculation; and

d. The analytical techniques, procedures and methods used; and

e. The results of the analysis.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

1.20 Completing Reports. The Permittee shall submit the results of the required sampling and monitoring activities on the forms provided, specified, or approved by the MPCA. The information shall be recorded in the specified areas on those forms and in the units specified. (Minn. R. 7001.1090, subp. 1, item D; Minn. R. 7001.0150, subp. 2, item B)

Required forms may include:

DMR Supplemental Form
Individual values for each sample and measurement must be recorded on the DMR Supplemental Form which, if required, will be provided by the MPCA. DMR Supplemental Forms shall be submitted with the appropriate DMRs. You may design and use your own supplemental form; however it must be approved by the MPCA. Note: Required summary information MUST also be recorded on the DMR. Summary information that is submitted ONLY on the DMR Supplemental Form does not comply with the reporting requirements.

1.21 Submitting Reports. DMRs and DMR Supplemental Forms shall be submitted to:

MPCA
Attn: Discharge Monitoring Reports
520 Lafayette Road North
St. Paul, Minnesota 55155-4194.

DMRs and DMR Supplemental Forms shall be postmarked by the 21st day of the month following the sampling period or as otherwise specified in this permit. A DMR shall be submitted for each required station even if no discharge occurred during the reporting period. (Minn. R. 7001.0150, subps. 2.B and 3.H)

Other reports required by this permit shall be postmarked by the date specified in the permit to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

1.22 Incomplete or Incorrect Reports. The Permittee shall immediately submit an amended report or DMR to the MPCA upon discovery by the Permittee or notification by the MPCA that it has submitted an incomplete or incorrect report or DMR. The amended report or DMR shall contain the missing or corrected data along with a cover letter explaining the circumstances of the incomplete or incorrect report. (Minn. R. 7001.0150 subp. 3, item G)

1.23 Required Signatures. All DMRs, forms, reports, and other documents submitted to the MPCA shall be signed by the Permittee or the duly authorized representative of the Permittee. Minn. R. 7001.0150, subp. 2, item D. The person or persons that sign the DMRs, forms, reports or other documents must certify that he or she understands and complies with the certification requirements of Minn. R. 7001.0070 and 7001.0540, including the penalties for submitting false information. Technical documents, such as design drawings and specifications and engineering studies required to be submitted as part of a permit application or by permit conditions, must be certified by a registered professional engineer. (Minn. R. 7001.0540)

Chapter 9. Total Facility Requirements

1. General Requirements

1.24 Detection Level. The Permittee shall report monitoring results below the reporting limit (RL) of a particular instrument as "<" the value of the RL. For example, if an instrument has a RL of 0.1 mg/L and a parameter is not detected at a value of 0.1 mg/L or greater, the concentration shall be reported as "<0.1 mg/L." "Non-detected," "undetected," "below detection limit," and "zero" are unacceptable reporting results, and are permit reporting violations. (Minn. R. 7001.0150, subp. 2, item B)

Where sample values are less than the level of detection and the permit requires reporting of an average, the Permittee shall calculate the average as follows:

a. If one or more values are greater than the level of detection, substitute zero for all nondetectable values to use in the average calculation.

b. If all values are below the level of detection, report the averages as "<" the corresponding level of detection.

c. Where one or more sample values are less than the level of detection, and the permit requires reporting of a mass, usually expressed as kg/day, the Permittee shall substitute zero for all nondetectable values.
(Minn. R. 7001.0150, subp. 2, item B)

1.25 Records. The Permittee shall, when requested by the Agency, submit within a reasonable time the information and reports that are relevant to the control of pollution regarding the construction, modification, or operation of the facility covered by the permit or regarding the conduct of the activity covered by the permit. (Minn. R. 7001.0150, subp. 3, item H)

1.26 Confidential Information. Except for data determined to be confidential according to Minn. Stat. Sec. 116.075, subd. 2, all reports required by this permit shall be available for public inspection. Effluent data shall not be considered confidential. To request the Agency maintain data as confidential, the Permittee must follow Minn. R. 7000.1300.

Noncompliance and Enforcement

1.27 Subject to Enforcement Action and Penalties. Noncompliance with a term or condition of this permit subjects the Permittee to penalties provided by federal and state law set forth in section 309 of the Clean Water Act; United States Code, title 33, section 1319, as amended; and in Minn. Stat. Sec. 115.071 and 116.072, including monetary penalties, imprisonment, or both. (Minn. R. 7001.1090, subp. 1, item B)

1.28 Criminal Activity. The Permittee may not knowingly make a false statement, representation, or certification in a record or other document submitted to the Agency. A person who falsifies a report or document submitted to the Agency, or tampers with, or knowingly renders inaccurate a monitoring device or method required to be maintained under this permit is subject to criminal and civil penalties provided by federal and state law. (Minn. R. 7001.0150, subp.3, item G., 7001.1090, subps. 1, items G and H and Minn. Stat. Sec. 609.671)

1.29 Noncompliance Defense. It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. (40 CFR 122.41(c))

1.30 Effluent Violations. If sampling by the Permittee indicates a violation of any discharge limitation specified in this permit, the Permittee shall immediately make every effort to verify the violation by collecting additional samples, if appropriate, investigate the cause of the violation, and take action to prevent future violations. Violations that are determined to pose a threat to human health or a drinking water supply, or represent a significant risk to the environment shall be immediately reported to the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area). In addition, you may also contact the MPCA during business hours. Otherwise the violations and the results of any additional sampling shall be recorded on the next appropriate DMR or report.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

1.31 Unauthorized Releases of Wastewater Prohibited. Except for conditions specifically described in Minn. R. 7001.1090, subp. 1, items J and K, all unauthorized bypasses, overflows, discharges, spills, or other releases of wastewater or materials to the environment, whether intentional or not, are prohibited. However, the MPCA will consider the Permittee's compliance with permit requirements, frequency of release, quantity, type, location, and other relevant factors when determining appropriate action. (40 CFR 122.41 and Minn. Stat. Sec 115.061)

1.32 Discovery of a release. Upon discovery of a release, the Permittee shall:

a. Take all reasonable steps to immediately end the release.

b. Notify the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 or (651)649-5451 (metro area) immediately upon discovery of the release. You may contact the MPCA during business hours at 1(800)657-3864 or (651)296-6300 (metro area).

c. Recover as rapidly and as thoroughly as possible all substances and materials released or immediately take other action as may be reasonably possible to minimize or abate pollution to waters of the state or potential impacts to human health caused thereby. If the released materials or substances cannot be immediately or completely recovered, the Permittee shall contact the MPCA. If directed by the MPCA, the Permittee shall consult with other local, state or federal agencies (such as the Minnesota Department of Natural Resources and/or the Wetland Conservation Act authority) for implementation of additional clean-up or remediation activities in wetland or other sensitive areas.

d. Collect representative samples of the release. The Permittee shall sample the release for parameters of concern immediately following discovery of the release. The Permittee may contact the MPCA during business hours to discuss the sampling parameters and protocol. In addition, Fecal Coliform Bacteria samples shall be collected where it is determined by the Permittee that the release contains or may contain sewage. If the release cannot be immediately stopped, the Permittee shall consult with MPCA regarding additional sampling requirements. Samples shall be collected at least, but not limited to, two times per week for as long as the release continues.

e. Submit the sampling results as directed by the MPCA. At a minimum, the results shall be submitted to the MPCA with the next DMR.

1.33 Upset Defense. In the event of temporary noncompliance by the Permittee with an applicable effluent limitation resulting from an upset at the Permittee's facility due to factors beyond the control of the Permittee, the Permittee has an affirmative defense to an enforcement action brought by the Agency as a result of the noncompliance if the Permittee demonstrates by a preponderance of competent evidence:

a. The specific cause of the upset;

b. That the upset was unintentional;

c. That the upset resulted from factors beyond the reasonable control of the Permittee and did not result from operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or increases in production which are beyond the design capability of the treatment facilities;

d. That at the time of the upset the facility was being properly operated;

e. That the Permittee properly notified the Commissioner of the upset in accordance with Minn. R. 7001.1090, subp. 1, item I; and

f. That the Permittee implemented the remedial measures required by Minn. R. 7001.0150, subp. 3, item J.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

Operation and Maintenance

1.34 The Permittee shall at all times properly operate and maintain the facilities and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. The Permittee shall install and maintain appropriate backup or auxiliary facilities if they are necessary to achieve compliance with the conditions of the permit and, for all permits other than hazardous waste facility permits, if these backup or auxiliary facilities are technically and economically feasible Minn. R. 7001.0150. subp. 3, item F.

1.35 In the event of a reduction or loss of effective treatment of wastewater at the facility, the Permittee shall control production or curtail its discharges to the extent necessary to maintain compliance with the terms and conditions of this permit. The Permittee shall continue this control or curtailment until the wastewater treatment facility has been restored or until an alternative method of treatment is provided. (Minn. R. 7001.1090, subp. 1, item C)

1.36 Solids Management. The Permittee shall properly store, transport, and dispose of biosolids, septage, sediments, residual solids, filter backwash, screenings, oil, grease, and other substances so that pollutants do not enter surface waters or ground waters of the state. Solids should be disposed of in accordance with local, state and federal requirements. (40 CFR 503 and Minn. R. 7041 and applicable federal and state solid waste rules)

1.37 Scheduled Maintenance. The Permittee shall schedule maintenance of the treatment works during non-critical water quality periods to prevent degradation of water quality, except where emergency maintenance is required to prevent a condition that would be detrimental to water quality or human health. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

1.38 Control Tests. In-plant control tests shall be conducted at a frequency adequate to ensure compliance with the conditions of this permit. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

Changes to the Facility or Permit

1.39 Permit Modifications. No person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the Agency has issued a written permit for the facility or activity. (Minn. R. 7001.0030)

Permittees that propose to make a change to the facility or discharge that requires a permit modification must follow Minn. R. 7001.0190. If the Permittee cannot determine whether a permit modification is needed, the Permittee must contact the MPCA prior to any action. It is recommended that the application for permit modification be submitted to the MPCA at least 180 days prior to the planned change.

1.40 Construction. No construction shall begin until the Permittee receives written approval of plans and specifications from the MPCA (Minn. Stat. Sec. 115.03(f)).

Plans, specifications and MPCA approval are not necessary when maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent. For instance, a broken pipe, lift station pump, aerator, or blower can be replaced with the same design-sized equipment without MPCA approval.

If the proposed construction is not expressly authorized by this permit, it may require a permit modification. If the construction project requires an Environmental Assessment Worksheet under Minn. R. 4410, no construction shall begin until a negative declaration is issued and all approvals are received or implemented.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

1.41 Report Changes. The Permittee shall give advance notice as soon as possible to the MPCA of any substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit. (Minn. R. 7001.0150, subp. 3, item M)

1.42 Chemical Additives. The Permittee shall receive prior written approval from the MPCA before increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge.

The Permittee shall request approval for an increased or new use of a chemical additive at least 60 days, or as soon as possible, before the proposed increased or new use.

This written request shall include at least the following information for the proposed additive:

a. The process for which the additive will be used;
b. Material Safety Data Sheet (MSDS) which shall include aquatic toxicity, human health, and environmental fate information for the proposed additive;
c. A complete product use and instruction label;
d. The commercial and chemical names and Chemical Abstract Survey (CAS) number for all ingredients in the additive (If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, the Permittee shall contact the supplier to have this information provided); and
e. The proposed method of application, application frequency, concentration, and daily average and maximum rates of use.

Upon review of the information submitted regarding the proposed chemical additive, the MPCA may require additional information be submitted for consideration. This permit may be modified to restrict the use or discharge of a chemical additive and include additional influent and effluent monitoring requirements.

Approval for the use of an additive shall not justify the exceedance of any effluent limitation nor shall it be used as a defense against pollutant levels in the discharge causing or contributing to the violation of a water quality standard. (Minn. R. 7001.0170)

1.43 MPCA Initiated Permit Modification, Suspension, or Revocation. The MPCA may modify or revoke and reissue this permit pursuant to Minn. R. 7001.0170. The MPCA may revoke without reissuance this permit pursuant to Minn. R. 7001.0180.

1.44 TMDL Impacts. Facilities that discharge to an impaired surface water, watershed or drainage basin may be required to comply with additional permits or permit requirements, including additional restriction or relaxation of limits and monitoring as authorized by the CWA 303(d)(4)(A) and 40 CFR 122.44.l.2.i., necessary to ensure consistency with the assumptions and requirements of any applicable US EPA approved wasteload allocations resulting from Total Maximum Daily Load (TMDL) studies.

1.45 Permit Transfer. The permit is not transferable to any person without the express written approval of the Agency after compliance with the requirements of Minn. R. 7001.0190. A person to whom the permit has been transferred shall comply with the conditions of the permit. (Minn. R., 7001.0150, subp. 3, item N)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 9. Total Facility Requirements

1. General Requirements

1.46 Facility Closure. The Permittee is responsible for closure and postclosure care of the facility. The Permittee shall notify the MPCA of a significant reduction or cessation of the activities described in this permit at least 180 days before the reduction or cessation. The MPCA may require the Permittee to provide to the MPCA a facility Closure Plan for approval.

Facility closure that could result in a potential long-term water quality concern, such as the ongoing discharge of wastewater to surface or ground water, may require a permit modification or reissuance.

The MPCA may require the Permittee to establish and maintain financial assurance to ensure performance of certain obligations under this permit, including closure, postclosure care and remedial action at the facility. If financial assurance is required, the amount and type of financial assurance, and proposed modifications to previously MPCA-approved financial assurance, shall be approved by the MPCA. (Minn. Stat. Sec. 116.07, subd. 4)

1.47 Permit Reissuance. If the Permittee desires to continue permit coverage beyond the date of permit expiration, the Permittee shall submit an application for reissuance at least 180 days before permit expiration. If the Permittee does not intend to continue the activities authorized by this permit after the expiration date of this permit, the Permittee shall notify the MPCA in writing at least 180 days before permit expiration.

If the Permittee has submitted a timely application for permit reissuance, the Permittee may continue to conduct the activities authorized by this permit, in compliance with the requirements of this permit, until the MPCA takes final action on the application, unless the MPCA determines any of the following (Minn. R. 7001.0040 and 7001.0160):

a. The Permittee is not in substantial compliance with the requirements of this permit, or with a stipulation agreement or compliance schedule designed to bring the Permittee into compliance with this permit;

b. The MPCA, as a result of an action or failure to act by the Permittee, has been unable to take final action on the application on or before the expiration date of the permit;

c. The Permittee has submitted an application with major deficiencies or has failed to properly supplement the application in a timely manner after being informed of deficiencies.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

STATE OF MINNESOTA

Minnesota Pollution Control Agency

Industrial Division

National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS) Permit MN0055948

PERMITTEE:	United States Steel Corporation		
FACILITY NAME:	Minnesota Ore Operations – Keetac – Tailings Basin		
RECEIVING WATER:	Reservoir 2, Welcome Creek		
CITY OR TOWNSHIP:	Keewatin	**COUNTY:**	Itasca
ISSUANCE DATE:		**EXPIRATION DATE:**	

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to construct, install and operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to reduce pollutant levels in point source discharges and protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7050, 7053, 7060, 7090.3000 through 7090.3080, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, and supersedes the previous permit that was issued for this facility on March 10, 2006. This permit expires at midnight on the expiration date identified above.

Signature: ______________________________

Jeff Udd, P.E. *for* The Minnesota Pollution Control Agency
Acting Supervisor, Water Quality Permits Unit
Land and Water Quality Permits Section
Industrial Division

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Questions on this permit?
- For DMR and other permit reporting issues, contact: Belinda Nicholas, 651-757-2613.
- For specific permit requirements or permit compliance status, contact: John Thomas, 218-302-6616.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

Table of Contents

Facility Description

The principal activity at this facility is the disposal of taconite tailings and related wastewater from the U.S. Steel Corporation – Keewatin Taconite Operations plant. The facility consists of the Keewatin Taconite tailings basin, the drainage area contributing surface run-off to the basin, and all non-sewage wastewater disposal systems within the permitted area. The facility has proposed an expansion of the mining and taconite pellet manufacturing operations at the processing plant associated with this tailings basin. The conditions of this permit reflect the changes associated with this expansion.

The tailings and related wastewater that are disposed of in the tailings basin are generated by the Keewatin Taconite plant, which is located north of Highway 169. The plant consists of a series of crushers and screens, a concentrator, and an agglomerator. The concentrator consists of a series of mills, magnetic separators, hydroseparators, hydroclones, screens, and thickeners. A flocculant is added to the concentrator tailings slurry before the thickening stage, at a maximum rate of 250,000 lbs/yr. The agglomerator receives the concentrate, which is mixed with limestone then dewatered by disc filters. The filter cake is then mixed with bentonite and formed into pellets in balling drums. The agglomerator wastewater, as well as wet scrubber, recirculating non-contact cooling water, and normal floor drain wastewater that is generated at the plant, is recirculated as process water within the plant. The make-up water for the recirculating non-contact cooling water system in the plant is treated with softening, along with chemical additives, such as corrosion inhibitors, descalers, and microbiocides are also added. Chemicals used in the wet scrubber system are added for pH control, clarification, and coagulation aid. Corrosion inhibitor/descaler chemicals are used in the vacuum seal water system. A kiln slag inhibitor chemical is used at approximately 1,175 pounds per day or 430,000 pounds per year.

The wastewater flow to the tailings basin consists only of the tailings slurry, associated concentrator process wastewater, and wet scrubber blowdown water for a total average flow rate of 20 MGD. The tailings slurry and plant process wastewater is piped under pressure from the plant across Highway 169 and is spigotted into the tailings basin. The dual tailings pipelines have several gravity flow drainage points along their route that are used during routine maintenance, winter operations, and emergency situations, such as pump failure. Dump valve drainage points 4, 5, 6W, 6E, 7, and 8 flow by gravity directly to the tailings basin. An average of 13 million long tons of dry tailings are disposed of each year in the basin. The tailings are generated from the plant thickeners. The basin is divided into several parts, principally the older Stage 1 and the active Stage 2 basins. Much of the Stage 1 basin has undergone re-vegetation. Water is occasionally pumped from Reservoir 2 to Reservoir 6 for water level maintenance, at an average rate of 814 million gallons per year. The tailings basin is principally underlain by glacial till and glaciofluvial deposits.

The interior tailings basin dikes are constructed of coarse tailings which are spigotted from the tailings pipelines. The exterior basin dikes are constructed of clay starter dikes with a coarser sand and gravel chimney drain. A decant tower on the south side of the second stage interior tailings basin drains basin wastewater to the second stage exterior pond for additional sedimentation. A decant tower on the west side of the basin area drains water from the second stage exterior to Reservoir 6 for reuse. Return water for the plant water supply is pumped from a station on Reservoir 6. This reservoir discharges through siphon outfall SD001, at a combined maximum rate of 9.4 MGD, to Reservoir 2. Outfall SD005 was established to discharge to Reservoir 2 North and Welcome Creek, to Reservoir 2, at a maximum flow of approximately 23 MGD. The proposed expansion to the mining and pellet manufacturing process will result in a vertical expansion of the tailings basin, and changes to the volumes discharged to and from the tailings basin. Discharges to surface water from the tailings basin following the expansion will not exceed the pre-expansion volumes.

Due to the proposed discharge location, direct discharge of mine pit dewatering from the Sargent Pit to an unnamed ditch is authorized under this permit. This activity is similar to other mine pit dewatering operations authorized in NPDES/SDS Permit MN0031879.

Surface drainage from the tailings basin area, in the form of surface run-off from the exterior dikes, flows to the West Swan River, unnamed wetlands, Hay Creek to Swan Lake, Reservoir 2, Reservoir 2 North, and Welcome Creek. These are all class 2B, 3B, 4A, 4B, 5, and 6 waters, except for Welcome Creek, which is class 2C, 3C, 4A, 4B, 5, and 6 waters.

Surface water station SW001 is located at the weir outlet of Reservoir 2 and was established at the request of the Permittee. No limits are associated with this monitoring station.

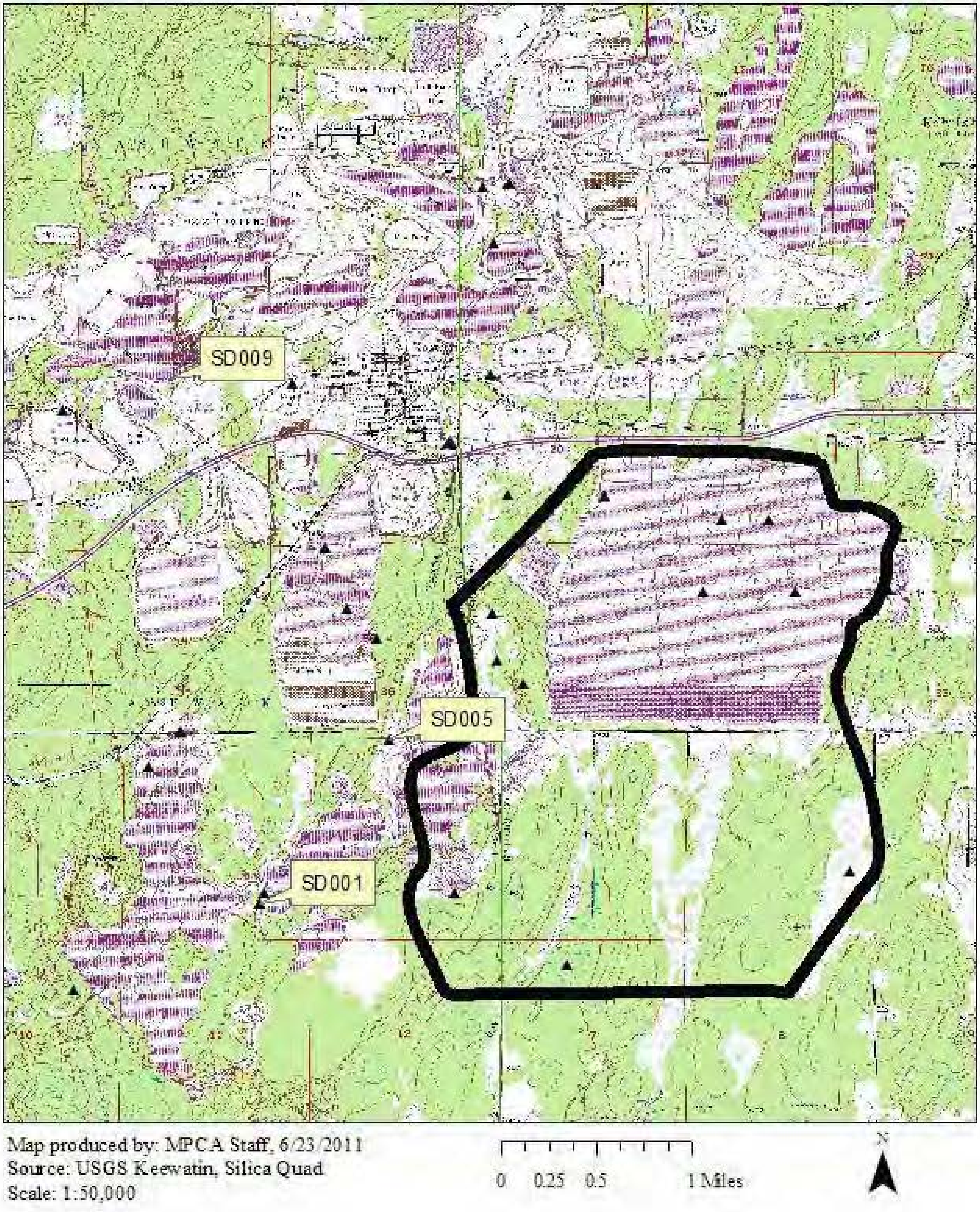
Chemical dust suppressants are occasionally used at the facility in accordance with MPCA approvals.

Repair shops and a garage are located in the Southwest ¼ of the Southeast ¼ of Section 36. Sewage generated at this site is contained in portable units and disposed of in a nearby municipal wastewater treatment facility.

The locations of the facility’s tailings basin discharge sites are shown on the following page.

Topographic Map of Permitted Facility

MN0055948, United States Steel Corporation - Keetac Tailings Basin
St. Louis & Itasca County, Minnesota



Map produced by: MPCA Staff, 6/23/2011
Source: USGS Keewatin, Silica Quad
Scale: 1:50,000

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD001	Effluent To Surface Water	Siphon Outfalls 011, 012, 013	SE Quarter of Section 2, Township 56 North, Range 22 West
SD005	Effluent To Surface Water	Culvert Outfall from Reservoir 6	NE Quarter of the NE Quarter of the NW Quarter of Section 1, Township 56 North, Range 22 West
SD008	Effluent To Surface Water	Sum of outfalls 011-013, 015	SE Quarter of Section 2, Township 56 North, Range 22 West
SD009	Effluent To Surface Water	Sargent Pit Dewatering to Unnamed Ditch	

Surface Water Stations

Station	Type of Station	Local Name	PLS Location
SW001	Lake/Reservoir	Reservoir 2	NE Quarter of Section 10, Township 56 North, Range 22 West

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS001	Water Intake	Non-pptn water inputs to the facility	SE Quarter of Section 2, Township 56 North, Range 22 West

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	4
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Month	5
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	4
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	4
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	4

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Week	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Interim Period

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

SD 009

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Chloride, Total	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	3
Nitrite Plus Nitrate, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	4
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Month	4

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	4
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Month	5
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	4
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	4
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	4
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	4
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	4

SD 005

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Estimate	1 x Week	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Week	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	2
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SD 008

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Evaporation, Accumulated	Monitor Only	in	Calendar Month Total	Jan-Dec	Calculation	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Calculation	1 x Month	6
Precipitation	Monitor Only	in	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Month	

SD 009

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Chloride, Total	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	Grab	1 x Month	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	1 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Single Value	Jan-Dec	Grab	1 x Quarter	3
Nitrite Plus Nitrate, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
pH	9.0	SU	Instantaneous Maximum	Jan-Dec	Grab	1 x Month	
pH	6.0	SU	Instantaneous Minimum	Jan-Dec	Grab	1 x Month	
Selenium, Total (as Se)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Single Value	Jan-Dec	Grab	2 x Year	1
Solids, Total Suspended (TSS)	20	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	7
Sulfate, Total (as SO4)	14	mg/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	
Sulfate, Total (as SO4)	24	mg/L	Calendar Month Maximum	Jan-Dec	Grab	2 x Month	

SW 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Estimate	1 x Month	

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

The Permittee shall comply with the limits and monitoring requirements as specified below.

Period: Limits Applicable in the Final Period

SW 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Estimate	1 x Month	
Solids, Total Suspended (TSS)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Average	Jan-Dec	Grab	1 x Month	
Turbidity	Monitor Only	NTU	Calendar Month Average	Jan-Dec	Grab	1 x Month	

WS 001

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	1 x Month	8

Notes:
1 -- At least one sample shall be collected in each April and September.
2 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisions to those methods.
3 -- Samples may be taken any time during each calendar quarter but must be reported on the DMR for the last month of each quarter (e.g. the sample for the first calendar quarter of Jan - Mar should be reported on the March DMR). Use EPA method 1631, with clean techniques method 1669, and any revisionsto this methods.
4 -- Sampling shall be conducted in accordance with Chapter 5 of this permit.
5 -- Sampling shall be conducted in accordance with Chapter 5 of this permit. Use EPA method 1631, with clean techniques method 1669, and any revisions to those methods.
6 -- Sum of annual discharge from outfalls 010, 011, 012, 013 and 015 shall not exceed the annual net precipitation at the facility as calculated according to PART I, C.8.
7 -- The permittee may request to modify this requirement after 12 months of monitoring data have been submitted to MPCA.
8 -- Volume of non-precipitation water inputs to the facility (for example, from Reservoir 2 or from Reservoir 5).

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 1. Special Requirements

1. Compliance Schedule

Compliance Schedule for Sulfate

1.1 The Permittee is operating under a schedule of compliance pursuant to NPDES/SDS Permit MN0031879 to attain compliance with final effluent limitations for total sulfate. The Permittee shall comply with the schedule of compliance contained in Chapter 1 of NPDES/SDS Permit MN0031879. Pursuant to that schedule, the MPCA will submit notification to the Permittee that the final effluent limitations for total sulfate contained in this permit apply.

2. Special Requirements

Effluent Limit Study

2.1 The Permittee may opt to conduct a study to gather data and information that would support a total sulfate limit other than the final limitations included in this permit.

2.2 When cause exists according to state and federal law regarding modification of permits, this permit may be reopened for modification of effluent limitations, discharge restrictions, monitoring requirements, and or conditions of a schedule of compliance. Any modified permit conditions shall be consistent with all applicable state and federal requirements. MPCA shall comply with all procedural requirements under state and federal law prior to reopening and modifying this permit.

Chapter 2. Industrial Process Wastewater

1. Prohibited Discharges

1.1 This permit does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

1.2 The Permittee shall prevent the routing of pollutants from the facility to a municipal wastewater treatment system in any manner unless authorized by the pretreatment standards of the MPCA and the municipal authority.

1.3 The Permittee shall not transport pollutants to a municipal wastewater treatment system that will interfere with the operation of the treatment system or cause pass-through violations of effluent limits or water quality standards.

2. Toxic Substance Reporting

2.1 The Permittee shall notify the MPCA immediately of any knowledge or reason to believe that an activity has occurred that would result in the discharge of a toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10 or listed below that is not limited in the permit, if the discharge of this toxic pollutant has exceeded or is expected to exceed the following levels:

a. for acrolein and acrylonitrile, 200 ug/L;

b. for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, 500 ug/L;

c. for antimony, 1mg/L;

d. for any other toxic pollutant listed in Minnesota Rules, pt. 7001.1060, subp. 4 to 10, 100 ug/L; or

e. five times the maximum concentration value identified and reported for that pollutant in the permit application. (Minnesota Rules, pt. 7001.1090, subp. 2.A)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 2. Industrial Process Wastewater

2. Toxic Substance Reporting

2.2 The Permittee shall notify the MPCA immediately if the Permittee has begun or expects to begin to use or manufacture as an intermediate or final by-product a toxic pollutant that was not reported in the permit application under Minnesota Rules, pt. 7001.1050, subp. 2.J. (Minnesota Rules, pt. 7001.1090, subp. 2.B)

3. Hydrotest Discharges

3.1 The Permittee shall notify the MPCA prior to discharging hydrostatic test waters. The Permittee shall provide information necessary to evaluate the potential impact of this discharge and to ensure compliance with this permit. This information shall include:

a. the proposed discharge dates;

b. the name and location of receiving waters, including city or township, county, and township/range location;

c. an evaluation of the impact of the discharge on the receiving waters in relation to the water quality standards;

d. a map identifying discharge location(s) and monitoring point(s);

e. the estimated average and maximum discharge rates;

f. the estimated total flow volume of discharge;

g. the water supply for the test water, with a copy of the appropriate Minnesota Department of Natural Resources (DNR) water appropriation permit;

h. water quality data for the water supply;

i. proposed treatment method(s) before discharge; and

j. methods to be used to prevent scouring and erosion due to the discharge.

3.2 This permit does not authorize the construction or installation of pipeline facilities.

4. Polychlorinated Biphenyls (PCBs)

4.1 PCBs, including but not limited to those used in electrical transformers and capacitors, shall not be discharged or released to the environment.

5. New Proposed Dewatering

5.1 The Permittee shall obtain a permit modification before discharging from a new dewatering outfall.

5.2 In addition to the requirements in the Permit Modifications section of this permit, the Permittee shall submit to the MPCA detailed plans and specifications for the proposed methods of achieving discharge limits for turbidity and total suspended solids, based in part upon representative water quality data for untreated wastewater and a detailed map and diagram description of the proposed design for the flow control structures, and route of the discharge to receiving waters.

6. Application for Permit Reissuance

6.1 The permit application shall include analytical data as part of the application for reissuance of this permit. These analyses shall be done on individual samples taken during the twelve-month period before the reissuance application is submitted.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 2. Industrial Process Wastewater

6. Application for Permit Reissuance

6.2 The permit application shall include analytical data for at least the following parameters at monitoring station SD005:

a. biochemical oxygen demand, chemical oxygen demand, total organic carbon, gasoline range organics, diesel range organics, fecal coliform, ammonia, temperature;

b. color, fluoride, nitrate-nitrite (as nitrogen), total organic nitrogen, oil and grease, total phosphorus, chloride, sulfate, sulfide (as sulfur), surfactants, bicarbonates, alkalinity, total salinity, total dissolved solids, specific conductance;

c. aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, vanadium, zinc (all in total form) using approved methods according to 40 CFR Part 136.3;

d. total mercury using EPA Method 1631;

e. gross alpha particles, radium-226, radium-228, radon-222, uranium;

f. PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260; and

g. a scan of constituents using EPA Methods 624 and 625, in 40 CFR Part 136.

The Permittee shall identify, in addition to those pollutants noted in Methods 624 and 625 (Appendix D, Table II), the concentrations of at least ten of the most abundant constituents of the acid and base/neutral organic fractions shown to be present by peaks on the total ion plots (reconstructed gas chromatograms) within ten percent of the nearest internal standard. Identification shall be through the use of U.S. EPA/NIH computerized library of mass spectra, with visual confirmation and potential quantification.

6.3 The Permittee shall include, as part of the application for reissuance of this permit, and updated Operating Plan for the tailings basin for the next five (5) years.

Chapter 3. Metallic Mining

1. Mine Tailings Basin

1.1 To summarize the status of the tailings basin, the Permittee shall submit an Annual Report by January 31 of year following permit issuance.

1.2 The Annual Report shall include a current map of the tailings basin area that details the dikes, berms, dams, roads and cells, as well as the current topographic and water level elevations.

1.3 The Annual Report for the tailings basin shall also report the annual net precipitation determined from the previous calendar year and the annual flow volume discharged via outfalls SD001 and SD005.

1.4 The Permittee shall conduct a detailed field survey of seepage zones from the perimeter dikes of the tailings basin during October of each year.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 3. Metallic Mining

1. Mine Tailings Basin

1.5 The Annual Report shall include a Dike Seepage Survey Report. The Dike Seepage Survey Report shall summarize the field survey and include the following information:

a. a clearly labeled map indicating the locations of the visible seepage zones;

b. the estimated flow rates for the seepage zones;

c. the specific conductance, pH and temperature values for the seepage zones;

d. a brief description of the changes in the nature of the seepage from previous observations; and

e. photographs as needed to document items a. - d.

1.6 The Permittee shall discharge through outfalls SD001 and SD005 no more than the annual net precipitation from the tailings basin during each calendar year. The annual net precipitation shall be determined as follows:

Y = (Af * P) - (At * E)

where:

Y = annual net precipitation
Af = area of the tailings basin plus the drainage area contributing surface runoff to the tailings basin
P = total annual precipitation
At = open water area of the tailings basin plus Reservoir 6, and
E = annual lake evaporation.

The total annual precipitation and the annual lake evaporation shall be based on the sum of the data reported through station SD008.

1.7 If the Permittee does not discharge through outfalls SD001 and SD005 the volume equivalent to the annual net precipitation in a given calendar year, then the Permittee may carry over the difference between the annual net precipitation and the actual volume discharged as a credit to the annual net precipitation for the following calendar year. Such credit may be carried over only to that calendar year immediately following the year in which not all of the allowable discharge volume was utilized.

1.8 The Permittee shall notify the Commissioner in writing at least 180 days in advance of any expansion of the area covered by mine tailings beyond the area enclosed by the perimeter basin dams on the date of issuance of this permit.

1.9 The Permittee shall notify the Commissioner in writing at least 30 days prior to the addition or modification of hydraulic relief features, such as granular blanket and filter drains, relief wells and relief trenches, other than those described in the Facility Description.

1.10 The Permittee shall make every effort to prevent and contain any breaks in or spills from the tailings pipeline which runs from the Keewatin Taconite plant to the tailings basin. In particular, the Permittee shall comply with the requirements of the Noncompliance, Upset Defense and Duty to Notify and Avoid Pollution requirements of the Total facility section of the permit, as well as the Tailings Spill Response Plan, should a pipeline break or spill occur.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 3. Metallic Mining

2. Mobile and Rail Equipment Service Areas

2.1 Mobile equipment and rail equipment service areas in the facility shall be operated in compliance with the following:

a. The Permittee shall collect and dispose of locomotive traction sand, degreasing wastes, motor oil, oil filters, oil sorbent pads and booms, transmission fluids, power steering fluids, brake fluids, coolant/antifreeze, radiator flush wastewater and spent solvents in accordance with applicable solid and hazardous waste management rules. These materials shall not be discharged to surface or ground waters of the state.

b. The steam-cleaning of mobile equipment and rail equipment, except for limited outdoor cleaning of large drills and shovels, shall be conducted in wash bays that drain to wastewater treatment systems that include the removal of suspended solids and flammable liquids. The only washing of mobile equipment done in outside areas shall be to remove mud and dirt that has accumulated during outside work.

c. The Permittee shall not use solvent-based cleaners, such as those available for brake cleaning and degreasing, to wash mobile and rail equipment unless the cleaning fluids are completely contained and not allowed to flow to surface or ground waters of the state. Soaps and detergents used in washing shall be biodegradable.

d. Mobile and rail equipment maintenance and repairs shall not be conducted in wash bays.

e. Hazardous materials shall not be stored or handled in wash bays.

f. The Permittee shall inspect wastewater containment systems regularly, and repair any leaks that are detected immediately.

g. If the Permittee discovers that recoverable amounts of petroleum products have entered wastewater containment systems, they shall be recovered immediately and reported to the MPCA.

h. Spill cleanup procedures shall be posted in mobile and rail equipment maintenance and repair areas.

Chapter 4. Stormwater Management

1. Authorization

1.1 This chapter authorizes the Permittee to discharge stormwater associated with industrial activity in accordance with the terms and conditions of this chapter. The MPCA may initiate modification of this chapter in accordance with Minn. R. 7001.0170 and Minn. R. 7001.0190 Subp. 1 to incorporate revised requirements in response to the reissuance or modification of the General Stormwater Permit for Industrial Activity (MNG611000).

2. Prohibited Discharges

2.1 This permit, unless specifically authorized by another chapter, does not authorize the discharge of sewage, wash water, scrubber water, spills, oil, hazardous substances, or equipment/vehicle cleaning and maintenance wastewaters to ditches, wetlands or other surface waters of the state.

2.2 This permit does not authorize discharges from sites for which Environmental Assessment Worksheets or Environmental Impact Statements are required, in accordance with Minn. R. ch. 4410, until that environmental review is completed.

3. Water Quality Standards

3.1 The Permittee shall operate and maintain the facility and shall control runoff, including stormwater, from the facility to prevent the exceedance of water quality standards specified in Minnesota Rules, chs. 7050 and 7060.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

3. Water Quality Standards

3.2 The Permittee shall limit and control the use of materials at the facility that may cause exceedances of ground water standards specified in Minnesota Rules, ch. 7060. These materials include, but are not limited to, detergents and cleaning agents, solvents, chemical dust suppressants, lubricants, fuels, drilling fluids, oils, fertilizers, explosives and blasting agents.

4. Stormwater Pollution Prevention Plan

4.1 The Permittee shall develop and implement a Stormwater Pollution Prevention Plan (Plan) to address the specific conditions at the industrial facility. The goal of the Plan is to eliminate or minimize contact of stormwater with significant materials that may result in pollution of the runoff. If contact cannot be eliminated or reduced, stormwater that has contacted significant material should be treated before it is discharged from the site. The Plan shall apply to those areas of the facility where industrial activities occur or significant materials are stored, and stormwater runoff does not receive treatment prior to discharge via a permitted surface discharge station. In addition, the Plan should indentify all areas of the facility where the necessary treatment of stormwater is addressed by a permitted surface discharge station.

4.2 The Plan shall be implemented at the site before the Permittee is covered under this permit.

4.3 The Stormwater Pollution Prevention Plan shall include a description of appropriate Best Management Practices for protection of surface and ground water quality at the facility, and a schedule for implementing the practices. The Plan shall also include the procedures to be followed by designated staff employed by the Permittee to implement the plan.

4.4 The Permittee shall comply with its Stormwater Pollution Prevention Plan.

4.5 The Permittee shall submit the Stormwater Pollution Prevention Plan to MPCA upon request.

Plan Contents

4.6 Complete a drainage map. The map should indicate the following items at or adjacent to the facility:

a. drainage areas and directions of stormwater runoff (indicated by arrows);

b. discharge outfalls from the site (structures that carry stormwater runoff from the facility such as ditches or storm sewers);

c. the name and location of waters of the state that receive facility stormwater runoff (if waters of the state are too distant from the facility to be indicated on the site map, indicate the name, direction and shortest distance to the lake, river, stream or wetland that receives runoff from your site);

d. areas where significant materials are exposed to stormwater;

e. locations of storm sewer inlets and an indication of which, if any, structures have floor drains or loading dock drains that are connected to storm sewers; and

f. locations and types of Best Management Practices (BMPs) currently installed at the facility to reduce or eliminate pollutants to stormwater.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.7 Complete an inventory of exposed significant materials. Indicate the types of significant materials handled or stored at the site that may potentially contact stormwater. The following are examples of materials that, if exposed to stormwater, must be included in the inventory:

a. raw materials, such as fuels; solvents; petroleum products; detergents; plastic pellets; materials used in food processing or production; stockpiled sand, salt or coal;

b. by-products or intermediate products, such as wood dust, chips or bark; screened limestone, taconite or gravel by-product, recycled blacktop;

c. finished materials, such as metallic products, including scrap metal and recycled or scrap motor vehicle parts, old process equipment/machinery, taconite pellets;

d. waste products, such as ashes, sludge, solid and liquid waste, slag;

e. hazardous substances designated under section 101(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA);

f. any chemical the facility is required to report under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

4.8 Evaluate facility areas for exposure of significant materials to stormwater. In creating the inventory of exposed significant materials, the Permittee must, at a minimum, evaluate the following areas at the industrial site (as well as other areas where appropriate) to determine whether or not significant materials are exposed in these areas:

a. vehicle and equipment maintenance, parking and storage areas including fueling and washing/cleaning areas, to determine if there is discolored soil in these areas as a result of fuel and lubricant leaks and spills;

b. liquid storage tanks and other bulk material stockpile areas;

c. loading and unloading areas;

d. outdoor manufacturing, processing or storage areas and industrial plant yards, to determine if there is discolored soil in these areas as a result of leaked or spilled solvents, fuels, or lubricants;

e. dust or particulate generating areas including dust collection devices that may release dust;

f. rooftops contaminated by industrial activity or operation of a pollution control device;

g. on-site waste disposal areas, such as waste ponds, dumpsters, solid waste storage or management areas; and

h. exposed (non-vegetated) soil areas where there is a potential for erosion to occur.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

4. Stormwater Pollution Prevention Plan

4.9 Describe appropriate BMPs, including structural and non-structural BMPs, that will be used at the facility to minimize or eliminate pollution of stormwater at the site. The description must include an objective for each BMP, as well as a description of how to evaluate proper functioning of the BMP and any maintenance requirements of the BMP. BMPs should target significant materials and areas identified in subparts 7 and 8 of this part. The following general categories of BMPs shall be considered and one or more shall be incorporated into the facility's Plan if significant materials are exposed to stormwater on-site:

a. Source reduction: reduce or eliminate the significant materials that are exposed to stormwater. Materials management practices should be evaluated to determine whether inventories of exposed materials can be reduced or eliminated. This can include clean-up of equipment yards, periodic checking of dust control equipment to ensure minimal accumulation of dust in the area of control equipment, removal and treatment of petroleum contaminated soil, consolidation of materials from multiple areas into one area, and training employees regarding proper handling and disposal of materials. Significant materials may also be moved indoors or covered with a tarp or structure to eliminate contact with precipitation.

b. Diversion: divert stormwater drainage away from exposed significant materials through use of curbing, berms, sewers or other forms of drainage control or elevate exposed significant material above surrounding drainage.

c. Treatment: where contact of stormwater with significant materials is unavoidable, use treatment devices to reduce the concentration and amount of pollutants in the discharge. Such devices include oil/water separators, stormwater detention/retention ponds, and vegetative swales.

4.10 Evaluate all discharge conveyances from the site (storm sewers, pipes, tile lines, ditches, etc.) to determine if liquids other than stormwater are being discharged from these devices. This should be done during dry weather when stormwater discharge is not occurring. The evaluation should cover sewer inlets and floor drains to determine which inlets/drains are connected to sanitary sewer lines, storm sewer lines, or septic tanks/drainage fields; appropriate methods such as dye or smoke testing or video imaging should be used to determine the source of discharges.

The Plan must certify that discharges from the site have been evaluated for the presence of non-stormwater discharges. The certification shall indicate the date of testing, location of testing, describe the method used to determine the source of discharges and the results of testing. Discharge of non-stormwater (such as sanitary sewer or floor drain connections to storm sewers) is not authorized by this permit; before such discharge may continue, authorization under an appropriate NPDES permit must be obtained.

4.11 Develop a preventive maintenance program. The program must require regular inspection and maintenance of stormwater management devices (e.g. cleaning oil/water separators and catch basins), as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants (e.g. hydraulic leaks, torn bag-house filters) to surface waters.

4.12 Develop a spill prevention and response procedure. In order to develop this procedure, Permittees should evaluate where spills have occurred and where they have the potential to occur. Determine drainage points for potential spill areas and develop appropriate spill prevention and containment measures, should a spill occur. Detailed procedures for cleaning-up spills shall be identified and made available to appropriate personnel. If your facility has any other spill contingency plan that satisfies the above requirements, that plan may be incorporated by reference into this Plan to satisfy this requirement.

4.13 Develop and implement an employee training program to inform appropriate personnel of the components and goals of the Plan. Training shall address spill response, good housekeeping and materials management practices. The Plan shall identify periodic dates for such training.

4.14 Identify personnel responsible for managing and implementing the Plan as well as those responsible for the reporting requirements of this permit. This should include the facility contact person as indicated on the permit application. Identified personnel must be available at reasonable times of operation.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

5. Temporary Protection and Permanent Cover

5.1 The Permittee shall provide and maintain temporary protection or permanent cover for the exposed areas at the facility.

5.2 Temporary protection methods are used to prevent erosion on a short-term basis, such as the placement of mulching straw, wood fiber blankets, wood chips, erosion control netting, or temporary seeding.

5.3 Permanent cover or final stabilization methods are used to prevent erosion, such as the placement of rip rap, sodding, or permanent seeding or planting. Permanent seeding and planting must have a uniform perennial vegetation cover of at least 70 percent density to constitute final stabilization.

6. Inspection and Maintenance

6.1 Site inspections shall be conducted at least once every two months throughout the calendar year. During winter months, the inspections shall be conducted during non-frozen conditions. Inspections shall be conducted by an appropriately trained personnel at the facility site, as identified in part 4.13 of this chapter. The purpose of inspections is to: 1) determine whether structural and non-structural BMPs require maintenance or changes, and 2) evaluate the completeness and accuracy of the Plan.

At least one inspection during a reporting period shall be conducted while stormwater is discharging from the facility. Inspections may be documented using an inspection form provided by the MPCA. A Storm Water Site Inspection Form is provided in the appendices section of this permit.

6.2 Inspections shall be documented and a copy of all documentation shall remain on the permitted site whenever Permittee staff are availbale on the site, and be available upon request. The inspection form developed for the General Storm Water Permit for Industrial Activity may be used for recording inspection results, and is included in the appendices section of this permit.

6.3 The following compliance items will be inspected, and documented where appropriate:

a. evaluate the facility to determine that the Plan accurately reflects site conditions as described in subpart 6 of this part, and document any inaccuracies;

b. evaluate the facility to determine whether new exposed materials have been added to the site since completion of the Plan, and document any new significant materials;

c. during the inspection conducted during the runoff event, observe the runoff to determine if it is discolored or otherwise visibly contaminated, and document observations; and,

d. determine if the non-structural and structural BMPs as indicated in the Plan are installed and functioning properly.

6.4 The Permittee shall ensure that temporary protection and permanent cover for the exposed areas at the site are maintained.

6.5 Indicate the date and time of the inspection as well as the name of the inspector on the inspection form.

6.6 When the depth of sediment collected in the final sedimentation basin above the outfall reaches one-half of the riser height, or one-half of the basin design hydraulic storage volume, the Permittee shall drain the basin and remove the sediment within sixty (60) days of discovery. No outflow from the sedimentation basin shall occur while sediment is being removed from that basin. The sediment removed from the basin shall be disposed of at a site which drains to sedimentation basin(s) at the facility.

6.7 If conditions are observed at the site that require changes in the Plan, such changes shall be made to the Plan prior to submission of the annual report for that calendar year.

6.8 The Permittee shall minimize vehicle tracking of gravel, soil or mud onto paved surfaces at the facility.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

6. Inspection and Maintenance

6.9 If the findings of a site inspection indicate that BMPs are not meeting the objectives as identified in subpart 9 of this part, corrective actions must be initiated within 30 days and the BMP restored to full operation as soon as field conditions allow.

6.10 The Permittee shall remove tracked material from the road surface and return it to the facility within one (1) day of discovery so that the materials drain to sedimentation basin(s) at the facility.

7. Sedimentation Basin Design and Construction

New Sedimentation Basins

7.1 Sedimentation basins shall be designed by a registered professional engineer, and installed under the direct supervision of a registered professional engineer.

7.2 The basin shall provide at least 1800 cubic feet, per acre drained, of hydraulic storage volume below the top of the outlet riser pipe.

7.3 Inlet(s) and outlet(s) shall be designed to prevent short circuiting and the discharge of floating debris.

7.4 The inlet(s) shall be placed at an elevation at least above one-half of the basin design hydraulic storage volume.

7.5 The outlet(s) shall consist of a perforated riser pipe wrapped with filter fabric and covered with crushed gravel. The perforated riser pipe shall be designed to allow complete drawdown of the basin(s).

7.6 Permanent erosion control, such as rip rap, splash pads or gabions shall be installed at the outlet(s) to prevent downstream erosion.

7.7 The basins shall be designed to allow for regular removal of accumulated sediment by a backhoe or other suitable equipment.

8. Application of Chemical Dust Suppressants

8.1 If chemical dust suppressants are applied, the Permittee shall submit a Chemical Dust Suppressant Annual Report due 31 days after the end of each calendar year following the application of a chemical dust suppressant.

8.2 The Chemical Dust Suppressant Annual Report shall include:

a. a record of the dates, methods, locations and amounts by volume of chemical application at the facility;

b. whether the product was applied in the preceding year; and,

c. the results of a chemical analysis of the materials applied each year.

8.3 If a material applied is mixed with water or another solvent before application, the chemical analysis shall be done on the aqueous or other mixture that is representative of the solution applied. This analysis shall be conducted during the same calendar year of application. This analysis shall include the parameters that may be determined by U.S. Environmental Protection Agency (EPA) Methods 624 and 625 which are described in 40 CFR Part 136.

8.4 Chemical dust suppressants, if used, shall not be applied within 100 feet of the surface receiving waters identified in the 'Facility Description' section of this permit. These materials also shall not be applied within 100 feet of ditches that conduct surface flow to the surface receiving waters identified on Page 1 of this permit.

9. Reporting

9.1 Submit a Stormwater Annual Report by March 31 of each year following permit issuance. A copy of the Stormwater Annual Report Form is provided in the appendices section of this permit.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

9. Reporting

9.2 The Permittee shall, upon request of the Agency, submit within a reasonable time the information and reports that are relevant to compliance with this Chapter, including the Plan, inspection reports, annual reports, original laboratory sheets from analyses conducted on the waste stream, and BMP plans and specifications.

10. Records

10.1 The Plan shall be retained for the duration of the permit. A copy of the Plan shall remain on the permitted site whenever Permittee staff are available on the site, and be available upon request. The Permittee shall maintain the following records for the period of permit coverage:

a. dates of inspections;

b. findings of inspections;

c. corrective actions taken;

d. documentation of all changes to the Plan; and,

e. a copy of annual reports.

11. Notification

11.1 If the Permittee discharges stormwater into a municipal storm sewer, the Permittee shall notify the operator of the municipal storm sewer of the existence of this permit.

12. Request for Termination of Stormwater Permit Coverage

12.1 All Permittees regulated by 40 CFR 122.26(b)(14)(i) through (ix) and (xi) may request termination of permit coverage by applying for the no exposure exclusion from permitting. The Permittee must submit (form provided by the Agency) a written certification that a condition of no exposure exists at the facility and that the facility meets the definition of no exposure of industrial activities and materials to storm water.

The application for the no exposure exclusion must be completed by the Permittee and sent to: MPCA, Industrial Storm Water Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

Failure to complete an accurate application will result in the facility being denied the no exposure exclusion from permitting. The facility must submit the application to the Agency once every five years.

12.2 The no exposure exclusion is conditional. The Permittee must maintain a condition of no exposure at the facility in order for the no exposure exclusion to remain applicable. In the event of any change or circumstance that causes exposure of industrial activities or materials to stormwater, the Permittee must comply with the stormwater requirements of this chapter.

12.3 The no exposure certification is non-transferrable. In the event that the facility operator changes, then the new operator must submit a new no exposure certification to the MPCA, Industrial Stormwater Program, 520 Lafayette Rd N, St Paul, MN 55155-4194.

12.4 The MPCA retains the authority to require the facility operator to comply with the requirements of this chapter, even when an industrial operator certifies no exposure, if the MPCA has determined that the discharge is contributing to the violation of, or interfering with the attainment or maintenance of water quality standards, including designated uses.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 4. Stormwater Management

13. Definitions

13.1 "No exposure" means all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snow melt, and/or runoff. Industrial activities or materials include, but are not limited to, material handling equipment or activities, industrial machinery, raw materials, intermediate products, by-products, final products, or waste products.

13.2 "Non-stormwater discharge" means any discharge not comprised entirely of stormwater discharges authorized by a NPDES permit.

13.3 "Runoff" means any liquid that drains over land from any part of a facility.

Chapter 5. Surface Discharge Stations

1. Requirements for Specific Stations

1.1 SD 001, SD 005, SD 008, SD 009: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

2.1 Samples shall be taken at SD001 during any and all discharge events. The time, date, and duration of each discharge event shall be submitted with the appropriate Discharge Monitoring Report.

3. Sampling Location

3.1 Samples for Station SD001 shall be taken at one of the four siphon outfall points which has the greatest flow at the time of sampling.

3.2 Samples for Station SD005 shall be taken at the culvert prior to combination with Reservoir 2 North waters, during a period of discharge from Reservoir 6. If a discharge from Reservoir 6 occurs at any time during the sampling month, a sample must be obtained for analysis.

3.3 Samples for SD009 shall be taken at a point representative of the discharge of dewatering effluent from Sargent Pit to the unnamed ditch.

3.4 Samples and measurements required by this permit shall be representative of the monitored activity.

4. Surface Discharges

4.1 Floating solids or visible foam shall not be discharged in other than trace amounts.

4.2 Oil or other substances shall not be discharged in amounts that create a visible color film.

4.3 The Permittee shall install and maintain outlet protection measures at the discharge stations to prevent erosion.

5. Winter Sampling Conditions

5.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

6. Discharge Monitoring Reports

6.1 The Permittee shall submit monitoring results for discharges in accordance with the limits and monitoring requirements for this station. If no discharge occurred during the reporting period, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR).

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 6. Surface Water Stations

1. Requirements for Specific Stations

1.1 SW 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Special Requirements

2.1 Station SW001 was established at the request of the Permittee.

3. Discharge Monitoring Reports

3.1 The Permittee shall submit monitoring results in accordance with the limits and monitoring requirements for this station. If flow conditions are such that no sample could be acquired, the Permittee shall check the "No Flow" box and note the conditions on the Discharge Monitoring Report (DMR).

4. Sampling Location

4.1 Samples for Station SW001 shall be taken at the weir outlet on Reservoir 2.

5. Sampling Protocol

5.1 All instruments used for field measurements shall be maintained and calibrated to insure accuracy of measurements.

5.2 Sample water shall be preserved according to lab instructions and delivered to a certified lab within the minimum holding times.

6. Winter Sampling Conditions

6.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Flow" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

Chapter 7. Waste Stream Stations

1. Requirements for Specific Stations

1.1 WS 001: Submit a monthly DMR monthly by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Flow measurements for Station WS001 shall be representative of the non-precipitation inputs to the facility (for example, from Reservoir 2 and/or from Reservoir 6).

Chapter 8. Total Facility Requirements

1. General Requirements

General Requirements

1.1 Incorporation by Reference. The following applicable federal and state laws are incorporated by reference in this permit, are applicable to the Permittee, and are enforceable parts of this permit: 40 CFR pts. 122.41, 122.42, 136, 403 and 503; Minn. R. pts. 7001, 7041, 7045, 7050, 7052, 7053, 7060, and 7080; and Minn. Stat. Sec. 115 and 116.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.2 Permittee Responsibility. The Permittee shall perform the actions or conduct the activity authorized by the permit in compliance with the conditions of the permit and, if required, in accordance with the plans and specifications approved by the Agency. (Minn. R. 7001.0150, subp. 3, item E)

1.3 Toxic Discharges Prohibited. Whether or not this permit includes effluent limitations for toxic pollutants, the Permittee shall not discharge a toxic pollutant except according to Code of Federal Regulations, Title 40, sections 400 to 460 and Minnesota Rules 7050, 7052, 7053 and any other applicable MPCA rules. (Minn. R. 7001.1090, subp.1, item A)

1.4 Nuisance Conditions Prohibited. The Permittee's discharge shall not cause any nuisance conditions including, but not limited to: floating solids, scum and visible oil film, acutely toxic conditions to aquatic life, or other adverse impact on the receiving water. (Minn. R. 7050.0210 subp. 2)

1.5 Property Rights. This permit does not convey a property right or an exclusive privilege. (Minn. R. 7001.0150, subp. 3, item C)

1.6 Liability Exemption. In issuing this permit, the state and the MPCA assume no responsibility for damage to persons, property, or the environment caused by the activities of the Permittee in the conduct of its actions, including those activities authorized, directed, or undertaken under this permit. To the extent the state and the MPCA may be liable for the activities of its employees, that liability is explicitly limited to that provided in the Tort Claims Act. (Minn. R. 7001.0150, subp. 3, item O)

1.7 The MPCA's issuance of this permit does not obligate the MPCA to enforce local laws, rules, or plans beyond what is authorized by Minnesota Statutes. (Minn. R. 7001.0150, subp.3, item D)

1.8 Liabilities. The MPCA's issuance of this permit does not release the Permittee from any liability, penalty or duty imposed by Minnesota or federal statutes or rules or local ordinances, except the obligation to obtain the permit. (Minn. R. 7001.0150, subp.3, item A)

1.9 The issuance of this permit does not prevent the future adoption by the MPCA of pollution control rules, standards, or orders more stringent than those now in existence and does not prevent the enforcement of these rules, standards, or orders against the Permittee. (Minn. R. 7001.0150, subp.3, item B)

1.10 Severability. The provisions of this permit are severable and, if any provisions of this permit or the application of any provision of this permit to any circumstance are held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

1.11 Compliance with Other Rules and Statutes. The Permittee shall comply with all applicable air quality, solid waste, and hazardous waste statutes and rules in the operation and maintenance of the facility.

1.12 Inspection and Entry. When authorized by Minn. Stat. Sec. 115.04; 115B.17, subd. 4; and 116.091, and upon presentation of proper credentials, the agency, or an authorized employee or agent of the agency, shall be allowed by the Permittee to enter at reasonable times upon the property of the Permittee to examine and copy books, papers, records, or memoranda pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit; and to conduct surveys and investigations, including sampling or monitoring, pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit. (Minn. R. 7001.0150, subp.3, item I)

1.13 Control Users. The Permittee shall regulate the users of its wastewater treatment facility so as to prevent the introduction of pollutants or materials that may result in the inhibition or disruption of the conveyance system, treatment facility or processes, or disposal system that would contribute to the violation of the conditions of this permit or any federal, state or local law or regulation.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

Sampling

1.14 Representative Sampling. Samples and measurements required by this permit shall be conducted as specified in this permit and shall be representative of the discharge or monitored activity. (40 CFR 122.41 (j)(1))

1.15 Additional Sampling. If the Permittee monitors more frequently than required, the results and the frequency of monitoring shall be reported on the Discharge Monitoring Report (DMR) or another MPCA-approved form for that reporting period. (Minn. R. 7001.1090, subp. 1, item E)

1.16 Certified Laboratory. A laboratory certified by the Minnesota Department of Health shall conduct analyses required by this permit. Analyses of dissolved oxygen, pH, temperature and total residual oxidants (chlorine, bromine) do not need to be completed by a certified laboratory but shall comply with manufacturers specifications for equipment calibration and use. (Minn. Stat. Sec. 144.97 through 144.98 and Minn. R. 4740.2010 and 4740.2050 through 4740.2120) (Minn. R. 4740.2010 and 4740.2050 through 2120)

1.17 Sample Preservation and Procedure. Sample preservation and test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and Minn. R. 7041.3200.

1.18 Equipment Calibration: Flow meters, pumps, flumes, lift stations or other flow monitoring equipment used for purposes of determining compliance with permit shall be checked and/or calibrated for accuracy at least twice annually. (Minn. R. 7001.0150, subp. 2, items B and C)

1.19 Maintain Records. The Permittee shall keep the records required by this permit for at least three years, including any calculations, original recordings from automatic monitoring instruments, and laboratory sheets. The Permittee shall extend these record retention periods upon request of the MPCA. The Permittee shall maintain records for each sample and measurement. The records shall include the following information (Minn. R. 7001.0150, subp. 2, item C):

a. The exact place, date, and time of the sample or measurement;

b. The date of analysis;

c. The name of the person who performed the sample collection, measurement, analysis, or calculation; and

d. The analytical techniques, procedures and methods used; and

e. The results of the analysis.

1.20 Completing Reports. The Permittee shall submit the results of the required sampling and monitoring activities on the forms provided, specified, or approved by the MPCA. The information shall be recorded in the specified areas on those forms and in the units specified. (Minn. R. 7001.1090, subp. 1, item D; Minn. R. 7001.0150, subp. 2, item B)

Required forms may include:

DMR Supplemental Form
Individual values for each sample and measurement must be recorded on the DMR Supplemental Form which, if required, will be provided by the MPCA. DMR Supplemental Forms shall be submitted with the appropriate DMRs. You may design and use your own supplemental form; however it must be approved by the MPCA. Note: Required summary information MUST also be recorded on the DMR. Summary information that is submitted ONLY on the DMR Supplemental Form does not comply with the reporting requirements.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.21 Submitting Reports. DMRs and DMR Supplemental Forms shall be submitted to:

MPCA
Attn: Discharge Monitoring Reports
520 Lafayette Road North
St. Paul, Minnesota 55155-4194.

DMRs and DMR Supplemental Forms shall be postmarked by the 21st day of the month following the sampling period or as otherwise specified in this permit. A DMR shall be submitted for each required station even if no discharge occurred during the reporting period. (Minn. R. 7001.0150, subps. 2.B and 3.H)

Other reports required by this permit shall be postmarked by the date specified in the permit to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

1.22 Incomplete or Incorrect Reports. The Permittee shall immediately submit an amended report or DMR to the MPCA upon discovery by the Permittee or notification by the MPCA that it has submitted an incomplete or incorrect report or DMR. The amended report or DMR shall contain the missing or corrected data along with a cover letter explaining the circumstances of the incomplete or incorrect report. (Minn. R. 7001.0150 subp. 3, item G)

1.23 Required Signatures. All DMRs, forms, reports, and other documents submitted to the MPCA shall be signed by the Permittee or the duly authorized representative of the Permittee. Minn. R. 7001.0150, subp. 2, item D. The person or persons that sign the DMRs, forms, reports or other documents must certify that he or she understands and complies with the certification requirements of Minn. R. 7001.0070 and 7001.0540, including the penalties for submitting false information. Technical documents, such as design drawings and specifications and engineering studies required to be submitted as part of a permit application or by permit conditions, must be certified by a registered professional engineer. (Minn. R. 7001.0540)

1.24 Detection Level. The Permittee shall report monitoring results below the reporting limit (RL) of a particular instrument as "<" the value of the RL. For example, if an instrument has a RL of 0.1 mg/L and a parameter is not detected at a value of 0.1 mg/L or greater, the concentration shall be reported as "<0.1 mg/L." "Non-detected," "undetected," "below detection limit," and "zero" are unacceptable reporting results, and are permit reporting violations. (Minn. R. 7001.0150, subp. 2, item B)

Where sample values are less than the level of detection and the permit requires reporting of an average, the Permittee shall calculate the average as follows:

a. If one or more values are greater than the level of detection, substitute zero for all nondetectable values to use in the average calculation.

b. If all values are below the level of detection, report the averages as "<" the corresponding level of detection.

c. Where one or more sample values are less than the level of detection, and the permit requires reporting of a mass, usually expressed as kg/day, the Permittee shall substitute zero for all nondetectable values.
(Minn. R. 7001.0150, subp. 2, item B)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.25 Records. The Permittee shall, when requested by the Agency, submit within a reasonable time the information and reports that are relevant to the control of pollution regarding the construction, modification, or operation of the facility covered by the permit or regarding the conduct of the activity covered by the permit. (Minn. R. 7001.0150, subp. 3, item H)

1.26 Confidential Information. Except for data determined to be confidential according to Minn. Stat. Sec. 116.075, subd. 2, all reports required by this permit shall be available for public inspection. Effluent data shall not be considered confidential. To request the Agency maintain data as confidential, the Permittee must follow Minn. R. 7000.1300.

Noncompliance and Enforcement

1.27 Subject to Enforcement Action and Penalties. Noncompliance with a term or condition of this permit subjects the Permittee to penalties provided by federal and state law set forth in section 309 of the Clean Water Act; United States Code, title 33, section 1319, as amended; and in Minn. Stat. Sec. 115.071 and 116.072, including monetary penalties, imprisonment, or both. (Minn. R. 7001.1090, subp. 1, item B)

1.28 Criminal Activity. The Permittee may not knowingly make a false statement, representation, or certification in a record or other document submitted to the Agency. A person who falsifies a report or document submitted to the Agency, or tampers with, or knowingly renders inaccurate a monitoring device or method required to be maintained under this permit is subject to criminal and civil penalties provided by federal and state law. (Minn. R. 7001.0150, subp.3, item G., 7001.1090, subps. 1, items G and H and Minn. Stat. Sec. 609.671)

1.29 Noncompliance Defense. It shall not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. (40 CFR 122.41(c))

1.30 Effluent Violations. If sampling by the Permittee indicates a violation of any discharge limitation specified in this permit, the Permittee shall immediately make every effort to verify the violation by collecting additional samples, if appropriate, investigate the cause of the violation, and take action to prevent future violations. Violations that are determined to pose a threat to human health or a drinking water supply, or represent a significant risk to the environment shall be immediately reported to the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area). In addition, you may also contact the MPCA during business hours. Otherwise the violations and the results of any additional sampling shall be recorded on the next appropriate DMR or report.

1.31 Unauthorized Releases of Wastewater Prohibited. Except for conditions specifically described in Minn. R. 7001.1090, subp. 1, items J and K, all unauthorized bypasses, overflows, discharges, spills, or other releases of wastewater or materials to the environment, whether intentional or not, are prohibited. However, the MPCA will consider the Permittee's compliance with permit requirements, frequency of release, quantity, type, location, and other relevant factors when determining appropriate action. (40 CFR 122.41 and Minn. Stat. Sec 115.061)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.32 Discovery of a release. Upon discovery of a release, the Permittee shall:

a. Take all reasonable steps to immediately end the release.

b. Notify the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 or (651)649-5451 (metro area) immediately upon discovery of the release. You may contact the MPCA during business hours at 1(800)657-3864 or (651)296-6300 (metro area).

c. Recover as rapidly and as thoroughly as possible all substances and materials released or immediately take other action as may be reasonably possible to minimize or abate pollution to waters of the state or potential impacts to human health caused thereby. If the released materials or substances cannot be immediately or completely recovered, the Permittee shall contact the MPCA. If directed by the MPCA, the Permittee shall consult with other local, state or federal agencies (such as the Minnesota Department of Natural Resources and/or the Wetland Conservation Act authority) for implementation of additional clean-up or remediation activities in wetland or other sensitive areas.

d. Collect representative samples of the release. The Permittee shall sample the release for parameters of concern immediately following discovery of the release. The Permittee may contact the MPCA during business hours to discuss the sampling parameters and protocol. In addition, Fecal Coliform Bacteria samples shall be collected where it is determined by the Permittee that the release contains or may contain sewage. If the release cannot be immediately stopped, the Permittee shall consult with MPCA regarding additional sampling requirements. Samples shall be collected at least, but not limited to, two times per week for as long as the release continues.

e. Submit the sampling results as directed by the MPCA. At a minimum, the results shall be submitted to the MPCA with the next DMR.

1.33 Upset Defense. In the event of temporary noncompliance by the Permittee with an applicable effluent limitation resulting from an upset at the Permittee's facility due to factors beyond the control of the Permittee, the Permittee has an affirmative defense to an enforcement action brought by the Agency as a result of the noncompliance if the Permittee demonstrates by a preponderance of competent evidence:

a. The specific cause of the upset;

b. That the upset was unintentional;

c. That the upset resulted from factors beyond the reasonable control of the Permittee and did not result from operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or increases in production which are beyond the design capability of the treatment facilities;

d. That at the time of the upset the facility was being properly operated;

e. That the Permittee properly notified the Commissioner of the upset in accordance with Minn. R. 7001.1090, subp. 1, item I; and

f. That the Permittee implemented the remedial measures required by Minn. R. 7001.0150, subp. 3, item J.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

Operation and Maintenance

1.34 The Permittee shall at all times properly operate and maintain the facilities and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. The Permittee shall install and maintain appropriate backup or auxiliary facilities if they are necessary to achieve compliance with the conditions of the permit and, for all permits other than hazardous waste facility permits, if these backup or auxiliary facilities are technically and economically feasible Minn. R. 7001.0150. subp. 3, item F.

1.35 In the event of a reduction or loss of effective treatment of wastewater at the facility, the Permittee shall control production or curtail its discharges to the extent necessary to maintain compliance with the terms and conditions of this permit. The Permittee shall continue this control or curtailment until the wastewater treatment facility has been restored or until an alternative method of treatment is provided. (Minn. R. 7001.1090, subp. 1, item C)

1.36 Solids Management. The Permittee shall properly store, transport, and dispose of biosolids, septage, sediments, residual solids, filter backwash, screenings, oil, grease, and other substances so that pollutants do not enter surface waters or ground waters of the state. Solids should be disposed of in accordance with local, state and federal requirements. (40 CFR 503 and Minn. R. 7041 and applicable federal and state solid waste rules)

1.37 Scheduled Maintenance. The Permittee shall schedule maintenance of the treatment works during non-critical water quality periods to prevent degradation of water quality, except where emergency maintenance is required to prevent a condition that would be detrimental to water quality or human health. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

1.38 Control Tests. In-plant control tests shall be conducted at a frequency adequate to ensure compliance with the conditions of this permit. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

Changes to the Facility or Permit

1.39 Permit Modifications. No person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the Agency has issued a written permit for the facility or activity. (Minn. R. 7001.0030)

Permittees that propose to make a change to the facility or discharge that requires a permit modification must follow Minn. R. 7001.0190. If the Permittee cannot determine whether a permit modification is needed, the Permittee must contact the MPCA prior to any action. It is recommended that the application for permit modification be submitted to the MPCA at least 180 days prior to the planned change.

1.40 Construction. No construction shall begin until the Permittee receives written approval of plans and specifications from the MPCA (Minn. Stat. Sec. 115.03(f)).

Plans, specifications and MPCA approval are not necessary when maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent. For instance, a broken pipe, lift station pump, aerator, or blower can be replaced with the same design-sized equipment without MPCA approval.

If the proposed construction is not expressly authorized by this permit, it may require a permit modification. If the construction project requires an Environmental Assessment Worksheet under Minn. R. 4410, no construction shall begin until a negative declaration is issued and all approvals are received or implemented.

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.41 Report Changes. The Permittee shall give advance notice as soon as possible to the MPCA of any substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit. (Minn. R. 7001.0150, subp. 3, item M)

1.42 Chemical Additives. The Permittee shall receive prior written approval from the MPCA before increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge.

The Permittee shall request approval for an increased or new use of a chemical additive at least 60 days, or as soon as possible, before the proposed increased or new use.

This written request shall include at least the following information for the proposed additive:

a. The process for which the additive will be used;
b. Material Safety Data Sheet (MSDS) which shall include aquatic toxicity, human health, and environmental fate information for the proposed additive;
c. A complete product use and instruction label;
d. The commercial and chemical names and Chemical Abstract Survey (CAS) number for all ingredients in the additive (If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, the Permittee shall contact the supplier to have this information provided); and
e. The proposed method of application, application frequency, concentration, and daily average and maximum rates of use.

Upon review of the information submitted regarding the proposed chemical additive, the MPCA may require additional information be submitted for consideration. This permit may be modified to restrict the use or discharge of a chemical additive and include additional influent and effluent monitoring requirements.

Approval for the use of an additive shall not justify the exceedance of any effluent limitation nor shall it be used as a defense against pollutant levels in the discharge causing or contributing to the violation of a water quality standard. (Minn. R. 7001.0170)

1.43 MPCA Initiated Permit Modification, Suspension, or Revocation. The MPCA may modify or revoke and reissue this permit pursuant to Minn. R. 7001.0170. The MPCA may revoke without reissuance this permit pursuant to Minn. R. 7001.0180.

1.44 TMDL Impacts. Facilities that discharge to an impaired surface water, watershed or drainage basin may be required to comply with additional permits or permit requirements, including additional restriction or relaxation of limits and monitoring as authorized by the CWA 303(d)(4)(A) and 40 CFR 122.44.l.2.i., necessary to ensure consistency with the assumptions and requirements of any applicable US EPA approved wasteload allocations resulting from Total Maximum Daily Load (TMDL) studies.

1.45 Permit Transfer. The permit is not transferable to any person without the express written approval of the Agency after compliance with the requirements of Minn. R. 7001.0190. A person to whom the permit has been transferred shall comply with the conditions of the permit. (Minn. R., 7001.0150, subp. 3, item N)

DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT

Chapter 8. Total Facility Requirements

1. General Requirements

1.46 Facility Closure. The Permittee is responsible for closure and postclosure care of the facility. The Permittee shall notify the MPCA of a significant reduction or cessation of the activities described in this permit at least 180 days before the reduction or cessation. The MPCA may require the Permittee to provide to the MPCA a facility Closure Plan for approval.

Facility closure that could result in a potential long-term water quality concern, such as the ongoing discharge of wastewater to surface or ground water, may require a permit modification or reissuance.

The MPCA may require the Permittee to establish and maintain financial assurance to ensure performance of certain obligations under this permit, including closure, postclosure care and remedial action at the facility. If financial assurance is required, the amount and type of financial assurance, and proposed modifications to previously MPCA-approved financial assurance, shall be approved by the MPCA. (Minn. Stat. Sec. 116.07, subd. 4)

1.47 Permit Reissuance. If the Permittee desires to continue permit coverage beyond the date of permit expiration, the Permittee shall submit an application for reissuance at least 180 days before permit expiration. If the Permittee does not intend to continue the activities authorized by this permit after the expiration date of this permit, the Permittee shall notify the MPCA in writing at least 180 days before permit expiration.

If the Permittee has submitted a timely application for permit reissuance, the Permittee may continue to conduct the activities authorized by this permit, in compliance with the requirements of this permit, until the MPCA takes final action on the application, unless the MPCA determines any of the following (Minn. R. 7001.0040 and 7001.0160):

a. The Permittee is not in substantial compliance with the requirements of this permit, or with a stipulation agreement or compliance schedule designed to bring the Permittee into compliance with this permit;

b. The MPCA, as a result of an action or failure to act by the Permittee, has been unable to take final action on the application on or before the expiration date of the permit;

c. The Permittee has submitted an application with major deficiencies or has failed to properly supplement the application in a timely manner after being informed of deficiencies.

ATTACHMENT 5

Minnesota Pollution Control Agency

National Pollutant Discharge Elimination System /State Disposal System (NPDES/SDS) Permit Program Statement of Basis

Permittee: United States Steel, Minnesota Ore Operations
Name: Keetac – Mining Operations
Permit Number: MN0031879

Current Permit Expiration: May 31, 2011

Public Comment Period Begins: June 27, 2011
Period Ends: August 19, 2011

Receiving Water: Welcome Lake; Welcome Creek to Reservoir 2 North; Unnamed wetlands and creeks tributary to O'Brien Reservoir

Proposed Action: Permit Reissuance

Permitting Contact
Brandon Smith
520 Lafayette Road N.
St. Paul, MN 55155
Phone: 651-757-2740
Fax: 651-296-8717

Table of Contents

Purpose and Participation

Purpose
This Statement of Basis outlines the principal issues related to the preparation of this permit reissuance and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

The permit will be reissued if the Minnesota Pollution Control Agency (MPCA) determines that the proposed Permittee or Permittees will, with respect to the facility or activity to be permitted, comply or undertake a schedule to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA and the conditions of the permit and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

More detail on all requirements placed on the facility may be found in the Permit document.

Facility Description

Background Information
Facility Location
The permitted facility includes the mining and processing operations for the U. S. Steel – Keetac facility, located to the north of Keewatin, Minnesota.

Outfall Locations
SD001: This outfall represents the discharge of filter backwash water from the potable water system to Welcome Lake. PLS coordinates are T57N, R21W, Section 19b.

SD002: The overflow discharge from Reservoir 5 treatment basin and diversion ditch treatment system is to Welcome Creek, south of Welcome Lake. PLS coordinates are T 57 N, R 21 W, Section 30b.

SD003: The Mesabi Chief dewatering outfall is located off the southwestern edge of the Mesabi Chief pit, PLS coordinates are T 57 N, R 22 W, Section 27a.

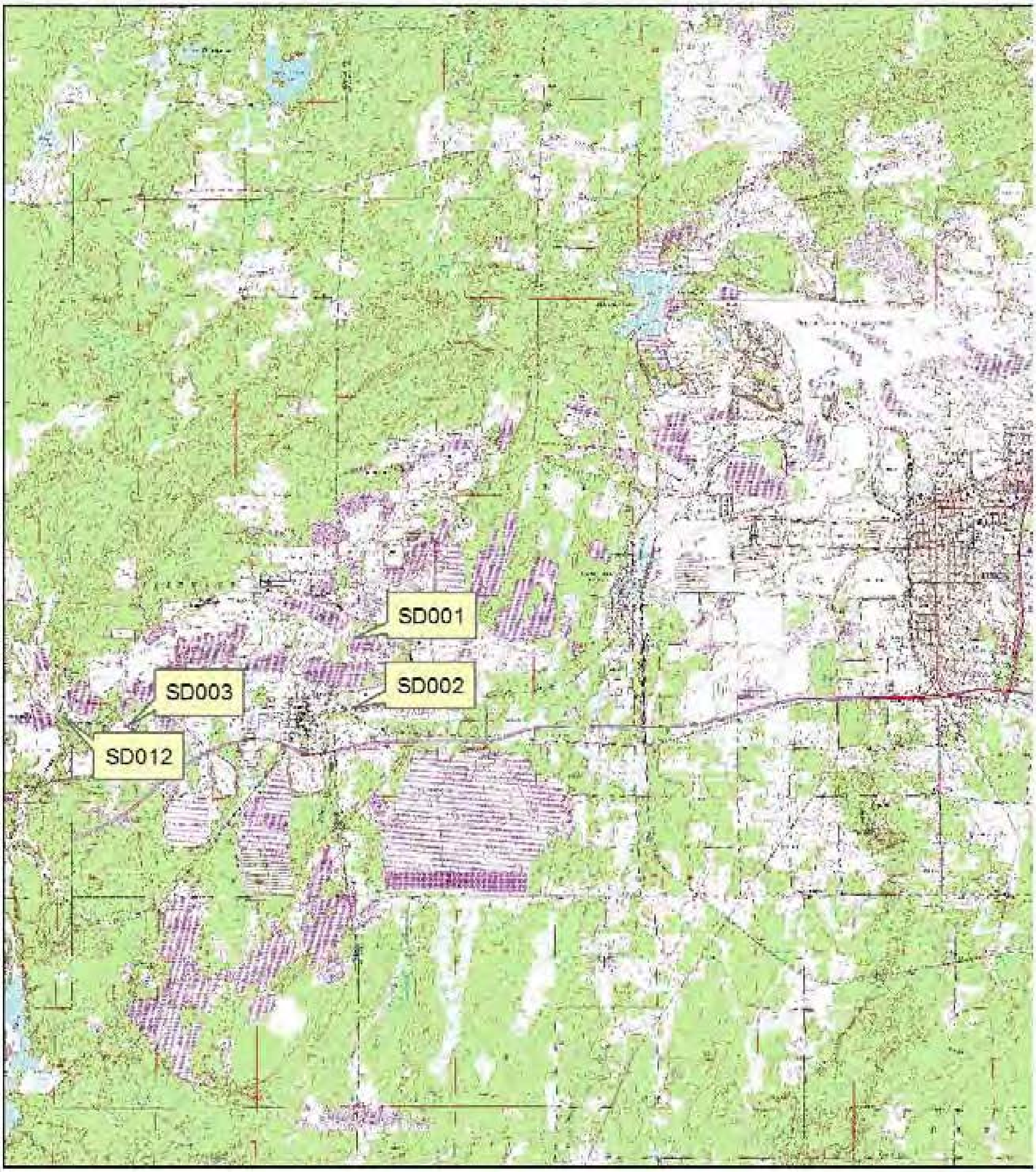
SD012: The Perry Pit dewatering outfall is located off the southwest side of the Perry Pit. PLS coordinates are T 57 N, R 22 W, Section 27b.

Changes to Facility or Operation
The facility has proposed an expansion of the taconite processing plant with which the permitted operations are associated.

Recent Compliance History
The Facility was inspected on May 10, 2010. No significant compliance issues were found that would affect modification of this permit.

Topographic Map of Permitted Facility

MN003189, US Steel - Keewatin Taconite Operations, Mining
St. Louis County & Itasca County, Minnesota



Map produced by: MPCA Staff, 4/15/2010
Source: USGS Nashwauk, Keewatin, Hibbing, Pengilly, Silica, Riley Quads
Scale: 1:24,000

Receiving Waters

Use Classification
The receiving waters affected by this permit reissuance include Welcome Lake, Welcome Creek, O'Brien Creek, and the O'Brien Reservoir.

All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek and O'Brien Creek are classified as Class 2C waters as listed in Minn. R. 7050.0470 subp. 4.A. items (127) and (236), respectively. According to Minn. R.7050.0410, any listed water in Minn. R. 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water.

Welcome Lake and O'Brien Reservoir are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in Minn. R. 7050.0470 and that are not wetlands as defined in Minn. R. 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

Impairments
Minnesota is required to maintain a list of impaired waters, pursuant to Section 303(d) of the Federal Clean Water Act. Impairments have been identified in the receiving waters affected by this permit modification for mercury. Permit conditions with regard to mercury for this permit modification are discussed later in this statement of basis.

Proposed Permit Effluent Limits

The MPCA may develop effluent limitations based on Minnesota state water quality standards for the receiving water use classification, federal categorical standards applicable to specific industrial categories, or combination of these standards to regulate discharge of industrial wastewater. In addition, the MPCA may derive standards that are specific to a particular discharge. These standards may be based on toxicity studies, best professional judgment analysis, technology based standards, and in some instances standards developed by other U.S. states or regulatory agencies. Minnesota Rules and the U.S. Code of Federal Regulations (CFR) require that the MPCA categorize industrial dischargers consistent with the U.S. Environmental Protection Agency federal categorical standards, and state standards if appropriate.

Technology Based Effluent Limits
Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit. These standards, along with Minnesota State Water Discharge Restrictions, have been used to develop the effluent limitations for discharge via permitted outfalls as summarized in the tables below.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD001: Water Treatment Plant Backwash

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	Minn. R. 7053.0225 subp. 1.B.
Total Suspended Solids	30 mg/L Daily Maximum	Minn. R. 7053.0225 subp. 1.B.

Pursuant to Minn. R. 7053.0225, given that effluent limitations have not been promulgated for treatment plant backwash under 40 CFR 440, Minnesota State Water Discharge Restrictions are applied to ensure adequate treatment is achieved prior to discharge via SD001.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Stations SD002 and SD003

Effluent Characteristic	*Effluent Limitation*	*Basis*
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Effluent from SD002 and SD003 consists primarily of industrial stormwater and mine drainage as described in 40 CFR pt. 440. Effluent limitations have been included for total dissolved iron and total suspended solids to ensure that treatment requirements based on BAT and BPT considerations are achieved. Effluent limitations for pH based on water quality considerations have been determined to be more restrictive than the applicable limitations based on BAT and BPT.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD012: Perry Pit Dewatering

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(a)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Effluent from SD012 consists of mine drainage from Perry Pit, which receives surface runoff from stripping and stockpiling activities associated with mining from Keetac operations. Therefore, effluent limitations have been included to reflect BAT and BPT for this waste stream.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Waste Stream Station WS005: Internal Waste Stream

Effluent Characteristic	*Effluent Limitation*	*Basis*
Carbonaceous Biochemical Oxygen Demand, 5 Day	25 mg/L, 3.8 kg/day Calendar Month Average; 40 mg/L, 6.0 kg/day Daily Maximum	Minn. R. 7053.0215 subp. 1
Fecal Coliform	200 Organisms/100 mL Geometric Mean	Minn. R. 7053.0215
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	Minn. R. 7053.0215
Total Suspended Solids	30 mg/L, 4.5 kg/day Calendar Month Average; 45 mg/L, 6.8 kg/day Daily Maximum	Minn. R. 7053.0215

WS005 consists of treated effluent from an activated sludge package plant that commingles with pit drainage effluent prior to discharge. To ensure adequate treatment is applied prior to discharge as required by Minn. R. 7053.0215, the permit requires that effluent limitations for discharges of sewage are met prior to commingling with other waste sources.

Water Quality Based Limits
Effluent limitations based on Minnesota state water quality standards for the receiving water use classifications previously discussed have been included in the permit for surface discharge stations SD002, SD003, and SD012.

The MPCA has made the determination that, based on the information available at the time of this permit modification, sulfate from the facility's discharges via SD002, SD003, and SD012 reaches waters that are used for the production of wild rice. Pursuant to Minn. R. 7050.0224 subp. 2, the available information at the time of this permit modification, and currently established permitting policies, the MPCA is including final effluent limitations for total sulfate based on a water quality standard of 10 mg/L total sulfate for these outfalls. The effluent limitations and associated reasonable potential calculations are detailed for each outfall in this section. The calculations are based on a zero-dilution factor, due to the fact that the receiving waters are above the currently supported water quality standard of 10 mg/L sulfate.

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD002: Weir Outfall

Effluent Characteristic	*Effluent Limitation*	*Basis*
Ammonia, Unionized	0.04 mg/L Calendar Month Average	Minn. R. 7050.0222 subp. 5
Oil and Grease	0.5 mg/L Calendar Quarter Average; 5.0 mg/L Daily Maximum	Minn. R. 7050.0222 Subp. 5
pH	6.5 Standard Units (SU) Instantaneous Minimum; 8.5 SU Instantaneous Maximum	Minn. R. 7050.0222 subp. 5, Minn. R. 7050.0224 subp. 2
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information
Turbidity	25 Nephelometric Turbidity Units Calendar Month Average	Minn. R. 7050.0222 subp. 5

Effluent limitations are included for the parameters listed in the table above based on reasonable potential analyses completed during previous permit actions. Reasonable potential analysis completed utilizing data collected for mercury and specific conductance indicated that effluent limitations were not necessary for those parameters, as detailed in the following table.

Table – Reasonable Potential Calculations for SD002

PARAMETER	Hg (ng/l)	Sp. Conductance (µmhos/cm)
Maximum measured effluent value	1.9	784
Projected effluent quality (PEQ) @ n data points	2.66 (18)	784 (38)
Plant design flow (mgd)	15.1	15.1
Receiving water design flow (mgd)	0	0
Background concentration	0	0
Continuous standard (cs)	6.9	700
Maximum standard (ms)	2400	
Final acute value (FAV)	4900	
Mass Balance - cs	6.9	700
Mass Balance - ms	2400	
Coefficient Of Variation (CV)	0.64	0.19
Long Term Average: LTA cs	5.31	924.78
LTA ms	732.48	
Preliminary Effluent Limit (PEL): Daily Maximum	17.4	1395
Monthly Average	10	1137
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD003: Mesabi Chief Pit Dewatering

Effluent Characteristic	***Effluent Limitation***	***Basis***
Oil and Grease	0.5 mg/L Calendar Quarter Average; 5.0 mg/L Daily Maximum	Minn. R. 7050.0222 subp. 5
pH	6.5 Standard Units (SU) Instantaneous Minimum; 8.5 SU Instantaneous Maximum	Minn. R. 7050.0222 subp. 5, Minn. R. 7050.0224 subp. 2
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information

Effluent limitations are included for the parameters listed in the table above based on reasonable potential analyses completed during previous permit actions. Reasonable potential analysis completed utilizing data collected for mercury and specific conductance indicated that effluent limitations were not necessary for those parameters, as detailed in the following table.

Table – Reasonable Potential Calculations for SD003

PARAMETER	Hg (ng/l)	Sp. Conductance (µmhos/cm)
Maximum measured effluent value	5.2	702
Projected effluent quality (PEQ)	7.28	702
@ n data points	(18)	(39)
Plant design flow (mgd)	5.85	5.85
Receiving water design flow (mgd)	0	0
Background concentration	0	0
Continuous standard (cs)	6.9	700
Maximum standard (ms)	2400	
Final acute value (FAV)	4900	
Mass Balance - cs	6.9	700
Mass Balance - ms	2400	
Coefficient Of Variation (CV)	0.62	0.15
Long Term Average: LTA cs	5.34	939.41
LTA ms	746.94	
Preliminary Effluent Limit (PEL): Daily Maximum	17.1	1309
Monthly Average	10	1109
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No

Table – Water Quality-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0031879, Surface Discharge Station SD012: Perry Pit Dewatering

Effluent Characteristic	*Effluent Limitation*	*Basis*
Total Sulfate	14 mg/L Calendar Month Average, 24 mg/L Daily Maximum	Minn. R. 7050.0224 subp. 2, in combination with currently available information

With the exception of bicarbonate alkalinity, reasonable potential analyses completed during a permit modification in 2010 were used to determine the need for water quality-based effluent limitations due to the fact that the data are still representative of Perry Pit effluent quality. Effluent limitations are included for total sulfate based on those reasonable potential calculations.

As described in the previous permit, reasonable potential for bicarbonate alkalinity was recalculated following representative monitoring by the Permittee. Based on the new information collected, an effluent limitation for bicarbonates is not warranted in this permit reissuance, as indicated in the table below.

Table – Reasonable Potential Calculations for SD012

PARAMETER	Hardness (mg/L)	TDS (mg/L)	Bicarb (meq/L)	Sp. Cond. (µmhos/cm)	Hg (ng/L)	Sulfate (mg/l)
Maximum measured effluent value	256	345	3.86	702	1.7	23.4
Projected effluent quality (PEQ)	780	1035	5.404	842.4	4.42	60.84
@ n data points	(3)	(3)	(14)	(38)	(4)	(4)
Plant design flow (mgd)	4.32	4.32	4.32	4.32	4.32	4.32
Receiving water design flow (mgd)	0	0	0	0	0	0
Background concentration	0	0	0	0	0	0
Continuous standard (cs)	500	700	5	1000	6.9	10
Maximum standard (ms)					2400	-
Final acute value (FAV)					4900	-
Mass Balance - cs	500	700	5	1000	6.9	10
Mass Balance - ms					2400	-
Coefficient Of Variation (CV)	0.6	0.6	0.45	0.6	0.6	0.6
Long Term Average: LTA cs	390	546	4.15	780	5.4	7.8
LTA ms					771	-
Preliminary Effluent Limit (PEL):	1215	1701	10.21	2430	17	
Daily Maximum						24
Monthly Average	701	982	6.57	1403	10	14
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	No	No	No	No	Yes

Additional Requirements

Compliance Schedule
The permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2019. The term of the compliance schedule is based on the time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The compliance schedule has been developed in accordance with the requirements of 40 CFR § 122.47.

Nondegredation and Anti-Backsliding

Anti-Backsliding
The effluent limitations contained in this permit modification are not less stringent than the effluent limitations in the existing permit, in accordance with the antibacksliding requirements found in 40 CFR § 122.44(l) and Minn. R. 7053.0275.

Nondegradation
In accordance with the MPCA rules regarding nondegradation for all waters, the design flow of the facility as of January 1, 1988, and associated mass loading are the baseline design flow and mass loading. This baseline flow and mass loading are used to determine whether nondegradation review is required for any change in the discharge. Additional volume and pollutant loading associated with the discharge of Perry Pit dewatering effluent was reviewed in accordance with Minn. R. 7050.0185 as part of a permit modification completed on June 17, 2010, including consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water.

The Permittee has not proposed expansion of any permitted discharges above the volumes and mass loadings authorized under previous permit actions.

Minnesota Pollution Control Agency

National Pollutant Discharge Elimination System /State Disposal System (NPDES/SDS) Permit Program Statement of Basis

Permittee: United States Steel, Minnesota Ore Operations
Name: Keetac – Tailings Basin
Permit Number: MN0055948

Current Permit Expiration: February 28, 2011

Public Comment Period Begins: June 27, 2011
Period Ends: August 19, 2011

Receiving Water: Reservoir 2; Welcome Creek

Proposed Action: Permit Reissuance

Permitting Contact
Brandon Smith
520 Lafayette Road N.
St. Paul, MN 55155
Phone: 651-757-2740
Fax: 651-296-8717

Table of Contents

Purpose and Participation

Purpose
This Statement of Basis outlines the principal issues related to the preparation of this permit reissuance and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

The permit will be reissued if the Minnesota Pollution Control Agency (MPCA) determines that the proposed Permittee or Permittees will, with respect to the facility or activity to be permitted, comply or undertake a schedule to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA and the conditions of the permit and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

More detail on all requirements placed on the facility may be found in the Permit document.

Facility Description

Background Information
Facility Location
The permitted facility includes the tailings basin and Sargent Pit dewatering operations for the U. S. Steel – Keetac facility, located to the north of Keewatin, Minnesota.

Outfall Locations
SD001: Four siphon outfalls to Reservoir 2. This outfall is used as an emergency discharge to maintain the integrity of the dike system. The outfalls are located at the southwestern edge of Reservoir 6, at PLS coordinates T 56 N, R 22 W, Section 2.

SD005: Weir outfall to Reservoir 2 North/Welcome Creek. This is the primary outfall for discharges from the tailings basin system. The outfall is located at the northeastern edge of Reservoir 6, at PLS coordinates T 56 N, R 22 W, Section 1.

SD008: Combination of discharges from SD001 and SD005. This station is for compliance reporting purposes only.

SD009: Sargent Pit dewatering outfall to unnamed ditch, leading to Welcome Creek. This will be a new outfall constructed to facilitate direct discharge of Sargent Pit dewatering, which is currently directed to other outfalls that are covered under NPDES/SDS Permit MN0031879. The outfall will be located at the edge of the Sargent Pit, at PLS coordinates T 57 N, R 22 W, Section 26.

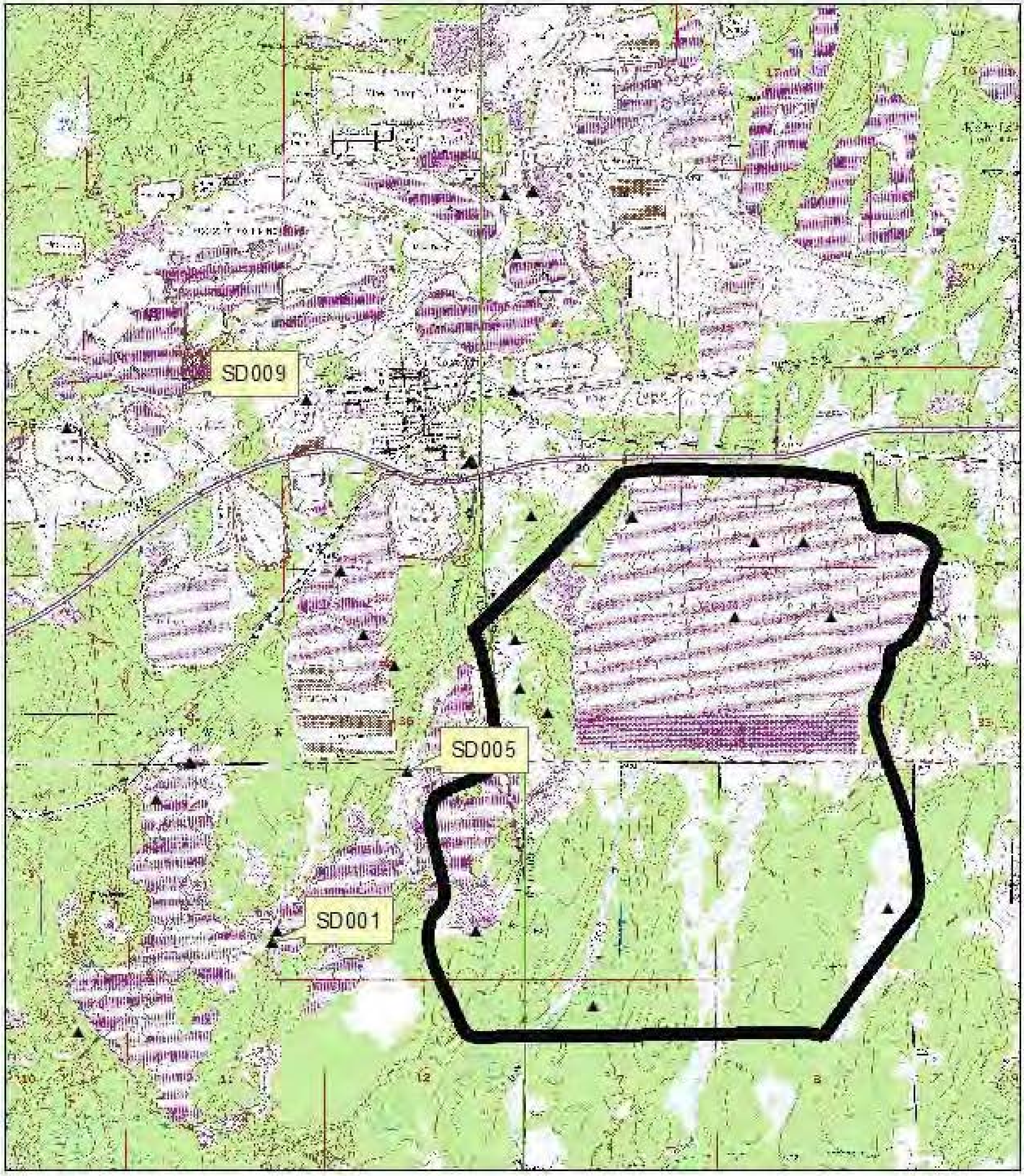
Changes to Facility or Operation
The facility has proposed an expansion of the taconite processing plant with which the permitted operations are associated. As a result, the rate of tailings deposition to the tailings basin will be increased. An increase in the discharge rate of process wastewaters from the tailings basin is not expected to exceed the volumes already permitted.

The facility is proposing to discharge dewatering effluent from the Sargent Pit directly to surface water. This discharge is discussed later in this statement of basis.

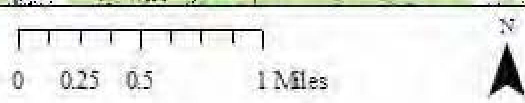
Recent Compliance History
The Facility was inspected on May 10, 2010. No significant compliance issues were found that would affect reissuance of this permit.

Topographic Map of Permitted Facility

MN0055948, United States Steel Corporation - Keetac Tailings Basin
St. Louis & Itasca County, Minnesota



Map produced by: MPCA Staff, 6/23/2011
Source: USGS Keewatin, Silica Quad
Scale: 1:50,000



Receiving Waters

Use Classification

The receiving waters affected by this permit reissuance include Reservoir 2, Reservoir 2 North, Welcome Creek, and an unnamed ditch, which discharges to Welcome Creek.

All waters of the state of Minnesota must be classified based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, as described in Minn. R. 7050.0140. Based on these considerations, Welcome Creek is classified as Class 2C waters as listed in Minn R. 7050.0470 subp. 4.A. item (236). According to Minn. R. 7050.0410, any listed water in part 7050.0470 is also classified as a Class 3C, 4A, 4B, 5, and 6 water.

Reservoir 2, Reservoir 2 North, and the unnamed ditch leading to Welcome Creek are not listed waters in Minn. R. 7050.0470. As detailed in Minn. R. 7050.0430, all surface waters of the state that are not listed in part 7050.0470 and that are not wetlands as defined in part Minn. R. 7050.0186, subp. 1a, are classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Based on the applicable classifications, the receiving waters named above are designated for use in the forms of aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other uses.

Impairments

Minnesota is required to maintain a list of impaired waters, pursuant to Section 303(d) of the Federal Clean Water Act. Impairments have been identified in the receiving waters affected by this permit reissuance for mercury. Permit conditions with regard to mercury for this permit modification are discussed later in this statement of basis.

Proposed Permit Effluent Limits

The MPCA may develop effluent limitations based on Minnesota state water quality standards for the receiving water use classification, federal categorical standards applicable to specific industrial categories, or combination of these standards to regulate discharge of industrial wastewater. In addition, the MPCA may derive standards that are specific to a particular discharge. These standards may be based on toxicity studies, best professional judgment analysis, technology based standards, and in some instances standards developed by other U.S. states or regulatory agencies. Minnesota Rules and the U.S. Code of Federal Regulations (CFR) require that the MPCA categorize industrial dischargers consistent with the U.S. Environmental Protection Agency federal categorical standards, and state standards if appropriate.

Technology Based Effluent Limits

Minn. R. 7053.0225 subp. 1.A requires that all point source dischargers of industrial or other wastes shall comply with applicable federal standards, including those listed in 40 CFR pt. 401 through 469. The MPCA has determined that the specific industrial category and federal effluent limitation guidelines (Categorical Standards) applicable to this facility are those described in 40 CFR pt. 440 subp. A, for the iron ore mining and dressing point source category. The facility constitutes an existing source, and is therefore not subject to the New Source Performance Standards for this industry. The Categorical Standards for Best Practicable Control Technology currently available (BPT) and Best Available Technology economically achievable (BAT) have been applied for the conditions in this permit. These standards have been used to develop the effluent limitations for discharge of process wastewaters and dewatering effluent summarized in the tables below.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0055948, Surface Discharge Stations SD001: Siphon Outfalls to Reservoir 2 and SD005: Weir Outfall to Reservoir 2 North

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(c)(2)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(c)(2), 40 CFR § 440.13(c)(2)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(c)(2)

Stations SD001 and SD005 are both discharges of process wastewater from Reservoir 6 to surface water. Both constitute discharges of process wastewaters from a mill that employs magnetic and physical methods to beneficiate iron ore in the Mesabi Range. Therefore, pursuant to 40 CFR §§ 440.12(c) and 440.13(c), the allowable discharges from these outfalls are limited to the volume associated with the net accumulation of annual precipitation when annual precipitation exceeds evaporation. Compliance with this requirement is monitored for the combination of flows from SD001 and SD005 and reported via station SD008, along with the annual precipitation and annual evaporation.

Table – Technology-Based Effluent Limitations Proposed for NPDES/SDS Permit No. MN0055948, Surface Discharge Station SD009: Sargent Pit Dewatering to Unnamed Ditch

Effluent Characteristic	*Effluent Limitation*	*Basis*
pH	6.0 Standard Units (SU) Instantaneous Minimum; 9.0 SU Instantaneous Maximum	40 CFR § 440.12(a)
Iron, dissolved (as Fe)	1.0 mg/L Calendar Month Average, 2.0 mg/L Daily Maximum	40 CFR § 440.12(a), 40 CFR § 440.13(a)
Total Suspended Solids	20 mg/L Calendar Month Average, 30 mg/L Daily Maximum	40 CFR § 440.12(a)

Water Quality Based Effluent Limits

Stations SD001, SD005, and SD009 have been evaluated to determine the need for effluent limitations to protect the receiving waters for the use classifications previously discussed. Water quality-based effluent limitations have been included for the permit reissuance as discussed below.

The MPCA has made the determination that, based on the information available at the time of this permit reissuance, sulfate from the facility's discharges via SD001, SD005, and SD009 reaches waters that are used for the production of wild rice. Pursuant to Minn. R. 7050.0224 subp. 2, the available information at the time of this permit reissuance, and currently established permitting policies, the MPCA is including final effluent limitations for total sulfate based on a water quality standard of 10 mg/L total sulfate for these outfalls. The effluent limitations and associated reasonable potential calculations are detailed in the two tables below. The calculations are based on a zero-dilution factor, due to the fact that the receiving waters are above the currently supported water quality standard of 10 mg/L sulfate.

Discharges from the tailings basin were evaluated for reasonable potential for water quality parameters as directed by MPCA permitting policy. The discharge indicates reasonable potential for sulfate as previously discussed. None of the additional parameters evaluated indicated reasonable potential to exceed water quality standards in the receiving waters.

Table – Reasonable Potential Calculations for SD001 and SD005

PARAMETER	SO4 AQ. LIFE (mg/l)	SO4 WILD RICE (mg/l)	SPEC. COND. (umohms/cm)	HG (ng/l)	CL- AQ. LIFE (mg/l)	CL- CLASS 3 (mg/l)
Maximum measured effluent value	137	137	958	2.4	24.8	24.8
Projected effluent quality (PEQ) @ n data points	1 (47)	1 (47)	1 (47)	4 (10)	154 (1)	154 (1)
Plant design flow (mgd)	23	23	23	23	23	23
Receiving water design flow (mgd)	0	0	0	0	0	0
Background concentration	0	0	0	6.9	0	0
Continuous standard (cs) @302 Hd	1210	10	1000	6.9	230	250
Maximum standard (ms) @ 302 Hd	1452	Na	Na	2400	860	Na
Final acute value (FAV) @ 302 Hd	2904	Na	Na	4900	1720	Na
Mass Balance – cs	1210	10	1000	6.9	230	250
Mass Balance - ms	1452	-	-	2400	860	-
Coefficient Of Variation (CV)	0.6	0.6	0.1763	0.6	0.6	0.6
Long Term Average: LTA cs	638.2	7.8029	928.3732	5.3840	121.3	195.0737
LTAms	466	-	-	771	276	-
Preliminary Effluent Limit (PEL): Daily Maximum	1452	24.3	1373.3	16.8	378	1607.5
Monthly Average	838	14.0	1130	9.7	218	350.7
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	**Yes**	No	No	No	No

The proposed discharge of Sargent Pit dewatering effluent to an unnamed ditch was evaluated for the potential to exceed water quality standards. The reasonable potential calculations for this discharge are summarized in the table below.

Table – Reasonable Potential Calculations for SD009

PARAMETER	BA (ug/l)	SE (ug/l)	CL-AQ. LIFE (mg/l))	CL-CLASS 3 (mg/l))	SO4 AQ. LIFE (mg/l)	SO4 WILD RICE (mg/l)	AS (ug/l)	HG (ng/l)	SP. COND (umhos/cm)
Maximum measured effluent value	35.6	2.9	8.84	8.84	113	113	12.6	1.2	660
Projected effluent quality (PEQ) @ n data points	220.7 (1)	17.98 (1)	55 (1)	55 (1)	700.6 (1)	700.6 (1)	32.8 (1)	7 (1)	4092 (1)
Plant design flow (mgd)	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75
Receiving water design flow (mgd)	0	0	0	0	0	0	0	0	0
Background concentration	0	0	0	0	0	0	0	0	0
Continuous standard (cs) @331 Hd	683	5	230	250	908	10	53	6.9	1000
Maximum standard (ms) @ 331 Hd	2758	20	860	Na	1090	Na	360	2400	Na
Final acute value (FAV) @ 331 Hd	5516	40	1720	Na	2179	Na	720	4900	Na
Mass Balance – cs	683	5	230	250	908	10	53	6.9	1000
Mass Balance - ms	2758	20	860	-	1090	-	360	2400	-
Coefficient Of Variation (CV)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Long Term Average: LTA cs	360.2	2.64	121.31	195.07	478.9	7.803	28	5.384	780.295
LTAms	885.6	6.42	276.14	-	350.0	-	115.6	771	-
Preliminary Effluent Limit (PEL): Daily Maximum	1122	8.2	378	607.5	1090	24.3	87	16.8	2430.1
Monthly Average	647.6	5	218	350.7	629	14.0	50	9.7	1403
Reasonable Potential PEQ>PEL (Dmax/FAV)	No	**Yes**	No	No	No	**Yes**	No	No	**Yes**

The discharge of Sargent Pit dewatering effluent indicated reasonable potential for sulfate as previously discussed. In addition, reasonable potential to exceed water quality standards for selenium and specific conductance was identified; however this indication is based on a limited data set. Therefore, effluent limitations have not been included for the reissuance of this permit; however monitoring requirements have been included to provide additional detail regarding these pollutants as discussed in greater detail later in this statement of basis.

Additional Requirements

Compliance Schedule

The permit reissuance includes a schedule for attaining compliance with the final effluent limitations for total sulfate. The schedule requires attainment of compliance as soon as possible and in no case later than August 17, 2020. The term of the compliance schedule is based on the time required for completion of evaluations by the Permittee, as well as time for implementation of any final plans for attaining compliance, including time for obtaining various regulatory approvals. The compliance schedule has been developed in accordance with the requirements of 40 CFR § 122.47.

Monitoring for Selenium and Specific Conductance

The permit contains effluent limitations for selenium and specific conductance and previously discussed. However, these effluent limitations have been calculated based on a single data point, which may or may not be representative of the actual discharge conditions. The permit includes a requirement to monitor the discharge from Sargent Pit monthly for selenium and specific conductance, and discharges from the tailings basin monthly for selenium. After accumulating a data set that represents at least 12 data points, and characterizes the seasonal variability of these discharges, the Permittee has the option of requesting reduction or elimination of monitoring for these parameters based on a revised reasonable potential analysis.

Nondegredation and Anti-Backsliding

Anti-Backsliding

The effluent limitations contained in this permit modification are not less stringent than the effluent limitations in the existing permit, in accordance with the antibacksliding requirements found in 40 CFR § 122.44(l) and Minn. R. 7053.0275.

Nondegradation

In accordance with the MPCA rules regarding nondegradation for all waters, the design flow of the facility as of January 1, 1988, and associated mass loading are the baseline design flow and mass loading. This baseline flow and mass loading are used to determine whether nondegradation review is required for any change in the discharge.

Given that the new discharge location for Sargent Pit dewatering to the unnamed ditch represents an expansion of the facility's permitted discharge to this receiving water by more than 0.2 mgd, and an increased loading of one or more pollutants over the baseline quality in the receiving water, the discharge of dewatering effluent has been reviewed in accordance with Minn. R. 7050.0185. The review includes consideration of the quantity and quality of the proposed discharge and the potential for violating water quality standards in the receiving water. The statistical reasonable potential analysis discussed previously in this Statement of Basis shows that the proposed project will not impair the designated beneficial uses of the receiving waters. The results of the analysis, including the water quality-based effluent limits for sulfate, selenium, and specific conductance have been included in this modified permit to ensure continued protection of existing beneficial uses.

The permit contains conditions for installation of treatment technology to ensure that sulfate loading associated with inputs to the tailings basin complies with nondegradation requirements following expansion of the facility's taconite processing operations.

The Permittee has provided information for the proposed Sargent Pit dewatering as required under the provisions of the nondegradation rule. Using the information provided and all available data, the MPCA is required to determine appropriate effluent limitations protective of existing beneficial uses and determine whether additional controls can reasonably be taken to minimize the potential for impact on receiving waters. The discharge restrictions and monitoring requirements included in this permit have been designed to maintain water quality and preserve designated beneficial uses of the receiving waters. Additional controls beyond these measures are not warranted. Effluent monitoring and reporting requirements ensure ongoing compliance with the discharge permit conditions. Monitoring without numerical effluent limits is included for those parameters that do not have a reasonable potential to exceed water quality standards.

ATTACHMENT 7

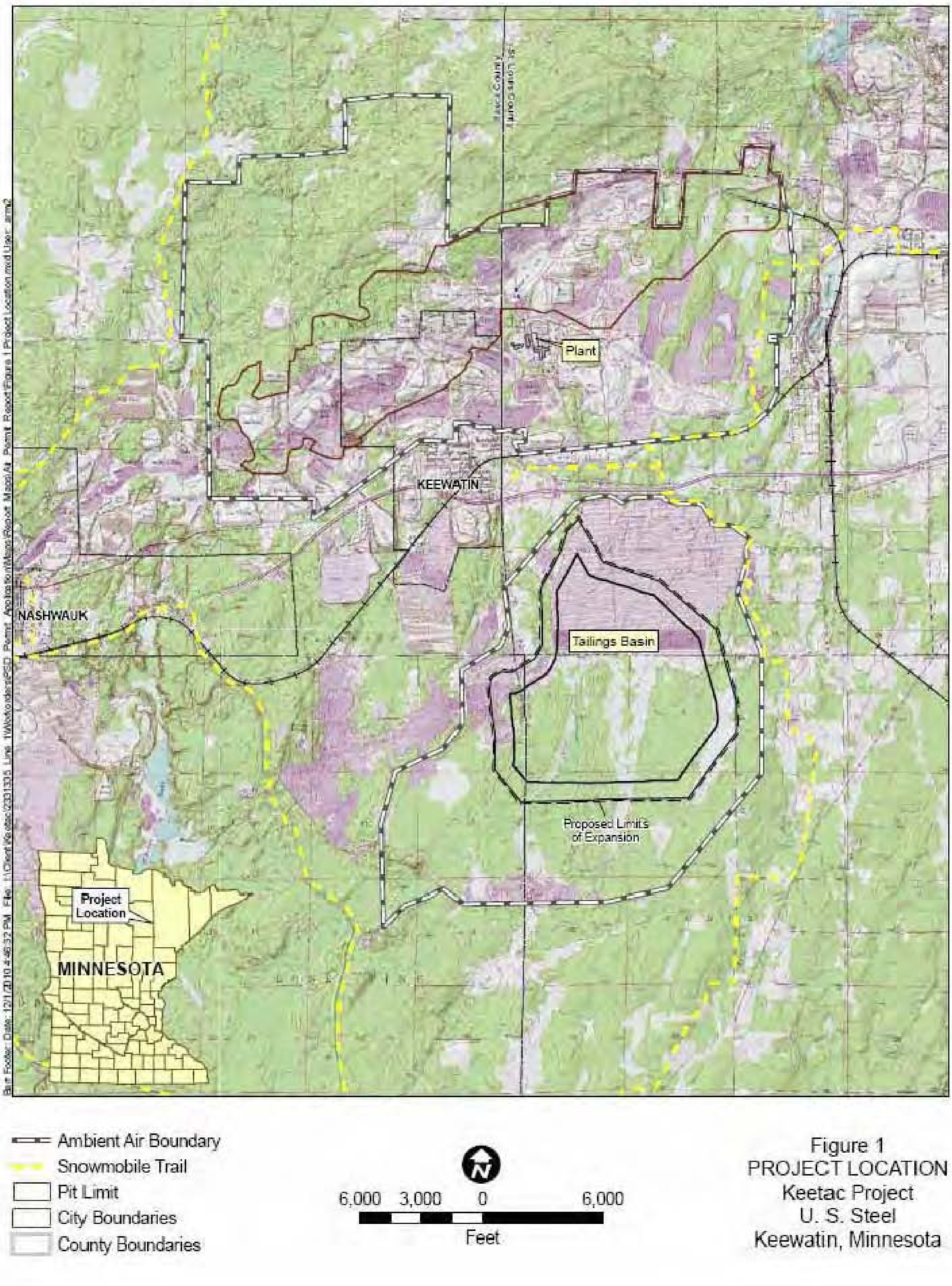


Figure 1
PROJECT LOCATION
Keetac Project
U. S. Steel
Keewatin, Minnesota

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota & MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT S

(U. S. Steel – Keetac (MN0031879) and U.S. Steel [Keetac] Tailings (MN0055948) Sulfate Discharge Monitoring Reports)

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

DMR Bulk Export_data

Facility	Preferred Id	Permit Action	Station	Station Description	Year of Mon End Date	Month of Mon End Date	Mon End Date	Parameter	Limit	Non- detect	Rpt Value	Units	Limit Type	Epa Class	Huc12 Code	Huc12 Name	Huc8 Code
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	August	8/31/2018	Sulfate, Total (as SO4)	14ave/24 max		120	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	August	8/31/2018	Sulfate, Total (as SO4)			128	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	September	9/30/2018	Sulfate, Total (as SO4)			122.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	September	9/30/2018	Sulfate, Total (as SO4)			124	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	October	10/31/2018	Sulfate, Total (as SO4)			117	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	October	10/31/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	November	11/30/2018	Sulfate, Total (as SO4)			123.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	November	11/30/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	December	12/31/2018	Sulfate, Total (as SO4)			120	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2018	December	12/31/2018	Sulfate, Total (as SO4)			125	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	January	1/31/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	January	1/31/2019	Sulfate, Total (as SO4)			137	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	February	2/28/2019	Sulfate, Total (as SO4)			128.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	February	2/28/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	March	3/31/2019	Sulfate, Total (as SO4)			114.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	March	3/31/2019	Sulfate, Total (as SO4)			130	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	April	4/30/2019	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	April	4/30/2019	Sulfate, Total (as SO4)			134	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	May	5/31/2019	Sulfate, Total (as SO4)			133	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	May	5/31/2019	Sulfate, Total (as SO4)			136	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	June	6/30/2019	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	June	6/30/2019	Sulfate, Total (as SO4)			137	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	July	7/31/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	July	7/31/2019	Sulfate, Total (as SO4)			134	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	August	8/31/2019	Sulfate, Total (as SO4)			124	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	August	8/31/2019	Sulfate, Total (as SO4)			125	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	September	9/30/2019	Sulfate, Total (as SO4)			114	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	September	9/30/2019	Sulfate, Total (as SO4)			117	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	October	10/31/2019	Sulfate, Total (as SO4)			114.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	October	10/31/2019	Sulfate, Total (as SO4)			117	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	November	11/30/2019	Sulfate, Total (as SO4)			129.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	November	11/30/2019	Sulfate, Total (as SO4)			132	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	December	12/31/2019	Sulfate, Total (as SO4)			125.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2019	December	12/31/2019	Sulfate, Total (as SO4)			129	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	January	1/31/2020	Sulfate, Total (as SO4)			130.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	January	1/31/2020	Sulfate, Total (as SO4)			132	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	February	2/29/2020	Sulfate, Total (as SO4)			135.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	February	2/29/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	March	3/31/2020	Sulfate, Total (as SO4)			133	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	March	3/31/2020	Sulfate, Total (as SO4)			140	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	April	4/30/2020	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	April	4/30/2020	Sulfate, Total (as SO4)			135	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	May	5/31/2020	Sulfate, Total (as SO4)			148	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	May	5/31/2020	Sulfate, Total (as SO4)			150	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	June	6/30/2020	Sulfate, Total (as SO4)			135.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	June	6/30/2020	Sulfate, Total (as SO4)			140	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	July	7/31/2020	Sulfate, Total (as SO4)			141.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	July	7/31/2020	Sulfate, Total (as SO4)			146	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	August	8/31/2020	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	August	8/31/2020	Sulfate, Total (as SO4)			136	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	September	9/30/2020	Sulfate, Total (as SO4)			144	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	September	9/30/2020	Sulfate, Total (as SO4)			148	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	October	10/31/2020	Sulfate, Total (as SO4)			142.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	October	10/31/2020	Sulfate, Total (as SO4)			145	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	November	11/30/2020	Sulfate, Total (as SO4)			139.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	November	11/30/2020	Sulfate, Total (as SO4)			141	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	December	12/31/2020	Sulfate, Total (as SO4)			131.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2020	December	12/31/2020	Sulfate, Total (as SO4)			135	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	January	1/31/2021	Sulfate, Total (as SO4)			141	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	January	1/31/2021	Sulfate, Total (as SO4)			145	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	February	2/28/2021	Sulfate, Total (as SO4)			140.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	February	2/28/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	March	3/31/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	March	3/31/2021	Sulfate, Total (as SO4)			139	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	April	4/30/2021	Sulfate, Total (as SO4)			134	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	April	4/30/2021	Sulfate, Total (as SO4)			134	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	May	5/31/2021	Sulfate, Total (as SO4)			146.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	May	5/31/2021	Sulfate, Total (as SO4)			147	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	June	6/30/2021	Sulfate, Total (as SO4)			145.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	June	6/30/2021	Sulfate, Total (as SO4)			148	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	July	7/31/2021	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	July	7/31/2021	Sulfate, Total (as SO4)			157	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	August	8/31/2021	Sulfate, Total (as SO4)			143.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	August	8/31/2021	Sulfate, Total (as SO4)			144	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	September	9/30/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	September	9/30/2021	Sulfate, Total (as SO4)			142	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	October	10/31/2021	Sulfate, Total (as SO4)			135	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	October	10/31/2021	Sulfate, Total (as SO4)			140	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	November	11/30/2021	Sulfate, Total (as SO4)			143	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	November	11/30/2021	Sulfate, Total (as SO4)			148	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	December	12/31/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2021	December	12/31/2021	Sulfate, Total (as SO4)			146	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	January	1/31/2022	Sulfate, Total (as SO4)			144.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	January	1/31/2022	Sulfate, Total (as SO4)			146	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	February	2/28/2022	Sulfate, Total (as SO4)			145.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	February	2/28/2022	Sulfate, Total (as SO4)			146	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	March	3/31/2022	Sulfate, Total (as SO4)			141	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	March	3/31/2022	Sulfate, Total (as SO4)			145	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	April	4/30/2022	Sulfate, Total (as SO4)			151.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	April	4/30/2022	Sulfate, Total (as SO4)			158	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	May	5/31/2022	Sulfate, Total (as SO4)			154.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	May	5/31/2022	Sulfate, Total (as SO4)			167	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	June	6/30/2022	Sulfate, Total (as SO4)			154	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	June	6/30/2022	Sulfate, Total (as SO4)			155	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	July	7/31/2022	Sulfate, Total (as SO4)			151	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	July	7/31/2022	Sulfate, Total (as SO4)			151	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	August	8/31/2022	Sulfate, Total (as SO4)			152.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	August	8/31/2022	Sulfate, Total (as SO4)			153	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	September	9/30/2022	Sulfate, Total (as SO4)			148.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	September	9/30/2022	Sulfate, Total (as SO4)			149	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	October	10/31/2022	Sulfate, Total (as SO4)			146.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	October	10/31/2022	Sulfate, Total (as SO4)			150	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	November	11/30/2022	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	November	11/30/2022	Sulfate, Total (as SO4)			139	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	December	12/31/2022	Sulfate, Total (as SO4)			128.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2022	December	12/31/2022	Sulfate, Total (as SO4)			136	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	January	1/31/2023	Sulfate, Total (as SO4)			130	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	January	1/31/2023	Sulfate, Total (as SO4)			134	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	February	2/28/2023	Sulfate, Total (as SO4)			129.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	February	2/28/2023	Sulfate, Total (as SO4)			132.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	March	3/31/2023	Sulfate, Total (as SO4)			132	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	March	3/31/2023	Sulfate, Total (as SO4)			138	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	April	4/30/2023	Sulfate, Total (as SO4)			148.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	April	4/30/2023	Sulfate, Total (as SO4)			165	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	May	5/31/2023	Sulfate, Total (as SO4)			150.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	May	5/31/2023	Sulfate, Total (as SO4)			156	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	June	6/30/2023	Sulfate, Total (as SO4)			139	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 002	Weir Outfall 050	2023	June	6/30/2023	Sulfate, Total (as SO4)			148	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
										AVERAGE	138.12						
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	August	8/31/2018	Sulfate, Total (as SO4)	14ave/24max		55.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	August	8/31/2018	Sulfate, Total (as SO4)			55.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	September	9/30/2018	Sulfate, Total (as SO4)			55.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	September	9/30/2018	Sulfate, Total (as SO4)			56.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	October	10/31/2018	Sulfate, Total (as SO4)			61.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	October	10/31/2018	Sulfate, Total (as SO4)			61.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	November	11/30/2018	Sulfate, Total (as SO4)			62.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	November	11/30/2018	Sulfate, Total (as SO4)			62.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	December	12/31/2018	Sulfate, Total (as SO4)			53.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2018	December	12/31/2018	Sulfate, Total (as SO4)			55.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	January	1/31/2019	Sulfate, Total (as SO4)			51.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	January	1/31/2019	Sulfate, Total (as SO4)			52	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	February	2/28/2019	Sulfate, Total (as SO4)			51.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	February	2/28/2019	Sulfate, Total (as SO4)			53.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	March	3/31/2019	Sulfate, Total (as SO4)			52.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	March	3/31/2019	Sulfate, Total (as SO4)			55.9	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	April	4/30/2019	Sulfate, Total (as SO4)			63.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	April	4/30/2019	Sulfate, Total (as SO4)			70.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	May	5/31/2019	Sulfate, Total (as SO4)			71.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2019	May	5/31/2019	Sulfate, Total (as SO4)			77.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	June	6/30/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	June	6/30/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	July	7/31/2019	Sulfate, Total (as SO4)			55	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	July	7/31/2019	Sulfate, Total (as SO4)			55	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	August	8/31/2019	Sulfate, Total (as SO4)			59.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	August	8/31/2019	Sulfate, Total (as SO4)			63.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	September	9/30/2019	Sulfate, Total (as SO4)			62.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	September	9/30/2019	Sulfate, Total (as SO4)			64.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	October	10/31/2019	Sulfate, Total (as SO4)			68.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	October	10/31/2019	Sulfate, Total (as SO4)			73.1	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	November	11/30/2019	Sulfate, Total (as SO4)			62.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	November	11/30/2019	Sulfate, Total (as SO4)			67.9	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	December	12/31/2019	Sulfate, Total (as SO4)			51.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2019	December	12/31/2019	Sulfate, Total (as SO4)			53.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	January	1/31/2020	Sulfate, Total (as SO4)			56.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	January	1/31/2020	Sulfate, Total (as SO4)			58.8	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	February	2/29/2020	Sulfate, Total (as SO4)			56.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	February	2/29/2020	Sulfate, Total (as SO4)			56.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	March	3/31/2020	Sulfate, Total (as SO4)			56.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	March	3/31/2020	Sulfate, Total (as SO4)			57.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	April	4/30/2020	Sulfate, Total (as SO4)			61.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	April	4/30/2020	Sulfate, Total (as SO4)			64.9	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	May	5/31/2020	Sulfate, Total (as SO4)			59.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	May	5/31/2020	Sulfate, Total (as SO4)			59.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	June	6/30/2020	Sulfate, Total (as SO4)			62.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	June	6/30/2020	Sulfate, Total (as SO4)			69.4	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	July	7/31/2020	Sulfate, Total (as SO4)			66.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	July	7/31/2020	Sulfate, Total (as SO4)			72.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	August	8/31/2020	Sulfate, Total (as SO4)			68.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	August	8/31/2020	Sulfate, Total (as SO4)			69.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	September	9/30/2020	Sulfate, Total (as SO4)			61.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	September	9/30/2020	Sulfate, Total (as SO4)			62.8	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	October	10/31/2020	Sulfate, Total (as SO4)			63.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	October	10/31/2020	Sulfate, Total (as SO4)			66.1	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	November	11/30/2020	Sulfate, Total (as SO4)			62.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	November	11/30/2020	Sulfate, Total (as SO4)			63.1	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	December	12/31/2020	Sulfate, Total (as SO4)			59.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2020	December	12/31/2020	Sulfate, Total (as SO4)			59.4	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	January	1/31/2021	Sulfate, Total (as SO4)			60.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	January	1/31/2021	Sulfate, Total (as SO4)			61.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	February	2/28/2021	Sulfate, Total (as SO4)			60.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	February	2/28/2021	Sulfate, Total (as SO4)			61.4	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	March	3/31/2021	Sulfate, Total (as SO4)			62.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	March	3/31/2021	Sulfate, Total (as SO4)			64.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	April	4/30/2021	Sulfate, Total (as SO4)			69.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	April	4/30/2021	Sulfate, Total (as SO4)			74.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	May	5/31/2021	Sulfate, Total (as SO4)			66.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	May	5/31/2021	Sulfate, Total (as SO4)			70	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	June	6/30/2021	Sulfate, Total (as SO4)			66.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	June	6/30/2021	Sulfate, Total (as SO4)			70	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	July	7/31/2021	Sulfate, Total (as SO4)			68.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	July	7/31/2021	Sulfate, Total (as SO4)			70.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	August	8/31/2021	Sulfate, Total (as SO4)			65.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	August	8/31/2021	Sulfate, Total (as SO4)			67	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	September	9/30/2021	Sulfate, Total (as SO4)			74.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	September	9/30/2021	Sulfate, Total (as SO4)			84.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	October	10/31/2021	Sulfate, Total (as SO4)			69.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	October	10/31/2021	Sulfate, Total (as SO4)			72.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	November	11/30/2021	Sulfate, Total (as SO4)			69.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	November	11/30/2021	Sulfate, Total (as SO4)			73.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	December	12/31/2021	Sulfate, Total (as SO4)			65.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2021	December	12/31/2021	Sulfate, Total (as SO4)			68.8	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	January	1/31/2022	Sulfate, Total (as SO4)			65.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	January	1/31/2022	Sulfate, Total (as SO4)			66	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	February	2/28/2022	Sulfate, Total (as SO4)			63.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	February	2/28/2022	Sulfate, Total (as SO4)			64	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	March	3/31/2022	Sulfate, Total (as SO4)			66.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	March	3/31/2022	Sulfate, Total (as SO4)			68	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	April	4/30/2022	Sulfate, Total (as SO4)			73.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	April	4/30/2022	Sulfate, Total (as SO4)			76.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	May	5/31/2022	Sulfate, Total (as SO4)			61.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	May	5/31/2022	Sulfate, Total (as SO4)			72.6	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	June	6/30/2022	Sulfate, Total (as SO4)			71.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	June	6/30/2022	Sulfate, Total (as SO4)			72.2	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	July	7/31/2022	Sulfate, Total (as SO4)			71.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	July	7/31/2022	Sulfate, Total (as SO4)			72.2	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	August	8/31/2022	Sulfate, Total (as SO4)			73.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	August	8/31/2022	Sulfate, Total (as SO4)			76	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	September	9/30/2022	Sulfate, Total (as SO4)			66.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	September	9/30/2022	Sulfate, Total (as SO4)			66.5	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	October	10/31/2022	Sulfate, Total (as SO4)			61.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	October	10/31/2022	Sulfate, Total (as SO4)			61.8	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	November	11/30/2022	Sulfate, Total (as SO4)			62.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	November	11/30/2022	Sulfate, Total (as SO4)			63.4	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	December	12/31/2022	Sulfate, Total (as SO4)			59.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2022	December	12/31/2022	Sulfate, Total (as SO4)			61.7	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	January	1/31/2023	Sulfate, Total (as SO4)			62.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	January	1/31/2023	Sulfate, Total (as SO4)			65	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	February	2/28/2023	Sulfate, Total (as SO4)			60.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	February	2/28/2023	Sulfate, Total (as SO4)			61.1	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	March	3/31/2023	Sulfate, Total (as SO4)			64.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	March	3/31/2023	Sulfate, Total (as SO4)			67.1	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	April	4/30/2023	Sulfate, Total (as SO4)			66.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080		2023	April	4/30/2023	Sulfate, Total (as SO4)			73.4	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	May	5/31/2023	Sulfate, Total (as SO4)			69.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	May	5/31/2023	Sulfate, Total (as SO4)			69.8	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	June	6/30/2023	Sulfate, Total (as SO4)			67.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 003	Pipe Outfall 080	2023	June	6/30/2023	Sulfate, Total (as SO4)			68.3	mg/L	CalYrMax	EPA Minor	70101030401	Hay Creek	7010103
										AVERAGE	64.24						
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	August	8/31/2018	Sulfate, Total (as SO4)	14ave/24max		23	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	August	8/31/2018	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	September	9/30/2018	Sulfate, Total (as SO4)			21.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	September	9/30/2018	Sulfate, Total (as SO4)			21.7	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	October	10/31/2018	Sulfate, Total (as SO4)			22.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	October	10/31/2018	Sulfate, Total (as SO4)			23	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	November	11/30/2018	Sulfate, Total (as SO4)			22.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	November	11/30/2018	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	December	12/31/2018	Sulfate, Total (as SO4)			21.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2018	December	12/31/2018	Sulfate, Total (as SO4)			21.4	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	January	1/31/2019	Sulfate, Total (as SO4)			24.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	January	1/31/2019	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	February	2/28/2019	Sulfate, Total (as SO4)			25.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	February	2/28/2019	Sulfate, Total (as SO4)			25.3	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	March	3/31/2019	Sulfate, Total (as SO4)			25.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	March	3/31/2019	Sulfate, Total (as SO4)			26.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	April	4/30/2019	Sulfate, Total (as SO4)			25.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	April	4/30/2019	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	May	5/31/2019	Sulfate, Total (as SO4)			23.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	May	5/31/2019	Sulfate, Total (as SO4)			24.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	June	6/30/2019	Sulfate, Total (as SO4)			24.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	June	6/30/2019	Sulfate, Total (as SO4)			24.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	July	7/31/2019	Sulfate, Total (as SO4)			22.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	July	7/31/2019	Sulfate, Total (as SO4)			22.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	August	8/31/2019	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	August	8/31/2019	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	September	9/30/2019	Sulfate, Total (as SO4)			20.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	September	9/30/2019	Sulfate, Total (as SO4)			20.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	October	10/31/2019	Sulfate, Total (as SO4)			19.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	October	10/31/2019	Sulfate, Total (as SO4)			20.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	November	11/30/2019	Sulfate, Total (as SO4)			20.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	November	11/30/2019	Sulfate, Total (as SO4)			21.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	December	12/31/2019	Sulfate, Total (as SO4)			20.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2019	December	12/31/2019	Sulfate, Total (as SO4)			20.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	January	1/31/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	January	1/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	February	2/29/2020	Sulfate, Total (as SO4)			25.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	February	2/29/2020	Sulfate, Total (as SO4)			25.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	March	3/31/2020	Sulfate, Total (as SO4)			25.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	March	3/31/2020	Sulfate, Total (as SO4)			25.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	April	4/30/2020	Sulfate, Total (as SO4)			27.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2020	April	4/30/2020	Sulfate, Total (as SO4)			28.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	May	5/31/2020	Sulfate, Total (as SO4)			24.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	May	5/31/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	June	6/30/2020	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	June	6/30/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	July	7/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	July	7/31/2020	Sulfate, Total (as SO4)			25.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	August	8/31/2020	Sulfate, Total (as SO4)			23.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	August	8/31/2020	Sulfate, Total (as SO4)			23.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	September	9/30/2020	Sulfate, Total (as SO4)			21.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	September	9/30/2020	Sulfate, Total (as SO4)			21.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	October	10/31/2020	Sulfate, Total (as SO4)			21.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	October	10/31/2020	Sulfate, Total (as SO4)			22.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	November	11/30/2020	Sulfate, Total (as SO4)			21.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	November	11/30/2020	Sulfate, Total (as SO4)			21.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	December	12/31/2020	Sulfate, Total (as SO4)			22.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2020	December	12/31/2020	Sulfate, Total (as SO4)			24	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	January	1/31/2021	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	January	1/31/2021	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	February	2/28/2021	Sulfate, Total (as SO4)			26.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	February	2/28/2021	Sulfate, Total (as SO4)			26.3	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	March	3/31/2021	Sulfate, Total (as SO4)			26	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	March	3/31/2021	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	April	4/30/2021	Sulfate, Total (as SO4)			24.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	April	4/30/2021	Sulfate, Total (as SO4)			25.3	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	May	5/31/2021	Sulfate, Total (as SO4)			21.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	May	5/31/2021	Sulfate, Total (as SO4)			22.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	June	6/30/2021	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	June	6/30/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	July	7/31/2021	Sulfate, Total (as SO4)			24.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	July	7/31/2021	Sulfate, Total (as SO4)			24.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	August	8/31/2021	Sulfate, Total (as SO4)			23.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	August	8/31/2021	Sulfate, Total (as SO4)			24.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	September	9/30/2021	Sulfate, Total (as SO4)			22	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	September	9/30/2021	Sulfate, Total (as SO4)			22	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	October	10/31/2021	Sulfate, Total (as SO4)			23.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	October	10/31/2021	Sulfate, Total (as SO4)			23.3	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	November	11/30/2021	Sulfate, Total (as SO4)			22.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	November	11/30/2021	Sulfate, Total (as SO4)			23	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	December	12/31/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2021	December	12/31/2021	Sulfate, Total (as SO4)			22.8	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	January	1/31/2022	Sulfate, Total (as SO4)			24.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	January	1/31/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	February	2/28/2022	Sulfate, Total (as SO4)			24.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	February	2/28/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	March	3/31/2022	Sulfate, Total (as SO4)			25.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	March	3/31/2022	Sulfate, Total (as SO4)			26.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering		2022	April	4/30/2022	Sulfate, Total (as SO4)			26.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	April	4/30/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	May	5/31/2022	Sulfate, Total (as SO4)			27.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	May	5/31/2022	Sulfate, Total (as SO4)			27.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	June	6/30/2022	Sulfate, Total (as SO4)			26.7	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	June	6/30/2022	Sulfate, Total (as SO4)			26.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	July	7/31/2022	Sulfate, Total (as SO4)			26	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	July	7/31/2022	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	August	8/31/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	August	8/31/2022	Sulfate, Total (as SO4)			26.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	September	9/30/2022	Sulfate, Total (as SO4)			23.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	September	9/30/2022	Sulfate, Total (as SO4)			25.2	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	October	10/31/2022	Sulfate, Total (as SO4)			23	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	October	10/31/2022	Sulfate, Total (as SO4)			24.7	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	November	11/30/2022	Sulfate, Total (as SO4)			24.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	November	11/30/2022	Sulfate, Total (as SO4)			24.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	December	12/31/2022	Sulfate, Total (as SO4)			24.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2022	December	12/31/2022	Sulfate, Total (as SO4)			25	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	January	1/31/2023	Sulfate, Total (as SO4)			25.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	January	1/31/2023	Sulfate, Total (as SO4)			25.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	February	2/28/2023	Sulfate, Total (as SO4)			24.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	February	2/28/2023	Sulfate, Total (as SO4)			24.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	March	3/31/2023	Sulfate, Total (as SO4)			25.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	March	3/31/2023	Sulfate, Total (as SO4)			25.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	April	4/30/2023	Sulfate, Total (as SO4)			26.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	April	4/30/2023	Sulfate, Total (as SO4)			26.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	May	5/31/2023	Sulfate, Total (as SO4)			25.7	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	May	5/31/2023	Sulfate, Total (as SO4)			26.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	June	6/30/2023	Sulfate, Total (as SO4)			26	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
United States Steel Corp - Keetac	MN0031879	IND20120003	SD 012	Perry Pit Dewatering	2023	June	6/30/2023	Sulfate, Total (as SO4)			26.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
										AVERAGE	24.23						
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	August	8/31/2019	Sulfate, Total (as SO4)	14ave/24max		96.1	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	August	8/31/2019	Sulfate, Total (as SO4)			96.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	September	9/30/2019	Sulfate, Total (as SO4)			95.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	September	9/30/2019	Sulfate, Total (as SO4)			95.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	October	10/31/2019	Sulfate, Total (as SO4)			92.3	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	October	10/31/2019	Sulfate, Total (as SO4)			97.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	November	11/30/2019	Sulfate, Total (as SO4)			103.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	November	11/30/2019	Sulfate, Total (as SO4)			104	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	December	12/31/2019	Sulfate, Total (as SO4)			102	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2019	December	12/31/2019	Sulfate, Total (as SO4)			105	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	January	1/31/2020	Sulfate, Total (as SO4)			111.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	January	1/31/2020	Sulfate, Total (as SO4)			115	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	February	2/29/2020	Sulfate, Total (as SO4)			123	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	February	2/29/2020	Sulfate, Total (as SO4)			130	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	March	3/31/2020	Sulfate, Total (as SO4)			124.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	March	3/31/2020	Sulfate, Total (as SO4)			125	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2020	April	4/30/2020	Sulfate, Total (as SO4)			102	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	April	4/30/2020	Sulfate, Total (as SO4)			107	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	May	5/31/2020	Sulfate, Total (as SO4)			110	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	May	5/31/2020	Sulfate, Total (as SO4)			110	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	June	6/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	June	6/30/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	July	7/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	July	7/31/2020	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	August	8/31/2020	Sulfate, Total (as SO4)			103.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	August	8/31/2020	Sulfate, Total (as SO4)			106	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	September	9/30/2020	Sulfate, Total (as SO4)			96	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	September	9/30/2020	Sulfate, Total (as SO4)			96.8	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	October	10/31/2020	Sulfate, Total (as SO4)			95.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	October	10/31/2020	Sulfate, Total (as SO4)			95.7	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	November	11/30/2020	Sulfate, Total (as SO4)			96.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	November	11/30/2020	Sulfate, Total (as SO4)			97.9	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	December	12/31/2020	Sulfate, Total (as SO4)			102.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2020	December	12/31/2020	Sulfate, Total (as SO4)			104	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	January	1/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	January	1/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	February	2/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	February	2/28/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	March	3/31/2021	Sulfate, Total (as SO4)			112	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	March	3/31/2021	Sulfate, Total (as SO4)			120	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	April	4/30/2021	Sulfate, Total (as SO4)			106.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	April	4/30/2021	Sulfate, Total (as SO4)			107	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	May	5/31/2021	Sulfate, Total (as SO4)			109.5	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	May	5/31/2021	Sulfate, Total (as SO4)			112	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	June	6/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	June	6/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	July	7/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	July	7/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	August	8/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	August	8/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	September	9/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	September	9/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	October	10/31/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	November	11/30/2021	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	December	12/31/2021	Sulfate, Total (as SO4)			131	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2021	December	12/31/2021	Sulfate, Total (as SO4)			131	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	January	1/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	January	1/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	February	2/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	February	2/28/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	March	3/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015		2022	March	3/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103

U.S. Steel Keetac Mine & Tailings Basin
Sulfate Discharge Monitoring Data

US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	April	4/30/2022	Sulfate, Total (as SO4)			105.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	April	4/30/2022	Sulfate, Total (as SO4)			123	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	May	5/31/2022	Sulfate, Total (as SO4)			94.9	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	May	5/31/2022	Sulfate, Total (as SO4)			102	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	June	6/30/2022	Sulfate, Total (as SO4)			95.4	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	June	6/30/2022	Sulfate, Total (as SO4)			95.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	July	7/31/2022	Sulfate, Total (as SO4)			95.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	July	7/31/2022	Sulfate, Total (as SO4)			95.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	August	8/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	August	8/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	September	9/30/2022	Sulfate, Total (as SO4)			93.6	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	September	9/30/2022	Sulfate, Total (as SO4)			93.6	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	October	10/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	November	11/30/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2022	December	12/31/2022	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	January	1/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	January	1/31/2023	Sulfate, Total (as SO4)				mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	February	2/28/2023	Sulfate, Total (as SO4)			105.56	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	February	2/28/2023	Sulfate, Total (as SO4)			106.38	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	March	3/31/2023	Sulfate, Total (as SO4)			126	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	March	3/31/2023	Sulfate, Total (as SO4)			136	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	April	4/30/2023	Sulfate, Total (as SO4)			111.2	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	April	4/30/2023	Sulfate, Total (as SO4)			133	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	May	5/31/2023	Sulfate, Total (as SO4)			86.1	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	May	5/31/2023	Sulfate, Total (as SO4)			87.5	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	June	6/30/2023	Sulfate, Total (as SO4)			89	mg/L	CalMoAvg	EPA Minor	70101030401	Hay Creek	7010103
US Steel Corp - Tailings	MN0055948	IND20110001	SD 005	Weir Outfall 015	2023	June	6/30/2023	Sulfate, Total (as SO4)			90.4	mg/L	CalMoMax	EPA Minor	70101030401	Hay Creek	7010103
										Average	105.76						

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT T

(MPCA Draft Wild Rice Sulfate Rule, Minn. R. 7050.0224, 2017)

[For text of subitems (15) and (16), see M.R.]

[For text of items B to E, see M.R.]

[For text of subp 7, see M.R.]

7050.0224 SPECIFIC WATER QUALITY STANDARDS FOR CLASS 4 WATERS OF THE STATE; AGRICULTURE AND WILDLIFE.

Subpart 1. **General.** The numeric and narrative water quality standards in this part prescribe the qualities or properties of the waters of the state that are necessary for the agriculture and wildlife designated public uses and benefits. ~~Wild rice is an aquatic plant resource found in certain waters within the state. The harvest and use of grains from this plant serve as a food source for wildlife and humans. In recognition of the ecological importance of this resource, and in conjunction with Minnesota Indian tribes, selected wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subpart 1. The quality of these waters and the aquatic habitat necessary to support the propagation and maintenance of wild rice plant species must not be materially impaired or degraded.~~ If the standards in this part are exceeded in waters of the state that have the class 4 designation, it is considered indicative of a polluted condition ~~which~~ that is actually or potentially deleterious, harmful, detrimental, or injurious with respect to the designated uses.

Subp. 2. **Class 4A waters.** The quality of class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area, including truck garden crops. The following standards shall be used as a guide in determining the suitability of the waters for such uses, together with the recommendations contained in Handbook 60 published by the Salinity Laboratory of the United States Department of Agriculture, and any revisions, amendments, or supplements to it:

Substance, Characteristic, or Pollutant	Class 4A Standard

Bicarbonates (HCO_3)	5 milliequivalents per liter
Boron (B)	0.5 mg/L
pH, minimum value	6.0
pH, maximum value	8.5
Specific conductance	1,000 micromhos per centimeter at 25°C
Total dissolved salts	700 mg/L
Sodium (Na)	60% of total cations as milliequivalents per liter
~~Sulfates (SO_4)~~	~~10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.~~
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

[For text of subps 3 and 4, see M.R.]

Subp. 5. **Class 4D waters; wild rice waters.**

A. The standards in items B and C apply to wild rice waters identified in part 7050.0471 to protect the use of the grain of wild rice as a food source for wildlife and humans. The numeric sulfate standard for wild rice is designed to maintain sulfide concentrations in pore water at 120 micrograms per liter or less. The commissioner must maintain all numeric sulfate standards for wild rice waters on a public Web site.

B. The annual average concentration of sulfate in a wild rice water must not exceed the concentration established as the calculated sulfate standard under subitem (1) or alternate sulfate standard under subitem (2) more than one year out of every ten years.

(1) The calculated sulfate standard, expressed as milligrams of sulfate ion per liter (mg SO_4^{2-}/L), is determined by the following equation:

$$\text{Calculated sulfate standard} = 0.0000121 \times \frac{\text{iron}^{1.923}}{\text{organic carbon}^{1.197}}$$

Where:

(a) organic carbon is the amount of organic matter in dry sediment. The concentration is expressed as percentage of carbon, as determined using the method for organic carbon analysis in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E;

(b) iron is the amount of extractable iron in dry sediment. The concentration is expressed as micrograms of iron per gram of dry sediment, as determined using the method for extractable iron in Sampling and Analytical Methods for Wild Rice Waters;

(c) sediment samples are collected using the procedures established in Sampling and Analytical Methods for Wild Rice Waters; and

(d) the calculated sulfate standard is the lowest sulfate value resulting from the application of the equation to each pair of organic carbon and iron values collected and analyzed in accordance with units (a) to (c).

(2) The commissioner may establish an alternate sulfate standard for a wild rice water when the ambient sulfate concentration is above the calculated sulfate standard and data demonstrates that sulfide concentrations in pore water are 120 micrograms per liter or less. Data must be gathered using the procedures specified in Sampling and Analytical Methods for Wild Rice Waters, which is incorporated by reference in item E. The alternate sulfate standard established must be either the annual average sulfate concentration in the ambient water or a level of sulfate the commissioner has determined will maintain the sulfide concentrations in pore water at or below 120 micrograms per liter.

C. The commissioner may establish a site-specific sulfate standard using the process in part 7050.0220, subpart 7, or 7052.0270 when the commissioner determines that the beneficial use is not harmed. This decision must be based on reliable and representative data characterizing the health and viability of the wild rice in the wild rice water.

D. Discharges of sulfate in sewage, industrial waste, or other wastes affecting class 4D waters must be controlled so that the numeric sulfate standard for wild rice is maintained at stream flows that are equal to or greater than $365Q_{10}$.

E. Sampling and Analytical Methods for Wild Rice Waters, Minnesota Pollution Control Agency (2017), is incorporated by reference. The document is not subject to frequent change and is available on the agency's Web site at www.pca.state.mn.us/regulations/minnesota-rulemaking and through the Minitex interlibrary loan system.

Subp. 6. **Class 4D [WR]; selected wild rice waters.** In recognition of the ecological importance of the wild rice resource and in conjunction with Minnesota Indian tribes, selected class 4D wild rice waters have been specifically identified [WR] and listed in part 7050.0470, subpart 1. The quality of these waters and the aquatic habitat necessary to support propagation and maintenance of wild rice plant species must not be materially impaired or degraded.

7050.0470 CLASSIFICATIONS FOR SURFACE WATERS IN MAJOR DRAINAGE BASINS.

Subpart 1. **Lake Superior basin.** The water use classifications for the listed waters in the Lake Superior basin are as identified in items A to D. See parts 7050.0425 ~~and~~, 7050.0430, and 7050.0471 for the classifications of waters not listed.

[For text of items A to D, see M.R.]

WaterLegacy Comments September 4, 2023
MPCA Procedures for implementing the Class 4A Wild Rice Sulfate Standards in NPDES Wastewater Permits in Minnesota &
MPCA Framework for Developing and Evaluating Site-specific Sulfate Standards for the Protection of Wild Rice

ATTACHMENT U

(EPA, Transmittal Letter and Final List of 32 Waters Added to the Minnesota 2020 Impaired Waters List due to exceedance of the wild rice sulfate criterion, 2021)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:
W-15J

Ms. Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Re: Minnesota's 2020 List of Impaired Waters under Clean Water Act, Section 303(d)

Dear Ms. Kessler:

The U.S. Environmental Protection Agency is finalizing the additions to the Minnesota Pollution Control Agency's (MPCA) Clean Water Act Section 303(d) List of Impaired Waters, which was submitted as part of Minnesota's 2020 Integrated Report, on February 25, 2021. EPA added thirty Water Quality Limited Segments (WQLSs) that are subject to the beneficial use and that exceed the sulfate criterion on April 27, 2021 and three WQLSs on September 1, 2021 to the Minnesota 2020 Impaired Waters List.

Based on comments received during the public comments periods of April 29 to June 30, 2021, and September 1 to October 1, 2021, EPA determined that one of the waters that EPA added did not meet EPA's screening criteria for addition to the Minnesota 2020 Impaired Waters List. Therefore, EPA is removing the Embarrass River (04010201-B00) segment from the Minnesota 2020 Impaired Waters List.

The list of thirty-two waters that EPA has added to the Minnesota 2020 Impaired Waters List is found at Attachment 1. EPA's response to comments received during the public notice periods is enclosed at Attachment 2 and its associated appendices. We are also enclosing EPA's responses to topics raised in tribal consultation discussions and communications (Attachment 3).

If you have any questions, please contact Mr. David Pfeifer, Chief, Watersheds and Wetlands Branch, at (312) 353-9024 or pfeifer.david@epa.gov.

Sincerely,

Tera L. Fong
Division Director, Water Division

cc: Catherine Neuschler, MPCA
Miranda Nichols, MPCA

Attachments:

Attachment 1: Waters Added by U.S. EPA to the Minnesota 2020 Impaired Waters List
Attachment 2: EPA Additions to the Minnesota 2020 Impaired Waters List - Response to Public Comments and Appendices
Attachment 3: Response to Comments Raised in During Consultation on EPA's Review of the Minnesota 2020 Impaired Waters List

Attachment 1: Waters Added by U.S. EPA to the Minnesota 2020 Impaired Waters List

Waterbody Name	AUID
Partridge River	04010201-552
Embarrass River	04010201-579
Second Creek	04010201-952
Embarrass River	04010201-A99
Swan River	07010103-753
Long Prairie River	07010108-501
Crow River, Middle Fork	07010204-537
Stanchfield Creek	07010207-518
Trott Brook	07010207-680
Mississippi River	07040003-627
Mississippi River	07060001-509
Clearwater River	09020305-647
Sand River	09030002-501
Pike River	09030002-503
Sturgeon Lake	25-0017-01
Hay Lake	31-0037-00
Swan Lake (SW Bay)	31-0067-03
Ox Hide	31-0106-00
Lake Monongalia	34-0158-01
Lake Monongalia	34-0158-02
East Vermillion	69-0378-01
Vermillion (Pike Bay)	69-0378-03
Wynne	69-0434-02
Embarrass Lake	69-0496-00
Esquagama Lake	69-0565-00
Cedar Island (N)	69-0568-01
Cedar Island (S)	69-0568-02
Perch Lake	69-0688-00
Little Sandy Lake	69-0729-00
Sandy Lake	69-0730-00
St. Louis River Estuary	69-1291-04
Rice Lake	71-0142-00