NPDES/SDS Permit Application

Volume III – Waste Water Treatment System

Prepared for
Poly Met Mining, Inc.

POLYMET MINING

July 2016 (initial submittal)

October 2017 (updated)
NPDES/SDS Permit Application  
Volume III – Waste Water Treatment System  
July 2016 (initial submittal)  
October 2017 (updated)  

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<table>
<thead>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>NPDES/SDS Permit Application</td>
</tr>
<tr>
<td>Band</td>
<td>Fond du Lac Band of Lake Superior Chippewa</td>
</tr>
<tr>
<td>BTPT</td>
<td>Best Technology in Process and Treatment</td>
</tr>
<tr>
<td>CIP</td>
<td>Clean-in-Place</td>
</tr>
<tr>
<td>Cliffs Erie</td>
<td>Cliffs Erie, LLC</td>
</tr>
<tr>
<td>FEIS</td>
<td>Final Environmental Impact Statement</td>
</tr>
<tr>
<td>FTB</td>
<td>Flotation Tailings Basin</td>
</tr>
<tr>
<td>GPM</td>
<td>Gallons per Minute</td>
</tr>
<tr>
<td>GSF</td>
<td>Greensand Filter</td>
</tr>
<tr>
<td>HCEQ</td>
<td>High Concentration Equalization</td>
</tr>
<tr>
<td>HRF</td>
<td>Hydrometallurgical Residue Facility</td>
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<tr>
<td>LCEQ</td>
<td>Low Concentration Equalization</td>
</tr>
<tr>
<td>LSB</td>
<td>Lake Superior Basin</td>
</tr>
<tr>
<td>LTVSMC</td>
<td>LTV Steel Mining Company</td>
</tr>
<tr>
<td>mg/L</td>
<td>Milligrams per liter</td>
</tr>
<tr>
<td>MPCA</td>
<td>Minnesota Pollution Control Agency</td>
</tr>
<tr>
<td>MPP</td>
<td>Mine to Plant Pipelines</td>
</tr>
<tr>
<td>NF</td>
<td>Nanofiltration</td>
</tr>
<tr>
<td>ng/L</td>
<td>Nanogram per liter</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
</tr>
<tr>
<td>NSPS</td>
<td>New Source Performance Standards</td>
</tr>
<tr>
<td>OIRW</td>
<td>Outstanding International Resource Water</td>
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<tr>
<td>ORVW</td>
<td>Outstanding Resource Value Water</td>
</tr>
<tr>
<td>OSLA</td>
<td>Overburden Storage and Laydown Area</td>
</tr>
<tr>
<td>P90</td>
<td>90th percentile</td>
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<tr>
<td>PolyMet</td>
<td>Poly Met Mining, Inc.</td>
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<tr>
<td>Project</td>
<td>NorthMet Project</td>
</tr>
<tr>
<td>Reservation</td>
<td>Fond du Lac Reservation</td>
</tr>
<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
</tr>
<tr>
<td>RPE</td>
<td>Reasonable Potential to Exceed</td>
</tr>
<tr>
<td>RTH</td>
<td>Rail Transfer Hopper</td>
</tr>
<tr>
<td>SDS</td>
<td>State Disposal System</td>
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<tr>
<td>TAS</td>
<td>Treatment as State</td>
</tr>
<tr>
<td>TSD</td>
<td>Technical Support Document for Water Quality-based Toxics Control</td>
</tr>
<tr>
<td>USEPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>VSEP</td>
<td>Vibratory Sheer Enhanced Process</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>WET</td>
<td>Whole Effluent Toxicity</td>
</tr>
<tr>
<td>WWTF</td>
<td>Waste Water Treatment Facility</td>
</tr>
<tr>
<td>WWTP</td>
<td>Waste Water Treatment Plant</td>
</tr>
<tr>
<td>WWTS</td>
<td>Waste Water Treatment System</td>
</tr>
</tbody>
</table>
Industrial Process Wastewater is wastewater which, during the manufacturing or processing, comes into direct contact with, or is left over from production of a raw material, intermediate product, finished product, byproduct or waste product.

This checklist is intended to help permit applicants determine the correct forms to submit as part of a complete permit application package. The Minnesota Pollution Control Agency (MPCA) will review the application materials for completeness and notify the applicant within 30 business days of receipt whether the application is incomplete or complete enough for processing.

Print or type application: Before submitting an application, make a photocopy of this form and all other application materials for your records. The MPCA will review the application for completeness and provide an official response to the permittees within 30 days of receipt of all necessary application materials.

Permit application assembly: To expedite the processing and review of your application, put this form and any other applicable permit application checklists for other waste types at the beginning of your submittal package. Please place all other application forms in order as listed on the back of this form. Do not place forms and checklists in an appendix as this makes it difficult and time consuming for staff to locate them.

Completeness instructions: The MPCA will not process an application without properly completed forms. All sections of required forms must be completed. If portions do not apply to this facility, please indicate using “n/a” or explain why it doesn’t apply. For permit reissuance, all forms information must also be completed in full even if the information requested is not changing from the existing permit. This allows the MPCA to quickly verify that the existing information is correct.

Facility name: NorthMet Waste Water Treatment System
Permit No.: MN TBD

Reason for Application (check all that apply):
☑ New permit  ☐ Permit Modification  ☐ Permit Reissuance
☐ Resubmittal of an application determined to be incomplete.
(Include copies of all returned forms with a resubmittal.)

Does this action include construction activities:
☑ Construction is proposed as part of the permit action.
☐ No construction is proposed as part of this permit action.

Form Submittal
Submit two (2) complete copies of the permit application package. At least one (1) copy must be a hard copy. The other may be an electronic copy. The completed form is to be returned to:

Attn: Fiscal Services – 6th floor
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Assistance
If you have any questions regarding the selection of the proper forms or how to complete the required information, contact the MPCA staff assigned to your facility. Staff is assigned by regions and a director of regional staff can be located at:
http://www.pca.state.mn.us/index.php/about-m pca/m pca-overview/agency-structure/m pca-offices/m pca-offices.html

You may also contact the MPCA at:
• In Metro Area 651-296-6300
• Outside Metro Area: 800-657-3864
• E-mail to: askpca@state.mn.us.
### Application Forms Selection

Check all boxes that apply. Include a copy of all completed application forms with the submittal.

<table>
<thead>
<tr>
<th>Form Category</th>
<th>Description</th>
<th>For MPCA use only</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required for all water quality permits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☒ Application Fee as specified on the Transmittal Form</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>☒ Certification Signature as specified on Transmittal Form</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td><strong>Required for all new permits and modifications with a change in design flow</strong></td>
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<tr>
<td><strong>Major NPDES facilities and/or Categorical NPDES facilities</strong></td>
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</tr>
<tr>
<td><strong>Discharge to surface water (for major and minor facilities)</strong></td>
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<tr>
<td><strong>Non-contact cooling water</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Discharge to land</strong></td>
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<td></td>
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<tr>
<td>☐ Industrial Land Application of Industrial By-products Application (wwprm7-27)</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td><strong>Discharge to municipal wastewater treatment facility</strong></td>
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<td><strong>Treatment facilities using stabilization ponds</strong></td>
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<tr>
<td><strong>Stormwater management for wastewater treatment permit holders</strong></td>
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<tr>
<td><strong>Additional attachments</strong></td>
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<tr>
<td><strong>Supplemental information</strong> (This information may be information required on one, or more of the forms listed above, such as a map. A single map that provides all the information required from multiple forms may be acceptable. A separate copy of each form is not required.)</td>
<td></td>
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<tr>
<td>☒ Topographic map.</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>☒ A schematic drawing or treatment process flow diagram showing all treatment components, direction of flow, compliance monitoring station locations, and discharge locations.</td>
<td>☐</td>
<td>☐</td>
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</tbody>
</table>
List any additional documents, reports, plans, or attachments included as part of the application package. (Common types of supplemental information may include maps, process flow diagrams, facility plans, engineering reports, plans and specifications, technical checklists and other reports related to the facility or proposed project.)

<p>| | | |</p>
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<tr>
<td>Refer to Volume III Table of Contents</td>
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</table>

**Other waste types** Some facilities may also include other waste types that are not covered by this checklist. Facilities with multiple types of wastes should review the other permit application checklists to determine if additional forms and attachments may be required.

- Permit Application Checklist for Municipal/Domestic Wastewater (wq-wwprm7-04a)
- Permit Application Checklist for Miscellaneous Waste Types (wq-wwprm7-04c)
- Permit Application Checklist for Water Treatment (wq-wwprm7-04d)
Disclaimer

This is an updated PDF document that allows you to type your information directly into the form, print it, and save the completed form.

Note: This form can be viewed and saved only using Adobe Acrobat Reader version 7.0 or higher, or if you have the full Adobe Professional version.

Instructions:
1. Type in your information
2. Save file (if desired)
3. Print the completed form
4. Sign and date the printed copy
5. Mail it to the directed contact.
This form must be completed by all persons applying for a permit under EPA's Consolidated Permits Program. See the general instructions to Form 1 to determine which other application forms you will need.
Who Must Apply
With the exceptions described in Section C of these instructions, Federal laws prohibit you from conducting any of the following activities without a permit.


UIC (Underground Injection Control Under the Safe Drinking Water Act, 42 U.S.C. 300f). Injection of fluids underground by gravity flow or pumping.

PSD (Prevention of Significant Deterioration Under the Clean Air Act, 72 U.S.C 7401). Emission of an air pollutant by a new or modified facility in or near an area which has attained the National Ambient Air Quality Standards for that pollutant.

Each of the above permit programs is operated in any particular State by either the United States Environmental Protection Agency (EPA) or by an approved State agency. You must use this application form to apply for a permit for those programs administered by EPA. For those programs administered by approved states, contact the State environmental agency for the proper forms.

If you have any questions about whether you need a permit under any of the above programs, or if you need information as to whether a particular program is administered by EPA or a State agency, or if you need to obtain application forms, contact your EPA Regional office (listed in Table 1).

Upon your request, and based upon information supplied by you, EPA will determine whether you are required to obtain a permit for a particular facility. Be sure to contact EPA if you have a question, because Federal laws provide that you may be heavily penalized if you do not apply for a permit when a permit is required.

Form 1 of the EPA consolidated application forms collects general information applying to all programs. You must fill out Form 1 regardless of which permit you are applying for. In addition, you must fill out one of the supplementary forms (Forms 2 – 5) for each permit needed under each of the above programs. Item II of Form 1 will guide you to the appropriate supplementary forms.

You should note that there are certain exclusions to the permit requirements listed above. The exclusions are described in detail in Section C of these instructions. If your activities are excluded from permit requirements then you do not need to complete and return any forms.

NOTE: Certain activities not listed above also are subject to EPA administered environmental permit requirements. These include permits for ocean dumping, dredged or fill material discharging, and certain types of air emissions. Contact your EPA Regional office for further information.

Table 1. Addresses of EPA Regional Contacts and States Within the Regional Office Jurisdictions

REGION 1
Permit Contact, Environmental and Economic Impact Office, U.S. Environmental Protection Agency, 1 Congress St., Suite 1100, Boston, MA 02114-2023, Phone: (617) 918-1111, Fax: (617) 918-1809, Toll free within Region 1: (888) 372-7341, http://www.epa.gov/region01/. Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

REGION 2

REGION 3
Permit Contact (3 EN 23), U.S. Environmental Protection Agency, 1650 Arch Street, Philadelphia, PA 19103-2029, Phone: (215) 814-5000, Fax: (215) 814-5103, Toll free: (800) 438-2474, http://www.epa.gov/region03/. Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.
SECTION A – GENERAL INSTRUCTIONS

REGION 4
Permit Contact, Permits Section, U.S. Environmental Protection Agency, Atlanta Federal Center, 61 Forsyth Street, SW, Atlanta, GA 30303-3104, Phone: (404) 562-9900, Fax: (404) 562-8174, Toll free: (800) 241-1754, http://www.epa.gov/region04/.
Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

REGION 5
Permit Contact (SEP), U.S. Environmental Protection Agency, 77 West Jackson Boulevard, Chicago, IL 60604-3507, Phone: (312) 353-2000, Fax: (312) 353-4135, Toll free within Region 5: (800) 621-8431, http://www.epa.gov/region5/.
Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

REGION 6
Permit Contact (6AEP), U.S. Environmental Protection Agency, Fountain Place 12th Floor, Suite 1200, 1445 Ross Avenue, Dallas, TX 75202-2733, Phone: (214) 665-2200, Fax: (214) 665-7113, Toll free within Region 6: (800) 887-6063, http://www.epa.gov/region06/.
Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

REGION 7
Permit Contact, Permits Branch, U.S. Environmental Protection Agency, 901 North 5th Street, Kansas City, KS 66101, Phone: (913) 551-7003, Toll free: (800) 223-0425, http://www.epa.gov/region07/.
Iowa, Kansas, Missouri, and Nebraska.

REGION 8
Permit Contact (8E-WE), U.S. Environmental Protection Agency, 999 18th Street, Suite 500, Denver, CO 80202-2466, Phone: (303) 312-6312, Fax: (303) 312-6339, Toll free: (800) 227-8917, http://www.epa.gov/region08/.
Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

REGION 9
Permit Contact, Permits Branch (E-4), U.S. Environmental Protection Agency, 75 Hawthorne Street, San Francisco, CA 94105, Phone: (415) 947-8000, Fax: (415) 947-3553, Toll free within Region 9: (866) EPA-WEST, http://www.epa.gov/region09/.
Arizona, California, Hawaii, Nevada, Guam, American Samoa, and Trust Territories.

REGION 10
Permit Contact (M/S 521), U.S. Environmental Protection Agency, 1200 Sixth Avenue, Seattle, WA 98101, Phone: (206) 553-1200, Fax: (206) 553-2955, Toll free: (800) 424-4372, http://www.epa.gov/region10/.

Where to File
The application forms should be mailed to the EPA Regional office whose Region includes the State in which the facility is located (see Table 1).

If the State in which the facility is located administers a Federal permit program under which you need a permit, you should contact the appropriate State agency for the correct forms. Your EPA Regional office (Table 1) can tell you to whom to apply and can provide the appropriate address and phone number.

When to File
Because of statutory requirements, the deadlines for filing applications vary according to the type of facility you operate and the type of permit you need. These deadlines are as follows: ¹

Table 2. Filing Dates for Permits

<table>
<thead>
<tr>
<th>FORM (permit)</th>
<th>WHEN TO FILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A (NPDES)</td>
<td>180 days before your present NPDES permit expires.</td>
</tr>
<tr>
<td>2B (NPDES)</td>
<td>180 days before your present NPDES permit expires¹, or 180 days prior to startup if you are a new facility.</td>
</tr>
<tr>
<td>2C (NPDES)</td>
<td>180 days before your present NPDES permit expires¹.</td>
</tr>
<tr>
<td>2D (NPDES)</td>
<td>180 days prior to startup.</td>
</tr>
<tr>
<td>3 (Hazardous Waste) . . . . . Existing facility: Six months following publication of regulations listing hazardous wastes. New facility: 180 days before commencing physical construction.</td>
<td></td>
</tr>
<tr>
<td>4 (UIC) . . . . . A reasonable time prior to construction for new wells; as directed by the Director for existing wells.</td>
<td></td>
</tr>
<tr>
<td>5 (PSD) . . . . . Prior to commencement of construction.</td>
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</tbody>
</table>

¹ Please note that some of these forms are not yet available for use and are listed as “Reserved” at the beginning of these instructions. Contact your EPA Regional office for information on current application requirements and forms.

² If your present permit expires on or before November 30, 1980, the filing date is the date on which your permit expires. If your permit expires during the period December 1, 1980–May 31, 1981, the filing date is 90 days before your permit expires.

Federal regulations provide that you may not begin to construct a new source in the NPDES program, a new hazardous waste management facility, a new injection well, or a facility covered by the PSD program before the issuance of a permit under the applicable program. Please note that if you are required to obtain a permit before beginning construction, as described above, you may need to submit your permit application well in advance of an applicable deadline listed in Table 2.

Fees
The U.S. EPA does not require a fee for applying for any permit under the consolidated permit programs. (However, some States which administer one or more of these programs require fees for the permits which they issue.)

Availability of Information to Public
Information contained in these application forms will, upon request, be made available to the public for inspection and copying. However, you may request confidential treatment for certain information which you submit on certain supplementary forms. The specific instructions for each supplementary form state what information on the form, if any, may be claimed as confidential and what procedures govern the claim. No information on Forms 1 and 2A through 2D may be claimed as confidential.

Completion of Forms
Unless otherwise specified in instructions to the forms, each item in each form must be answered. To indicate that each item has been considered, enter “NA,” for not applicable, if a particular item does not fit the circumstances or characteristics of your facility or activity.

If you have previously submitted information to EPA or to an approved State agency which answers a question, you may either repeat the information in the space provided or attach a copy of the previous submission. Some items in the form require narrative explanation. If more space is necessary to answer a question, attach a separate sheet entitled “Additional Information.”

Financial Assistance for Pollution Control
There are a number of direct loans, loan guarantees, and grants available to firms and communities for pollution control expenditures. These are provided by the Small Business Administration, the Economic Development Administration, the Farmers Home Administration, and the Department of Housing and Urban Development. Each EPA Regional office (Table 1) has an economic assistance coordinator who can provide you with additional information.

EPA’s construction grants program under Title II of the Clean Water Act is an additional source of assistance to publicly owned treatment works. Contact your EPA Regional office for details.
This form must be completed by all applicants.

Completing This Form
Please type or print in the unshaded areas only. Some items have small graduation marks in the fill-in spaces. These marks indicate the number of characters that may be entered into our data system. The marks are spaced at 1/6" intervals which accommodate elite type (12 characters per inch). If you use another type you may ignore the marks. If you print, place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Item I
Space is provided at the upper right hand corner of Form 1 for insertion of your EPA Identification Number. If you have an existing facility, enter your Identification Number. If you don’t know your EPA Identification Number, please contact your EPA Regional office (Table 1), which will provide you with your number. If your facility is new (not yet constructed), leave this item blank.

Item II
Answer each question to determine which supplementary forms you need to fill out. Be sure to check the glossary in Section D of these instructions for the legal definitions of the bold faced words. Check Section C of these instructions to determine whether your activity is excluded from permit requirements.

If you answer “no” to every question, then you do not need a permit, and you do not need to complete and return any of these forms.

If you answer “yes” to any question, then you must complete and file the supplementary form by the deadline listed in Table 2 along with this form. (The applicable form number follows each question and is enclosed in parentheses.) You need not submit a supplementary form if you already have a permit under the appropriate Federal program, unless your permit is due to expire and you wish to renew your permit.

Questions (I) and (J) of Item II refer to major new or modified sources subject to Prevention of Significant Deterioration (PSD) requirements under the Clean Air Act. For the purpose of the PSD program, major sources are defined as: (A) Sources listed in Table 3 which have the potential to emit 100 tons or more per year emissions; and (B) All other sources with the potential to emit 250 tons or more per year. See Section C of these instructions for discussion of exclusions of certain modified sources.

Table 3. 28 Industrial Categories Listed In Section 169(1) of the Clean Air Act of 1977
Fossil fuel-fired steam generators of more than 250 million BTU per hour heat input;
Coal cleaning plants (with thermal dryers);
Kraft pulp mills;
Portland cement plants;
Primary zinc smelters;
Iron and steel mill plants;
Primary aluminum ore reduction plants;
Primary copper smelters;
Municipal incinerators capable of charging more than 250 tons of refuse per day;
Hydrofluoric acid plants;
Nitric acid plants;
Sulfuric acid plants;
Petroleum refineries;
Lime plants;
Phosphate rock processing plants;
Coke oven batteries;
Sulfur recovery plants;
Carbon black plants (furnace process);
Primary lead smelters;
Fuel conversion plants;
Sintering plants;
Secondary metal production plants;
Chemical process plants;
Fossil fuel boilers (or combination thereof) totaling more than 250 million BTU per hour heat input;

Table 3 (continued)
Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels;
Taconite ore processing plants;
Glass fiber processing plants; and
Charcoal production plants.

Item III
Enter the facility’s official or legal name. Do not use a colloquial name.

Item IV
Give the name, title, and work telephone number of a person who is thoroughly familiar with the operation of the facility and with the facts reported in this application and who can be contacted by reviewing offices if necessary.

Item V
Give the complete mailing address of the office where correspondence should be sent. This often is not the address used to designate the location of the facility or activity.

Item VI
Give the address or location of the facility identified in Item III of this form. If the facility lacks a street name or route number, give the most accurate alternative geographic information (e.g., section number or quarter section number from county records or at intersection of Rts. 425 and 22).

Item VII
List, in descending order of significance, the four 4-digit standard industrial classification (SIC) codes which best describe your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words. These classifications may differ from the SIC codes describing the operation generating the discharge, air emissions, or hazardous wastes.

SIC code numbers are descriptions which may be found in the “Standard Industrial Classification Manual” prepared by the Executive Office of the President, Office of Management and Budget, which is available from the Government Printing Office, Washington, D.C. Use the current edition of the manual. If you have any questions concerning the appropriate SIC code for your facility, contact your EPA Regional office (see Table 1).

Item VIII-A
Give the name, as it is legally referred to, of the person, firm, public organization, or any other entity which operates the facility described in this application. This may or may not be the same name as the facility. The operator of the facility is the legal entity which controls the facility’s operation rather than the plant or site manager. Do not use a colloquial name.

Item VIII-B
Indicate whether the entity which operates the facility also owns it by marking the appropriate box.

Item VIII-C
Enter the appropriate letter to indicate the legal status of the operator of the facility. Indicate “public” for a facility solely owned by local government(s) such as a city, town, county, parish, etc.

Items VIII-D-H
Enter the telephone number and address of the operator identified in Item VIII-A.

Item IX
Indicate whether the facility is located on Indian Lands.

Item X
Give the number of each presently effective permit issued to the facility for each program or, if you have previously filed an application but have not yet received a permit, give the number of the application, if any. Fill in the unshaded area only. If you have more than one currently effective permit for your facility under a particular permit program, you may list additional permit numbers on a separate sheet of paper. List any relevant environmental Federal (e.g., permits...
SECTION B – FORM 1 LINE BY LINE INSTRUCTIONS

under the Ocean Dumping Act, Section 404 of the Clean Water Act or the Surface Mining Control and Reclamation Act), State (e.g., State permits for new air emission sources in nonattainment areas under Part D of the Clean Air Act or State permits under Section 404 of the Clean Water Act), or local permits or applications under "other."

Item XI
Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the facility which clearly show the following:

The legal boundaries of the facility;

The location and serial number of each of your existing and proposed intake and discharge structures;

All hazardous waste management facilities;

Each well where you inject fluids underground; and

All springs and surface water bodies in the area, plus all drinking water wells within 1/4 mile of the facility which are identified in the public record or otherwise known to you.

If an intake or discharge structure, hazardous waste disposal site, or injection well associated with the facility is located more than one mile from the plant, include it on the map, if possible. If not, attach additional sheets describing the location of the structure, disposal site, or well, and identify the U.S. Geological Survey (or other) map corresponding to the location.

On each map, include the map scale, a meridian arrow showing north, and latitude and longitude at the nearest whole second. On all maps of rivers, show the direction of the current, and in tidal waters, the directions of the ebb and flow tides. Use a 7-1/2 minute series map published by the U.S. Geological Survey. If neither a 7-1/2 nor 15 minute series map has been obtained through the U.S. Geological Survey Offices listed below, if a 7-1/2 minute series map has not been published for your facility site, then you may use a 15 minute series map from the U.S. Geological Survey. If neither a 7-1/2 nor 15 minute series map has been published for your facility site, use a plat map or other appropriate map, including all the requested information; in this case, briefly describe land uses in the map area (e.g., residential, commercial).

You may trace your map from a geological survey chart, or other map meeting the above specifications. If you do, your map should bear a note showing the number or title of the map or chart it was traced from. Include the names of nearby towns, water bodies, and other prominent points. An example of an acceptable location map is shown in Figure 1-1 of these instructions. (NOTE: Figure 1-1 is provided for purposes of illustration only, and does not represent any actual facility.)

U.S.G.S. OFFICES

Eastern Mapping Center
National Cartographic Information Center
U.S.G.S.
536 National Center
Reston, VA 22092
Phone No. (703) 860-6336

Mid Continent Mapping Center
National Cartographic Information Center
U.S.G.S.
1400 Independence Road
Rolla, MO 65401
Phone No. (314) 341-0851

Rocky Mountain Mapping Center
National Cartographic Information Center
U.S.G.S.
Stop 504, Box 25046 Federal Center
Denver, CO 80226
Phone No. (303) 234-2326

Western Mapping Center
National Cartographic Information Center
U.S.G.S.
345 Middlefield Road
Menlo Park, CA 94025
Phone No. (415) 323-8111

AREA SERVED


Item XII
Briefly describe the nature of your business (e.g., products produced or services provided).

Item XIII
Federal statues provide for severe penalties for submitting false information on this application form.

18 U.S.C. Section 1001 provides that “Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes or uses any false writing or document knowing some to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.”

Section 309(c)(2) of the Clean Water Act and Section 113(c)(2) of the Clean Air Act each provide that “Any person who knowingly makes any false statement, representation, or certification in any application, . . . shall upon conviction, be punished by a fine of no more than $10,000 or by imprisonment for not more than six months, or both.”

In addition, Section 3008(d)(3) of the Resource Conservation and Recovery Act provides for a fine up to $25,000 per day or imprisonment up to one year, or both, for a first conviction for making a false statement in any application under the Act, and for double these penalties upon subsequent convictions.

FEDERAL REGULATIONS REQUIRE THIS APPLICATION TO BE SIGNED AS FOLLOWS:

A. For a corporation, by a principal executive officer of at least the level of vice president. However, if the only activity in Item II which is marked “yes” is Question G, the officer may authorize a person having responsibility for the overall operations of the well or well field to sign the certification. In that case, the authorization must be written and submitted to the permitting authority.

B. For partnership or sole proprietorship, by a general partner or the proprietor, respectively; or

C. For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.
SECTION C – ACTIVITIES WHICH DO NOT REQUIRE PERMITS

1. National Pollutant Discharge Elimination System Permits Under the Clean Water Act. You are not required to obtain an NPDES permit if your discharge is in one of the following categories, as provided by the Clean Water Act (CWA) and by the NPDES regulations (40 CFR Parts 122-125). However, under Section 510 of CWA a discharge exempted from the federal NPDES requirements may still be regulated by a State authority; contact your State environmental agency to determine whether you need a State permit.

A. DISCHARGES FROM VESSELS. Discharges of sewage from vessels, effluent from properly functioning marine engines, laundry, shower, and galley sink wastes, and any other discharge incidental to the normal operation of a vessel do not require NPDES permits. However, discharges of rubbish, trash, garbage, or other such materials discharged overboard require permits, and so do other discharges when the vessel is operating in a capacity other than as a means of transportation, such as when the vessel is being used as an energy or mining facility, a storage facility, or a seafood processing facility, or is secured to the bed of the ocean, contiguous zone, or waters of the United States for the purpose of mineral or oil exploration or development.

B. DREDGED OR FILL MATERIAL. Discharges of dredged or fill material into waters of the United States do not need NPDES permits if the dredging or filling is authorized by a permit issued by the U.S. Army Corps of Engineers or an EPA approved State under Section 404 of CWA.

C. DISCHARGES INTO PUBLICLY OWNED TREATMENT WORKS (POTW). The introduction of sewage, industrial wastes, or other pollutants into a POTW does not need an NPDES permit. You must comply with all applicable pretreatment standards promulgated under Section 307(b) of CWA, which may be included in the permit issued to the POTW. If you have a plan or an agreement to switch to a POTW in the future, this does not relieve you of the obligation to apply for and receive an NPDES permit until you have stopped discharging pollutants into waters of the United States.

(NOTE: Dischargers into privately owned treatment works do not have to apply for or obtain NPDES permits except as otherwise required by the EPA Regional Administrator. The owner or operator of the treatment works itself, however, must apply for a permit and identify all users in its application. Users so identified will receive public notice of actions taken on the permit for the treatment works.)

D. DISCHARGES FROM AGRICULTURAL AND SILVICULTURAL ACTIVITIES. Most discharges from agricultural and silvicultural activities to waters of the United States do not require NPDES permits. These include runoff from orchards, cultivated crops, pastures, range lands, and forest lands. However, the discharges listed below do require NPDES permits. Definitions of the terms listed below are contained in the Glossary section of these instructions.

1. Discharges from Concentrated Animal Feeding Operations. (See Glossary for definitions of “animal feeding operations” and “concentrated animal feeding operations.” Only the latter require permits.)

2. Discharges from Concentrated Aquatic Animal Production Facilities. (See Glossary for size cutoffs.)

3. Discharges associated with approved Aquaculture Projects.

4. Discharges from Silvicultural Point Sources. (See Glossary for the definition of “silvicultural point source.”) Nonpoint source silvicultural activities are excluded from NPDES permit requirements. However, some of these activities, such as stream crossings for roads, may involve point source discharges of dredged or fill material which may require a Section 404 permit. See 33 CFR 209.120.

E. DISCHARGES IN COMPLIANCE WITH AN ON-SCENE COORDINATOR’S INSTRUCTIONS.

II. Hazardous Waste Permits Under the Resource Conservation and Recovery Act. You may be excluded from the requirement to obtain a permit under this program if you fall into one of the following categories:

- Generators who accumulate their own hazardous waste on-site for less than 90 days as provided in 40 CFR 262.34;
- Farmers who dispose of hazardous waste pesticide from their own use as provided in 40 CFR 262.51;
- Certain persons treating, storing, or disposing of small quantities of hazardous waste as provided in 40 CFR 261.4 or 261.5; and
- Owners and operators of totally enclosed treatment facilities as defined in 40 CFR 260.10.

Check with your Regional office for details. Please note that even if you are excluded from permit requirements, you may be required by Federal regulations to handle your waste in a particular manner.

III. Underground Injection Control Permits Under the Safe Drinking Water Act. You are not required to obtain a permit under this program if you:

- Inject into existing wells used to enhance recovery of oil and gas or to store hydrocarbons (note, however, that these underground injections are regulated by Federal rules); or
- Inject into or above a stratum which contains, within 1/4 mile of the well bore, an underground source of drinking water (unless your injection is the type identified in Item II-H, for which you do need a permit). However, you must notify EPA of your injection and submit certain required information on forms supplied by the Agency, and your operation may be phased out if you are a generator of hazardous wastes or a hazardous waste management facility which uses wells or septic tanks to dispose of hazardous waste.

IV. Prevention of Significant Deterioration Permits Under the Clean Air Act. The PSD program applies to newly constructed or modified facilities (both of which are referred to as "new sources") which increase air emissions. The Clean Air Act Amendments of 1977 exclude small new sources of air emissions from the PSD review program. Any new source in an industrial category listed in Table 3 of these instructions whose potential to emit is less than 100 tons per year is exempted from the PSD requirements. In addition, any new source in an industrial category not listed in Table 3 whose potential to emit is less than 250 tons per year is exempted from the PSD requirements.

Modified sources which increase their net emissions (the difference between the total emission increases and total emission decreases at the source) less than the significant amount set forth in EPA regulations are also exempt from PSD requirements. Contact your EPA Regional office (Table 1) for further information.
NOTE: This Glossary includes terms used in the instructions and in Forms 1, 2B, 2C, and 3. Additional terms will be included in the future when other forms are developed to reflect the requirements of other parts of the Consolidated Permits Program. If you have any questions concerning the meaning of any of these terms, please contact your EPA Regional office (Table 1).

ALIQUOT means a sample of specified volume used to make up a total composite sample.

ANIMAL FEEDING OPERATION means a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

A. Animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period; and

B. Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Two or more animal feeding operations under common ownership are a single animal feeding operation if they adjoin each other or if they use a common area or system for the disposal of wastes.

ANIMAL UNIT means a unit of measurement for any animal feeding operation calculated by adding the following numbers: The number of slaughter and feeder cattle multiplied by 1.0; Plus the number of mature dairy cattle multiplied by 1.4; Plus the number of swine weighing over 25 kilograms (approximately 55 pounds) multiplied by 0.4; Plus the number of sheep multiplied by 0.1; Plus the number of horses multiplied by 2.0.

APPLICATION means the EPA standard national forms for applying for a permit, including any additions, revisions, or modifications to the forms; or forms approved by EPA for use in approved States, including any approved modifications or revisions. For RCRA, “application” also means “Application, Part B.”

APPLICATION, PART A means that part of the Consolidated Permit Application forms which a RCRA permit applicant must complete to qualify for interim status under Section 3005(e) of RCRA and for consideration for a permit. Part A consists of Form 1 (General Information) and Form 3 (Hazardous Waste Application Form).

APPLICATION, PART B means that part of the application which a RCRA permit applicant must complete to be issued a permit. (NOTE: EPA is not developing a specific form for Part B of the permit application, but an instruction booklet explaining what information must be supplied is available from the EPA Regional office.)

APPROVED PROGRAM or APPROVED STATE means a State program which has been approved or authorized by EPA under 40 CFR Part 123.

AQUACULTURE PROJECT means a defined managed water area which uses discharges of pollutants into that designated area for the maintenance or production of harvestable freshwater, estuarine, or marine plants or animals. “Designated area” means the portions of the waters of the United States within which the applicant plans to confine the cultivated species, using a method of plan or operation (including, but not limited to, physical confinement) which, on the basis of reliable scientific evidence, is expected to ensure the specific individual organisms comprising an aquaculture crop will enjoy increased growth attributable to the discharge of pollutants and be harvested within a defined geographic area.

AQUIFER means a geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

AREA OF REVIEW means the area surrounding an injection well which is described according to the criteria set forth in 40 CFR Section 146.06.

AREA PERMIT means a UIC permit applicable to all or certain wells within a geographic area, rather than to a specified well, under 40 CFR Section 122.37.

ATTAINMENT AREA means, for any air pollutant, an area which has been designated under Section 107 of the Clean Air Act as having ambient air quality levels better than any national primary or secondary ambient air quality standard for that pollutant. Standards have been set for sulfur oxides, particulate matter, nitrogen dioxide, carbon monoxide, ozone, lead, and hydrocarbons. For purposes of the Glossary, “attainment area” also refers to “unclassifiable area,” which means, for any pollutants, an area designated under Section 107 as unclassifiable with respect to that pollutant due to insufficient information.

BEST MANAGEMENT PRACTICES (BMP) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMP’s include treatment requirements, operation procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

BIological MONITORING TEST means any test which includes the use of aquatic algal, invertebrate, or vertebrate species to measure acute or chronic toxicity, and any biological or chemical measure of bioaccumulation.

BYPASS means the intentional diversion of wastes from any portion of a treatment facility.

CONCENTRATED ANIMAL FEEDING OPERATION means an animal feeding operation which meets the criteria set forth in either (A) or (B) below or which the Director designates as such on a case-by-case basis:

A. More than the numbers of animals specified in any of the following categories are confined:

1. 1,000 slaughter or feeder cattle,
2. 700 mature dairy cattle (whether milked or dry cows),
3. 2,500 swine each weighing over 25 kilograms (approximately 55 pounds),
4. 500 horses,
5. 10,000 sheep or lambs,
6. 55,000 turkeys,
7. 100,000 laying hens or broilers (if the facility has a continuous overflow watering),
8. 30,000 laying hens or broilers (if the facility has a liquid manure handling system),
9. 5,000 ducks,
10. 1,000 animal units; or

B. More than the following numbers and types of animals are confined:

1. 300 slaughter or feeder cattle,
2. 200 mature dairy cattle (whether milked or dry cows),
3. 750 swine each weighing over 25 kilograms (approximately 55 pounds),
4. 150 horses,
5. 3,000 sheep or lambs,
6. 16,500 turkeys,
7. 30,000 laying hens or broilers (if the facility has continuous overflow watering),
8. 9,000 laying hens or broilers (if the facility has a liquid manure handling system),
9. 1,500 ducks,
10. 300 animal units; AND

Table 1
Either one of the following conditions are met: Pollutants are discharged into waters of the United States through a manmade ditch, flushing system or other similar manmade device ("manmade" means constructed by man and used for the purpose of transporting wastes); or Pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.

Provided, however, that no animal feeding operation is a concentrated animal feeding operation as defined above if such animal feeding operation discharges only in the event of a 25 year, 24 hour storm event.

CONCENTRATED AQUATIC ANIMAL PRODUCTION FACILITY means a hatchery, fish farm, or other facility which contains, grows or holds aquatic animals in either of the following categories, or which the Director designates as such on a case-by-case basis: A. Cold water fish species or other cold water aquatic animals including, but not limited to, the Salmonidae family of fish (e.g., trout and salmon) in ponds, raceways, or other similar structures which discharge at least 30 days per year but does not include: 1. Facilities which produce less than 9,090 harvest weight kilograms (approximately 20,000 pounds) of aquatic animals per year; and 2. Facilities which feed less than 2,272 kilograms (approximately 5,000 pounds) of food during the calendar month of maximum feeding. B. Warm water fish species or other warm water aquatic animals including, but not limited to, the Ameiuridae, Cetrarchidae, and Cyprinidae families of fish (e.g., respectively, catfish, sunfish, and minnows) in ponds, raceways, or other similar structures which discharge at least 30 days per year, but does not include; 1. Closed ponds which discharge only during periods of excess runoff; or 2. Facilities which produce less than 45,454 harvest weight kilograms (approximately 100,000 pounds) of aquatic animals per year.

CONTACT COOLING WATER means water used to reduce temperature which comes into contact with a raw material, intermediate product, waste product other than heat, or finished product.

CONTAINER means any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.

CONTIGUOUS ZONE means the entire zone established by the United States under article 24 of the convention of the Territorial Sea and the Contiguous Zone.


DIKE means any embankment or ridge of either natural or manmade materials used to prevent the movement of liquids, sludges, solids, or other materials.

DIRECT DISCHARGE means the discharge of a pollutant as defined below.

DIRECTOR means the EPA Regional Administrator or the State Director as the context requires.

DISCHARGE (OF A POLLUTANT) means:

A. Any addition of any pollutant or combination of pollutants to waters of the United States from any point source; or

B. Any addition of any pollutant or combination of pollutants to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation.

This definition includes discharges into waters of the United States from: Surface runoff which is collected or channelled by man; Discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to POTW’s; and Discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works. This term does not include an addition of pollutants by any indirect discharger.

DISPOSAL (in the RCRA program) means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any hazardous waste into or on any land or water so that the hazardous waste or any constituent of it may enter the environment or be emitted into the air or discharged into any waters, including ground water.

DISPOSAL FACILITY means a facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which hazardous waste will remain after closure.

EFFLUENT LIMITATION means any restriction imposed by the Director on quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into waters of the United States, the waters of the contiguous zone, or the ocean.

EFFLUENT LIMITATION GUIDELINE means a regulation published by the Administrator under Section 304(b) of the Clean Water Act to adopt or revise effluent limitations.

ENVIRONMENTAL PROTECTION AGENCY (EPA) means the United States Environmental Protection Agency.

EPA IDENTIFICATION NUMBER means the number assigned by EPA to each generator, transporter, and facility.

EXEMPTED AQUIFER means an aquifer or its portion that meets the criteria in the definition of USDW, but which has been exempted according to the procedures in 40 CFR Section 122.35(b).

EXISTING HWFM FACILITY means a Hazardous Waste Management facility which was in operation, or for which construction had commenced, on or before October 21, 1976. Construction had commenced if (A) the owner or operator had obtained all necessary Federal, State, and local preconstruction approvals or permits, and either (B1) a continuous on-site, physical construction program had begun, or (B2) the owner or operator had entered into contractual obligations, which could not be cancelled or modified without substantial loss, for construction of the facility to be completed within a reasonable time.

NOTE: This definition reflects the literal language of the statute. However, EPA believes that amendments to RCRA now in conference will shortly be enacted and will change the date for determining when a facility is an “existing facility” to one no earlier than May of 1980; indications are the conferees are considering October 30, 1980. Accordingly, EPA encourages every owner or operator of a facility which was built or under construction as of the promulgation date of the RCRA program regulations to file Part A of its permit application so that it can be quickly processed for interim status when the change in the law takes effect. When those amendments are enacted, EPA will amend this definition.

EXISTING SOURCE or EXISTING DISCHARGER (in the NPDES program) means any source which is not a new source or a new discharger.

EXISTING INJECTION WELL means an injection well other than a new injection well.

FACILITY means any HWFM facility, UIC underground injection well, NPDES point source, PSD stationary source, or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the RCRA, UIC, NPDES, or PSD programs.

FLUID means material or substance which flows or moves whether in a semisolid, liquid, sludge, gas, or any other form or state.

GENERATOR means any person by site, whose act or process produces hazardous waste identified or listed in 40 CFR Part 261.

GROUNDWATER means water below the land surface in a zone of saturation.

HAZARDOUS SUBSTANCE means any of the substances designated under 40 CFR Part 116 pursuant to Section 311 of CWA. (NOTE: These substances are listed in Table 2c-4 of the instructions to Form 2C.)
HAZARDOUS WASTE means a hazardous waste as defined in 40 CFR Section 261.3 published May 19, 1980.

HAZARDOUS WASTE MANAGEMENT FACILITY (HWM facility) means all contiguous land, structures, appurtenances, and improvements on the land, used for treating, storing, or disposing of hazardous wastes. A facility may consist of several treatment, storage, or disposal operational units (for example, one or more landfills, surface impoundments, or combinations of them).

IN OPERATION means a facility which is treating, storing, or disposing of hazardous waste.

INCINERATOR (in the RCRA program) means an enclosed device using controlled flame combustion, the primary purpose of which is to thermally break down hazardous waste. Examples of incinerators are rotary kiln, fluidized bed, and liquid injection incinerators.

INDIRECT DISCHARGER means a nondomestic discharger introducing pollutants to a publicly owned treatment works.

INJECTION WELL means a well into which fluids are being injected.

INTERIM AUTHORIZATION means approval by EPA of a State hazardous waste program which has met the requirements of Section 3006(c) of RCRA and applicable requirements of 40 CFR Parts 123, A, B, and F.

LANDFILL means a disposal facility or part of a facility where hazardous waste is placed in or on land and which is not a land treatment facility, a surface impoundment, or an injection well.

LAND TREATMENT FACILITY (in the RCRA program) means a facility or part of a facility at which hazardous waste is applied onto or incorporated into the soil surface; such facilities are disposal facilities if the waste will remain after closure.

LISTED STATE means a State listed by the Administrator under Section 1422 of SDWA as needing a State UIC program.

MUNICIPALITY means a city, village, town, borough, county, parish, district, association, or other public body created by or under State law and having jurisdiction over disposal of sewage, industrial wastes, or other wastes, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under Section 208 of CWA.

MGD means millions of gallons per day.

MUNICIPALITY means a city, town, village, borough, county, parish, district, association, or other public body created by or under State law and having jurisdiction over disposal of sewage, industrial wastes, or other wastes, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under Section 208 of CWA.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) means the national program for issuing modifying, revoking and reissuing, terminating, monitoring, and enforcing permits and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of CWA. The term includes an approved program.

NEW DISCHARGER means any building, structure, facility, or installation: (A) From which there is or may be a new or additional discharge of pollutants at a site at which on October 18, 1972, it had never discharged pollutants; (B) Which has never received a finally effective NPDES permit for discharges at that site; and (C) Which is not a “new source.” This definition includes an indirect discharger which commences discharging into waters of the United States. It also includes any existing mobile point source, such as an offshore oil drilling rig, seafood processing vessel, or aggregate plant that begins discharging at a location for which it does not have an existing permit.

NEW HWM FACILITY means a Hazardous Waste Management facility which began operation or for which construction commenced after October 21, 1976.

NEW INJECTION WELL means a well which begins injection after a UIC program for the State in which the well is located is approved.

NEW SOURCE (in the NPDES program) means any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced:

A. After promulgation of standards of performance under Section 306 of CWA which are applicable to such source; or

B. After proposal of standards of performance in accordance with Section 306 of CWA which are applicable to such source, but only if the standards are promulgated in accordance with Section 306 within 120 days of their proposal.

NON-CONTACT COOLING WATER means water used to reduce temperature which does not come into direct contact with any raw material, intermediate product, waste product (other than heat), or finished product.

OFF-SITE means any site which is not “on-site”.

ON-SITE means on the same or geographically contiguous property which may be divided by public or private right(s)-of-way, provided the entrance and exit between the properties is at a cross-roads intersection, and access is by crossing as opposed to going along, the right(s)-of-way. Non-contiguous properties owned by the same person, but connected by a right-of-way which the person controls and to which the public does not have access, is also considered on-site property.

OPEN BURNING means the combustion of any material without the following characteristics;

A. Control of combustion air to maintain adequate temperature for efficient combustion;

B. Containment of the combustion-reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion; and

C. Control of emission of the gaseous combustion products.

(See also “incinerator” and “thermal treatment”).

OPERATOR means the person responsible for the overall operation of a facility.

OUTFALL means a point source.

OWNER means the person who owns a facility or part of a facility.

PERMIT means an authorization, license, or equivalent control document issued by EPA or an approved State to implement the requirements of 40 CFR Parts 122, 123, and 124.

PHYSICAL CONSTRUCTION (in the RCRA program) means excavation, movement of earth, erection of forms or structures, or similar activity to prepare a HWM facility to accept hazardous waste.

PILE means any noncontainerized accumulation of solid, nonflowing hazardous waste that is used for treatment or storage.

POINT SOURCE means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

POLLUTANT means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical waste, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended [42 U.S.C. Section 2011 et seq.]), heat, wrecked or discarded equipment, rocks, sand, cellar dirt and Industrial, municipal, and agriculture waste discharged into water. It does not mean:

A. Sewage from vessels; or

B. Water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil and gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if the State determines that the injection or disposal will not result in the degradation of ground or surface water resources.

( NOTE: Radioactive materials covered by the Atomic Energy Act are those encompassed in its definition of source, byproduct, or special nuclear materials. Examples of materials not covered include radium and accelerator produced isotopes. See Train v. Colorado Public Interest Research Group, Inc., 426 U.S. 1 [1976].)
PREVENTION OF SIGNIFICANT DETERIORATION (PSD) means the national permitting program under 40 CFR 52.21 to prevent emissions of certain pollutants regulated under the Clean Air Act from significantly deteriorating air quality in attainment areas.


PRIVATELY OWNED TREATMENT WORKS means any device or system which is: (A) Used to treat wastes from any facility whose operator is not the operator of the treatment works; and (B) Not a POTW.

PROCESS WASTEWATER means any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

PUBLICLY OWNED TREATMENT WORKS or POTW means any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature which is owned by a State or municipality. This definition includes any sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

RENT means use of another’s property in return for regular payment.


ROCK CRUSHING AND GRAVEL WASHING FACILITIES are facilities which process crushed and broken stone, gravel, and riprap (see 40 CFR Part 436, Subpart B, and the effluent limitations guidelines for these facilities).

SDWA means the Safe Drinking Water Act (Pub. L. 95-523, as amended by Pub. L. 95-1900, 42 U.S.C. Section 300f et seq.).

SECONDARY INDUSTRY CATEGORY means any industry category which is not a primary industry category.

SEWAGE FROM VESSELS means human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes that are discharged from vessels and regulated under Section 312 of CWA, except that with respect to commercial vessels on the Great Lakes this term includes graywater. For the purposes of this definition, “graywater” means galley, bath, and shower water.

SEWAGE SLUDGE means the solids, residues, and precipitate separated from or created in sewage by the unit processes of a POTW. “Sewage” as used in this definition means any wastes, including wastes from humans, households, commercial establishments, industries, and storm water runoff, that are discharged to or otherwise enter a publicly owned treatment works.

SILVICULTURAL POINT SOURCE means any discernable, confined, and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States. This term does not include nonpoint source silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance from which there is natural runoff. However, some of these activities (such as stream crossing for roads) may involve point source discharges of dredged or fill material which may require a CWA Section 404 permit. “Log sorting and log storage facilities” are facilities whose discharges result from the holding of unprocessed wood, e.g., logs or roundwood with bark or after removal of bark in self-contained bodies of water (mill ponds or log ponds) or stored on land where water is applied intentionally on the logs (wet decking). (See 40 CFR Part 429, Subpart J, and the effluent limitations guidelines for these facilities.)

STATE means any of the 50 States, the District of Columbia, Guam, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, the Trust Territory of the Pacific Islands (except in the case of RCRA), and the Commonwealth of the Northern Mariana Islands (except in the case of CWA).

STATIONARY SOURCE (in the PSD program) means any building, structure, facility, or installation which emits or may emit any air pollutant regulated under the Clean Air Act. “Building, structure, facility, or installation” means any grouping of pollutant-emitting activities which are located on one or more contiguous or adjacent properties and which are owned or operated by the same person (or by persons under common control).

STORAGE (in the RCRA program) means the holding of hazardous waste for a temporary period at the end of which the hazardous waste is treated, disposed, or stored elsewhere.

STORM WATER RUNOFF means water discharged as a result of rain, snow, or other precipitation.

SURFACE IMPOUNDMENT or IMPOUNDMENT means a facility or part of a facility which is a natural topographic depression, manmade excavation, or diked area formed primarily of earthen materials (although it may be lined with manmade materials), which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons.

TANK (in the RCRA program) means a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials (e.g., wood, concrete, steel, plastic) which provide structural support.

THERMAL TREATMENT (in the RCRA program) means the treatment of hazardous waste in a device which uses elevated temperature as the primary means to change the chemical, physical, or biological character or composition of the hazardous waste. Examples of thermal treatment processes are incineration, molten salt, pyrolysis, calcination, wet air oxidation, and microwave discharge. (See also “incinerator” and “open burning”).

TOTA LLY ENCLOSED TREATMENT FACILITY (in the RCRA program) means a facility for the treatment of hazardous waste which is directly connected to an industrial production process and which is constructed and operated in a manner which prevents the release of any hazardous waste or any constituent thereof into the environment during treatment. An example is a pipe in which waste acid is neutralized.

TOXIC POLLUTANT means any pollutant listed as toxic under Section 307(a)(1) of CWA.

TRANSPORTER (in the RCRA program) means a person engaged in the off-site transportation of hazardous waste by air, rail, highway, or water.

TREATMENT (in the RCRA program) means any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume.

UNDERGROUND INJECTION means well injection.

UNDERGROUND SOURCE OF DRINKING WATER or USDW means an aquifer or its portion which is not an exempted aquifer (e.g., wood, concrete, steel, plastic) which provide structural support.

UPSET means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.
WATERS OF THE UNITED STATES means:

A. All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

B. All interstate waters, including interstate wetlands;

C. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, and natural ponds, the use, degradation, or destruction of which would or could affect interstate or foreign commerce including any such waters:
   1. Which are or could be used by interstate or foreign travelers for recreational or other purposes,
   2. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce,
   3. Which are used or could be used for industrial purposes by industries in interstate commerce;

D. All impoundments of waters otherwise defined as waters of the United States under this definition;

E. Tributaries of waters identified in paragraphs (A) – (D) above;

F. The territorial sea; and

G. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (A) – (F) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet requirement of CWA (other than cooling ponds as defined in 40 CFR Section 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as a disposal area in wetlands) nor resulted from the impoundments of waters of the United States.

WELL INJECTION or UNDERGROUND INJECTION means the subsurface emplacement of fluids through a bored, drilled, or driven well; or through a dug well, where the depth of the dug well is greater than the largest surface dimension.

WETLANDS means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.
### GENERAL INFORMATION
Consolidated Permits Program
(Read the "General Instructions" before starting.)

### SPECIFIC QUESTIONS

<table>
<thead>
<tr>
<th>Specific Questions</th>
<th>Yes</th>
<th>No</th>
<th>Form Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Does or will this facility (either existing or proposed) include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>D. Is this a proposed facility (other than those described in A or B above) which will result in a discharge to waters of the U.S.? (FORM 2D)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>F. Do you or will you inject at this facility industrial or municipal effluent below the lowest stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### NAME OF FACILITY

Poly Met Mining, Inc.

### FACILITY CONTACT

A. NAME & TITLE (last, first, & title)  
Moore, Brad, Executive VP Environmental & Governmental

B. PHONE (area code & no.)  
(651) 389-4100

### FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX  
P.O. Box 475

B. CITY OR TOWN  
Hoyt Lakes

C. STATE  
MN

D. ZIP CODE  
55750

### FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER  
6500 County Road 666

B. COUNTY NAME  
Hoyt Lakes

C. CITY OR TOWN  
Hoyt Lakes

D. STATE  
MN

E. ZIP CODE  
55750

F. COUNTY CODE (if known)  
-
CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

<table>
<thead>
<tr>
<th>A. FIRST</th>
<th>B. SECOND</th>
</tr>
</thead>
<tbody>
<tr>
<td>71021 (specify) Active Metal Mining Facilities - Copper Ores</td>
<td>71099 (specify) Miscellaneous Metal Ores, Not Elsewhere Classified</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. THIRD</th>
<th>D. FOURTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>71041 (specify) Active Metal Mining Facilities - Gold Ores</td>
<td>(specify)</td>
</tr>
</tbody>
</table>

VIII. OPERATOR INFORMATION

A. NAME
Poly Met Mining, Inc.

B. Is the name listed in Item VIII-A also the owner? ☑ YES ☐ NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box: “F” if “Other,” specify.)
F = FEDERAL
S = STATE
M = PUBLIC (other than federal or state)
P = PRIVATE
O = OTHER (specify)

D. PHONE (area code & no.)
A (218) 471-2150

E. STREET OR P.O. BOX
P.O. Box 475

F. CITY OR TOWN
Hoyt Lakes

G. STATE
MN

H. ZIP CODE
55750

I. INDIAN LAND
☐ YES ☐ NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water)

B. UIC (Underground Injection of Fluids)

C. RCRA (Hazardous Wastes)

D. PSD (Air Emissions from Proposed Sources)

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers, and other surface water bodies in the map area. See instructions for precise requirements. Refer to Large Figure 1

XII. NATURE OF BUSINESS (provide a brief description)

Open pit mining of copper-nickel-PGE ore and processing of ore into copper concentrate, nickel concentrate, mixed nickel-copper hydroxide, and/or gold and PGE precipitate.

XIII. CERTIFICATION (see instructions)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)
Brad Moore, Executive VP
Environmental & Governmental Affairs

B. SIGNATURE

C. DATE SIGNED
11/21/16

COMMENTS FOR OFFICIAL USE ONLY

C

EPA Form 3510-1 (8-90)
Disclaimer

This is an updated PDF document that allows you to type your information directly into the form, print it, and save the completed form.

Note: This form can be viewed and saved only using Adobe Acrobat Reader version 7.0 or higher, or if you have the full Adobe Professional version.

Instructions:
1. Type in your information
2. Save file (if desired)
3. Print the completed form
4. Sign and date the printed copy
5. Mail it to the directed contact.
Application Form 2D —

New Sources and New Dischargers:

Application for Permit to Discharge Process Wastewater
PAPERWORK REDUCTION ACT NOTICE: The public reporting and recordkeeping burden for this collection of information is estimated to average 32 hours as an average response for some minor facilities, to 46 hours as an average per response for some major facilities, with a weighted average for major and minor of 33.2 hours per response. This estimate includes the time needed to review instructions; develop, acquire, install, and utilize validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to respond to a collection of information; search existing data sources; complete and review the collection of information; and transmit or otherwise disclose the information. As specified in 5 CFR 1320.5(b) (2), an Agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Chief, OPPE Regulatory Information Division, U.S. Environmental Protection Agency 1200 Pennsylvania Ave., NW, Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th St., NW, Washington, DC 20503, Attention: Desk Officer for EPA. Include the OMB control number in any correspondence. Do not send the completed application form to these addresses.
Form 2D Instructions

Form 2D must be completed in conjunction with EPA form 3510-1 (Form 1).

This form must be completed by applicants who checked “yes” to Item II-D in Application Form 1. However, facilities which discharge only nonprocess wastewater that is not regulated by an effluent limitations guideline or new source performance standard may use EPA Form 3510-2E (Form 2E). Educational, medical, and commercial chemical laboratories should use this form or EPA Form 3510-2C (Form 2C). To further determine if you are a new source or a new discharger, see §122.2 and §122.29. This form should not be used for discharges of stormwater runoff.

Public Availability of Submitted Information.

You may not claim as confidential any information required by this form or Form 1, whether the information is reported on the forms or in an attachment, Section 402(j) of the CWA requires that all permit applications shall be available to the public. This information will therefore be made available to the public upon request.

You may not claim as confidential any information you submit to EPA which goes beyond that required by this form and Form 1. Confidentiality claims for effluent data must be denied. If you do not assert a claim of confidentiality at the time of submitting the information, EPA may make the information public without further notice. Claims of confidentiality will be handled in accordance with EPA’s business confidentiality regulations in 40 CFR Part 2.

Completeness

Your application will not be considered complete unless you answer every question on this form and on Form 1 (except as instructed below). If an item does not apply to you, enter “NA” (for “not applicable”) to show that you considered the question.

Followup Requirements

Although you are now required to submit estimated data on this form (Form 2D), please note that no later than two years after you begin discharging from the proposed facility, you must complete and submit Items V and VI of NPDES application Form 2C (EPA Form 3510-2C). However, you need not complete those portions of Item V requiring tests which you have already performed under the discharge monitoring requirements of your NPDES permit. In addition, the permitting authority may waive requirements of Items V-A and VI if the permittee makes the demonstrations required under 40 CFR §122.22(g)(7)(ii)(B) and 122.21(g)(9).

Definitions

All significant terms used in these instructions and in the form are defined in the glossary found in the General Instructions which accompany Form 1.

**Item I**

You may use the map you provided for Item XI of Form 1 to determine the latitude and longitude (to the nearest 15 seconds) of each of your outfalls and the name of the receiving water. You should name all waters to which discharge is made and which flow into significant receiving waters. For example, if the discharge is made to a ditch which flows into an unnamed tributary which in turn flows into a named river, you should provide the name or description (if no name is available) of the ditch, the tributary, and the river.

**Item II**

This item requires your best estimate of the date on which your facility or new outfall will begin to discharge.

**Item III-A**

List all outfalls, their source (operations contributing to the flow), and estimate an average flow from each source. Briefly describe the planned treatment for these wastewaters prior to discharge. Also describe the ultimate disposal of any solid or liquid wastes not discharged. You should describe the treatment in either a narrative form or list the proper code for the treatment unit from a list provided in Table 2D-1.

**Item III-B**

An example of an acceptable line drawing appears in Figure 2D-1 to these instructions. The line drawing should show the route taken by water in your proposed facility form intake to discharge. Show all sources of wastewater, including process and production areas, sanitary flows, cooling water, and storm water runoff. You may group similar operations into a single unit, labeled to correspond to the more detailed listing in Item III-A. The water balance should show estimates of anticipated average flows. Show all significant losses of water to production, atmosphere, and discharge. You should use your best estimates.

**Item III-C**

Fill in every applicable column in this item for each source of intermittent or seasonal discharge. Base your answers on your best estimate. A discharge is intermittent if it occurs with interruptions during the operating hours of the facility. Discharges caused by routine maintenance shutdowns, process changes, or other similar activities are not considered to be intermittent. A discharge is seasonal if it occurs only during certain parts of the year. The reported flow rate is the highest daily value and should be measured in gallons per day. Maximum total volume means the total volume of any one discharge within 24 hours and is measured in units such as gallons.

**Item IV**

“Production” in this question refers to those goods which the proposed facility will produce, not to “wastewater” production. This information is only necessary where production-based new source performance standards (NSPS) or effluent guidelines apply to your facility. Your estimated production figures should be based on a realistic projection of actual daily production level (not design capacity) for each of the first three operating years of the facility. This estimate must be a long-term-average estimate (e.g., average production on an annual basis). If production will vary depending on long-term shifts in operating schedule or capacity, the applicant may report alternative production estimates and the basis for the alternate estimates.

If known, report quantities in the units of measurement used in the applicable NSPS or effluent guideline. For example, if the applicable NSPS is expressed as “grams of pollutant discharged per kilogram of unit production;” then report maximum “Quantity Per Day” in kilograms. If you do not know whether any NPSP or effluent guideline applies to your facility, report quantities in any unit of measurement known to you. If an effluent guideline or NSPS specifies a method for estimating production, that method must be followed.

There is no need to conduct new studies to obtain these figures; only data already on hand are required. You are not required to indicate how the reported information was calculated.

**Item V-A, B, and C**

These items require you to estimate and report data on the pollutants expected to be discharged from each of your outfalls. Where there is more than one outfall, you should submit a separate Item V for each outfall. For Part C only a list is required. Sampling and analysis are not required at this time. If, however, data from such analyses are available, then those data should be reported. Each part of this item addresses a different set of pollutants or parameters and must be completed in accordance with the specific instructions for that part. The following are the general and specific instructions for Items V-A through V-C.

**Item V – General Instructions**

Each part of this item requires you to provide an estimated maximum daily and average daily value for each pollutant or parameter listed (see Table 2D-2), according to the specific instructions below. The source of the data is also required.

For Parts A through C, base your determination of whether a pollutant will be present in your discharge on your knowledge of the proposed facility’s raw materials, maintenance chemicals,
intermediate and final products, byproducts, and any analyses of your effluent or of any similar effluent. You may also provide the determination and the estimates based on available in-house or contractor’s engineering reports or any other studies performed on the proposed facility (see Item VI of the form). If you expect a pollutant to be present solely as a result of its presence in your intake water, please state this information on the form.

Please note that no later than 2 years after you begin discharging from the proposed facility, you must complete and submit Items V and VI of NPDES application Form 2C (followup data).

**Reporting Intake Data.** You are not required to report pollutants or parameters present in intake water unless you wish to demonstrate your eligibility for a “net” effluent limitation for these pollutants or parameters, that is, an effluent limitation adjusted to provide allowance for the pollutants or parameters present in your intake water. If you wish to obtain credits for pollutants or parameters present in your intake water, please insert a separate sheet, with a short statement of why you believe you are eligible (see §122.45(g)), under Item VII (Other Information). You will then be contacted by the permitting authority for further instructions.

All estimated pollutant or parameter levels must be reported as concentration and as total mass, except for discharge flow, temperature, and pH. Total mass is the total weight of pollutants or parameters discharged over a day.

Use the following abbreviations for units:

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm............</td>
<td>lbs.</td>
</tr>
<tr>
<td>mg/L...........</td>
<td>mg/L</td>
</tr>
<tr>
<td>ug/L...........</td>
<td>ug/L</td>
</tr>
<tr>
<td>kg...............</td>
<td>kg</td>
</tr>
</tbody>
</table>

**Source**

In providing the estimates, use the codes in the following table to indicate the source of such information in column 4 of Parts V – A and – B.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering study</td>
</tr>
<tr>
<td>2</td>
<td>Actual data from pilot plants</td>
</tr>
<tr>
<td>3</td>
<td>Estimates from other engineering studies</td>
</tr>
<tr>
<td>4</td>
<td>Data from other similar plants</td>
</tr>
<tr>
<td>5</td>
<td>Best professional estimates</td>
</tr>
<tr>
<td>6</td>
<td>Others</td>
</tr>
</tbody>
</table>

**Item V-A**

Estimates of data on pollutants or parameters in Group A must be reported by all applicants for all outfalls: including outfalls containing only noncontact cooling water or nonprocess wastewater. To request a waiver from reporting any of these pollutants or parameters, the applicant must submit to the permitting authority a written request specifying which pollutants or parameters should be waived and the reasons for requesting such a waiver. This request should be submitted to the permitting authority before or with the permit application. The permitting authority may waive the requirements for information about these pollutants or parameters if he or she determines that less stringent reporting requirements are adequate to support issuance of the permit. No extensive documentation will normally be needed, but the applicant should contact the permitting authority if she or he wishes to receive instructions on what his or her particular request should contain.

**Item V-B**

Estimates of data on pollutants in Group B must be reported by all applicants for all outfalls, including outfalls containing only noncontact cooling water or nonprocess wastewater. You are merely required to report estimates for those pollutants which you know or have reason to believe will be discharged or which are limited directly by an effluent limitations guideline (or NSPS) or indirectly through promulgated limitations on an indicator pollutant. The priority pollutants in Group B are divided into the following three sections:

1. Metal toxic pollutants, total cyanide, and total phenols
2. 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (TCDD) (CAS # 1764-016)
3. Organic Toxic Pollutants (Gas Chromatography/Mass Spectrometry Fractions)
   a) Volatile compounds
   b) Acid compounds
   c) Base/neutral compounds
   d) Pesticides

For pollutants listed in Sections 1 and 3, you must report estimates as instructed above:

For Section 2, you are required to report that TCDD may be discharged if you will use or manufacture one of the following compounds, or if you know or have reason to believe that TCDD is or may be present in an effluent:

- A. 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) (CAS # 93-765);
- B. 2-(2,4,5-trichlorophenoxy) propanoic acid (Silvex, 2,4, 5TP) (CAS # 93-72-1);
- C. 2-(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate (Erbon) (CAS # 136-25-4);
- D. 0-dimethyl 0-(2,4,5-trichlorophenyl) phosphorothioate (Ronnel) (CAS # 299-84-3);
- E. 2,4,5-trichlorophenol (TCP) (CAS # 95-95-4); or
- F. Hexachlorophene (HCP) (CAS # 70-30-4).

**Small Business Exemption**

If you are a “small business,” you are exempt from the reporting requirement for Item V-B (section 3). You may qualify as a “small business” if you fit one of the following definitions:

1. Your expected gross sales will total less than $100,000 per year for the next three years, or
2. In the case of coal mines, you average production will be less than 100,000 tons of coal per year.

If you are a “small business,” you may submit projected sales or production figures to qualify for this exemption. The sales or production figures you submit must be for the facility which is the source of the discharge. The data should not be limited only to production or sales for the process or processes which contribute to the discharge, unless those are the only processes at your facility. For sales data, where intracorporate transfers of goods and services are involved, the transfer price per unit should approximate market prices for those goods and services as closely as possible. If necessary, you may index your sales figures to the second quarter of 1980 to demonstrate your eligibility for a small business exemption. This may be done by using the gross national product price deflator (second quarter of 1980 = 100), an index available in “National Income and Product Accounts of the United States” (Department of Commerce, Bureau of Economic Analysis).

The small business exemption applies to the GC/MS fractions (Section 3) of Item V-B only. Even if you are eligible for a small business exemption, you are still required to provide information on metals, cyanide, total phenols, and dioxin in Item V-B, as well as all of Items V-A and C.

**Item V-C**

List any pollutants in Table 2D-3 that you believe to be present in any outfalls and briefly explain why you believe they will be present. No estimate of the pollutant’s quantity is required, unless you already have quantitative data.

**Note:** The discharge of pollutants listed in Table 2D-4 may subject you to the additional requirements of section 311 of the CWA (Oil and Hazardous Substance Liability). These requirements are not administered through the NPDES program. However, if you wish an exemption under 40 CFR 117.12(a)(2) from these requirements, attach additional sheets of paper to this form providing the following information:
A. The substance and the amount of each substance which may be discharged;

B. The origin and source of the discharge of the substance;

C. The treatment which is to be provided for the discharge by:
   1. An onsite treatment system separate from any treatment system which will treat your normal discharge;
   2. A treatment system designed to treat your normal discharge and which is additionally capable of treating the amount of the substance identified under paragraph 1 above; or
   3. Any combination of the above.

An exemption from the section 311 reporting requirements pursuant to 40 CFR Part 117 for pollutants on Table 2D does not exempt you from the section 402 reporting requirements pursuant to 40 CFR Part 122 (Item V-C) for pollutants listed on Table 2D-3.

For further information on exclusions from Section 311, see 40 CFR Section 117.12(a)(2) and (c), or contact your EPA Regional office (Table 1 in Form 1 instructions).

**Item VI-A**

If an engineering study was conducted, check the box labeled “report available.” If no study was done, check the box labeled “no report.”

**Item VI-B**

Report the name and location of any existing plant(s) which (to the best of your knowledge) resembles your planned operation with respect to items produced, production process, wastewater constituents, or wastewater treatment. No studies need be conducted to respond to this item. Only data which are already available need be submitted.

This information will be used to inform the permit writer of appropriate treatment methods and their associated permit conditions and limits.

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**Item VII**

A space is provided for additional information which you believe would be useful in setting permit limits, such as additional sampling. Any response is optional.

**Item VIII**

The Clean Water Act provides for severe penalties for submitting false information on this application form.

Section 309(c)(2) of the Clean Water Act provides that “Any person who knowingly makes any false statement, representation, or certification in any application,… shall upon conviction, be punished by a fine of no more than $10,000 or by imprisonment for not more than six months, or both.”

**40 CFR Part 122.22 Requires the Certification to be Signed as Follows:**

A. For a corporation: by a responsible corporate officer.

A responsible corporate officer means (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25,000,000 (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

B. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

C. For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of the principal geographic unit of the agency (e.g., Regional Administrators of EPA).
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<th>PHYSICAL TREATMENT PROCESSES</th>
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<td>Dialysis</td>
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<td>Reverse Osmosis (Hyperfiltration)</td>
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<td><em><em>GC/MS FRACTION</em> — VOLATILE COMPOUNDS</em>*</td>
<td><strong>GS/MS FRACTION — ACID COMPOUNDS</strong></td>
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<td>1,2-Dichloroethane</td>
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### GC/MS Fraction — Base/Neutral Compounds

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<td>Anthracene</td>
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<td>Benzo (a) Anthracene</td>
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<tr>
<td>3,5-Benzofluoranthenic</td>
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<td>Benzo (k) Fluoranthene</td>
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<tr>
<td>Bis (2-Chloroethyl) Ether Bis</td>
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<td>Bis (2-Ethylnhexyl) Phthalate</td>
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<td>Butyl Benzyl Phthalate</td>
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<td>4-Chlorophenyl Phenyl Ether</td>
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<td>Dibenzo (a, h) Anthracene</td>
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<td>1,3-Dichlorobenzene</td>
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<td>3,3-Dichlorobenzidine</td>
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<td>Dimethyl Phthalate</td>
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<td>2,4-Dinitrotoluene</td>
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<td>Di-N-Octyl Phthalate</td>
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<td>Hexachlorobenzene</td>
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<td>Hexachlorocyclopentadiene</td>
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<td>Indeno (1,2,3-cd) Pyrene</td>
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<td>Naphthalene</td>
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<td>N-Nitrosodimethylamine</td>
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### GC/MS Fraction — Pesticides

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<td>Endrin Aldehyde</td>
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<td>Toxaphene</td>
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*Fractions defined in 40 CFR Part 136
# TOXIC POLLUTANTS AND HAZARDOUS SUBSTANCES

REQUIRED TO BE IDENTIFIED BY APPLICANTS IF EXPECTED TO BE PRESENT

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<th>HAZARDOUS SUBSTANCES</th>
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**Table 2D-3**

EPA Form 3510-2D (Rev. 8-90)
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New Sources and New Dischargers
Application for Permit to Discharge Process Wastewater

I. Outfall Location
For each outfall, list the latitude and longitude of its location to the nearest 15 seconds and the name of the receiving water.

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<th>Outfall Number (list)</th>
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<th>Longitude</th>
<th>Receiving Water (name)</th>
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<td>Deg.</td>
<td>Min.</td>
<td>Sec.</td>
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<td>Refer to attached table</td>
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II. Discharge Date (When do you expect to begin discharging?)
Target discharge date: 07/2019; discharge expected 24 months after start of construction. Discharge to coincide with the start of Project operations.

III. Flows, Sources of Pollution, and Treatment Technologies
A. For each outfall, provide a description of: (1) All operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and storm water runoff; (2) The average flow contributed by each operation; and (3) The treatment received by the wastewater. Continue on additional sheets if necessary.

<table>
<thead>
<tr>
<th>Outfall Number</th>
<th>1. Operations Contributing Flow (List)</th>
<th>2. Average Flow (Include Units)</th>
<th>3. Treatment (Description or List codes from Table 2D-1)</th>
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<tbody>
<tr>
<td></td>
<td>Refer to attached table</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item III-A. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined (e.g., for certain mining activities), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

C. Except for storm runoff, leaks, or spills, will any of the discharges described in Items III-A be intermittent or seasonal?

☐ YES (complete the following table)

☐ NO (go to Section IV)

<table>
<thead>
<tr>
<th>Outfall Number</th>
<th>Frequency</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Days Per Week (specify average)</td>
<td>a. Maximum Daily Flow Rate (in mgd)</td>
</tr>
<tr>
<td></td>
<td>b. Months Per Year (specify average)</td>
<td>b. Maximum Total Volume (specify with units)</td>
</tr>
<tr>
<td></td>
<td>c. Duration (in days)</td>
<td>c. Duration (in days)</td>
</tr>
</tbody>
</table>

Line drawings with average flows through the facility for Mine Years 1, 10, and 15 are provided as Large Figures 2, 3, and 4 of this volume, respectively. Mine Year 1 (MY 1) and Mine Year 10 (MY 10) represent the waste water treatment system (WWTS) flow configuration from the beginning of operations until mine pit flooding begins, showing the minimal (MY1) and maximal (MY10) flows during this period. While outside this permit term, Mine Year 15 is provided to represent the waste water treatment system flow configuration when the treated mine water is used to flood and flush the East Pit.

IV. Production

If there is an applicable production-based effluent guideline or NSPS, for each outfall list the estimated level of production (projection of actual production level, not design), expressed in the terms and units used in the applicable effluent guideline or NSPS, for each of the first 3 years of operation. If production is likely to vary, you may also submit alternative estimates (attach a separate sheet).

<table>
<thead>
<tr>
<th>Year</th>
<th>A. Quantity Per Day</th>
<th>B. Units Of Measure</th>
<th>c. Operation, Product, Material, etc. (specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
V. Effluent Characteristics

A and B: These items require you to report estimated amounts (both concentration and mass) of the pollutants to be discharged from each of your outfalls. Each part of this item addresses a different set of pollutants and should be completed in accordance with the specific instructions for that part. Data for each outfall should be on a separate page. Attach additional sheets of paper if necessary.

**General Instructions** *(See table 2D-2 for Pollutants)*

Each part of this item requests you to provide an estimated daily maximum and average for certain pollutants and the source of information. Data for all pollutants in Group A, for all outfalls, must be submitted unless waived by the permitting authority. For all outfalls, data for pollutants in Group B should be reported only for pollutants which you believe will be present or are limited directly by an effluent limitations guideline or NSPS or indirectly through limitations on an indicator pollutant.

<table>
<thead>
<tr>
<th>1. Pollutant</th>
<th>2. Maximum Daily Value <em>(include units)</em></th>
<th>3. Average Daily Value <em>(include units)</em></th>
<th>4. Source <em>(see instructions)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Refer to attached tables
C. Use the space below to list any of the pollutants listed in Table 2D-3 of the instructions which you know or have reason to believe will be discharged from any outfall. For every pollutant you list, briefly describe the reasons you believe it will be present.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Reason for Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanadium</td>
<td>observed in pilot feed water</td>
</tr>
<tr>
<td>Strontium</td>
<td>observed in pilot feed water</td>
</tr>
</tbody>
</table>

VI. Engineering Report on Wastewater Treatment

A. If there is any technical evaluation concerning your wastewater treatment, including engineering reports or pilot plant studies, check the appropriate box below.

- [ ] Report Available
- [ ] No Report

B. Provide the name and location of any existing plant(s) which, to the best of your knowledge resembles this production facility with respect to production processes, wastewater constituents, or wastewater treatments.

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to attached table</td>
<td></td>
</tr>
</tbody>
</table>
VII. OTHER INFORMATION (OPTIONAL)

Use the space below to expand upon any of the above questions or to bring to the attention of the reviewer any other information you feel should be considered in establishing permit limitations for the proposed facility. Attach additional sheets if necessary.

VIII. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name and Official Title (type or print)
Brad Moore, Executive VP Environmental and Governmental Affairs

B. Phone No.
(651) 389-4100

C. Signature

D. Date Signed
7/11/16
NorthMet NPDES/SDS Permit Application - Volume III: Waste Water Treatment System

Attachment to EPA NPDES Form 2D

Item I. Outfall Location
For each outfall, list the latitude and longitude of its location to the nearest 15 seconds and the name of the receiving water.

<table>
<thead>
<tr>
<th>Outfall Number</th>
<th>Latitude Deg.</th>
<th>Latitude Min.</th>
<th>Latitude Sec.</th>
<th>Longitude Deg.</th>
<th>Longitude Min.</th>
<th>Longitude Sec.</th>
<th>Receiving Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD002</td>
<td>47</td>
<td>37</td>
<td>0</td>
<td>-92</td>
<td>9</td>
<td>30</td>
<td>Wetlands in the headwater area of Unnamed Creek</td>
</tr>
<tr>
<td>SD003</td>
<td>47</td>
<td>37</td>
<td>30</td>
<td>-92</td>
<td>9</td>
<td>30</td>
<td>Wetlands in the headwater area of Unnamed Creek</td>
</tr>
<tr>
<td>SD004</td>
<td>47</td>
<td>37</td>
<td>60</td>
<td>-92</td>
<td>8</td>
<td>60</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD005</td>
<td>47</td>
<td>37</td>
<td>60</td>
<td>-92</td>
<td>8</td>
<td>30</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD006</td>
<td>47</td>
<td>38</td>
<td>0</td>
<td>-92</td>
<td>8</td>
<td>15</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD007</td>
<td>47</td>
<td>38</td>
<td>0</td>
<td>-92</td>
<td>7</td>
<td>45</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD008</td>
<td>47</td>
<td>38</td>
<td>0</td>
<td>-92</td>
<td>7</td>
<td>30</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD009</td>
<td>47</td>
<td>38</td>
<td>0</td>
<td>-92</td>
<td>7</td>
<td>0</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD010</td>
<td>47</td>
<td>38</td>
<td>0</td>
<td>-92</td>
<td>6</td>
<td>45</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD011</td>
<td>47</td>
<td>35</td>
<td>45</td>
<td>-92</td>
<td>7</td>
<td>30</td>
<td>Headwater segment of Second Creek</td>
</tr>
</tbody>
</table>
NorthMet NPDES/SDS Permit Application - Volume III: Waste Water Treatment System

Attachment to EPA NPDES Form 2D

Item III. Flows, Sources of Pollution, and Treatment Technologies

A. For each outfall, provide a description of: (1) All operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and storm water runoff; (2) The average flow contributed by each operation; and (3) The treatment received by the wastewater. Continue on additional sheets if necessary.

<table>
<thead>
<tr>
<th>Outfall Number</th>
<th>1. Operations Contributing Flow (List)</th>
<th>2. Average Flow</th>
<th>3. Treatment (Description or List codes from Table 2D-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD002</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD003</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD004</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD005</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD006</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD007</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD008</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD009</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
<tr>
<td>SD010</td>
<td>WWTS Discharge (1)</td>
<td>185 gpm</td>
<td>280 gpm</td>
</tr>
<tr>
<td>SD011</td>
<td>WWTS Discharge (1)</td>
<td>169 gpm</td>
<td>270 gpm</td>
</tr>
</tbody>
</table>

(1) Refer to Large Figures 2, 3, and 4 of this volume for the operations that contribute waste water to the effluent.
(2) Mine Year 1 will be the first year of discharge from the WWTS and, for the first 15 years of the Project, is expected to be the year of minimal discharge and minimal loading from the WWTS.
(3) Mine Year 10 is expected to be the year of maximal discharge and maximal loading from the WWTS.
Item V. Effluent Characteristics

Each part of this item requests you to provide an estimated daily maximum and average for certain pollutants and the source of information for all data in parts A through B. For all outfalls, data for pollutants in Group B should be reported only for pollutants which you believe will be present or are limited directly by an effluent limitations guideline or NPS or indirectly by limitations on an indicator pollutant.

### Outfalls 20002 and 20003

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Concentration Mass</th>
<th>Average Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Silver, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Selenium, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Copper, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Chromium, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Beryllium, Total µg/L g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Magnesium, Total mg/L g/day</td>
<td>2 - Based on hardness treatment target(7)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Sulfate mg/L(10) g/day</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - WWTS design model discharge(8)</td>
<td>2 - WWTS design model discharge(8)</td>
</tr>
<tr>
<td>Flow gpm L/day</td>
<td>1 - Preliminary WWTS design(5)</td>
<td>2 - GoldSim model WWTS effluent(6)</td>
<td>2 - GoldSim model WWTS effluent(6)</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>&lt; 15 mg/L &lt; 164,712 g/day</td>
<td>&lt; 22,056 g/day</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Temperature (Winter) oC</td>
<td>4 - Heat transfer calculation</td>
<td>4 - Heat transfer calculation</td>
<td>4 - Heat transfer calculation</td>
</tr>
<tr>
<td>Current (Winter) m/sec</td>
<td>3.2 10 9.3</td>
<td>4 - Heat transfer calculation</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>0.3 13.4</td>
<td>5 - Heat transfer calculation</td>
<td>5 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>pH SU</td>
<td>8.5 SU 8.5 SU 8.5 SU 8.5 SU</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - Based on internal performance operating target(8)</td>
</tr>
<tr>
<td>Temperature (Summer) oC</td>
<td>2.5 8.5</td>
<td>4 - Heat transfer calculation</td>
<td>4 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Flow gpm L/day</td>
<td>3.4 5 12</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>4 10</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>pH SU</td>
<td>8.3 8.3 8.3 8.3</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - Based on internal performance operating target(8)</td>
</tr>
<tr>
<td>Temperature (Summer) oC</td>
<td>5.3 10</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Flow gpm L/day</td>
<td>12.5 12.5 12.5 12.5</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - Based on internal performance operating target(8)</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>&lt; 15 mg/L &lt; 5309 g/day</td>
<td>&lt; 0.5 mg/L &lt; 461 g/day</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Temperature (Winter) oC</td>
<td>0.3 13.4</td>
<td>5 - Heat transfer calculation</td>
<td>5 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Flow gpm L/day</td>
<td>3.4 5 12</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Temperature (Summer) oC</td>
<td>5.3 10</td>
<td>2 - GoldSim model WWTS influent(9)</td>
<td>2 - GoldSim model WWTS influent(9)</td>
</tr>
<tr>
<td>Flow gpm L/day</td>
<td>12.5 12.5 12.5 12.5</td>
<td>2 - Based on treatment target(7)</td>
<td>2 - Based on internal performance operating target(8)</td>
</tr>
</tbody>
</table>

(1) Estimated pollutant concentration and mass to be discharged from each of the listed outfalls is identical. Data presented in this table is per outfall.
(2) Mine Year 1 will be the first year of discharge from the WWTs and, for the first 15 years of the Project, is expected to be the year of minimal discharge and minimal loading from the WWTs.
(3) Mine Year 20 is expected to be the year of maximal discharge and maximal loading from the WWTs.
(4) Refer to "Reverse Osmosis and Softening (Manual of Water Supply Practices MWS/ American Water Works Association 2007)."
(5) Refer to Section 3.2 of Water Waste Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017).
(6) Refer to Table 6.8, Attachment L, and Large Table 28 of NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11) (Poly Met Mining Inc., March 2016).
(7) Preliminary plans to implement an internal performance operating target of 0 mg/L and an internal performance operating limit of 10 mg/L, as described in Appendix D of Volume 1.
(8) Refer to Section 6.8, Attachment L, and Large Table 28 of NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11) (Poly Met Mining Inc., March 2016).
(9) GoldSim model effluent limits were less than or equal to treatment targets. Refer to Large Table 28 of NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11) (Poly Met Mining Inc., March 2016).
GoldSim model effluent limits were less than or equal to treatment targets. Refer to Large Table 28 of NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11) (Poly Met Mining Inc., March 2015).

WWTS design model discharge results (Attachment H of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017)) were adjusted to estimate pH after degassification by setting CO

Refer to Table 2-1 of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017).

Refer to Large Table 8 and Section 6.6 of NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11) (Poly Met Mining Inc., March 2015).

Refer to Section 3.3.2 of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017).

PolyMet plans to implement an internal performance operating target of 9 mg/L and an internal performance operating limit of 10 mg/L, as described in Appendix D of Volume I.

Mine Year 1 will be the first year of discharge from the WWTS and, for the first 15 years of the Project, is expected to be the year of minimal discharge and minimal loading from the WWTS.

Refer to Appendix D of Volume I.

Refer to Attachment H of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017))

Item V. Effluent Characteristics

A and B: These items require you to report estimated amounts (both concentration and mass) for all pollutants and the source of information. Data for all pollutants in Group A, for all outfalls, must be submitted unless waived by the permitting authority. For all outfalls, data for pollutants in Group B should be reported only for pollutants which you believe will be present or are limited directly by an effluent limitations guideline or NSPS or indirectly through limitations on an indicator pollutant.

### Outfalls S004, S005, S006, S007, S008, S009, and S010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Oxygen Demand</td>
<td>non-det</td>
<td>non-det</td>
<td>non-det</td>
</tr>
<tr>
<td>Chemical Oxygen Demand</td>
<td>non-det</td>
<td>non-det</td>
<td>non-det</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>non-det</td>
<td>non-det</td>
<td>non-det</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>15 mg/L</td>
<td>66</td>
<td>15 mg/L</td>
</tr>
<tr>
<td>Ammonia (as N)</td>
<td>0.5 mg/L</td>
<td>0.5 mg/L</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td>Temperature (Winter)</td>
<td>0.3 °C</td>
<td>0.3 °C</td>
<td>0.3 °C</td>
</tr>
<tr>
<td>Temperature (Summer)</td>
<td>14.8 °C</td>
<td>14.8 °C</td>
<td>14.8 °C</td>
</tr>
<tr>
<td>pH</td>
<td>8.5 Su</td>
<td>8.5 Su</td>
<td>8.5 Su</td>
</tr>
<tr>
<td>Sulfate</td>
<td>10 mg/L</td>
<td>10 mg/L</td>
<td>10 mg/L</td>
</tr>
<tr>
<td><strong>4. Source</strong></td>
<td><strong>A. Maximum Daily Value</strong></td>
<td><strong>B. Average Daily Value</strong></td>
<td><strong>C. Source</strong></td>
</tr>
<tr>
<td></td>
<td><strong>D. Maximum Daily Value</strong></td>
<td><strong>E. Average Daily Value</strong></td>
<td><strong>F. Source</strong></td>
</tr>
</tbody>
</table>

*General Instructions (See table 2D-2 for Pollutants)*

Attach additional sheets of paper if necessary.

*Item V. Effluent Characteristics*
## Outfall 10011

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Mine Year 1</th>
<th>Mine Year 10</th>
<th>Source</th>
<th>For Maximum Daily Value</th>
<th>For Average Daily Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mine Year 28</td>
<td>Mine Year 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration</td>
<td>Mass</td>
<td>Concentration</td>
<td>Mass</td>
<td>Concentration</td>
<td>Mass</td>
</tr>
<tr>
<td><strong>Biochemical Oxygen Demand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
</tr>
<tr>
<td><strong>Chemical Oxygen Demand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
</tr>
<tr>
<td><strong>Total Organic Carbon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
<td>non-detect</td>
</tr>
<tr>
<td><strong>Total Suspended Solids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 15 mg/L</td>
<td>&lt; 17.76 g/day</td>
<td>&lt; 15 mg/L</td>
<td>&lt; 33.85 g/day</td>
<td>&lt; 15 mg/L</td>
<td>&lt; 13.17 g/day</td>
</tr>
<tr>
<td><strong>Ammonia (as N)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 0.5 mg/L</td>
<td>&lt; 590 g/day</td>
<td>&lt; 0.5 mg/L</td>
<td>&lt; 1127 g/day</td>
<td>&lt; 0.5 mg/L</td>
<td>&lt; 504 g/day</td>
</tr>
</tbody>
</table>

### General Instructions (See Table 2D-2 for Pollutants)

- **Mine Year 1** will be the first year of discharge from the WWTP and, for the first 15 years of the Project, is expected to be the year of minimal discharge and minimal loading from the WWTS.
- **Mine Year 10** is expected to be the year of maximal discharge and maximal loading from the WWTS.
- Refer to Table 3.2.2 of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (Barr Engineering, October 2017).
- Refer to Section 3.3.2 of Waste Water Treatment Systems: Design and Operation Report - NorthMet Project v2 (NorthMet Project v2 Barr Engineering, October 2017) were adjusted to estimate pH after desalination by setting CO₂ at atmospheric equilibrium.
## NorthMet Waste Water Treatment Process Unit

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Membrane</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consol Buchanan Mine</td>
<td>Virginia</td>
<td>Mine Water</td>
</tr>
<tr>
<td>Queensland Gas</td>
<td>Australia</td>
<td>Mine Water</td>
</tr>
<tr>
<td>Eagle Mine</td>
<td>Michigan</td>
<td>Clarified/Soft water</td>
</tr>
<tr>
<td><strong>Secondary Membrane</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eagle Mine</td>
<td>Michigan</td>
<td>First pass permeate</td>
</tr>
<tr>
<td>Calpine</td>
<td>California</td>
<td>High Efficiency Reverse Osmosis Concentrate</td>
</tr>
<tr>
<td>Niagara</td>
<td>California</td>
<td>Reverse Osmosis Concentrate</td>
</tr>
<tr>
<td>Humboldt Mill, Eagle Mine LLC</td>
<td>Michigan</td>
<td>Tailings Pond water</td>
</tr>
<tr>
<td>Hemlo Gold Mines</td>
<td>Marathon, Ontario</td>
<td>Mine Water</td>
</tr>
<tr>
<td>Teck Corporation</td>
<td>Marathon, Ontario</td>
<td>Mine Water</td>
</tr>
<tr>
<td>Inco Limited</td>
<td>Port Colborne, Ontario</td>
<td>Mine Water</td>
</tr>
<tr>
<td>HBM&amp;S Co. Limited</td>
<td>Trout Mine, Manitoba</td>
<td>Mine Water</td>
</tr>
</tbody>
</table>

(1) Chemical precipitation is only used in the WWTS.
Industrial Surface Water Discharge of Process Wastewater Application

NPDES/SDS Permit Program

Doc Type: Permit Application

The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This application applies to industrial facilities that discharge process wastewater to a surface water of the state. Any other discharge types will require a different permit application.

Complete the application by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

- Review the application to ensure all requested items are submitted with this application.
- Please make a copy for your records.
- Refer to the Transmittal Form for mailing instructions.

Permittee name: Poly Met Mining, Inc.  
Permit number: MN TBD

Facility information

1. Waste Water Treatment System (WWTS): Management and treatment of mine water and tailings basin seepage
   Facility-Wide: Open pit mining of copper-nickel-PGE ore and processing of ore into copper concentrate, nickel concentrate, mixed nickel-copper hydroxide, and/or gold and PGE precipitate

2. Waste Water Treatment System: None; no products produced from the WWTS
   Facility-Wide (initial): Copper concentrate and nickel concentrate
   Facility-Wide (after commission of HRF): Copper concentrate, mixed nickel-copper hydroxide, and gold and PGE precipitate

3. Amount of product produced per Unit Time (such as tons/year, kilograms/day)*:
   Waste Water Treatment System: None
   Facility-Wide (initial): 94,000 tons/year copper concentrate and 123,000 tons/year nickel concentrate
   Facility-Wide (after commission of HRF): 113,000 tons/year copper concentrate, 18,000 tons/year mixed nickel-copper hydroxide, and 500 tons/year of gold and PGE precipitate

4. Waste Water Treatment System: None; no raw materials consumed at the WWTS. Refer to the Chemical Additives Attachment (wq-wwprm7-48) for information about chemical additives used in the treatment processes.
   Raw material(s) consumed: Facility-Wide: Copper-Nickel-PGE ore

5. Amount of product consumed per Unit Time (such as tons/year, kilograms/day)*:
   Waste Water Treatment System: None
   Facility-Wide: 28,000 tons/day
   Facility-Wide: 32,000 tons/day (after ramp-up)

6. Standard Industrial Classification (SIC) Code Number (list all that apply):

*Provide both daily maximum and long-term monthly average expected during the five-year permit term. If an effluent limitation guideline applies and is expressed in terms of production (or other measure of operation) please report the expected actual production rates in the units used in the applicable effluent guideline. Consumptive use and/or production rates should be in sufficient detail so as to aid in the development of technology-based effluent limitations. For new discharges, actual production shall be estimated using projected production.
7. If established, please indicate what you believe to be the applicable federal effluent limitation guideline(s) for your waste stream(s):

   40 CFR Part 440 (Ore Mining and Dressing) - Subpart G (Nickel Ore), Subpart J (Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores), and Subpart K (Platinum Ores)

8. What date did the facility initiate operation? TBD (new facility)

Water supply

9. What is the source of the intake water supply for the facility?

   - Municipal water supply, city name:
     - Mine water treatment train influent will be mine water from pit dewatering, runoff from haul roads and the Rail Transfer Hopper, and stockpile drainage.
     - Tailings basin seepage treatment train influent will be seepage collected by the FTB seepage capture systems.

   - Ground water, intake location:

   - Surface water, name:

10. If this is a surface or ground water intake, please provide the Minnesota Department of Natural Resources (DNR) Water Appropriation Permit Number:

    - Mine water – East Pit dewatering: DNR Water Appropriation (WA) Permit #2016-1363
    - Mine water – Central Pit dewatering: DNR WA Permit #2016-1364
    - Mine water – West Pit dewatering: DNR WA Permit #2016-1365
    - Mine water – Mine Site infrastructure: DNR WA Permit #2016-1367
    - Plant Site infrastructure: DNR WA Permit #2016-1369

11. Is the intake water supply chlorinated or otherwise disinfected? ☐ Yes ☑ No

12. Is the intake water supply treated with a scale and/or corrosion inhibitor? ☑ Yes ☐ No

Wastewater treatment

13. How does the facility dispose of sewage (sanitary wastewater)?

    Sanitary wastewater is treated by the Sewage Treatment System on-site. Refer to Volume IV for a description of the Sewage Treatment System.

14. Does the facility generate process wastewater? ☑ Yes ☐ No

    If yes, the process wastewater from the facility is disposed of to: (check all that apply)

    ☐ Municipal storm sewer ☐ Land
    ☑ Surface water: The headwater segment of Second Creek, wetlands in the headwater area of Trimble Creek, wetlands in the headwater area of Unnamed Creek
    ☐ Sanitary sewer
    ☐ Stormwater retention basin or pond ☐ Other (specify):
15. Provide a complete description of the existing or proposed wastewater treatment system. For existing facilities, indicate what changes, if any, have occurred since the last permit was issued.
Refer to Section 2.0 of this volume for details regarding the tailings basin seepage treatment train.
Refer to Section 3.0 of this volume for details regarding the mine water treatment trains.

16. Completely describe the type, amount, and fate of all residual solids, sludge, silage, and by-products generated from facility operations and/or wastewater treatment.

Production of dewatered sludge from the mine water chemical precipitation train is projected to be about 70 tons/day in Mine Year 1 and 200 tons/day in Mine Year 10 at a solids concentration of 50%. Dewatered sludge includes metal hydroxides produced in the HDS process and precipitated gypsum and calcite minerals. For the first years of operation, sludge from the mine water treatment trains will be disposed of off-site at the St. Louis County landfill. Sludge will be disposed of on-site at the Hydrometallurgical Residue Facility when it begins operations. Sludge filtrate will be routed to the head of the chemical precipitation train.

At the tailings basin seepage treatment train, by-products will include Clean-in-Place (CIP) Membrane Waste from the primary membranes (474,000 gal/year in Mine Year 7 and 916,000 gal/year in Mine Year 10; sent to the FTB), CIP Membrane Waste from the secondary membranes (24,000 gal/day in Mine Year 7 and 44,000 gal/day in Mine Year 10; sent to the FTB), and Greensand Filter Backwash (144,000 gal/day in Mine Year 7 and 281,000 gal/day in Mine Year 10, sent to the FTB).

At the mine water treatment trains, by-products will include CIP Membrane Waste from the primary membranes (94,000 gal/year in Mine Year 1, 212,000 gal/year in Mine Year 5, and 294,000 gal/year in Mine Year 10; sent to the FTB), CIP Membrane Waste from the secondary membranes (12,000 gal/day in Mine Year 1, 26,000 gal/day in Mine Year 5, and 35,000 gal/day in Mine Year 10; sent to the FTB), and Greensand Filter Backwash (18,000 gal/day in Mine Year 1, 40,000 gal/day in Mine Year 5, and 56,000 gal/day in Mine Year 10; sent through the chemical precipitation train to fate as high-density sludge (HDS)).

17. Identify the discharge rate in million gallons per day (MGD) and other information for each wastewater outfall discharge point:

<table>
<thead>
<tr>
<th>Station ID/Outfall number</th>
<th>Type of wastewater/waste streams</th>
<th>Discharge flow rate, average (MGD)</th>
<th>Discharge flow rate, maximum (MGD)</th>
<th>Discharge frequency</th>
<th>Route to receiving waters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to attached table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. Attach a topographical map of the route of discharge to the receiving waters. If this is a discharge to a storm sewer, you must show the route of the storm sewer to a receiving water body. A map showing only the discharge to a storm sewer is unacceptable. The map must show how and where the facility’s waste stream enters a receiving water body.

**Groundwater monitoring**

Refer to Large Figure 5 of this volume.

19. Are there groundwater monitoring wells or lysimeters at your facility? ☒ Yes ☐ No

If yes, describe where they were installed and the reason they were installed:

Refer to Large Table 3 and Large Figure 2 of Volume V for locations and information related to existing wells within the vicinity of the WWTS at the Plant Site.

Refer to Large Table 5 and Large Figure 3 of Volume II for locations and information related to existing wells within the vicinity of the Equalization Basin Area at the Mine Site.
Chemical additives

20. List below all chemical additives that are used or proposed to be used at the facility. This includes the process reagents, flocculants, descalants, corrosion inhibitors, biocides, wastewater treatment chemical additives, chlorine or other disinfectants, detergents, cleaning products, freeze conditioning agents, etc. MPCA approval is required for any additives that are new, increasing in usage, or not previously approved. Go to the MPCA chemical additive webpage at: http://www.pca.state.mn.us/a6krka9 to find the documents necessary to complete the approval process. Your additives will not be approved for use until you complete this process.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Purpose</th>
<th>Location in process of chemical addition</th>
<th>Frequency of addition</th>
<th>Type of application (slug dosing or continuous feed)</th>
<th>Average rate of use (weight or volume per day)</th>
<th>Maximum rate of use (weight or volume per day)</th>
<th>Previously approved? Yes or no</th>
<th>Date of approval (mm/dd/yyyy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes or No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>At the direction of MPCA, the chemical additives approval process for this project would be completed via the attached Industrial Chemical Additives Attachment (wq-wwprm7-48).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An Additional Chemical Additives attachment is available on the MPCA website at http://www.pca.state.mn.us/water/permits/index.html if more space is needed.

21. Do you use chemical dust suppressants at your facility? ☐ Yes ☒ No

If yes, fill out table below:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Location of use</th>
<th>Frequency of use</th>
<th>Average rate of use (weight or volume per day)</th>
<th>Maximum rate of use (weight or volume per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attach the Material Safety Data Sheets, complete product labels and any other information on chemical composition, aquatic toxicity, human health, and environmental fate for each chemical dust suppressant. Chemical dust suppressants are approved separately from the process required in question 20.

Water quality sample results

22. Attach a list of all pollutants known or reasonably believed to be present at each facility discharge point and provide sample results for those pollutants.

Pollutants may include, but are not limited to, total suspended solids, biochemical oxygen demand, pH, fecal coliform, temperature (heat), nutrients (phosphorus, ammonia, nitrate, nitrite), metals, salts, cyanide, residual chlorine, fluoride, oil and grease, polychlorinated biphenyls, phenols, polynuclear aromatic hydrocarbons, volatile organic compounds, pesticides and/or radioactivity. Clearly indicate the date, location where sample was taken, types of wastewater sampled, and method(s) of sampling (e.g. grab, composite) for each sample.

At a minimum, sample results must be provided for total suspended solids (TSS), biochemical oxygen demand (BOD), fecal coliform (if believed present or sanitary wastes will be discharged), pH, and total phosphorus, irrespective of what might be required by an existing permit.

If this is an application for reissuance of an existing permit, review your existing NPDES/SDS permit to see if it has special testing requirements as part of the application for reissuance process.

23. Certified laboratory analyzing samples: TBD

Minnesota Department of Health Certification Number: TBD

Refer to pages 16-17 of EPA Form 2D included with this volume.
24. Is the facility covered by an MPCA stormwater NPDES permit? □ Yes ☒ No

If yes, indicate the permit number (if stormwater discharges are authorized under the stormwater general permit give unique identifying number rather than general permit number): TBD. Separate applications will be submitted for coverage under the Minnesota NPDES/SDS Construction Stormwater General Permit and Minnesota NPDES/SDS Industrial Stormwater General Permit.

25. Does stormwater contact any raw or processed materials, finished products, industrial waste, byproducts, or any other type of materials at the facility? □ Yes ☒ No

If yes, describe these materials: (stormwater does not contact significant materials at the WWTS Building Area or the Equalization Basin Area)

26. Is any vehicle maintenance, transportation equipment cleaning, or airport deicing conducted at the facility? □ Yes ☒ No

27. Indicate where stormwater from the facility discharges to:

Refer to Section 2.3 of Volume IV for description of stormwater discharge at the Plant Site (where the WWTS Building is located). Refer to Section 2.4 of Volume II for a description of stormwater discharge at the Mine Site (where the Equalization Basin Area is located).

28. Summarize any treatment or best management practices that are used to regulate stormwater discharges at the facility:

For information regarding management of stormwater at the Plant Site (where the WWTS Building is located), refer to Section 2.3 of Volume IV.

For information regarding management of stormwater at the Mine Site (where the Equalization Basin Area is located), refer to Section 2.4 of Volume II.

Attachments

☒ Pond Attachment: If your facility has a pond treatment component (i.e., primary, secondary, aerated, polishing, cooling, etc.), complete the Pond Attachment.
## NorthMet NPDES/SDS Permit Application - Volume III: Waste Water Treatment System

### Attachment to Industrial Surface Water Discharge of Process Wastewater Application

17. Identify the discharge rate in million gallons per day (MGD) and other information for each wastewater outfall discharge point:

<table>
<thead>
<tr>
<th>Station ID/Outfall number</th>
<th>Type of wastewater/waste streams</th>
<th>Discharge flow rate, average (MGD) Mine Year 1&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Discharge flow rate, maximum (MGD) Mine Year 1&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Discharge flow rate, maximum (MGD) Mine Year 10&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>Discharge flow rate, maximum (MGD) Mine Year 10&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>Discharge frequency</th>
<th>Route to receiving waters</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD002</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Unnamed Creek</td>
</tr>
<tr>
<td>SD003</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Unnamed Creek</td>
</tr>
<tr>
<td>SD004</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD005</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD006</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD007</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD008</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD009</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD010</td>
<td>WWTS Discharge</td>
<td>0.24</td>
<td>0.39</td>
<td>0.29</td>
<td>0.57</td>
<td>Continuous</td>
<td>Wetlands in the headwater area of Trimble Creek</td>
</tr>
<tr>
<td>SD011</td>
<td>WWTS Discharge</td>
<td>0.27</td>
<td>0.42</td>
<td>0.31</td>
<td>0.62</td>
<td>Continuous</td>
<td>Headwater segment of Second Creek</td>
</tr>
</tbody>
</table>

<sup>(1)</sup> Mine Year 1 will be the first year of discharge from the WWTS and, for the first 15 years of the Project, is expected to be the year of minimal discharge and minimal loading from the WWTS.

<sup>(2)</sup> Mine Year 10 is expected to be the year of maximal discharge and maximal loading from the WWTS.
The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This attachment applies to municipal and industrial facilities with a pond system (i.e., primary, secondary, polishing, equalization, anaerobic, contaminated runoff, etc.).

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

Permittee name: Poly Met Mining, Inc. Permit number: MN TBD

Geology/Hydrogeology Information

1. Provide a description of the soil beneath or in the vicinity of the ponds. Use information from soil surveys or from existing soil borings or well logs if available. (Ex.: 8 feet (ft.) of fine sand underlain by 10 ft. of silty clay.)
   
   Refer to question #1 on attached table

2. What is the depth below ground surface of the water table at the pond site?

   Refer to question #2 on attached table

   How many feet below ground surface is the bottom of the pond? Refer to question #2 on attached table

3. What is the depth to bedrock at the pond site? ☐ <10 ft. ☑ 10-20 ft. ☐ 20-50 ft. ☐ >50 ft.

4. What is the bedrock type (Ex.: limestone, sandstone, etc.)? Refer to question #4 on attached table

5. What is the proximity to the ponds of private water supply wells? ☐ < ¼ mile ☑ ¼ - 1 mile ☒ > 1 mile

6. Describe the approximate number, type and depth of private water wells in the general vicinity of the ponds (3 mile radius). (Ex.: most (#?) wells generally drilled to greater than 50 ft., however, several shallow (20 ft.) sand point wells are present.)

   [Note: The following information is based on the Minnesota Department of Health’s County Well Index (CWI) database and has not been field verified.]

   Plant Site Pre-Treatment Basin: The Minnesota Well Index includes one well listed for public supply/non-community use within a 3-mile radius of the proposed pond Plant Site Pre-Treatment Basin: Unique Well ID 584559. This well was drilled for LTVSMC, is 406 ft deep, and is listed as sealed.

   The Minnesota Well Index includes one well listed for domestic use within a 3-mile radius of the proposed Plant Site Pre-Treatment Basin: Unique Well ID 665923. This well was drilled for LTVSMC, is 165 ft deep, and currently supplies potable water to PolyMet’s administration building.

   The Minnesota Well Index includes three wells listed for industrial use within a 3-mile radius of the proposed Plant Site Pre-Treatment Basin: Unique Well IDs 120609, 172068, and 786386. Well ID 120609 was drilled for Erie Mining Co., is 197 ft deep, and is listed as sealed. Well ID 172068 was drilled for Erie Mining Co., is 262 ft deep, and is listed as active. Well ID 786386 was drilled for PolyMet, is 71 ft deep, and is listed as active.

   There are no other known private water supply wells within a 3-mile radius of the proposed Plant Site Pre-Treatment Basin.

   Mine Site Equalization Basin Area Ponds: The Minnesota Well Index includes two wells listed for domestic use within a 3-mile radius of the proposed ponds at the Mine Site Equalization Basin Area: Unique Well IDs 23237 and 23239. These two wells were drilled for PolyMet and are listed as temporarily sealed. Well ID 23237 is 715 ft deep and Well ID 23239 is 498 ft deep.

   There are no other known private water supply wells within a 3-mile radius of the proposed ponds at the Mine Site Equalization Basin Area.

7. Are the ponds located in a designated Wellhead Protection Area? ☐ Yes ☒ No

8. Are monitoring wells present at the pond site? ☒ Yes ☐ No

   If yes, please submit a topographic or equivalent map showing well locations with respect to the pond system.
Have any wells shown adverse impacts (Ex.: high nitrate or chloride concentrations)?  

Yes ☐  No ☒

If yes, please describe the adverse impacts:

Plant Site Pre-Treatment Basin pond: Groundwater monitoring wells at the Plant Site show the following elevated parameters possibly influenced by previous industrial activity: boron, fluoride, molybdenum, sulfate, TDS, and turbidity. Additionally, groundwater monitoring wells at the Plant Site show the following elevated parameters that are known to be regionally elevated based on undisturbed natural background concentrations: aluminum, iron, manganese, and pH.

Mine Site Equalization Basin Area ponds: Not applicable; baseline groundwater quality observed in monitoring wells represents natural background levels rather than adverse impacts.

9. What is the proximity to the ponds of any nearby surface waters? (Ex.: Minnesota River located ¼ mile to the north.).

Refer to question #9 on attached table

**Pond Information**

10. Please indicate the types of ponds that are present at the facility. (Check all that apply)

☐ Primary  ☐ Secondary  ☐ Polishing  ☒ Equalization  ☐ Equalization runoff

☐ Aerated  ☐ Anaerobic  ☐ Cooling  ☐ Contaminated runoff

☐ Irrigation holding  ☐ Ash handling  ☐ Other: Refer to question #10 on attached table for specific descriptions

11. Please complete the following table for each pond at the facility.

<table>
<thead>
<tr>
<th>Pond type</th>
<th>Max operating depth (ft.)</th>
<th>Min operating depth (ft.)</th>
<th>Mean operating depth (ft.)</th>
<th>Acreage at mean operating depth</th>
<th>Days of detention time (design flow)</th>
<th>Year each pond was constructed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to question #11 on attached table</td>
<td></td>
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</tr>
</tbody>
</table>

12. What is the source of the acreage information in question 11 above? (Ex: as built plans and specs, engineering survey, etc.)

Refer to question #12 on attached table

13. Has the pond system ever been repaired or upgraded?  ☐ Yes  ☒ No  If yes, what year?  N/A

If yes, please describe what the upgrade included: N/A

14. Has the pond system ever been dredged?  ☐ Yes  ☒ No  If yes, what year?  N/A

If yes, please describe the method of dredge material disposal: N/A

15. What type of pond liner is present?  ☒ Clay  ☐ Synthetic/Vinyl  ☐ Bentonite  ☐ Other: Refer to question #15 on attached table

16. Is the pond system ever operated at a depth so that the freeboard is less than 3 feet?  ☐ Yes  ☒ No

If yes, please describe the situation and identify how often it occurs: Refer to question #16 on attached table

17. What is the relationship between current wastewater flows and pond designed hydraulic capacity?

☐ below capacity  ☐ at or near capacity  ☒ above capacity  Not applicable; no current wastewater flows
18. Are there any drain tiles (designed or pre-existing) located in the vicinity of or beneath the pond system? ☐ Yes ☑ No

If yes, please submit a topographic or equivalent map showing the drain tile locations and a description of each. (The map and description should include but not be limited to: the drain tile location in relation to the pond system; the drain tile location in relation to the irrigation field [if applicable]; each drain tile discharge location; and, each discharge location station identification code [if applicable].)

19. Please list the calendar month total influent and effluent flow in million gallons for each of the past 12 months (not applicable for municipal facilities).

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Influent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Effluent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

20. What is the average annual influent CBOD5? N/A mg/L

21. Are there known or potential sources of toxic pollutants (metals, Volatile Organic Compounds [VOCs] such as, trichloroethylene, chloroform, methyl tert-butyl ether [MTBE], benzene, etc.)? ☑ Yes ☐ No

If yes, please describe: Potential toxic pollutants in pond influent based on pilot testing include the following: silver, arsenic, aluminum, beryllium, cadmium, cobalt, chromium, copper, nickel, lead, antimony, selenium, thallium, and zinc. No toxic organic pollutants are expected.

22. Is the pond system located in karst topography? ☐ Yes ☑ No

If yes and if your facility is listed in the 1993 Administrative Order requiring the preparation of a contingency plan, please ensure your facility has an updated contingency plan on file.

Review the attachment and ensure all requested items are submitted with this attachment. Please make a copy for your records. Refer to the Transmittal Form for mailing instructions.
## Municipal and Industrial Pond Attachment Form

### Geology / Hydrogeology Information

1. Provide a description of the soil beneath or in the vicinity of the ponds:
   - Overburden, Glacial Till; Peat
   - Glaciorthents, loamy (cut and fill land) (1)
   - Sand with silt and gravel (2)

2. What is the depth below ground surface of the water table at the pond site? (feet)
   - Not available at this time
   - 10 to 25
   - 10 to 15

3. How many feet below ground surface is the bottom of the pond? (feet)
   - Not available at this time
   - 10-20 ft or 20-50 ft

4. What is the bedrock type?
   - Duluth Complex
   - Glacial Till
   - Sand with silt and gravel

5. What is the proximity to the ponds of any nearby surface waters?
   - approx. 550 ft south to wetland
   - approx. 3,250 ft southeast to Second Creek

### Pond Information

6. Please indicate the types of ponds that are present at the facility. (Primary / Aerated / Irrigation holding / Secondary / Anaerobic / Ash handling / Polishing / Cooling / Equalization / Contaminated runoff / Other)
   - Equalization

7. Max operating depth in feet
   - 13
   - 13

8. Mean operating depth in feet
   - 10
   - N/A

9. Acreage at mean operating depth (Acreage given at high water elevation)
   - 1.4
   - 8.2

10. Days of detention time (design flow)
    - 1
    - 14

11. Year pond will be constructed
    - Prior to Mine Year 1
    - Prior to Mine Year 1

12. What type of pond liner is present? (Clay / Synthetic/Vinyl / Bentonite / Other)
    - Geomembrane with Geosynthetic Clay Liner (GCL)

13. Is the pond system ever operated at a depth so that the freeboard is less than 3 feet? (Yes / No)
    - No

### Footnotes:

1. Based on predominant Natural Resources Conservation Service (NRCS) soil types
2. Based on predominant U.S. Forest Service (USFS) ecological land types and ecological land type phases
4. A section of the bottom of the pond is above existing ground
The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This is an attachment to the Industrial Applications for facilities with multiple chemical additives.

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

Permittee name: Poly Met Mining, Inc.  
Permit number: MN TBD

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Purpose</th>
<th>Location of chemical addition in process</th>
<th>Amount/duration/frequency of addition (i.e., continuous or slug dosing. If slug dosing give amount/duration and frequency of addition; e.g., slug dosing 13.5 gal/3 hours, once every two weeks)</th>
<th>Average rate of use (weight or volume per day)</th>
<th>Maximum rate of use (weight or volume per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anionic Polymer Flocculant (Standby)</td>
<td>Iron settling enhancement</td>
<td>Tailings basin seepage treatment train Pre-treatment Basin</td>
<td>Continuous as needed</td>
<td>0 lbs/day (Mine Years 1 and 7) 0 lbs/day (Mine Year 10)</td>
<td>Less than 70 lbs/day (Mine Year 1) Less than 72 lbs/day (Mine Year 7) less than 140 lbs/day (Mine Year 10)</td>
</tr>
<tr>
<td>Sodium Permanganate Solution (Primary)</td>
<td>Filter pretreatment</td>
<td>Tailings basin seepage treatment train greensand filter</td>
<td>Continuous</td>
<td>57 lbs/day (Mine Year 1) 206 lbs/day (Mine Year 7) 130 lbs/day (Mine Year 10)</td>
<td>58 lbs/day (Mine Year 1) 230 lbs/day (Mine Year 7) 200 lbs/day (Mine Year 10)</td>
</tr>
<tr>
<td>Carbon Dioxide (Primary)</td>
<td>pH adjustment</td>
<td>Tailings basin seepage treatment train secondary membranes</td>
<td>Continuous</td>
<td>5 tons/day (Mine Year 1) 7 tons/day (Mine Year 7) 12 tons/day (Mine Year 10)</td>
<td>10 tons/day (Mine Years 1 and 7) 20 tons/day (Mine Year 10)</td>
</tr>
<tr>
<td>Granular Calcite (Primary)</td>
<td>Effluent stabilization</td>
<td>Tailings basin seepage treatment train limestone contactor</td>
<td>Continuous</td>
<td>900 lbs/day (Mine Year 1) 1,800 lbs/day (Mine Year 7) 2,000 lbs/day (Mine Year 10)</td>
<td>900 lbs/day (Mine Year 1) 2,000 lbs/day (Mine Years 7 and 10)</td>
</tr>
<tr>
<td>GE Hypersperse MDC150 (Primary)</td>
<td>Membrane antiscalant</td>
<td>Tailings basin seepage treatment train primary membranes</td>
<td>Continuous</td>
<td>59 lbs/day (Mine Year 1) 60 lbs/day (Mine Year 7) 93 lbs/day (Mine Year 7)</td>
<td>65 lbs/day (Mine Year 1) 63 lbs/day (Mine Year 7) 120 lbs/day (Mine Year 7)</td>
</tr>
</tbody>
</table>

The modeled chemical requirements for projected 50th percentile (P50) values were used as the average rate of use, and the modeled chemical requirements for projected 90th percentile (P90) values were used as the maximum rate of use.
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Type</th>
<th>Application</th>
<th>Year 10)</th>
<th>Mine Year 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLR 759</td>
<td>Acid antiscalant</td>
<td>Tailings basin seepage treatment train secondary membranes</td>
<td>Continuous</td>
<td>3 gallons/day (Mine Years 1 and 7)</td>
</tr>
<tr>
<td>Sodium Bisulfite</td>
<td>Oxidant-quenching membrane pretreatment</td>
<td>Tailings basin seepage treatment train primary membranes</td>
<td>Continuous</td>
<td>27 lbs/day (Mine Year 1)</td>
</tr>
<tr>
<td>Sodium Bisulfite</td>
<td>Oxidant-quenching membrane pretreatment</td>
<td>Tailings basin seepage treatment train secondary membranes</td>
<td>Continuous</td>
<td>7 lbs/day (Mine Year 1)</td>
</tr>
<tr>
<td>MC-1</td>
<td>Citric acid membrane cleaner</td>
<td>Tailings basin seepage treatment train primary membranes</td>
<td>Continuous</td>
<td>7,500 lbs/year (Mine Year 1)</td>
</tr>
<tr>
<td>MC-4</td>
<td>Alkaline surfactant membrane cleaner</td>
<td>Tailings basin seepage treatment train primary membranes</td>
<td>Continuous</td>
<td>7,500 lbs/year (Mine Year 1)</td>
</tr>
<tr>
<td>NLR 404</td>
<td>Organic acid membrane cleaner</td>
<td>Tailings basin seepage treatment train secondary membranes</td>
<td>Continuous</td>
<td>10 gallons/day (Mine Years 1 and 7)</td>
</tr>
<tr>
<td>NLR 505</td>
<td>Alkaline surfactant membrane cleaner</td>
<td>Tailings basin seepage treatment train secondary membranes</td>
<td>Continuous</td>
<td>10 gallons/day (Mine Years 1 and 7)</td>
</tr>
</tbody>
</table>

*Remember to attach the Material Safety Data Sheets, complete product labels and any other information on chemical composition, aquatic toxicity, human health, and environmental fate for each chemical additive. Please make a copy for your records.*

**Refer to the Transmittal Form for mailing instructions.**

Chemicals listed as standby are not intended to be used at the average and maximum rates of use unless necessary.
Permit Application Checklist for Water Treatment

NPDES/SDS Permit Program
National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS)

Doc Type: Permit Application

Water Treatment waste types are discharges of residuals, such as solids and filter backwash, from the treatment of water for potable, non-potable, industrial, or other uses.

This checklist is intended to help permit applicants determine the correct forms to submit as part of a complete permit application package. The Minnesota Pollution Control Agency (MPCA) will review the application materials for completeness and notify the applicant within 30 business days of receipt whether the application is incomplete or complete enough for processing.

Print or type application: Before submitting an application, make a photocopy of this form and all other application materials for your records. The MPCA will review the application for completeness and provide an official response to the permittees within 30 days of receipt of all necessary application materials.

Permit application assembly: To expedite the processing and review of your application, put this form and any other applicable permit application checklists for other waste types at the beginning of your submittal package. Please place all other application forms in order as listed on the back of this form. Do not place forms and checklists in an appendix as this makes it difficult and time consuming for staff to locate them.

Completeness instructions: The MPCA will not process an application without properly completed forms. All sections of required forms must be completed. If portions do not apply to this facility, please indicate using “n/a” or explain why it doesn’t apply. For permit reissuance, all forms information must also be completed in full even if the information requested is not changing from the existing permit. This allows the MPCA to quickly verify that the existing information is correct.

Facility name: NorthMet Waste Water Treatment System
Permit No.: MN TBD

Reason for Application (check all that apply):
- ☒ New permit
- ☐ Permit Modification
- ☐ Permit Reissuance
- ☐ Resubmittal of an application determined to be incomplete. (Include copies of all returned forms with a resubmittal.)

Does this action include construction activities:
- ☒ Construction is proposed as part of the permit action.
- ☐ No construction is proposed as part of this permit action.

Form Submittal
Submit two (2) complete copies of the permit application package. At least one (1) copy must be a hard copy. The other may be an electronic copy. The completed form is to be returned to:

Attn: Fiscal Services – 6th floor
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN  55155-4194

Assistance
If you have any questions regarding the selection of the proper forms or how to complete the required information, contact the MPCA staff assigned to your facility. Staff is assigned by regions and a director of regional staff can be located at:
http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/agency-structure/mpca-offices/mpca-offices.html

You may also contact the MPCA at:
- In Metro Area 651-296-6300
- Outside Metro Area: 800-657-3864
- E-mail to: askpca@state.mn.us.
### Application Forms Selection

(Listed below are application forms and required submittals that may be required for a typical potable water treatment facility application. All required forms must be completed in-full and included with the submittal. The MPCA cannot process an application that does not include all of the required application forms. All forms, instructions, and additional information can be found on the MPCA website at [http://www.pca.state.mn.us/enzq915](http://www.pca.state.mn.us/enzq915).

Check all boxes that apply. Include a copy of all completed application forms with the submittal.

<table>
<thead>
<tr>
<th>Required for all water quality permits</th>
<th>For Transmittal Form: Refer to Volume I of this Permit Application.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ Application Fee as specified on the Transmittal Form</td>
<td></td>
</tr>
<tr>
<td>☒ Certification Signature as specified on Transmittal Form</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Water treatment residual wastes disposal</th>
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<table>
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<tr>
<th>Type of water treatment facility</th>
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<table>
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<tr>
<th>Additional attachments</th>
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</table>

<table>
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<tr>
<th>Supplemental information</th>
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<tbody>
<tr>
<td>☒ Topographic map.</td>
<td></td>
</tr>
<tr>
<td>☒ A schematic drawing or treatment process flow diagram showing all treatment components, direction of flow, compliance monitoring station locations, and discharge locations.</td>
<td></td>
</tr>
<tr>
<td>☒ List any additional documents, reports, plans, or attachments included as part of the application package. (Common types of supplemental information may include maps, process flow diagrams, facility plans, engineering reports, plans and specifications, technical checklists and other reports related to the facility or proposed project.)</td>
<td></td>
</tr>
<tr>
<td>☒ Refer to Volume III Table of Contents</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Other waste types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ Permit Application Checklist for Municipal/Domestic Wastewater (wq-wwprm7-04a)</td>
<td></td>
</tr>
<tr>
<td>☒ Permit Application Checklist for Industrial Process Wastewater (wq-wwprm7-04b)</td>
<td></td>
</tr>
<tr>
<td>☒ Permit Application Checklist for Miscellaneous Waste Types (wq-wwprm7-04c)</td>
<td></td>
</tr>
</tbody>
</table>
The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This application applies to municipal and industrial water treatment facilities.

Complete the application by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

- Review the application to ensure all requested items are submitted with this application.
- Please make a copy for your records.
- Refer to the Transmittal Form for mailing instructions.

### Facility information

1. **Permittee name:** Poly Met Mining, Inc.  
   **Permit number:** MN TBD

2. **Water treatment operator:** To be determined  
   **Mailing address:** PO Box 475  
   **City:** Hoyt Lakes  
   **State:** MN  
   **Zip code:** 55750  
   **Office phone:** (218) 471-2150  
   **Cell phone:** TBD  
   **Email:** TBD  
   **Minnesota Department of Health (MDH) certification number (water supply system):** N/A

3. Is any of the treated water used to supply a public water system?  
   - [ ] Yes  
   - [x] No

### Treated water use

4. Indicate the treated water distribution type:  
   - [ ] Public water supply drinking water  
   - [ ] Non-public water supply water  
   - [ ] Both

   Neither; treated WWTS effluent will be discharged to the environment.

If both distribution types are used include use percentages for each type of distribution:  

   - Public water supply: N/A  
   - Non-public water supply: N/A

### Facility type

5. What is/are the Standard Industrial Classification (SIC) code(s) which best reflect the principal products or services provided by the facility?  
   1021 (Active Metal Mining Facilities - Copper Ores), 1099 (Miscellaneous Metal Ores, Not Elsewhere Classified), 1041 (Active Metal Mining Facilities - Gold Ores)

   Municipal service districts and public utility facilities primarily engaged in distributing water for sale for residential, commercial, and industrial uses fall under SIC code 4941. **If that is the applicable SIC code, skip Questions 6 and 7.**

6. What is/are the average production/consumption rates at which this/these activities occur?  
   113,000 tons/year copper concentrate, 18,000 tons/year mixed nickel-copper hydroxide, and 500 tons/year of gold and PGE precipitate
7. What is/are the maximum production/consumption rates at which this/these activities occur?

32,000 tons of ore per day (after ramp-up)

The information for questions 1-3 must be projected for the next five years, since the Minnesota Pollution Control Agency (MPCA) permit will likely cover this period. The SIC code classification was developed by the U.S. Department of Commerce to classify facilities by their economic activities. SIC codes are commonly used on federal tax forms and unemployment insurance information provided to the Minnesota Department of Jobs and Training. If you do not know the four-digit SIC code number for your facility, please consult the Standard Industrial Classification Manual, which is available at http://www.osha.gov/pls/imis/sic_manual.html.

Production/consumption rates should be expressed as, for example, “100,000 lbs/day of milk”, "600 wafers/month of integrated circuits”, “5100 bbls/day of fuel oil”, “23,000 cans/week of canned poultry.”

Summary Information

8. Please give a brief description of your water treatment facility:

The Project waste water treatment strategy is integrated across the Mine and Plant Sites. The two primary components of the waste water treatment system are the mine water treatment trains and the tailings basin seepage treatment train, which are designed to operate in tandem. The mine water treatment trains manage and treat mine water and the tailings basin seepage treatment train manages and treats tailings basin seepage.

Refer to Section 2.0 of this volume for a description of the tailings basin seepage treatment train.

Refer to Section 3.0 of this volume for a description of the mine water treatment trains.

9. List all individual groundwater, surface water and interconnection sources that supply raw water to the treatment system. For each individual source identify use status. Indicate well/source water locations on topographic map.

<table>
<thead>
<tr>
<th>Raw water source (ex. well numbers – MDH and/or facility reference, surface water body)</th>
<th>Use status (ex. active use, emergency use, standby, seasonal use or peak use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NorthMet Mine Site mine water</td>
<td>Active Use</td>
</tr>
<tr>
<td>Colby Lake (via Plant Reservoir)</td>
<td>Standby</td>
</tr>
<tr>
<td>Precipitation collected on-site at the Plant Site</td>
<td>Active Use</td>
</tr>
<tr>
<td>Tailings basin seepage</td>
<td>Active Use</td>
</tr>
</tbody>
</table>

10. Have you obtained a Minnesota Department of Natural Resources (DNR) water appropriations permit(s) for this/these water supply/supplies? □ Yes  □ No  If yes, complete a. – d. below:

a. If yes, what is/are the DNR permit number(s)?

While not yet obtained, permit applications are in process for mine water appropriations:

Colby Lake: DNR Water Appropriation (WA) Permit #2017-0260
Mine water - East Pit dewatering: DNR WA Permit #2016-1363
Mine water - Central Pit dewatering: DNR WA Permit #2016-1364
Mine water - West Pit dewatering: DNR WA Permit : #2016-1365
Mine water - Mine Site infrastructure: DNR WA Permit: #2016-1367
Plant Site infrastructure: DNR WA Permit: #2016-1369

b. DNR permit expiration date(s)?

Unknown at this time

c. What are the DNR authorized annual appropriation limits (in million gallons per year)?

Colby Lake: 1,800 million gallons/year
East Pit: 1,000 MG/yr
Central Pit: 700 MG/yr
West Pit: 800 MG/yr
Mine Site: 1,200 MG/yr
Plant Site: 675 MG/yr

d. Are you proposing, or have you proposed within the past five years, to increase the DNR-authorized annual appropriation limits? □ Yes  □ No  If yes, please explain:

11. What is the total annual average design finished water production of the water treatment facility in gallons per day?
12. What is the total peak/maximum daily design finished production capacity of the water treatment facility in gallons per day?

This is a total of all components of the treatment system (ex. RO, media filters, etc).

- 2,500,000 (Mine Year 5)
- 4,000,000 (Mine Year 10)

For WWTS discharge off-site in gallons per day.

13. Are there any known raw water (groundwater, surface water, interconnection source) contaminants (ex: radium, arsenic, etc.)?

☐ Yes ☐ No  If yes, please explain: The water treated in this system is waste water associated with mining operations and will contain high levels of sulfate and metals.

14. Name of laboratory that analyzes your discharge samples: TBD

MDH certification number: TBD

15. If the facility is currently covered under an NPDES/SDS permit, has the facility been in compliance with the permit limits during the past five years? ☐ Yes ☐ No  If no, please explain:

Not applicable; the facility is not currently covered by an NPDES/SDS permit.
## Facility type

16. List below all chemical additives that are used or proposed to be used at the facility. This must include all process reagents, flocculants, biocides, water treatment chemical additives (for example, chlorine, chloramines, potassium permanganate, softener salts, alum), polymers, pH adjustment chemicals, antiscalants, brine solutions, etc. MPCA approval is required for any additives that are new, increasing in usage, or not previously approved. Go to the MPCA chemical additive webpage at: [http://www.pca.state.mn.us/a6krka9](http://www.pca.state.mn.us/a6krka9) to find the documents necessary to complete the approval process. Your additives will **not** be approved for use until you complete this process.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Purpose</th>
<th>Location in process of chemical addition</th>
<th>Frequency of addition</th>
<th>Type of application (slug dosing or continuous feed)</th>
<th>Average rate of use (weight or volume per day)</th>
<th>Maximum rate of use (weight or volume per day)</th>
<th>Previously approved? Yes or no</th>
<th>Date of approval (mm/dd/yyyy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>□ Yes □ No</td>
<td></td>
</tr>
</tbody>
</table>

At the direction of MPCA, the chemical additives approval process for this project would be completed via the attached Industrial Chemical Additives Attachment (wq-wwprm7-48).

An Additional Chemical Additives attachment is available on the MPCA website at [http://www.pca.state.mn.us/water/permits/index.html](http://www.pca.state.mn.us/water/permits/index.html) if more space is needed.

## General permit application information

All permit applications are reviewed for general permit qualification when the water treatment general permits are up for reissuance. Those who qualify will be notified of acceptance. Only domestic water treatment facilities qualify for inclusion in the general permits.

## Attachments

- **Media Filter Attachment**: If a media filter is used for water treatment (ex. sand filter) complete the Media Filter Attachment.
- **Softening Treatment**: If softening treatment is used for water treatment (ex. lime or ion-exchange) complete the Softening Treatment Attachment.
- **Membrane Filtration**: If membrane filtration is used for water treatment (ex. reverse osmosis or ultra filtration) complete the Membrane Filtration Attachment.
Water Treatment
Media Filter Attachment

The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This attachment applies to municipal and industrial water treatment facilities that utilize media filtration (i.e., anthracite or any other filter which is backwashed, rinsed, or flushed).

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

Facility Information

1. **Permittee name:** Poly Met Mining, Inc.
   **Permit number:** MN TBD

2. Describe the media filters. Include number of filters, cells, media type (e.g., activated alumina, anthracite, zeolite, garnet, activated carbon, silica sand, greensand, multimedia), etc.
   The WWTS will use greensand filters. The tailings basin seepage treatment train and mine water filtration train will each have two greensand filters. Each filter will have four cells. The filters will be bedded with anthracite and greensand.

Refer to Sections 3.3.5 and 4.3.6.2 of the Waste Water Treatment Systems Design and Operation Report for further information on greensand filter design and operation.

3. Has the media been replaced in the past? If so indicate the date and method of disposal.
   The system is not currently in operation.

4. **What is the average production capacity of the treatment component in gallons per day?**
   (The treatment component means all filters combined.)
   - 3,300,000 (Mine Year 1)
   - 6,100,000 (Mine Year 10) gallons/day

5. **What is the maximum production capacity of the treatment component in gallons per day?**
   - 3,500,000 (Mine Year 1)
   - 7,800,000 (Mine Year 10) gallons/day

   The projected 50th percentile (P50) value was used as the average production capacity, and the projected 90th percentile (P90) value was used as the maximum production capacity.

Backwash Wastewater

6. Backwash wastewater from the facility is discharged to (check all that apply):
   - Surface water – Name: ____________________________
   - Municipal storm sewer (identify where this discharges):
   - Sanitary sewer (discharges to sanitary sewer do not require an NPDES/SDS Permit)
   - Seepage basin or rapid infiltration basin

   Tailings basin seepage treatment train backwash water is discharged to the Flotation Tailings Basin (FTB). Mine water treatment train backwash water is routed to the head of the mine water

7. Describe the backwash process. (Include seasonal variations):
   A 25-minute backwash cycle will be conducted as needed (approximately once every 24 to 48 hours). Backwash will be performed using an approximate loading rate of 12 to 15 GPM/ft² using water from parallel in-service media filter cells.
   - **Backwash frequency:** Approximately every 24 to 48 hours (frequency and volume will be finalized in final design and will change seasonally based on flow rates)
   - **Backwash duration:** Approximately 25 minutes
   - **Backwash volume:** Approximately 180,000 to 400,000 gallons, depending on the Mine Year and flows
   - **Rinsate volume:** N/A
8. Is treated/finished water from the final distribution system used to backwash the filters?  □ Yes  □ No

If no, describe the backwash source and indicate it on the water treatment process flow diagram or water balance diagram.

Filtered water from parallel in-service media filter cells will be used to backwash cells which are out of service. The water is not filtered through the membrane system prior to use as backwash.

9. How is the backwash water treated to remove suspended solids and other related pollutants prior to discharge to the environment (ex. holding tank, holding pond, etc.)?

Filter backwash at the tailings basin seepage treatment train is sent to the Flotation Tailings Basin, not discharged directly. Tailings basin seepage is then routed through the tailings basin seepage treatment train before discharge.

Filter backwash at the mine water filtration train will be settled in a backwash tank, and decant will be routed back to filter influent. Backwash solids will be routed to the head of the mine water chemical precipitation train.

10. If there is backwash detention, what is the length of settling time?

At the mine water filtration train, backwash will be detained in a backwash tank for 4 hours at the flows expected between Mine Year 1 and Mine Year 10.

Discharge Information

11. How often is there a discharge to the environment (either from holding tanks/ponds, or straight from the facility)?

There is no discharge to the environment directly following media filtration. Discharge will occur at the end of the tailings basin seepage treatment train following membrane filtration.

12. What is the average daily design discharge rate for the treatment component in gallons per day?

<table>
<thead>
<tr>
<th>Component</th>
<th>Gallons/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS</td>
<td></td>
</tr>
<tr>
<td>Mine Year 5</td>
<td>2,592,000</td>
</tr>
<tr>
<td>Mine Year 10</td>
<td>5,112,000</td>
</tr>
</tbody>
</table>

13. What is the maximum daily design discharge rate for the treatment component in gallons per day?

<table>
<thead>
<tr>
<th>Component</th>
<th>Gallons/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS</td>
<td></td>
</tr>
<tr>
<td>Mine Year 5</td>
<td>2,880,000</td>
</tr>
<tr>
<td>Mine Year 10</td>
<td>5,760,000</td>
</tr>
</tbody>
</table>

Review the application to ensure all requested items are submitted with this attachment.

Please make a copy for your records

Refer to the Transmittal Form for mailing instructions.
The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This attachment applies to municipal and industrial water treatment facilities that utilize water softening treatment (i.e., lime and ion exchange).

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

### Facility Information

1. **Permittee name:** Poly Met Mining, Inc.  
   **Permit number:** MN TBD

2. Describe the softening process used by your facility:
   The facility treats industrial process water. In the high-density sludge precipitation process and in the sulfate removal process (both in the mine water chemical precipitation train), lime is added to raise pH and precipitate insoluble metal hydroxides and gypsum. Lime sludge will be dewatered and disposed of off-site. Lime-treated water will be routed to the Flotation Tailings Basin (FTB).

3. What percentage of water is softened? Approximately 20% of the influent to the mine water treatment trains is routed through the chemical precipitation train and softened.

### Treated Water Use

4. Water softening treatment wastewater from the facility is discharged to (check all that apply):
   - [ ] Surface water – Name: ____________________________
   - [ ] Municipal storm sewer (identify where this discharges):
   - [ ] Sanitary sewer *(discharges to sanitary sewer do not require an NPDES/SDS Permit)*
   - [x] Seepage basin or rapid infiltration basin
   - Treated mine water is discharged to the FTB. Tailings basin seepage is then treated by the tailings basin seepage treatment train prior to discharge.

### Lime Softening

5. What is the average production of the treatment component in gallons per day?  
   The projected 50th percentile (P50) value was used as the average production capacity, and the projected 90th percentile (P90) value was used as the maximum production capacity.
<table>
<thead>
<tr>
<th>Mine Year</th>
<th>Gallons/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>325,000</td>
</tr>
<tr>
<td>10</td>
<td>650,000</td>
</tr>
</tbody>
</table>

6. What is the maximum production capacity of the treatment component in gallons per day?  
<table>
<thead>
<tr>
<th>Mine Year</th>
<th>Gallons/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>375,000</td>
</tr>
<tr>
<td>10</td>
<td>800,000</td>
</tr>
</tbody>
</table>

7. What type of lime is used (ex. quicklime, hydrated lime, etc.)? Hydrated lime

8. What is quantity of lime is used for softening annually? Up to 4,000 tons (Mine Years 1 and 7); 9,000 tons (Mine Year 10)

9. Is there a dewatering system for the spent lime?  
   - [x] Yes  
   - [ ] No  
   If yes, describe: The liquid sludge is dewatered in a plate-and-frame filter press. Dewatered sludge will be stored in roll-off bins below the filter press.

10. What is the average daily design discharge rate for the treatment component in gallons per day? No discharge to the environment from the mine water treatment trains

11. What is the maximum daily design discharge rate for the treatment component in gallons per day? No discharge to the environment from the mine
12. How often is there a discharge for each treatment component to the environment? (Specify frequency, volume, and duration. Ex. 500 gal/2 hours, once every two weeks.)

There is no discharge to the environment directly from the lime softening system. Treated water will be routed to the FTB. Tailings basin seepage will be treated by the tailings basin seepage treatment train prior to discharge.

13. How is the lime waste stored?
Lime waste will be stored on-site in clarifiers and sludge storage tanks.

14. What quantity of lime waste is stored on-site?
The mine water treatment trains include an 80,000 gallon sludge storage tank to store 25% solids sludge from the chemical precipitation train. This includes, but is not limited to, lime waste.

15. How long does the lime waste remain on-site?
Dewatered sludge will be removed each day when the mine water treatment trains are operating near capacity. When operating at lower flows, it may be possible to hold sludge for up to four days between pickup.

16. Are there lime storage lagoons? Yes ☐ No ☑ If yes, are they lined? Yes ☐ No ☑

17. How is the lime waste managed?
If land applied, please provide MN Department of Agriculture License Number.

18. If lime waste management is subcontracted, provide information on subcontacts.
N/A

19. Are any other waste streams mixed with the lime softening waste process (ex. filter backwash water)? Yes ☑ No ☐ If yes, describe:
Sludge from high-density metals (lime treatment), gypsum precipitation (lime treatment), and calcite recarbonation (carbon dioxide treatment) will be combined for disposal.

**Ion-Exchange Softening**

21. What is the average production of the treatment component in gallons per day? N/A gallons/day

22. What is the maximum production capacity of the treatment component in gallons per day? N/A gallons/day

23. What is the average daily design discharge rate for the treatment component in gallons per day? N/A gallons/day

24. What is the maximum daily design discharge rate for the treatment component in gallons per day? N/A gallons/day

25. How often is there a discharge for each treatment component to the environment? (Specify frequency, volume, and duration. Ex. 500 gal/2 hours, once every two weeks.)
N/A

26. What is the volume of backwash wastewater discharged in gallons per day? N/A gallons/day

27. What is the volume of regeneration wastewater discharged in gallons per day? N/A gallons/day

28. What is the volume of rinsate wastewater discharged in gallons per day? N/A gallons/day

29. Is the recharge cycle based on water usage or time? N/A

**Water Quality Testing**

Sample results for the following parameters are required as part of the permit application submitted to the Minnesota Pollution Control Agency (MPCA). The sample shall be a composite sample, representative of the total discharge to the environment, collected at a time during the 12-month period before the permit application is submitted. Also include any additional test parameters required by your existing NPDES/SDS Permit. For proposed, new, and expanding discharges, these test parameters are required for the raw water.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Results</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>There is no discharge to the environment from the mine water treatment trains that employs lime treatment. Treated mine water will be routed to the Flotation Tailings Basin Pond.</td>
<td>mg/L</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride, Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Unit</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Chloride, Total Residual</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Chromium, Total</td>
<td>ug/L</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Hardness, Calcium &amp; Magnesium, calculated (as CaCO₃)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Lead, Total</td>
<td>ug/L</td>
<td></td>
</tr>
<tr>
<td>Magnesium, Total (as Mg)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>ug/L</td>
<td></td>
</tr>
<tr>
<td>pH, field¹</td>
<td>SU</td>
<td></td>
</tr>
<tr>
<td>Phosphorus, Total</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Potassium, Total (as K)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Salinity, Total</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Sodium, Total (as Na)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Solids, Total Dissolved (TDS)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Solids, Total Suspended (TSS)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Specific Conductance, field¹</td>
<td>umh/cm</td>
<td></td>
</tr>
<tr>
<td>Sulfate, Total (as SO₄)</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>ug/L</td>
<td></td>
</tr>
<tr>
<td>Volume per Discharge Event</td>
<td>gallons</td>
<td></td>
</tr>
</tbody>
</table>

¹ Analyze Immediately.

- mg/L = milligrams per liter
- ug/L = micrograms per liter

**Review the application to ensure all requested items are submitted with this attachment.**

**Please make a copy for your records**

**Refer to the Transmittal Form for mailing instructions.**
Water Treatment  
Membrane Filtration Attachment  
NPDES/SDS Permit Program  

The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This attachment applies to municipal and industrial water treatment facilities that utilize membrane filtration treatment (i.e. reverse osmosis, ultrafiltration, microfiltration, nanofiltration and electrodialysis).

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

---

**Facility Information**

1. **Permittee name:** Poly Met Mining, Inc.  
   **Permit number:** MN TBD

2. Describe the membrane filtration process used by your facility:
   - At the tailings basin seepage treatment train, the primary membrane separation process includes reverse osmosis and nanofiltration membranes. The secondary membrane separation system will use nanofiltration membranes in vibratory shear-enhanced process modules.
   - At the mine water treatment trains, the primary membrane separation process will use nanofiltration membranes. The secondary membrane separation system will use nanofiltration membranes in vibratory shear-enhanced process modules.

---

**Treated Water Use**

3. Water treatment wastewater from the facility is discharged to (check all that apply):
   - Surface water – Name:  
   - Municipal storm sewer (identify where this discharges):  
   - Sanitary sewer (Discharges to Sanitary do not require an NPDES/SDS Permit)  
   - Seepage basin or rapid infiltration basin

   Secondary membrane concentrate is discharged to the Flotation Tailings Basin (FTB) via the WWTS; the WWTS CIP waste is routed to the FTB; WWTS CIP waste is routed to the head of WWTS.

---

**Membrane Filtration**

4. What is the average production of the treatment component in gallons per day?  
   4,800,000 (Mine Year 1)  
   8,800,000 (Mine Year 10)  

   The projected 50th percentile (P50) value was used as the average production capacity, and the projected 90th percentile (P90) value was used as the maximum production capacity.

5. What is the maximum production capacity of the treatment component in gallons per day?  
   5,100,000 (Mine Year 1)  
   11,400,000 (Mine Year 10)

6. What is the average daily design discharge rate for the treatment component in gallons per day?  
   1,800 (Mine Year 5)  
   3,550 (Mine Year 10)  

   for WWTS discharge

7. What is the maximum daily design discharge rate for the treatment component in gallons per day?  
   2,000 (Mine Year 5)  
   4,000 (Mine Year 10)  

   for WWTS discharge

8. How often is there a discharge to the environment? Specify frequency, volume, and duration. (ex. 5000 gal/18 hours, once every day.)
The discharge to the environment is continuous. Average and maximum flow rates are provided in question 6 and 7, respectively.

9. What is the volume of the discharged rinsate water in gallons per day?
   - 1,800 (Mine Year 5)
   - 3,550 (Mine Year 10)
   - Average discharge rate for WWTS discharge gallons/day

10. What is the volume of the discharged reject water in gallons per day?
    - No membrane concentrate is discharged to the environment. gallons/day

11. Describe how system cleaning and maintenance wastewater is managed, including membrane clean-in-place, permeate flush, etc. Specify frequency, volume, and duration. (ex. 13.5 gal/3 hours, once every 2 months.)
   Membranes are cleaned in place using acid and caustic chemicals (MC1 and MC4 from GE Water & Process Technologies or similar for primary membranes and NLR 404 and NLR 505 from New Logic Research or similar for secondary membranes). Exact chemicals and usage rates will be determined during plant start-up. Refer to the Industrial Chemical Additives Attachment (wq-wwprm7-28) for estimates of chemical usage rates.

   Primary membranes at both the tailings basin seepage treatment train and mine water treatment trains will be cleaned approximately four times per year. At the tailings basin seepage treatment train, CIP waste will have a volume of 477,000 gal/year (Mine Year 7) and 916,000 gal/year (Mine Year 10). At the mine water treatment trains, CIP waste will have a volume of 94,000 gal/year (Mine Year 1), 212,000 gal/year (Mine Year 5), and 277,000 gal/year (Mine Year 10).

   Secondary membranes in both plants will be cleaned approximately once daily. At the tailings basin seepage treatment train, CIP waste will have a volume of 24,000 gal/day (Mine Year 7) and 44,000 gal/day (Mine Year 10). At the mine water treatment trains, CIP waste will have a volume of 12,000 gal/day (Mine Year 1), 26,000 gal/day (Mine Year 5), and 33,000 gal/day (Mine Year 10).

12. Where is the cleaning wastewater discharged? (ex. sanitary sewer, surface water, etc.)
   - Membrane cleaning (CIP) wastewater is routed to the Flotation Tailings Basin.

13. Spent membranes are a solid waste. Describe the disposal management of spent membranes.
   - Spent membranes will be transported to an approved off-site disposal facility.

### Water Quality Testing

Sample results for the following parameters are required as part of the permit application submitted to the MPCA. The sample shall be a composite sample, representative of the total discharge to the environment, collected at a time during the 12-month period before the permit application is submitted. Also include any additional test parameters required by your existing NPDES/SDS permit. For new discharges, these test parameters are required for the raw water. Additional sampling is required for other known contaminants in the source water that are not on the list below. An example of this would be radium.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Results</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Whole Effluent Toxicity1</td>
<td>MY7: 0.00013</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>MY10: 0.00043</td>
<td></td>
</tr>
<tr>
<td>Aluminum, Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic, Total (as As)</td>
<td>MY7: 0.000020</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>MY10: 0.000040</td>
<td></td>
</tr>
<tr>
<td>Ammonia-Nitrogen (as N)</td>
<td>&lt; 0.5</td>
<td>mg/L</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>MY7: 120</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>MY10: 470</td>
<td></td>
</tr>
<tr>
<td>Boron, Total (as B)</td>
<td>MY7: 260</td>
<td>ug/L</td>
</tr>
<tr>
<td></td>
<td>MY10: 210</td>
<td></td>
</tr>
<tr>
<td>Bromide, Total</td>
<td></td>
<td>mg/L</td>
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<tr>
<td>Calcium, Total (as Ca)</td>
<td>MY7: 0.000023</td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>MY10: 0.000056</td>
<td></td>
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<tr>
<td>Cadmium, Total</td>
<td></td>
<td>mg/L</td>
</tr>
<tr>
<td></td>
<td>MY7: 17</td>
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</tr>
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### Water Quality Test Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MY7</th>
<th>MY10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chloride, Total</strong></td>
<td>29 mg/L</td>
<td>22 mg/L</td>
</tr>
<tr>
<td><strong>Chromium, Hexavalent (as Cr)</strong></td>
<td>0.00031 mg/L</td>
<td>0.00028 mg/L</td>
</tr>
<tr>
<td><strong>Chromium, Total</strong></td>
<td>0.00017 mg/L</td>
<td>0.000017 mg/L</td>
</tr>
<tr>
<td><strong>Copper, Total</strong></td>
<td>0.00087 mg/L</td>
<td>0.00031 mg/L</td>
</tr>
<tr>
<td><strong>Cyanide, Total</strong></td>
<td>0.000028 mg/L</td>
<td>0.000017 mg/L</td>
</tr>
<tr>
<td><strong>Fluoride, Total</strong></td>
<td>1.1 mg/L</td>
<td>0.94 mg/L</td>
</tr>
<tr>
<td><strong>Hardness, Calcium &amp; Magnesium, calculated (as CaCO₃)</strong></td>
<td>53 mg/L</td>
<td>91 mg/L</td>
</tr>
<tr>
<td><strong>Iron, Total</strong></td>
<td>0.00023 mg/L</td>
<td>0.00038 mg/L</td>
</tr>
<tr>
<td><strong>Lead, Total</strong></td>
<td>0.0000028 mg/L</td>
<td>0.000099 mg/L</td>
</tr>
<tr>
<td><strong>Magnesium, Total (as Mg)</strong></td>
<td>2.2 mg/L</td>
<td>4.5 mg/L</td>
</tr>
<tr>
<td><strong>Mercury, Total</strong></td>
<td>&lt; 0.005 µg/L</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrate-Nitrite-Nitrogen (as N)</strong></td>
<td>6.5 to 8.5 SU</td>
<td></td>
</tr>
<tr>
<td><strong>Phosphorus, Total</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Potassium, Total (as K)</strong></td>
<td>3.3 mg/L</td>
<td>8.2 mg/L</td>
</tr>
<tr>
<td><strong>Salinity, Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Selenium, Total</strong></td>
<td>0.000052 mg/L</td>
<td>0.000046 mg/L</td>
</tr>
<tr>
<td><strong>Silver, Total</strong></td>
<td>0.000088 mg/L</td>
<td>0.000059 mg/L</td>
</tr>
<tr>
<td><strong>Sodium, Total (as Na)</strong></td>
<td>14 mg/L</td>
<td>26 mg/L</td>
</tr>
<tr>
<td><strong>Solids, Total Dissolved (TDS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Solids, Total Suspended (TSS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Specific Conductance, field²</strong></td>
<td>umh/cm</td>
<td></td>
</tr>
<tr>
<td><strong>Sulfate, Total (as SO₄)</strong></td>
<td>8.3 mg/L</td>
<td>9.8 mg/L</td>
</tr>
<tr>
<td><strong>Temperature, field²</strong></td>
<td></td>
<td>Degrees F</td>
</tr>
<tr>
<td><strong>Zinc, Total</strong></td>
<td>0.000050 mg/L</td>
<td>0.000065 mg/L</td>
</tr>
</tbody>
</table>

1 See information below on toxicity testing.  ² Analyze Immediately.  

**Acute whole effluent toxicity testing instructions:** The Acute Whole Effluent Toxicity Test is a static renewal test conducted on an exponentially diluted series of effluent. The purpose is to calculate the proportion of effluent that causes 50 percent mortality/immobility of aquatic organisms at 48 or 96 hours. An LC₅₀/EC₅₀ (lethal/immobile concentration) less than or equal to 100 percent effluent constitutes a positive for toxicity. Tests shall be conducted in accordance with procedures outlined in EPA-821-R-02-012 "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" - Fifth Edition (Acute Manual) and any revisions to the Manual. Any test that is begun with an effluent sample that exceeds a total ammonia concentration of 10 mg/L shall use the carbon dioxide-controlled atmosphere technique to control pH drift. Test organisms for each test battery shall include the fathead minnow (*Pimephales promelas*)-Method 2001.0, *Ceriodaphnia dubia*-Method 2002.0, and *Daphnia magna*-Method 2021.0. Static renewal acute serial dilution tests of the effluent shall consist of a control 12, 25, 50, 75 and 100 percent effluent. All effluent samples shall be flow proportioned, 24-hour composites. Test solutions shall be renewed daily from each fresh composite. Testing of the effluent shall begin within 36 hours of sample collection. Receiving water collected outside of the influence of discharge shall be used for dilution and controls. Any other circumstances not addressed in the previous requirements or that require deviation from that specified in the previous requirements shall first be approved by the MPCA.

Please make a copy for your records. Refer to the **Transmittal Form** for mailing instructions.
Industrial Chemical Additives
Attachment
NPDES/SDS Permit Program
Doc Type: Permit Application

The National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program regulates wastewater discharges to land and surface waters. This is an attachment to the Industrial Applications for facilities with multiple chemical additives.

Complete the attachment by typing or printing in black ink. Attach additional sheets as necessary. For more information, please contact the Minnesota Pollution Control Agency (MPCA) at: In Metro Area: 651-296-6300 or Outside Metro Area: 800-657-3864.

Permittee name: Poly Met Mining, Inc. Permit number: MN TBD

The modeled chemical requirements for projected 50th percentile (P50) values were used as the average rate of use, and the modeled chemical requirements for projected 90th percentile (P90) values were used as the maximum rate of use.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Purpose</th>
<th>Location of chemical addition in process (e.g., to raw water supply, at greensand filter, before RO unit #2, etc.)</th>
<th>Amount/duration/frequency of addition (i.e., continuous or slug dosing. If slug dosing give amount/duration and frequency of addition; e.g., slug dosing 13.5 gal/3 hours, once every two weeks)</th>
<th>Average rate of use (weight or volume per day)</th>
<th>Maximum rate of use (weight or volume per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Permanganate</td>
<td>Filter Pretreatment</td>
<td>Greensand Filter at mine water treatment trains</td>
<td>Continuous</td>
<td>12 lbs/day (Mine Year 1)</td>
<td>15 lbs/day (Mine Year 1)</td>
</tr>
<tr>
<td>Solution (Primary)</td>
<td></td>
<td></td>
<td></td>
<td>22 lbs/day (Mine Year 7)</td>
<td>33 lbs/day (Mine Year 5)</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>pH Adjustment</td>
<td>Re-carbonation at mine water treatment trains and Secondary Membranes at mine water treatment trains</td>
<td>Continuous</td>
<td>5 tons/day (Mine Year 1)</td>
<td>5 tons/day (Mine Year 1)</td>
</tr>
<tr>
<td>(Primary)</td>
<td></td>
<td></td>
<td></td>
<td>7 tons/day (Mine Year 7)</td>
<td>8 tons/day (Mine Year 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 tons/day (Mine Year 10)</td>
<td>11 tons/day (Mine Year 10)</td>
</tr>
<tr>
<td>Hydrochloric Acid (Standby)</td>
<td>pH Adjustment</td>
<td>Sulfate Removal at mine water treatment trains</td>
<td>Continuous as needed</td>
<td>0 lbs/day (Mine Years 1, 5, and 10)</td>
<td>Less than 1,600 lbs/day (Mine Year 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 tons/day (Mine Year 1)</td>
<td>Less than 3,200 lbs/day (Mine Year 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 tons/day (Mine Year 7)</td>
<td>Less than 5,000 lbs/day (Mine Year 10)</td>
</tr>
<tr>
<td>Hydrated Lime (Primary)</td>
<td>pH Adjustment</td>
<td>HDS Metals Removal at mine water treatment trains</td>
<td>Continuous</td>
<td>5 tons/day (Mine Year 1)</td>
<td>5 tons/day (Mine Year 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 tons/day (Mine Year 7)</td>
<td>15 tons/day (Mine Year 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13 tons/day (Mine Year 10)</td>
<td>26 tons/day (Mine Year 10)</td>
</tr>
<tr>
<td>Hydrated Lime (Primary)</td>
<td>pH Adjustment</td>
<td>Sulfate Removal at mine water treatment trains</td>
<td>Continuous</td>
<td>5 tons/day (Mine Year 1)</td>
<td>5 tons/day (Mine Year 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 tons/day (Mine Year 7)</td>
<td>12 tons/day (Mine Year 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11 tons/day (Mine Year 5)</td>
<td>15 tons/day (Mine Year 10)</td>
</tr>
</tbody>
</table>

www.pca.state.mn.us • 651-296-6300 • 800-657-3864 • TTY 651-282-5332 or 800-657-3864 • Available in alternative formats wq-wwprm7-48 • 2/8/2013
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>HDS Metals Removal at mine water treatment trains</th>
<th>Continuous as needed</th>
<th>Year 10</th>
<th>(Mine Year 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferric Sulfate</td>
<td>Iron Supplement</td>
<td>Continuous as needed</td>
<td>0 lbs/day (Mine Years 1, 5, and 10)</td>
<td>Less than 2,900 lbs/day (Mine Year 1)</td>
<td></td>
</tr>
<tr>
<td>(Standby)</td>
<td></td>
<td></td>
<td></td>
<td>Less than 4,500 lbs/day (Mine Year 5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Less than 6,400 lbs/day (Mine Year 10)</td>
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</tr>
<tr>
<td>GE Hypersperse</td>
<td>Membrane</td>
<td>Continuous</td>
<td>11 lbs/day (Mine Year 1)</td>
<td>12 lbs/day (Mine Year 1)</td>
<td></td>
</tr>
<tr>
<td>MDC150 (Primary)</td>
<td>Antiscalant</td>
<td></td>
<td></td>
<td>19 lbs/day (Mine Year 7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>37 lbs/day (Mine Year 10)</td>
<td></td>
</tr>
<tr>
<td>NLR 759 (Primary)</td>
<td>Phosphoric Acid</td>
<td>Continuous</td>
<td>4 gallons/day (Mine Year 1)</td>
<td>4 gallons/day (Mine Year 1)</td>
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</tr>
<tr>
<td></td>
<td>Antiscalant</td>
<td></td>
<td></td>
<td>6 gallons/day (Mine Year 7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 gallons/day (Mine Year 10)</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>Oxidant-Quenching</td>
<td>Continuous</td>
<td>5 lbs/day (Mine Year 1)</td>
<td>6 lbs/day (Mine Year 1)</td>
<td></td>
</tr>
<tr>
<td>Bisulfite</td>
<td>Membrane Pretreatment</td>
<td></td>
<td></td>
<td>9 lbs/day (Mine Year 7)</td>
<td></td>
</tr>
<tr>
<td>(Primary)</td>
<td></td>
<td></td>
<td></td>
<td>17 lbs/day (Mine Year 10)</td>
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</tr>
<tr>
<td>Sodium</td>
<td>Oxidant-Quenching</td>
<td>Continuous</td>
<td>3 lbs/day (Mine Year 1)</td>
<td>3 lbs/day (Mine Year 1)</td>
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<tr>
<td>Bisulfite</td>
<td>Membrane Pretreatment</td>
<td></td>
<td></td>
<td>5 lbs/day (Mine Year 5)</td>
<td></td>
</tr>
<tr>
<td>(Primary)</td>
<td></td>
<td></td>
<td></td>
<td>6 lbs/day (Mine Year 5)</td>
<td></td>
</tr>
<tr>
<td>MetClear</td>
<td>Metals Polishing</td>
<td>Continuous</td>
<td>0 lbs/day (Mine Years 1, 5, and 10)</td>
<td>Less than 6 lbs/day (Mine Year 1)</td>
<td></td>
</tr>
<tr>
<td>MR2405 (Standby)</td>
<td>Scavanger</td>
<td></td>
<td></td>
<td>Less than 9 lbs/day (Mine Year 5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Less than 14 lbs/day (Mine Year 10)</td>
<td></td>
</tr>
<tr>
<td>Anionic</td>
<td>Flocculant Aid</td>
<td>Continuous as needed</td>
<td>0 lbs/day (Mine Years 1, 5, and 10)</td>
<td>Less than 6 lbs/day (Mine Year 1)</td>
<td></td>
</tr>
<tr>
<td>Polymer</td>
<td></td>
<td></td>
<td></td>
<td>Less than 10 lbs/day (Mine Year 5)</td>
<td></td>
</tr>
<tr>
<td>Flocculant</td>
<td></td>
<td></td>
<td></td>
<td>Less than 14 lbs/day (Mine Year 10)</td>
<td></td>
</tr>
<tr>
<td>(Standby)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC-1 (Primary)</td>
<td>Citric Acid Membrane Cleaner</td>
<td></td>
<td>1,600 lbs/year (Mine Year 1)</td>
<td>1,600 lbs/year (Mine Year 1)</td>
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<td></td>
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<td></td>
<td>3,500 lbs/year (Mine Year 10)</td>
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</tr>
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<td></td>
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<td></td>
<td></td>
<td>3,500 lbs/year</td>
<td></td>
</tr>
<tr>
<td>Chemical Code</td>
<td>Chemical Type</td>
<td>Membrane Type</td>
<td>Use Rate</td>
<td>Year 1</td>
<td>Year 5</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------</td>
<td>----------------------------------------------------</td>
<td>---------------------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>MC-4</td>
<td>Alkaline Surfactant</td>
<td>Primary Membranes at mine water treatment trains</td>
<td>Continuous</td>
<td>1.600 lbs/year (Mine Year 1)</td>
<td>1.600 lbs/year (Mine Year 1)</td>
</tr>
<tr>
<td>NLR 404</td>
<td>Organic Acid</td>
<td>Secondary Membranes at mine water treatment trains</td>
<td>Continuous</td>
<td>9,000 gallons/yr (Mine Year 1)</td>
<td>9,000 gallons/yr (Mine Year 1)</td>
</tr>
<tr>
<td>NLR 505</td>
<td>Alkaline Surfactant</td>
<td>Secondary Membranes at mine water treatment trains</td>
<td>Continuous</td>
<td>9,000 gallons/yr (Mine Year 1)</td>
<td>9,000 gallons/yr (Mine Year 1)</td>
</tr>
</tbody>
</table>

*Remember to attach the Material Safety Data Sheets, complete product labels and any other information on chemical composition, aquatic toxicity, human health, and environmental fate for each chemical additive. Please make a copy for your records. Refer to the Transmittal Form for mailing instructions.

Chemicals listed as standby are not intended to be used at the average and maximum rates of use unless necessary.
1.0 Introduction

This volume, Volume III of the National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit Application (Application) for Poly Met Mining, Inc.'s (PolyMet) NorthMet Project (Project), describes the design and operation of the Waste Water Treatment System (WWTS). The primary components of the WWTS for the Project will include the Equalization Basin Area at the Mine Site, the Mine to Plant Pipelines (MPP), and the WWTS building, which is located at the Plant Site and will house the process equipment for the treatment trains.

As described below, the discharge from the WWTS as stream augmentation is the Project's sole point-source discharge (other than stormwater) to waters of the state. The WWTS will operate as a single, combined system at one location to replace the preliminarily proposed (and separately located) Waste Water Treatment Plant (WWTP) and Waste Water Treatment Facility (WWTF). There is no change to the level of treatment planned for the Project as a result of this relocation of treatment infrastructure.

Section 1.1 summarizes the overall Project water management strategy. Section 1.2 provides an overview of the WWTS. The tables in these sections include relevant definitions used in this volume and cross-reference information among key sections of the Application. Refer to Section 2.0 of Volume I for discussion of the permitting approach for this Application as it applies to the WWTS.

1.1 Project Water Management Strategy

The overall water management strategy for the Project was developed to achieve, among other things, the following goals:

- maximize beneficial reuse of mine water and process water in the Beneficiation Plant
- treat tailings basin seepage to meet all applicable state and federal standards before it is discharged
- reduce the overall mercury loading to the St. Louis River watershed by using the Tailings Basin as a filter
- minimize hydrologic impacts of the Project

To achieve these outcomes, the Project waste water treatment strategy is integrated across the Mine and Plant Sites. The two primary components of the WWTS are the mine water treatment trains and the tailings basin seepage treatment train. The two components have been designed to operate in tandem for the Project and are located in the WWTS building at the Plant Site. These trains are described separately throughout this volume to provide clarity to the intended purpose of each component. The WWTS will use the best demonstrated, efficient commercially available technologies to remove metals and sulfate from mine water and tailings basin seepage (as defined in Table 1-2). The WWTS is designed to meet applicable water quality standards, to satisfy applicable state antidegradation requirements (Section 4.0 and Appendix A), and to enable the Project to meet the New Source Performance Standards (NSPS)
applicable under federal or state requirements (Section 5.0 and Appendix B). Figure 1-1 illustrates the integrated waste water treatment strategy. The WWTS is an adaptive engineering control, as described in Sections 1.0, 2.0, and 4.0 of the Adaptive Water Management Plan (Reference (1)), and changes to this system will be made to its design, operation, and/or maintenance to achieve this water management strategy. In addition to Reference (1), additional information describing the water management strategy for the Project can be found in the Water Management Plan – Mine (Reference (2)) and the Water Management Plan – Plant (Reference (3)).

![Figure 1-1 Integrated Waste Water Treatment Strategy](image)

**Figure 1-1 Integrated Waste Water Treatment Strategy**

The WWTS mine water treatment trains will treat *mine water* (as defined in Table 1-2) from the Mine Site along with WWTS reject concentrate. The treated *mine water* will be pumped to the Flotation Tailings Basin (FTB) for reuse in the beneficiation process (as shown in Figure 1-1). Water from construction dewatering of saturated mineral overburden (construction *mine water*) and runoff from the Overburden Storage and Laydown Area (OSLA) will be pumped directly to the FTB. Reuse of the treated *mine water* at the Plant Site will eliminate the need to discharge treated *mine water* to surface waters during operations and will minimize the volume of water that will need to be appropriated from Colby Lake.

The WWTS tailings basin seepage treatment train will treat *tailings basin seepage* (as defined in Table 1-2). This treatment will include both existing ferrous seepage as well as new nonferrous seepage, both
collected by the FTB seepage capture systems (specifically, the FTB Seepage Containment System and the FTB South Seepage Management System, as described in Section 2.3.3 of Volume V). Some seepage will be recycled directly to the FTB Pond for reuse. The fraction of seepage to be treated at the WWTS and discharged will depend on operational factors and precipitation, but the discharge volume will be managed so as to:

- comply with the 40 CFR 440 NSPS zero-discharge requirement\(^1\) applicable to new copper processing facilities
- meet an internal performance operating limit such that the WWTS discharge will have a maximum sulfate concentration of 10 mg/L
- minimize hydrologic impacts resulting from the implementation of the FTB seepage capture systems
- comply with applicable water quality standards

### 1.2 Water Treatment System Overview

In accordance with the water management strategy for the Project, as well as the applicable water quality standards and the requirements of Minnesota’s nonferrous permit-to-mine requirements, the WWTS has been designed “to control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization” (Minnesota Rules, part 6132.0200). The design of the WWTS will include the best demonstrated, efficient commercially available technologies for managing water in a manner that results in compliance with applicable effluent limits and surface water quality standards at appropriate compliance points (Section 1.1 of Reference (3) and Section 1.1 of Reference (2)). PolyMet designed the WWTS to achieve compliance, based on results of treatability and pilot plant testing and modeling of projected water quantity and quality. Additionally, plans have been developed for adaptive management (Sections 1.0, 2.0, and 4.0 of Reference (1), Section 6.4 of Reference (3), and Section 6.4 of Reference (2)) and contingency mitigation (Section 6.5 of Reference (3) and Section 6.5 of Reference (2)) as deemed necessary to maintain compliance (refer to Sections 2.3.3 and 3.2.3 of this volume for further discussion).

The WWTS will use chemical precipitation, greensand filtration, and membrane separation to treat mine water and tailings basin seepage. Membrane separation is a mature technology that has been demonstrated for use in mine water treatment for over 40 years (Reference (4)). It is not widely used, however, to treat mine water because achievable effluent quality is much higher than is typically required for treated mine water discharge. Membrane separation is generally considered the best proven, commercially available technology for removing dissolved, inorganic constituents. Along with distillation, it is one of the only methods for treating water with high concentrations of dissolved salts. In addition, treated water will be chemically stabilized prior to discharge. The proposed waste water treatment

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\(^1\) Zero discharge requirements allow for discharge of net precipitation and waste streams combined with process wastewater, as described in Section 5.0 of this volume.
technology and level of treatment exceeds the level of treatment that is currently in place for any other waste water system discharging to the Partridge River or Embarrass River, or any other streams within the St. Louis River watershed. The proposed treatment is prudent and is an example of advanced treatment that exceeds the best available technology.

The WWTS discharge will be piped to streams north, west, and south of the Tailings Basin to minimize hydrologic and ecologic impacts resulting from the implementation of the FTB seepage capture systems.

Table 1-1 provides a high-level overview of the WWTS.

### Table 1-1 Waste Water Treatment System (WWTS) Summary

<table>
<thead>
<tr>
<th>Purpose of WWTS</th>
<th>To treat mine water and tailings basin seepage, and provide water for stream augmentation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS description</td>
<td>The primary components of the WWTS for the Project will include the Equalization Basin Area at the Mine Site, the Mine to Plant Pipelines (MPP), and the WWTS building, which is located at the Plant Site and will house the process equipment for the treatment trains. The WWTS will treat tailings basin seepage using reverse osmosis (RO) or equivalently performing technology. The WWTS will also treat mine water. Mine water flows will be segregated based on type and treated in two mine water treatment trains. The mine water chemical precipitation train will treat high-concentration mine water and also treat WWTS membrane concentrate. The mine water filtration train will treat low-concentration mine water using membrane separation. The WWTS will be an adaptive engineering control to meet PolyMet’s water management strategy, as described in Section 1.1, and these treatment trains will be an adaptable part of this strategy.</td>
</tr>
<tr>
<td>WWTS effluent destinations</td>
<td>• Effluent from the tailings basin seepage treatment train (WWTS discharge) will be piped to maintain flows in Trimble Creek, Second Creek, and Unnamed Creek. • Effluent from the mine water treatment trains (treated mine water) will be routed to the Flotation Tailings Basin (FTB) Pond.</td>
</tr>
<tr>
<td>Estimated commission</td>
<td>The WWTS will be constructed and tested during an estimated 18-24 month construction phase. Operation of the WWTS will begin at the start of Mine Year 1(^{(1)}). The mine water will be sent to the FTB prior to Mine Year 1.</td>
</tr>
<tr>
<td>Reclamation phase(^{(2)})</td>
<td>The WWTS will continue to treat tailings basin seepage collected by the FTB seepage capture systems. It will also treat mine water as needed.</td>
</tr>
<tr>
<td>Closure(^{(3)}) and postclosure maintenance phases(^{(4)})</td>
<td>The WWTS will be operated as needed until the Project can transition from mechanical water treatment to non-mechanical water treatment systems.</td>
</tr>
</tbody>
</table>

Italicized terms are defined in Table 1-2.  
(1) Mine Year 1 will begin on the first day of production blasting within the open pit at the Mine Site.  
(2) The reclamation phase is estimated to start in Mine Year 21.  
(3) The closure phase is estimated to start in Mine Year 25.  
(4) The postclosure maintenance phase is estimated to start in Mine Year 55, once the West Pit has flooded.
This volume is organized in five sections:

Section 1.0  Summarizes the Project water management strategy and water treatment system and provides the water definitions specific to this volume.

Section 2.0  Describes the WWTS tailings basin seepage treatment train, including the influent, WWTS discharge treatment targets, design and operation, discharge, additives and waste streams, and proposed monitoring plan.

Section 3.0  Describes the WWTS mine water treatment trains, including influents, design and operation, treated mine water, additives and waste streams, and proposed monitoring plan.

Section 4.0  Summarizes the WWTS Antidegradation Evaluation.

Section 5.0  Summarizes the Project’s compliance with requirements of the NSPS zero discharge rule, 40 CFR part 440.

Table 1-2 provides definitions for the terms *mine water, process water, tailings basin water,* and *tailings basin seepage,* as well as notes regarding the definitions’ application to specific facets of the WWTS.
### Table 1-2  Project Water Definitions

<table>
<thead>
<tr>
<th>Project-Specific Term</th>
<th>Project-Wide Definition&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Waste Water Treatment System (WWTS) Specifics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Water</td>
<td>Water collected by the mine water management systems, including precipitation, runoff, groundwater, and other water collected from areas of the Mine Site and routed from the Mine Site to the WWTS or Flotation Tailings Basin (FTB) via the Mine to Plant Pipelines (MPP) and, in later years, routed to the East and Central Pits for pit flooding.</td>
<td>The WWTS treats <em>mine water</em> conveyed from the equalization basins. The construction <em>mine water</em> and the Overburden Storage and Laydown Area (OSLA) runoff are conveyed to the FTB Pond and, in later years, to the East and Central Pits for pit flooding, rather than the WWTS.</td>
</tr>
<tr>
<td>Process Water</td>
<td>Water that has been used in the beneficiation process or hydrometallurgical process.</td>
<td><em>Process water</em> is an internal flow within the operation of the Beneficiation and Hydrometallurgical Plants and is not managed directly at the WWTS.</td>
</tr>
</tbody>
</table>
| Tailings Basin Water  | Water in the FTB Pond or in pores of the tailings, which includes the following sources:  
  - *process water* resulting from the beneficiation process  
  - treated *mine water* routed from the WWTS  
  - construction *mine water* conveyed from the Mine Site  
  - OSLA runoff  
  - *tailings basin seepage* collected by the FTB seepage capture systems and returned to the FTB Pond  
  - treated water from the Sewage Treatment System  
  - greensand filter backwash and clean-in-place (CIP) wastes from the WWTS  
  - precipitation and runoff from areas within the FTB dams and tributary to the FTB Pond | (no additions to Project-Wide Definition) |
| Tailings Basin Seepage| *Tailings basin water* that infiltrates through Flotation Tailings, LTV Steel Mining Company (LTVSMC) tailings, and/or Tailings Basin dams and migrates through the base or external dam faces of the Tailings Basin. | The WWTS treats *tailings basin seepage* collected by the FTB seepage capture systems. |

<sup>(1)</sup> If two types of waters mix, the mixture is handled as the more actively managed type of water (e.g., a mixture of *stormwater* and *mine water* is managed as *mine water*). Management of water mixtures will be governed by regulatory requirements.

During environmental review, PolyMet developed numerous Management Plans to provide details of the design, construction, operations, reclamation, closure, and postclosure maintenance phases of the Project. The Management Plans rely on and incorporate the results of Data Packages, which are compilations of technical data and related supporting information. In addition, the Waste Water Treatment System:
Design and Operation Report (Reference (5)) provides more detailed information regarding the proposed design and operation of the WWTS, the treatment and process modeling used for design basis, and relevant sources of data. A brief description of design and operation for the WWTS is presented in Sections 2.0 and 3.0 of this volume.

Information from the above-referenced documents, as well as from this and other permit applications and issued permits, will be incorporated into an operations plan for use during the operations, reclamation, closure, and postclosure maintenance phases of the Project. Refer to Section 1.7 of Volume I for a description of the Project phases.

To help the reviewer navigate the supporting material for Volume III of this Application, Table 1-3 cross-references key WWTS-related topics, PolyMet Management Plans and Data Packages, sections of this narrative, and permit application requirements.

Note that some terminology associated with the WWTS has changed since the environmental review process was completed and the NPDES/SDS Permit Application was submitted in July 2016. Changes are associated with the relocation of the mine water treatment trains that were previously planned for the Mine Site WWTF, which will now be in the Plant Site WWTS, and the relocation of the Mine Site equalization basins, Central Pumping Station, and Construction Mine Water Basin south of Dunka Road. There is no change to the level of treatment planned for the Project as a result of these relocations. To facilitate the review of documents prepared for the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) (Reference (6)) which are also referenced in this Application, Appendix C explains the WWTS terminology changes.
<table>
<thead>
<tr>
<th>Facility Topic</th>
<th>Location of Relevant Details:</th>
<th>NPDES/SDS Volume III</th>
<th>Permit Application Form</th>
<th>Application Question(s)</th>
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<td>Section 6.1</td>
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<td>WWTS Discharge Treatment Targets</td>
<td>NorthMet Project: Waste Water Treatment System: Design and Operation Report (Reference (5))</td>
<td>Section 2.2 and Table 2-1</td>
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<td>Attachment I</td>
<td>Water Treatment Residue Wastes Application (wq-wwprm7-17)</td>
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<td>Municipal &amp; Industrial Pond Attachment (wq-wwpm7-11)</td>
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<td>Section 3.3</td>
<td>Water Treatment Media Filter Attachment (wq-wwpm7-45)</td>
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<td>Section 3.4</td>
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<td>16</td>
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<td>Application Question¹,²,³</td>
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<td>Fate of Byproducts</td>
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<td>Industrial Surface Water Discharge of Process Wastewater Application (wq-wwprm7-20)</td>
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<td>Compliance with NSPS, 40 CFR 440</td>
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</tr>
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</table>

Gray shading indicates no corresponding reference material.

¹ Industrial Surface Discharge of Process Wastewater Application (wq-wwprm7-20) question 13 addresses disposal of sanitary waste water which does not occur at this facility; thus this question is not listed here.
² Industrial Surface Discharge of Process Wastewater Application (wq-wwprm7-20) questions 23 through 27 relate to discharge of stormwater which does not occur in this volume; thus these questions are not listed here.
³ Water Treatment Residue Wastes Application (wq-wwprm7-17) question 4 addresses the distribution of treated drinking water, which is not produced at this facility; these questions are not listed here.
2.0 Tailings Basin Seepage Treatment Train

The purpose of the tailings basin seepage treatment train is to treat *tailings basin seepage* before it is discharged to the environment. This discharge also provides the necessary flow to avoid significant hydrologic or ecologic impacts to Second Creek, Trimble Creek, and Unnamed Creek resulting from the implementation of the FTB seepage capture systems, which are described in Section 2.3.3 of Volume V. The selected treatment system represents the least degrading, feasible, and prudent technology for removing metals and sulfate from water (as documented in Appendix A) and includes adaptive management options to adjust treatment according to Project conditions.

This section describes the design and operation of the tailings basin seepage treatment train during Mine Years 1 through 10, which includes the period covered by this Application (approximately Mine Years 1 through 5) and the planned expansion of the tailings basin seepage treatment train to maximum capacity. The following sub-sections describe:

- the tailings basin seepage treatment train influent (Section 2.1)
- WWTS discharge treatment targets (Section 2.2)
- tailings basin seepage treatment train design and operation (Section 2.3), including the adaptive management approach that can be used to modify the treatment train in response to site-specific conditions encountered during operations (Section 2.3.3) and a brief overview of treatment train operations during the reclamation, closure, and postclosure maintenance phases (Section 2.3.4)
- the WWTS discharge (Section 2.4)
- chemical additives and byproducts proposed for use in the tailings basin seepage treatment train (Section 2.5)
- the proposed monitoring plan (Section 2.6)

Permit application support drawings for the WWTS, including the tailings basin seepage treatment train, are included in Appendix D.

2.1 Tailings Basin Seepage Treatment Train Influent

The influent to the tailings basin seepage treatment train will consist primarily of *tailings basin seepage* collected by the FTB seepage capture systems. The tailings basin seepage treatment train influent water quality and quantity used in water treatment models are based on 90th percentile (P90) annual average of the GoldSim model simulations for the Plant Site water quality and quantity completed for the FEIS (Reference (6)), as described in Section 3.2 of Reference (5).

Table 2-1 summarizes the estimated P90 tailings basin seepage treatment train influent quantity for Mine Year 1, Mine Year 8, and Mine Year 10. Mine Year 8 represents the first year that the influent flow to the tailings basin seepage treatment train will exceed 2,000 gallons per minute (gpm) on an annual average
basis, and thus will represent the approximate time when the tailings basin seepage treatment train will need to be expanded to its full capacity (refer to Section 2.3.2 of this volume). Mine Year 10 represents the highest projected flow rate during the operations phase of the Project.

Table 2-1  Tailings Basin Seepage Treatment Train Influent Flows

<table>
<thead>
<tr>
<th>Mine Year</th>
<th>Influent to Tailings Basin Seepage Treatment Train (gpm)</th>
<th>Annual Average</th>
<th>Monthly Maximum</th>
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<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>90th percentile</td>
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<tr>
<td>1</td>
<td></td>
<td>1,900</td>
<td>1,937</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2,278</td>
<td>2,868</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>3,026</td>
<td>3,900</td>
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</table>

Source: GoldSim Plant Site Model Simulations, December 2014 (Reference (7))

2.2 Waste Water Treatment System Discharge Treatment Targets

PolyMet has designed the tailings basin seepage treatment train so that the discharge will comply with applicable state water quality standards and federal effluent limitation guidelines. The tailings basin seepage treatment train will discharge to wetlands in the headwater areas of Trimble Creek and Unnamed Creek (classified under Minnesota Rules, part 7050.0425 as Class 2D, 3D, 4C, 5, and 6 waters) and to the headwater segment of Second Creek (classified under Minnesota Rules, part 7050.0430 as a Class 2B, 3C, 4A, 4B, 5, and 6 water). The most stringent standards applicable to these classes of waters were compiled, as detailed in Large Table 1 of Appendix A. In order to meet these standards, PolyMet has established parameter-specific treatment targets for the WWTS discharge (listed in Table 2-2) that will assist PolyMet in meeting or exceeding the most stringent applicable water quality standards. Meeting the applicable water quality standards at the “end of pipe” will help demonstrate that the WWTS discharge will not “cause or contribute to violation of water quality standards” (40 CFR 122.4(I)). Table 2-2 includes treatment targets for parameters anticipated to be present in the WWTS discharge. Barium, beryllium, iron, fluoride, and manganese were evaluated and assigned preliminary water quality targets as part of the environmental review process for the Project. However, because there are no promulgated surface water quality standards for these parameters, they were not assigned WWTS discharge treatment targets. During pilot-testing, stabilized effluent met Whole Effluent Toxicity (WET) targets (refer to Section 6.3.2.2 of Reference (9)). Full-scale stabilized WWTS discharge is also expected to meet WET limits. Although the WWTS will not discharge into any receiving waters that are listed as “wild rice” waters in the existing or proposed Minnesota Pollution Control Agency (MPCA) rules and PolyMet considers the sulfate water quality standard in Minnesota Rules, part 7050.0224 to be inapplicable to the Project, PolyMet plans an operating limit of 10 mg/L for sulfate as an internal performance metric for evaluation of the WWTS operation, as discussed in Appendix D of Volume I. Therefore, PolyMet has incorporated a 10 mg/L sulfate treatment target into the tailings basin seepage treatment train design. Actual effluent limits for constituents in the WWTS discharge that are subject to applicable water quality standards will be established in the NPDES/SDS permit.
<table>
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<tr>
<th>Parameter</th>
<th>Target</th>
<th>Basis</th>
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<td>Aluminum</td>
<td>125</td>
<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard)</td>
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<td>Antimony</td>
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<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard)</td>
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<tr>
<td>Arsenic(1,2)</td>
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<td>Federal Drinking Water Standard (Primary MCLs)</td>
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<tr>
<td>Boron</td>
<td>500</td>
<td>Minnesota Rules, part 7050.0224 Class 4A (chronic standard)</td>
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<td>Cadmium(2,3)</td>
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<td>Minnesota Rules, part 7052.0100 Class 2B (chronic standard)</td>
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<td>Chromium(4)</td>
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<td>Mercury(2)</td>
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<td>Nickel(3)</td>
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<td>Silver</td>
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<td>Thallium</td>
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<td>Zinc(2,3)</td>
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<tr>
<td>Chloride</td>
<td>230 mg/L</td>
<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard)</td>
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<td>Hardness</td>
<td>100 mg/L</td>
<td>Hardness target chosen to establish targets for metals with a hardness-based standard</td>
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<td>Oxygen, dissolved</td>
<td>&gt; 5.0 mg/L (min)</td>
<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard)</td>
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<tr>
<td>pH(2)</td>
<td>6.5-8.5 SU</td>
<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard) and Minnesota Rules, part 7050.0224 Class 4A (chronic standard)</td>
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<td>Solids, Total Suspended(2)</td>
<td>15 mg/L</td>
<td>Minnesota Rules, part 7050.0222 Class 2B (chronic standard)</td>
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<td>Sodium (%)</td>
<td>60% of cations</td>
<td>Minnesota Rules, part 7050.0224 Class 4A (chronic standard)</td>
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<tr>
<td>Sulfate</td>
<td>10 mg/L</td>
<td>Internal performance operating limit(6)</td>
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<tr>
<td>Whole Effluent Toxicity (WET)</td>
<td>Meet acute and chronic standards</td>
<td>Minnesota Rules, part 7050.0240</td>
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(1) Minnesota Rules, part 7050.0222 Class 2B standard for arsenic is 53 µg/L.
(2) Parameter with an effluent limit guideline in 40 CFR 440 which is less stringent than the listed target. See Table 5-1 of this volume.
(3) Surface water standard based on hardness, value shown assumes hardness of 100 mg/L
(4) Based on standard for Cr(+6)
(5) Minnesota Rules, part 7050.0223 Class 3C standard for hardness is 500 mg/L.
(6) PolyMet plans to implement an internal performance operating limit of 10 mg/L for sulfate, as described in Appendix D of Volume I.
2.3 Tailings Basin Seepage Treatment Train Design and Operation

The tailings basin seepage treatment train design and operation are based on the quality and quantity of influent flow and the anticipated WWTS discharge treatment targets, and use best available technology for removing dissolved, inorganic constituents, including metals and sulfate, from water. Design and operation are detailed in Sections 3.3 and 3.4 of Reference (5). Permit application support drawings are included in Appendix D. Key information that provides the basis for the design of the tailings basin seepage treatment train is included in the Plant Site WWTP pilot-test report (Reference (9)).

2.3.1 Treatment Processes

This section summarizes the tailings basin seepage treatment train processes, including the pre-treatment basin (Section 2.3.1.1); greensand filtration (Section 2.3.1.2); primary membrane separation (Section 2.3.1.3); secondary membrane separation (Section 2.3.1.4); and permeate stabilization (Section 2.3.1.5). Large Figure 2, Large Figure 3, and Large Figure 4 show treatment schematics of the WWTS in Mine Years 1, 10, and 15, including the tailings basin seepage treatment train. The WWTS equipment described in the following sections (with the exception of the Pre-Treatment Basin) will be contained within a heated building.

2.3.1.1 Pre-Treatment Basin

The Pre-Treatment Basin (as described in Section 3.3.4 of Reference (5)) will precipitate iron to reduce the load to the greensand filter. Tailings basin seepage from the FTB seepage capture systems may be dosed with a flocculant chemical to aid in settling iron particles prior to discharge to the Pre-Treatment Basin. The detention time for the Pre-Treatment Basin was selected to provide adequate time for oxidation and settling of the iron precipitate. The Pre-Treatment Basin will be lined to protect groundwater.

2.3.1.2 Greensand Filtration

The greensand filter (as described in Section 3.3.5 of Reference (5)) will be used to remove iron, manganese, and total suspended solids that would foul membranes during primary membrane separation if not removed. “Greensand filter” is a term of art that refers to a media filter with an oxidation process. While greensand filter media is typically silica sand coated with a manganese oxide coating, the specific media that will be used for the filter, which could be green sand or other media with an oxidative coating, will be determined during final design based on site-specific information. Sodium permanganate will be added as a pretreatment to oxidize dissolved manganese and iron for increased removal and to maintain the charge on the media to allow contact oxidation of manganese.

The greensand filter will also assist with the removal of other metals, including copper, nickel, cobalt, lead, and zinc as reported in Section 4.1 of Reference (10). Some mercury removal is expected across the greensand filter. However, the influent concentration of mercury to the tailings basin seepage treatment train is expected to be below the WWTS discharge treatment target because existing groundwater seepage data and other testing work has confirmed that mercury is retained within the FBT. Additional information on mercury in relation to the Project is provided in Reference (11). Effluent from greensand filtration will be routed to primary membrane separation.
2.3.1.3 Primary Membrane Separation

The primary membrane system (as described in Section 3.3.6 of Reference (5)) will use reverse osmosis (RO) or equivalently performing technology to separate dissolved constituents from water by applying pressure to drive water molecules across the membrane and away from the dissolved constituents. During this process, clean water (permeate) will pass through the membrane, while a concentrated brine solution (concentrate) will be retained by the membrane. The ability of RO or equivalently performing technology to reduce sulfate to below the 10 mg/L internal performance operating limit and corresponding WWTS discharge treatment target listed in Table 2-2 was the main reason for the selection of this technology for the tailings basin seepage treatment train.

The primary membrane separation system for the tailings basin seepage treatment train will use a conventional, spiral wound membrane configuration, with multiple membranes operating in a series and parallel configuration to provide the needed capacity. This system is designed to operate on a continuous basis while isolated elements are removed from operation for periodic cleaning. The majority of the primary membrane separation treatment unit capacity will be designed to treat tailings basin seepage. The primary membrane separation units will be designed to treat permeate from the secondary membrane.

A wide variety of membranes can be used in the primary RO or equivalently performing technology system. Several have been demonstrated to be effective with site-specific water as reported in Attachments B, D, and E of Reference (5). The membranes that will be used in the primary membrane separation system will be RO or equivalently performing technology, and will be selected during the final design based on demonstrated ability to remove the constituents of interest for this Project and to meet the effluent limitations established in the NPDES/SDS permit.

2.3.1.4 Secondary Membrane Separation

A secondary membrane system (as described in Section 3.3.7 of Reference (5)) will reduce the volume of the primary membrane concentrate. Minimizing the concentrate volume increases the concentration of sulfate and other constituents of concern so that they can subsequently be removed by chemical precipitation in the mine water chemical precipitation train (as depicted in Large Figure 4 of Reference (5) and described in Section 3.2.1.1 of this volume). The secondary membrane treatment system that will be used is referred to as a vibratory sheer enhanced process (VSEP) arrangement. This system will use a flat-sheet membrane configuration in a stacked configuration that works with the vibratory action to prohibit the initial crystallization of dissolved constituents.

Each membrane stack will operate independently in a batch-mode with a declining flux rate to produce the secondary membrane concentrate and the secondary membrane permeate. The membranes used in the secondary membrane treatment system will be selected to optimize the performance of the chemical precipitation units for the removal of the constituents of interest for this Project. Based on the results of the pilot-testing for this Project (References (9), (10), and (12)), the use of nanofiltration (NF) membranes specifically designed to retain many of the constituents of interest for this Project, including sulfate and divalent metals, while allowing monovalent ions such as sodium and chloride to pass through the membranes. This will limit the amount of monovalent ions routed with secondary membrane concentrate.
to the mine water chemical precipitation train, where they can interfere with precipitation. Secondary membrane permeate will be routed to the primary membrane separation process unit (as described in Section 2.3.1.3 of this volume) for treatment prior to discharge.

2.3.1.5 Permeate Stabilization

The permeate must be stabilized, prior to discharge, to prevent the water from being toxic to aquatic organisms because of mineral deficiency. Permeate from the primary membrane separation process will be stabilized using limestone bed contactors (as described in Section 3.3.8 of Reference (5)) and gas stripping to provide hardness and alkalinity and to remove excess dissolved carbon dioxide. “Limestone bed contactor” is a term of art that refers to a bed contacter containing minerals, not limited to limestone, used to stabilize membrane effluent. The specific design of the bed contactor will be determined during final design based on site-specific information.

2.3.2 Construction

Initial construction of the tailings basin seepage treatment train will be completed prior to the start of operations in Mine Year 1 and will include equipment to treat 2,000 gpm. It is estimated that the final build-out of the tailings basin seepage treatment train will need to be completed prior to Mine Year 8. The final build-out will increase the tailings basin seepage treatment train treatment capacity to 4,000 gpm.

2.3.3 Adaptive Management

The tailings basin seepage treatment train is an adaptive system for waste water treatment, as described in Section 4.0 of Reference (1). Variations of either influent water quantity or quality will be addressed in a timely manner within the overall concept for the design, construction, and operation of the tailings basin seepage treatment train to allow the system to meet the NPDES/SDS permit requirements for the Project. Because the plan for construction of the tailings basin seepage treatment train envisions a phased build-out of the capacity that will be needed when the maximum flow occurs, variations in quantity will be addressed by modifying the schedule for the installation of the additional equipment that is planned for the expansion of the tailings basin seepage treatment train. Treatment performance issues that could occur from changes in influent water quality will be addressed by installation of additional equipment or by making adjustments to operating conditions.

The primary membranes are produced in standard sizes that provide operational flexibility. Thus, membrane elements could be modified (upgraded) when new products are developed in the future that will provide an operational advantage over the currently envisioned models. In addition, the ratio of primary membrane module types can be adjusted as needed to maintain effluent quality.

2.3.4 Overview of the Reclamation, Closure, and Postclosure Maintenance Phases

While the activities described in this section are beyond the scope of the first NPDES/SDS permit term, an overview of the activities associated with the reclamation, closure, and postclosure maintenance phases,
which are estimated to begin in Mine Years 21, 25, and 55, respectively, are provided here as additional background.

The tailings basin seepage treatment train will continue to operate in various Project phases to support the reclamation, closure, and postclosure maintenance phase activities at the Plant Site and Mine Site until the transition to non-mechanical treatment is approved. Treatment units described in Section 2.3.1 of this volume can be used during the reclamation, closure, and postclosure maintenance phases. System operation will be modified to optimize unit performance. Waste water treatment will transition from mechanical treatment to non-mechanical treatment as soon as possible, anticipated to occur during the closure or postclosure maintenance phases, using mature technology once approved by the MPCA. Additional detail on WWTS operations during the reclamation, closure, and postclosure maintenance phases is provided in Sections 4.2.1.2 and 4.2.1.3 of Reference (1).

2.4 Waste Water Treatment System Discharge

The WWTS discharge will meet the requirements established as part of the NPDES/SDS permitting process for the Project and will be discharged to the environment according to the following sub-sections.

2.4.1 Waste Water Treatment System Discharge Quality

The tailings basin seepage treatment train will be operated to provide treated water that will meet the discharge requirements established in the NPDES/SDS permit for the Project. Modeling conducted for the WWTS design process\(^2\) indicates that the proposed WWTS design will be capable of meeting the WWTS discharge treatment targets listed in Section 2.2 of this volume and the NSPS standards outlined in 40 CFR 440.104 (Section 3.2.5 and Attachment H of Reference (5)). Furthermore, the tailings basin seepage treatment processes can be adapted, as necessary, in response to the actual conditions encountered during the Project, the monitoring results, and the conditions estimated by continued modeling updates as described in Section 4.0 of Reference (1). The Antidegradation Evaluation (Appendix A) assesses the effect of WWTS discharge on receiving waters and downstream waters.

2.4.2 Discharge Rate

The rate of discharge from the WWTS will vary during operations, depending on the volume of mine water, the amount of precipitation, and the needs of the Project. The tailings basin seepage treatment train will be operated such that the discharge rate meets the requirements of the NSPS (Section 5.0 of this volume) and achieves the stream augmentation objectives, as stated in the FEIS, to minimize ecologic and hydrologic impacts to Second Creek, Trimble Creek, and Unnamed Creek by limiting the change in average annual flow in the receiving waters to ±20% of existing conditions (conditions before the implementation of the pumpback systems, which are short term mitigation measures as part of the Cliffs Erie, LLC (Cliffs Erie) Consent Decree) (Section 5.2.2.1.2 of Reference (6)). Modeling indicates that both the NSPS and the stream augmentation objectives can be met with a total discharge rate of approximately 1,700 gpm to 3,200 gpm (Section 5.1.2.8 of Reference (7)), distributed to the receiving waters in

\(^2\) WWTS design modeling was based on the P90 influent flows and loads estimated by the FEIS GoldSim model.
proportion to the amount of seepage that is collected from the respective subwatersheds by the FTB seepage capture systems. The expected WWTS discharge rate from Mine Year 1 through Mine Year 10, shown on Figure 2-1, is within this range. The discharge rate will be relatively constant during the early years of operations, then will gradually increase after Mine Year 7, when pit dewatering increases. Increased pit dewatering will result in more treated mine water being sent to the FTB, decreasing the amount of tailings basin seepage that can be returned to the FTB, and therefore increasing the amount of tailings basin seepage that will be will treated and discharged.

![Graph showing WWTS discharge rate Mine Years 1 to 10 based on P50 (annual average) values from FEIS modeling](image)

**Figure 2-1**  WWTS discharge rate Mine Years 1 to 10 based on P50 (annual average) values from FEIS modeling

### 2.4.3 Surface Water Discharge Outfalls and Monitoring Stations

Treated tailings basin seepage will be collected in the Treated Water Storage Tank (SD001), then pumped to the surface water discharge outfalls. Water quality will be monitored at SD001, and the flow rates to the surface water discharge outfalls to the headwater wetlands of Unnamed Creek (SD002 and SD003), the headwater wetlands of Trimble Creek (SD004 through SD010), and the headwater segment of Second Creek (SD011) will be recorded in the WWTS, at the point where the flow is divided for routing to the outfalls. The WWTS discharge will be distributed to these tributaries in proportion to the flow required to minimize hydrologic or ecologic impacts. The headwater segment of Second Creek will be served by one surface water discharge outfall. For the discharges to the wetlands in the headwater areas of Unnamed Creek and Trimble Creek, a more diffuse hydrological approach is preferable, so multiple surface water discharge outfalls will serve these areas. The proposed design with two surface water discharge outfalls to the Unnamed Creek wetlands and seven surface water discharge outfalls to the Trimble Creek wetlands is shown on Large Figure 5. Refer to Section 2.7 of Reference (3) for additional information on stream augmentation.

WWTS discharge locations and requirements during the reclamation, closure, and postclosure maintenance phases will be determined during future NPDES/SDS permit renewals.
2.4.4 Reasonable Potential to Exceed Analysis

To evaluate whether effluent limits are required for state water quality standards, the MPCA is required to conduct a Reasonable Potential to Exceed Analysis (RPE). Under the Clean Water Act, the MPCA is required to use effluent limitations to “control all pollutants” that are or may be discharged at a level “which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality.” (40 CFR 122.44(d)(1)(i)).

The U.S. Environmental Protection Agency (USEPA) outlines procedures for conducting the RPE in a “Technical Support Document For Water Quality-based Toxics Control”, March 1991 (TSD) (Reference (13)). The TSD outlines two approaches to conduct the RPE:

- For facilities with data, a statistical evaluation of the data is conducted to determine whether the effluent has a reasonable potential to exceed a water quality standard as outlined in the procedures.
- For facilities without data, a RPE must consider at a minimum dilution, industry type, existing data, history of compliance problems and toxic pollutants, types of receiving waters and designated uses (refer to Section 3.2 of Reference (13)).

The Project is a new mining operation that will include a new waste water treatment system. While no operating data are available for comparison to effluent limits, a model of likely waste water quality originating from the Project was developed during environmental review. The output of this water quality modeling from the environmental review was used to evaluate, pilot-test, select, and design the operating configuration for the proposed WWTS, incorporating the best available technologies for the constituents of interest for this Project. A new, integrated waste water treatment model was also developed for this Application, after the FEIS was completed, based on the results of site-specific pilot-testing and vendor data to allow evaluation of all the process units operating in the proposed treatment sequence. The results from this additional modeling, in comparison to a set of water quality targets, effectively demonstrate that it is unlikely for any constituents of interest from the Project waste water to exceed water quality standards in the WWTS discharge, provided the system is operated in a manner consistent with the operating assumptions of the waste water treatment model. The modeled results for various years throughout the operation of the Project are included in Attachment H of Reference (5).

2.5 Additives and Waste Streams

Chemical use, byproducts, and waste streams associated with the tailings basin seepage treatment train are summarized in the following sub-sections and detailed in Sections 3.4.3 and 5.1.1 of Reference (5).

2.5.1 Chemical Additives

Chemicals proposed for use in the tailings basin seepage treatment train include:

- sodium permanganate for greensand filter pretreatment
- carbon dioxide for pH adjustment
- granular calcite for effluent stabilization
- membrane antiscalants for both primary and secondary membrane systems
- membrane cleaning chemicals for both primary and secondary membrane systems, including acidic and basic chemicals
- sodium bisulfite for removing excess oxidant prior to membrane filtration

Sodium permanganate and sodium bisulfite will be consumed in the treatment process, and carbon dioxide and calcite will be dissolved and neutralized. Membrane antiscalants will be incorporated into the concentrate streams and routed to the mine water chemical precipitation treatment train where they will ultimately precipitate with the sludge. Cleaning chemicals will be routed to the FTB with the cleaning waste streams. Preliminary usage rates and the ultimate fate of each chemical are further described in Table 5-1 of Reference (5). Chemical doses and usage rates will be optimized during startup and operation.

Additional information regarding proposed chemical additives that may be used at the tailings basin seepage treatment train can be found in Section 5.1.1 of Reference (5). Additionally, Safety Data Sheets and product information labels for each proposed chemical additive are included in Appendix E.

2.5.2 Tailings Basin Seepage Treatment Train Waste Streams

The byproducts from the tailings basin seepage treatment train will include waste from filter and membrane cleaning and concentrate from the secondary membrane separation process (as described in Section 3.4.3 of Reference (5)).

The primary and secondary membrane systems will be cleaned periodically using a manually initiated caustic and acid Clean-in-Place (CIP) process. Greensand filters will be backwashed periodically. CIP waste will contain cleaning chemicals and traces of membrane foulants. The greensand filter backwash waste will contain iron, manganese, hardness, and other salts. The CIP membrane waste and the greensand filter backwash will be routed to the FTB Pond.

Secondary membrane concentrate will be routed to the mine water chemical precipitation treatment train for treatment. Estimated tailings basin seepage treatment train byproduct volumes are presented in Section 3.4.3 of Reference (5).

2.6 Proposed Monitoring Plan

Monitoring proposed as part of permit requirements for the WWTS, including the tailings basin seepage treatment train, is included in the integrated Plant Site monitoring plan presented in Section 3.0 of Volume I. The proposed monitoring plan includes internal waste stream monitoring associated with tailings basin seepage treatment train influent as well as surface water discharge monitoring; these proposed monitoring stations are shown on Large Figure 5.
3.0 Mine Water Treatment Trains

The purpose of the mine water treatment trains is to maintain the overall water quality in the FTB Pond at or below water quality targets and to manage the water quality of tailings basin seepage, which will be the influent to the tailings basin seepage treatment train.

This section describes the design and operation of the mine water treatment trains during Mine Years 1 through 10, which includes the period covered by this Application (approximately Mine Years 1 through 5) and the planned expansion of the mine water treatment trains to maximum capacity. The following subsections describe:

- the mine water treatment train influents (Section 3.1)
- mine water treatment train design and operation (Section 3.2), including the adaptive management approach that can be used to modify the treatment trains in response to site-specific conditions encountered during operations (Section 3.2.3) and a brief overview of treatment train operations during the reclamation, closure, and postclosure maintenance phases (Section 3.2.4)
- treated mine water (Section 3.3)
- chemical additives and byproducts proposed for use in the mine water treatment trains (Section 3.4)
- the proposed monitoring plan (Section 3.5)

Permit application support drawings for the WWTS, including the mine water treatment trains, are included in Appendix D.

3.1 Mine Water Treatment Trains Influent

The mine water treatment trains will treat mine water from the Mine Site and secondary membrane concentrate from the tailings basin seepage treatment train. Mine water will be collected at the Mine Site Equalization Basin Area, as described in Sections 3.1.1 and 3.1.2.

3.1.1 Equalization Basin Area

In the Equalization Basin Area, PolyMet will manage mine water based on the projected water quality as follows:

- construction mine water and OSLA runoff will be routed to the Construction Mine Water Basin
- mine water from low-volume sources that are expected to have relatively high concentrations of dissolved constituents will be routed to the High Concentration Equalization (HCEQ) Basin
mine water from high-volume sources that are expected to have relatively low concentrations of dissolved constituents will be routed to Low Concentration Equalization (LCEQ) Basin 1 and LCEQ Basin 2.

Large Figure 6 shows the layout of the Equalization Basin Area. Additional detail on the Equalization Basin Area is provided in Section 2.1.6 of Reference (2).

### 3.1.2 Mine to Plant Pipelines (MPP)

Three pipelines (collectively referred to as the MPP) will convey water between the Mine Site and the Plant Site:

- the Construction Mine Water Pipeline will transport mine water from the Construction Mine Water Basin to the FTB through Mine Year 11 (see Section 2.1.8 of Reference (2))
- the Low Concentration Mine Water Pipeline will transport mine water from the LCEQ Basins to the mine water filtration treatment train at the WWTS (Section 3.2.1.2)
- the High Concentration Mine Water Pipeline will transport mine water from the HCEQ Basin to the mine water chemical precipitation treatment train at the WWTS (Section 3.2.1.1)

The MPP alignment is parallel to Dunka Road. The alignment of the three pipelines diverges within the Plant Site where the Construction Mine Water Pipeline heads north to the FTB and the Low Concentration Mine Water Pipeline and High Concentration Mine Water Pipeline go the WWTS. The location of the MPP are shown on Large Figure 1. Additional detail on the MPP is provided in Section 2.1.8 of Reference (2).

### 3.1.3 Influent Flow and Quality

The estimated influent water quality of the mine water treatment trains is outlined in Section 4.2 of Reference (5). Water quality estimates for water treatment models are based on the GoldSim modeled P90 annual average estimates for flows and concentrations from each water source (Section 2.2.3.2 of Reference (1)). This GoldSim modeling was developed for the FEIS (Reference (6)).

Table 3-1 outlines projected flows from the HCEQ and LCEQ Basins that will be treated in the mine water treatment trains in Mine Years 1, 5, and 10, respectively. Mine Year 10 reflects the highest projected flow rate and sulfate loading for the life of the Project.
This page contains a table and text. The table is titled "Table 3-1 Mine Water Treatment Trains Influent Flows" and includes data on influent flows from High Concentration Equalization (HCEQ) and Low Concentration Equalization (LCEQ) Basins. The text discusses the design and operation of mine water treatment trains, including the use of chemical precipitation and primary membrane separation. The text also mentions the basis for design and sizing of treatment system components and the use of excess treatment capacity for enhanced sulfate removal during low-flow periods.
HCEQ Basin at the Mine Site and routed through the High Concentration Mine Water Pipeline into the WWTS chemical precipitation train. VSEP concentrate from the tailings basin seepage treatment train and the mine water treatment trains will also be routed to the chemical precipitation train along with greensand filter backwash solids. As discussed in the following sub-sections, this treatment train will consist of headworks, chemical precipitation, and associated solids handling works.

**Headworks**

The HCEQ Basin is sized to provide storage of the spring snowmelt pumping event in Mine Year 10. Headworks design is described in more detail in Section 4.3.6.1 of Reference (5).

**Metals, Sulfate, and Calcite Precipitation Equipment**

Removal of metals, including nickel, copper, and cobalt, will be accomplished in a high-density sludge metals precipitation system (as described in Section 4.3.6.2 of Reference (5)). This system will comprise rapid-mix tanks, high-density sludge reactors, and clarifiers. In the first stage, lime will be added to adjust the pH to the desired set-point (between pH 9.5 and 10.8) in order to precipitate metals. Ferric sulfate will be a standby addition to be used if needed to increase iron concentrations to enhance metals removal. Removed metals will exit the system as a sludge that will be dewatered and hauled to the Hydrometallurgical Residue Facility (HRF) at the Plant Site or disposed at a permitted solid waste facility.

In the second stage of the chemical precipitation train, sulfate removal will be achieved via the addition of more lime to precipitate gypsum. This system will comprise rapid mix tanks, high-density sludge reactors, and clarifiers. Lime will be added to adjust the pH to between 12 and 12.5. Hydrochloric acid will be a standby addition to be used if needed to decrease the pH to allow dissolution of enough lime to meet treated mine water sulfate targets. Removed sulfate will exit the system as gypsum sludge that will be dewatered and hauled to the HRF at the Plant Site or disposed at a permitted solid waste facility.

Effluent from the gypsum precipitation system will have a high pH and a high concentration of calcium from added lime, both of which are undesirable during conveyance of the effluent to the FTB. Gypsum precipitation effluent will be re-carbonated by adding carbon dioxide in a carrier water stream to facilitate good mixing. This system will comprise a solids contact clarifier and will be operated at a target pH set-point between 10 and 10.5 to facilitate the precipitation of calcium carbonate. The excess calcium removed will exit the system as calcite sludge, which will be dewatered and hauled to the HRF or disposed at a permitted solid waste facility.

The metal and sulfate chemical precipitation reactors are proposed to be of the same design and size, allowing the flexibility to use any reactor for either metals or sulfate removal. Providing identical chemical precipitation reactors will also simplify operations and maintenance as the same replacement components and procedures can be used for all units. Clarifiers will be designed to meet applicable MPCA guidelines as listed in the MPCA Settling Review Checklist (Reference (14)).

An in-line carbonic acid injection point downstream of the solids contact clarifiers will provide final neutralization of the chemical precipitation effluent and meet effluent targets for pH.
Effluent pumping for the chemical precipitation system will allow the effluent to either be returned to the secondary membrane treatment system for additional mass removal or blended with the effluent from the mine water filtration train prior to routing the FTB Pond.

**Sludge Pumping and Pressing**

The chemical precipitation processes will result in the production of solid residuals in the form of sludge. In the case of the high density solids and sulfate precipitation processes, some fraction of the sludge collected in the clarifiers will be recycled to the precipitation reactors to maintain the necessary solids contact time. Any excess sludge generated will be pumped to sludge storage tanks and then to the filter press. Sludge piping and pumping will be designed to meet applicable MPCA guidelines.

**3.2.1.2 Mine Water Filtration Train**

The mine water filtration train is designed to treat mine water with relatively low concentrations of sulfate and metals and high flow rates, compared to the influent to the chemical precipitation train. The influent flows to the membrane separation process originate from dewatering of the mine pits, haul roads, and RTH area. As discussed in the following sub-sections, this treatment train will consist of headworks, greensand filtration, primary membrane separation, and secondary membrane separation.

**Headworks**

Equalization of spring flood flows to the primary membrane separation system will be achieved using two LCEQ Basins. The LCEQ Basins will be operated to cooperatively store the low-concentration mine water, thus allowing it to be treated at a lower rate over a longer period of time.

**Greensand Filtration**

Greensand filters (GSF) (as described in Section 4.3.7.2 of Reference (5)) will be used to remove iron, manganese, and total suspended solids that would foul NF membranes if not removed. The greensand filters will also provide some removal of metals, as described in Section 2.3.1.2 of this volume.

GSF media is typically silica sand coated with manganese oxide. As described in Section 2.3.1.2 of this volume, the actual media will be selected during the final design process. Sodium permanganate will be added as needed as a pretreatment to the GSF influent to oxidize dissolved manganese and iron for increased removal and to maintain the oxidation state of the media to allow contact oxidation of manganese.

Backwash from the GSF, which will contain iron, manganese, and metals removed from the mine water, will be separated via gravity and routed to the chemical precipitation train for treatment.

**Primary Membrane Separation**

The primary membrane separation system (Section 4.3.7.3 of Reference (5)) will treat GSF effluent. Similar to the primary membrane separation operation for the tailings basin seepage treatment train described in Section 2.3.1.3 of this volume, the primary membrane separation process of the mine water treatment trains will use RO or equivalently performing technology to separate dissolved constituents from water by
applying pressure to drive water molecules across the membrane and away from the dissolved constituents. During this process, clean water (permeate) will pass through the membrane, while a concentrated brine solution (concentrate) will be retained by the membrane.

The primary membrane separation system for the mine water treatment trains will use a conventional, spiral wound membrane configuration, with multiple membranes operating in a series and parallel configuration to provide the needed capacity. This system is designed to operate on a continuous basis while isolated elements are removed from the process for periodic cleaning. Additional details on the operation of this system are included in Section 4.3.7.3 of Reference (5).

The membranes that will be used in the primary membrane separation system will be selected during the design process based on demonstrated ability to remove the constituents of interest for this Project and to meet the treated mine water treatment targets. Based on the results of the site-specific pilot-testing (Reference (10)), the membranes used in the primary membrane separation operation of the mine water treatment trains will be NF membranes. These membranes have been shown to retain multivalent ions (such as metals and sulfate), while allowing water and monovalent ions (such as sodium and chloride) to pass through. The NF membranes have a high selectivity for multivalent ions over monovalent ions. This is an important consideration in the design and operation of the mine water treatment trains because retention of excessive concentrations of monovalent ions in the concentrate could adversely affect the subsequent sulfate precipitation process in the chemical precipitation treatment train.

The NF membranes will require periodic cleaning to remove accumulated foulants and maintain flux. These cleaning wastes will be routed to the FTB Pond with treated mine water.

Primary membrane system permeate will be blended with permeates from the secondary membrane system and chemical precipitation treatment train as described in Section 3.3. Primary membrane separation concentrate containing rejected metals and sulfate will be routed to the secondary membrane system and then to the chemical precipitation train for treatment, as described in the following subsections.

**Secondary Membrane Separation**

The mine water filtration train will be equipped with a secondary membrane system (as described in Section 4.3.7.4 of Reference (5)) to decrease the volume of membrane concentrate. The secondary membrane system of the mine water treatment trains will be similar to the secondary membrane system of the tailings basin seepage treatment train, as described in Section 2.3.1.4 of this volume. The mine water filtration train units will also use a flat-sheet membrane in a stacked configuration within a VSEP arrangement. Based on the results of the pilot-testing for this Project (Reference (10)), NF membranes will be used in the secondary membrane treatment system of the mine water filtration train for reasons specified in Section 2.3.1.4 of this volume. The membrane manufacturer and specific type will be defined during the final design.

Operation of secondary membrane capacity of the mine water filtration train will be adjusted seasonally to manage hydraulic load to the chemical precipitation train and to enhance mass removal on an annual
basis. Secondary membrane system permeate will be blended with permeates from the primary membrane system and chemical precipitation treatment train as described in Section 3.3. Secondary membrane concentrate will be routed to the chemical precipitation train.

The secondary membrane system will require periodic cleaning. Waste cleaning solution will be routed to the FTB Pond with treated mine water.

### 3.2.2 Construction

Initial construction of the mine water treatment trains will be completed prior to the start of operations in Mine Year 1 and will include equipment to treat 615 gpm in the chemical precipitation train and 1,440 gpm in the primary membrane train. Additional build-outs for the mine water filtration train are planned for Mine Years 5, 7, and 9. Expansion of the chemical precipitation train will occur before Mine Year 7. The incremental mine water treatment train capacity increases are outlined in Table 3-2.

#### Table 3-2 Incremental Mine Water Treatment Trains Capacity Buildout

<table>
<thead>
<tr>
<th>Mine Year</th>
<th>Total Chemical Precipitation Capacity (gpm)</th>
<th>Total Primary Membrane Filtration Capacity (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>615</td>
<td>1,440</td>
</tr>
<tr>
<td>5</td>
<td>615</td>
<td>1,820</td>
</tr>
<tr>
<td>7</td>
<td>820</td>
<td>2,160</td>
</tr>
<tr>
<td>9</td>
<td>820</td>
<td>2,730</td>
</tr>
</tbody>
</table>

Source: Section 4.3.4 of Reference (5)

### 3.2.3 Adaptive Management

Flexibility in operation of the mine water treatment trains will allow operators to adjust to changing or unforeseen conditions, as described in Section 2.2.4 of Reference (1). Because the actual water that will be generated by the Project will not be available until after the mine operations are initiated, pilot-testing with former LTV Steel Mining Company (LTVSMC) Area 5 pit water has been used to provide a basis for design (as described in Section 3.1 of Reference (10)). The composition of the actual mine water that will be realized at the Mine Site will likely vary from the pilot-test water source. For these reasons, treatment equipment has been selected such that component operation may be modified to account for unforeseen changes in influent water quality, reaction kinetics, sludge characteristics, or other factors that may modify the underlying chemistry in the process units.

Variations of either influent water quantity or quality will be addressed within the overall concept for the design, construction, and operation of the mine water treatment trains. Because the plan for construction of the WWTS already envisions a phased build-out of the capacity that will be needed when the maximum flow occurs (Mine Year 10), variations in flows and loads can easily be addressed by either accelerating or delaying the installation of the additional equipment that is planned for the second or third build-out of the mine water treatment trains. Treatment performance issues that could occur from changes in influent
water quality will be addressed by making adjustments to operating conditions. For example, during winter months when influent flows are low, primary membrane concentrate will be routed directly to the chemical precipitation train to maintain minimum flows through chemical precipitation equipment. At most times throughout the year, it is expected that the mine water treatment trains will have excess hydraulic capacity, which will be used, as necessary, to modify treatment performance, for example by reducing the recovery rates for the membrane separation processes or increasing the hydraulic retention times in the chemical precipitation processes. This additional capacity will be used to achieve treatment performance requirements on an annual average basis in accordance with the NPDES/SDS permit.

3.2.4 Overview of the Reclamation, Closure, and Postclosure Maintenance Phases

While the activities described in this section are beyond the scope of the first NPDES/SDS permit term, an overview of the activities associated with the reclamation, closure, and postclosure maintenance phases, which are estimated to begin in Mine Years 21, 25, and 55, respectively, are provided here as additional background.

The mine water treatment trains will continue to operate in various Project phases to support the reclamation, closure, and postclosure maintenance phase activities at the Mine Site and Plant Site. The unit processes described in Section 3.2.1 of this volume will be used during the reclamation, closure, and postclosure maintenance phases. It is anticipated that the mine water chemical precipitation train will continue to treat secondary membrane concentrate during these phases. The mine water filtration train is expected to treat water from the East Pit and remaining stockpile drainage during the reclamation and closure phases, and from the West Pit overflow in the postclosure maintenance phase. System operations and flow routing can be modified to optimize unit performance. Water treatment is anticipated to transition from mechanical treatment to non-mechanical treatment as soon as possible, anticipated to occur during the closure or postclosure maintenance phases, using mature technology once approved by the MPCA. Additional detail on WWTS operations during the reclamation, closure, and postclosure maintenance phases is provided in Sections 2.2.2.2 and 2.2.2.3 of Reference (1).

3.3 Treated Mine Water

Mine water will be treated through chemical precipitation and primary and secondary membranes. The chemical precipitation effluent and primary and secondary membrane permeates will be blended and mixed with intermittent membrane cleaning flows from the primary and secondary membranes. This combined treated mine water flow will be pumped to the FTB Pond, which is part of the internal treatment process. Therefore, treated mine water will be considered an internal waste stream. PolyMet will monitor mine water treatment train influents and treated mine water to track mine water treatment train performance. The need to report internal waste stream monitoring results will be determined during the NPDES/SDS permitting process. The basis for selection of the treated mine water treatment targets used in preliminary design is described in Section 2.4 of Reference (5)) with the treatment targets outlined in Table 2-2 of Reference (5)).
The mine water treatment trains will be operated to produce water that meets Project’s needs for discharge to the FTB Pond. Modeling shows that the proposed design of the mine water treatment trains is capable of meeting the treated mine water treatment targets. Furthermore, the mine water treatment processes can be adapted to meet the targets, as necessary, in response to the actual conditions encountered during the Project, the monitoring results, and the conditions estimated by continued model updates to Section 2.4 of Reference (1).

Treated _mine water_ characteristics for the reclamation, closure, and postclosure maintenance phases will be determined during future NPDES/SDS permit renewals. It is anticipated that during the reclamation and closure phases, there will be no direct discharge of treated _mine water_ to surface water; treated _mine water_ will be routed to the East Pit and West Pit to accelerate flooding of the pits. During the postclosure maintenance phase, treated _mine water_ may be discharged to an unnamed creek downstream from the future West Pit overflow, under the terms of a renewed, future NPDES/SDS permit.

### 3.4 Additives and Waste Streams

Chemical use, byproducts, and waste streams associated with the mine water treatment trains are summarized in the following sub-sections and detailed in Sections 4.4.4 and 5.1.2 of Reference (5).

#### 3.4.1 Chemical Additives

Chemicals proposed for use in the mine water treatment trains include:

- sodium permanganate for greensand filter pretreatment
- carbon dioxide for pH adjustment and recarbonation
- lime for pH adjustment in chemical precipitation
- ferric sulfate for ferric addition in chemical precipitation (standby use only)
- hydrochloric acid for pH adjustment in chemical precipitation (standby use only)
- membrane antiscalants for both primary and secondary membrane systems
- membrane cleaning chemicals for both primary and secondary membrane systems
- sodium bisulfite for removing excess oxidant prior to membrane filtration

Sodium permanganate and sodium bisulfite will be consumed in the treatment process, and carbon dioxide and lime will be dissolved and neutralized. Membrane antiscalants will be routed to the chemical precipitation train with membrane concentrate where they will ultimately leave the site in precipitated sludge. Cleaning chemicals will be routed to the FTB with the cleaning waste streams. Preliminary usage rates and the ultimate fate of each chemical are further described in Large Table 5 of Reference (5). Chemical doses and usage rates will be optimized during startup and operation.
Additional information regarding proposed chemical additives that may be used in the mine water treatment trains can be found in Large Table 5 of Reference (5). Additionally, Safety Data Sheets and product information labels for each proposed chemical additive are included in Appendix E.

3.4.2 Mine Water Treatment Trains Waste Streams

The mine water treatment trains will produce byproduct streams as a result of filter and membrane cleaning (as described in Section 4.4.4 of Reference (5)). These streams will be the CIP membrane waste and the greensand filter backwash and will be routed to the FTB. CIP waste will contain antiscalants, cleaning chemicals, and traces of membrane foulants, while the greensand filter backwash waste will contain iron, manganese, hardness, and other salts.

Excess sludge from high-density sludge precipitation, gypsum precipitation, and calcite precipitation will be dewatered in a filter press. Dewatered sludge will be disposed of at the HRF or disposed at a permitted solid waste facility. Filtrate will be routed to the head of the chemical precipitation train for treatment.

3.5 Proposed Monitoring Plan

Monitoring proposed as part of permit requirements for the WWTS, including the equalization basins, MPP, and mine water treatment trains, is included in the integrated Mine Site and Plant Site monitoring plans presented in Section 3.0 of Volume I. The proposed monitoring plan includes internal waste stream monitoring associated with mine water treatment trains influent and treated mine water. These proposed monitoring stations are shown on Large Figure 5 and Large Figure 6.
4.0 Antidegradation Summary

A detailed Antidegradation Evaluation\(^3\) of the effect of the WWTS discharge and related activities\(^4\) on surface waters is provided as Appendix A. In that Antidegradation Evaluation, PolyMet demonstrates that the water discharges from the Project have received the requisite antidegradation evaluations required by federal and state law.

4.1 Background

The WWTS will discharge to three receiving waters (Large Figure 1 of Appendix A):

- wetlands in the headwater area of Trimble Creek
- wetlands in the headwater area of Unnamed Creek
- the headwater segment of Second Creek near the location of existing monitoring station PM-7/SD026

For purposes of this Antidegradation Evaluation, a “receiving water” is the segment of a water body which receives WWTS discharge from a surface water discharge outfall. “Downstream waters,” for this evaluation, are waterbodies downstream of a receiving water. Downstream waters include Trimble Creek, Unnamed Creek, Second Creek, the Partridge River, the Embarrass River, the St. Louis River, and Lake Superior, all of which are within the Lake Superior Basin. Large Figure 2 and Large Figure 3 of Appendix A depict the connections between the receiving waters and Lake Superior, and the evaluation points used for the Antidegradation Evaluation.

Receiving and downstream waters, like all waters of the state, are classified to protect specific designated beneficial uses.\(^5\) Water use classifications are listed for some, but not all, waterbodies in Minnesota Rules, part 7050.0470. Wetlands in the headwater areas of Trimble Creek and Unnamed Creek are not listed under Minnesota Rules, part 7050.0470, and thus as unlisted wetlands, are classified under Minnesota Rules, part 7050.0425 as Class 2D, 3D, 4C, 5, and 6 waters. Trimble Creek, Unnamed Creek, Second Creek, the Partridge River, the Embarrass River, and the St. Louis River downstream of the Project are not listed under Minnesota Rules, part 7050.0470, and thus as unlisted waters, are classified under Minnesota Rules, part 7050.0430 as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Existing conditions at the Project Plant Site, where the WWTS discharge will occur, are relevant to this Antidegradation Evaluation. The Plant Site includes the former taconite processing plant, tailings basin, and other infrastructure previously operated by LTVSMC and its predecessors. Cliffs Erie acquired these facilities in connection with the 2001 LTVSMC bankruptcy, but has not actively operated them for mining.

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\(^3\) The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052.

\(^4\) “WWTS discharge and related activities” means the WWTS discharge and related activities that affect the quality and quantity of that discharge, including the FTB seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake.

\(^5\) Minnesota Rules, part 7050.0110
or production purposes. As part of a 2010 consent decree between Cliffs Erie and the MPCA, pumpback systems were installed in 2011 to capture seepage from the existing tailings basin, at locations shown on Large Figure 4 of Appendix A. Ferrous mining activities, which have taken place at the Plant Site and other nearby minelands since the 1950s, have impacted water quality in Trimble Creek, Unnamed Creek, Second Creek, the Embarrass River, and the Partridge River, as described in Section 3.1 of Volume V.

4.2 Regulatory Context

PolyMet is required to conduct an antidegradation assessment of potential surface water impacts in accordance with MPCA rules that became effective in November 2016 (Minnesota Rules, part 7050.0250 to 7050.0335, collectively, the "Revised Rule"). The Revised Rule repealed the state’s former general nondegradation rules (Minnesota Rules, parts 7050.0185 and 7050.0180, collectively, the "Former Rule"). In June 2017, the USEPA approved the Revised Rule. Due to the timing of the implementation of these rules related to the timing of PolyMet’s NPDES/SDS Permit Application, PolyMet has conducted its Antidegradation Assessment\(^6\) to address the antidegradation analysis requirements of both the Former Rule and the Revised Rule (summarized in Section 4.4). Antidegradation standards under the Revised Rule and the Former Rule apply to discharges of parameters other than mercury, which is subject to a separate set of requirements as discussed below.

The Revised Rule does not affect the antidegradation standards and procedures in Minnesota Rules, chapter 7052 (Minnesota Rules, parts 7052.0300 through 7052.0380), which address discharges of certain bioaccumulative chemicals to surface waters in the Lake Superior Basin (LSB), where the Project and all relevant waters are located. Based on the Project design specifications, which include limited discharge of mercury to receiving waters, PolyMet is also required to conduct an antidegradation demonstration\(^7\) for this Project, to address standards in Minnesota Rules chapter 7052 (the "LSB Rule", summarized in Section 4.5).

4.3 Methods

To a significant degree, antidegradation assessments are intended to evaluate the availability of alternatives to avoid or minimize any lowering of surface water quality, including both designated uses and numeric or narrative water quality standards. The Former, Revised, and LSB Rules all incorporate such alternative-analysis concepts into their specific requirements (former Minnesota Rules, part 7050.0185, subpart 4; Minnesota Rules, part 7050.0280, subpart 2; Minnesota Rules, part 7052.0320 subparts 2 and 3).

During the National Environmental Policy Act (NEPA) / Minnesota Environmental Policy Act (MEPA) review process for the Project, PolyMet and the Co-Lead Agencies identified and assessed available control-technology alternatives and mitigation measures to protect surface waters generally, and specifically to avoid where practicable, and minimize where avoidance was not practicable, degradation of high quality waters. The WWTS technology proposed for the Project was evaluated in the FEIS (Reference (6)).

\(^6\) The “Antidegradation Assessment” is PolyMet’s antidegradation analysis under Minnesota Rules, chapter 7050.

\(^7\) The “Antidegradation Demonstration” is PolyMet’s antidegradation analysis under Minnesota Rules, chapter 7052.
Accordingly, the FEIS alternatives analysis satisfies the requirements of the Former Rule, the Revised Rule, and the LSB rules, and no additional alternatives analysis is required.

More detail on the alternatives analysis is provided in Section 7.4 of Appendix A. The analysis establishes that the Project as evaluated in the FEIS is the least degrading prudent and feasible alternative for all parameters of concern, including mercury, and incorporates by design the best technology in process and treatment for mercury.

For the Antidegradation Evaluation, PolyMet assessed the estimated effects of the WWTS discharge and related activities relative to a specific list of parameters of concern. Parameters of concern are the parameters that could reasonably be expected to be present in the WWTS discharge and for which promulgated numeric or narrative surface water quality standards are applicable to the receiving or downstream waters. Parameters of concern for this Antidegradation Evaluation are listed in Table 4-1. See Section 5.1 of Appendix A for additional details about the parameters of concern. As noted in Table 4-1, the list of parameters of concern includes mercury, which has bioaccumulative properties and is subject to special requirements under the LSB Rule. Also, PolyMet plans an internal performance operating limit of 10 milligrams per liter (mg/L) for sulfate as part of the WWTS design. Although the WWTS receiving waters will not be subject to the existing or proposed “wild rice” rules, and hence, the wild-rice sulfate standard will not be applicable to the discharges, PolyMet will use the sulfate internal performance metric to evaluate the WWTS operation, as discussed in Appendix D of Volume I. Thus, PolyMet has incorporated a sulfate treatment target of 10 mg/L into the WWTS design.

### Table 4-1 Parameters of Concern for the NorthMet Antidegradation Evaluation

<table>
<thead>
<tr>
<th>Metals</th>
<th>General Parameters</th>
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</thead>
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<tr>
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<tr>
<td>Antimony</td>
<td>Mercury</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Nickel</td>
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<tr>
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<td>Selenium</td>
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<tr>
<td>Cadmium)</td>
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<tr>
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<td>Cobalt</td>
<td>Zinc</td>
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<tr>
<td>Copper</td>
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</tbody>
</table>

Note: See Section 5.1 of Appendix A for the surface water quality standards associated with the parameters of concern.

The estimated effects of the WWTS discharge and related activities for this Antidegradation Evaluation are based on the estimated WWTS discharge quality evaluated for the FEIS (Section 3.1.1 of Appendix A). The proposed WWTS design will be capable of meeting the applicable water quality standards and treatment targets, and delivering the discharge quality evaluated for the FEIS. Based on more recent modeling for the WWTS design process conducted during permitting, PolyMet anticipates that in practice the
concentrations of most parameters in the discharge will be below the concentrations evaluated in the FEIS (Section 3.1.1 of Appendix A). This is because operating the WWTS to remove enough sulfate to achieve the 10 mg/L internal performance operating limit will remove other parameters of concern to concentrations below—in some cases, substantially below—the concentrations evaluated in the FEIS. By using the higher FEIS-based concentrations (the estimated concentrations) rather than on the lower, more realistic, design modeling concentrations (the anticipated concentrations), this Antidegradation Evaluation overestimated the effects of the WWTS discharge and related activities on receiving and downstream waters for the parameters of concern other than sulfate.

4.4 Antidegradation Assessment for Parameters of Concern other than Mercury under Minnesota Rules, Chapter 7050

The following subsections summarize the Antidegradation Assessment under the Former Rule and the Revised Rule for parameters of concern other than mercury. Details are provided in Sections 6.0 and 7.0 of Appendix A.

4.4.1 Existing Uses Will Be Maintained and Protected

Existing uses in most sections of receiving and downstream waters co-exist with the waters’ designated uses, because the designated uses actually occur and the existing water quality meets numeric water quality standards associated with the designated uses. Existing uses that are also designated uses will be maintained and protected because estimated water quality will not interfere with the designated uses and will meet numeric (or if applicable, narrative) water quality standards associated with the designated uses. There is one undesignated existing use, referred to for this evaluation as natural wild rice stands, which has been observed in some downstream waters (Large Figure 5 of Appendix A). This undesignated existing use, and the existing water quality necessary to support it, will be maintained and protected because the Project will decrease sulfate loading to these downstream waters. There are no other known undesignated existing uses; therefore, the existing uses of receiving and downstream waters will be maintained and protected in accordance with the requirements of the Former Rule and the Revised Rule.

4.4.2 PolyMet Will Comply With Applicable Water Quality Standards

The WWTS discharge will meet all applicable numeric and narrative water quality standards in Minnesota Rules, chapter 7050. PolyMet will also comply with effluent limits in Minnesota Rules, chapter 7053, including general prohibitions for discharges and specific restrictions for industrial discharges. In particular, these chapter 7053 requirements will be met because parameters of concern are not associated with nuisance conditions or excess nutrients, and the WWTS discharge will meet acute and chronic WET standards. Finally, PolyMet will comply with all federal point source effluent limits in the applicable sections of 40 C.F.R. 440 at the surface water discharge outfalls. Therefore, PolyMet will comply with all applicable numeric and narrative water quality standards at these discharge outfalls.

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8 Designated uses are specified in Minnesota Rules, part 7050.0220 through part 7050.0226
9 See Minnesota Rules, part 7050.0265, subpart 2, and former Minnesota Rules, part 7050.0185, subpart 3.
10 See former Minnesota Rules, part 7050.0185, subpart 3. No comparable requirement exists in the Revised Rule.
4.4.3 Discharge Will Not Permanently Preclude Attainment of Water Quality Standards

With one potential exception, the receiving and downstream waters currently attain the water quality associated with their respective designated beneficial uses. The possible exception is at MNSW8 on Second Creek, where the existing values of hardness, total dissolved solids (TDS), and specific conductance are higher than the current numeric water quality standards for Class 3C and 4A waters. These conditions, however, are not precluding actual uses that conform to the designated uses. The location of MNSW8 is shown on Large Figure 2 of Appendix A. The WWTS discharge and related activities will not degrade existing conditions or uses; rather, PolyMet estimated that the WWTS discharge and related activities will decrease the hardness at MNSW8, and will decrease the loading of constituents that contribute to the current values of TDS and specific conductance, although no measurable decrease in TDS or specific conductance is expected. These estimated improvements in water quality due to the WWTS discharge and related activities at MNSW8 further the protection of beneficial uses.11

4.4.4 Degradation of High Water Quality Will Be Minimized, and the Project Will Have Social and Economic Benefits

The Revised Rule defines a water body as "high quality" if it "exceeds, on a parameter-by-parameter basis, levels necessary to support the protection and propagation of aquatic life and recreation in and on the water."12 The Project includes extensive management and treatment measures designed to minimize degradation and to protect high quality waters. PolyMet plans to implement a sulfate internal performance operating limit of 10 mg/L.13 The net effect of the Project will be to reduce sulfate loading to the St. Louis River watershed by approximately 1,400 metric tons per year.

The Project FEIS alternatives assessment established that there are no prudent and feasible alternatives for avoiding degradation of high quality waters.14 Potential degradation of high quality water due to the Project will be minimized by application of the least degrading prudent and feasible alternative controls to the new discharge. The proposed waste water treatment technology and level of treatment incorporated into the Project are the least degrading prudent and feasible alternative. PolyMet’s review of other waste water treatment systems indicated that the Project WWTS will exceed the level of treatment that is currently in place for any known waste water system discharging to the Partridge River or Embarrass River, or any other streams within the St. Louis River watershed. In this regard, the proposed treatment is prudent, and is an example of advanced treatment.

Based on the estimated water quality information used for the Antidegradation Evaluation, the WWTS discharge and related activities were estimated to increase the concentrations and loading of some parameters of concern in high quality receiving and downstream waters (antimony, arsenic, cadmium,

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11 See Minnesota Rules, part 7050.0265, subpart 4.
12 See Minnesota Rules, part 7050.0255, subpart 21.
13 None of the receiving waters are listed as “wild rice” waters in the existing or proposed rules. Additionally, the State’s wild rice standard is not currently enforceable due to the requirements of the law enacted in connection with MPCA’s pending review of that standard. 2015 Minn. Sess. Law Serv., 1st Sp. Sess. Ch. 4, art. 4, § 136.
14 See Minnesota Rules, part 7050.0265, subpart 5(A).
chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, and zinc). Therefore, PolyMet provides the required information on the important economic and social benefits that the Project will provide (Section 7.5 of Appendix A). These benefits include increasing employment and commercial opportunities, enhancing incomes and property values, improving water quality impacted by legacy mining operations, and remediating existing environmental conditions of concern. Any potential degradation of high water quality is justifiable to accommodate these important economic and social benefits of the Project. Thus, the antidegradation requirements of the Revised Rule are satisfied.15

4.4.5 Outstanding Resource Value Waters Will Be Protected

The Former, Revised, and LSB Rules all create special protections for surface waters defined as "Outstanding Resource Value Waters" (ORVW). The Project will not directly discharge to any ORVWs. The first downstream ORVW is Lake Superior, located approximately 175 river miles downstream of the Project along the St. Louis River. Lake Superior is classified as a restricted ORVW, and limited segments of the lake are classified as prohibited ORVWs, with classifications defined in the Revised Rule.16 The WWTS discharge and related activities were estimated to have no measurable effect on the average concentration of the parameters of concern at the evaluation point in Scanlon, Minnesota, prior to the St. Louis River’s entry into Lake Superior. As a result, the WWTS discharge and related activities will not degrade the existing water quality of a downstream ORVW.17 The Project’s proximity to Lake Superior is shown on Large Figure 3 of Appendix A.

4.5 Antidegradation Demonstration for Mercury under Minnesota Rules, Chapter 7052

Minnesota Rules, chapter 7052 regulates the discharge of specified bioaccumulative substances18 to "outstanding international resource waters" (OIRWs)19 in the LSB. The receiving and downstream waters are classified as OIRWs, as are all surface waters of the LSB (apart from ORVWs and Class 7 waters);20 therefore, the WWTS discharge and related activities must comply with the LSB antidegradation requirements. Mercury is the only bioaccumulative parameter specified in Chapter 7052 that is anticipated to be present in PolyMet’s proposed discharge from the WWTS. Accordingly, mercury is the only parameter that PolyMet has evaluated under the antidegradation standards in chapter 7052. Details on the Antidegradation Demonstration for mercury are provided in Sections 8.0 and 9.0 of Appendix A.

4.5.1 Existing Uses Will Be Maintained and Protected

In receiving and downstream waters (Class 2B waters), the existing uses with regard to mercury are “the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish

15 See Minnesota Rules, part 7050.0265, subpart 5(B).
16 See Minnesota Rules, part 7050.0335.
17 See Minnesota Rules, part 7050.0265, subparts 6 and 7 and also former Minnesota Rules, part 7050.0180, subparts 3, 6, and 9.
18 See Minnesota Rules, part 7052.0010 defining “bioaccumulative chemical[s] of concern” and “bioaccumulative substances of immediate concern.”
19 See Minnesota Rules, part 7052.0300, subpart A(1).
20 See Minnesota Rules, part 7052.0010, subpart 3.
and associated aquatic life, and their habitats” (Minnesota Rules, part 7050.0222 subpart 4). In the headwater segment of Second Creek, this existing use will be maintained and protected because the estimated water quality will meet the applicable mercury water quality standard of 1.3 nanogram per liter (ng/L) at the surface water discharge outfall.

At receiving and downstream evaluation points where existing mercury concentrations are above the applicable water quality standard of 1.3 ng/L, the existing use will be maintained and protected because the WWTS discharge and related activities will result in no measurable increase in water column mercury concentrations from the existing concentrations and will not change existing or designated uses. Potential effects on fish tissue mercury concentrations were estimated based on the concept of proportionality (as used by the MPCA and the USEPA, Reference 15), wherein changes in fish tissue mercury concentration are expected to be proportional to changes in water column mercury concentration (Section 8.3.3 of Appendix A). Using this approach, because no measurable change from existing water column mercury concentrations is expected, the WWTS discharge and related activities are estimated to result in no measurable change from background fish tissue mercury concentrations in receiving or downstream waters. Large Figure 6 of Appendix A compares the existing mercury concentrations with the estimated concentrations in Mine Year 10.

### 4.5.2 Discharge Will Not Lower Water Quality in Water Bodies That Are Impaired for Mercury

Although none of the receiving waters is on the State’s 303(d) impaired waters list, or on the 2016 proposed list, several downstream lakes (e.g., Sabin Lake) and reaches of the Partridge, Embarrass, and St. Louis River are either listed or proposed for listing as impaired for mercury in the water column and/or mercury in fish tissue.21

The net effect of the WWTS discharge and related activities is estimated to slightly reduce mercury loading in the impaired water bodies and estimated to cause no measurable increase in mercury concentration. As a result, the WWTS discharge will not lower water quality in any receiving or downstream waters, including any impaired waters, relative to mercury. Further, because changes in fish tissue mercury concentration are considered to be proportional to changes in mercury concentration (Section 8.3.3 of Appendix A), the WWTS discharge and related activities are estimated to result in no measurable change to the existing concentration of mercury in fish tissue in impaired waters.22 Therefore, no measurable change from background fish tissue concentrations attributable to the WWTS discharge and related activities is expected.

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21 USEPA-approved 2014 303(d) impaired waters list and the MPCA proposed 2016 list.
22 See Minnesota Rules, part 7052.0300 subpart 2.
In addition, the FEIS confirms that the Project will be consistent with the requirements of Minnesota's statewide Total Maximum Daily Load (TMDL) for mercury.\textsuperscript{23} In particular, the FEIS states that the Project "would not impede the [Minnesota] reduction goals" for mercury.\textsuperscript{24}

4.5.3 Extent of Discharge Will Be Minimized using Best Technology in Process and Treatment, and the Project Will Have Social and Economic Benefits

The Project will minimize mercury discharge by deploying the "best technology in process and treatment" (BTPT) as required by the LSB Rule.\textsuperscript{25} The BTPT was determined through an alternatives assessment as described in Section 9.3 of Appendix A. The BTPT in this instance is comprised of multiple aspects of the Project’s integrated water management system, including filtration through Flotation Tailings and taconite tailings, capture of seepage from the Tailings Basin, and membrane separation treatment by the WWTS. As a result of the BTPT, the WWTS discharge and related activities are estimated to result in no measurable increase in mercury concentrations, and a small potential decrease in mercury loading in the receiving and downstream waters except for the Second Creek headwater segment. In the Second Creek headwater segment, the mercury concentration is estimated to increase from the existing concentration of 0.6 ng/L, to a level at or below the 1.3 ng/L water quality standard. This estimated increase in mercury concentration in the headwater segment of Second Creek is necessary to accommodate the important economic and social developments and benefits associated with the Project (Section 7.5 of Appendix A).\textsuperscript{26} Moreover, the expected net effect of the WWTS discharge and related activities, downstream of the confluence of the Partridge River and the Embarrass River with the St. Louis River, is estimated to result in a potential small decrease in mercury loading to the St. Louis River (Section 8.3 of Appendix A).

4.5.4 Outstanding Resource Value Waters Will Be Protected

The Project will not directly discharge to an ORVW, as described in Section 4.4.5, and accordingly will not degrade any downstream ORVW with respect to mercury.\textsuperscript{27}

4.6 Other Related Permitting Considerations

Other considerations related to antidegradation of surface waters include the CWA prohibition of discharges that will "cause or contribute" to a violation water quality standards, and the requirement that discharges not degrade waters of downstream states.

4.6.1 Project Will Not "Cause or Contribute to the Violation of Water Quality Standards"

The CWA prohibits issuance of a permit for a new discharge or new discharger that will "cause or contribute to the violation of water quality standards."\textsuperscript{28} PolyMet has designed the Project so that the

\textsuperscript{23} FEIS Appendix A, A – 421-22
\textsuperscript{24} FEIS Appendix A, A – 421.
\textsuperscript{25} See Minnesota Rules, part 7052.0320, subpart 3.
\textsuperscript{26} See Minnesota Rules, part 7052.0300, subpart 4.
\textsuperscript{27} See Minnesota Rules, parts 7052.0300, subpart 1(B).
\textsuperscript{28} 40 CFR § 122.4(i).
concentration of parameters of concern in the WWTS discharge, including mercury, will be at or below applicable Minnesota water quality standards. Because of this design, the Project’s effect will be to either maintain compliance with Minnesota’s water quality standards in receiving and downstream waters or, through a reduction in pollutant concentrations and/or reduction of loading, actually improve water quality.

For most parameters of concern at evaluation points on receiving and downstream waters, the existing concentrations are below applicable numeric water quality standards, and future concentrations, during Project operations, were estimated to remain below applicable standards. In these situations, the discharge will not cause a violation of water quality standards.

Existing concentrations of a limited number of parameters of concern (i.e., mercury, hardness, TDS, and specific conductance) are above applicable numeric water quality standards at some evaluations points in receiving or downstream waters. The WWTS discharge and related activities will not contribute to these existing exceedances of water quality standards, because they were estimated to reduce mercury loading and decrease the concentrations of constituents that contribute to hardness, TDS, and specific conductance, although no measurable decrease in hardness, TDS, or specific conductance is expected. Therefore, the WWTS discharge and related activities will improve water quality with regard to the elevated parameters, and not contribute to the current exceedances.

4.6.2 Water Quality of Downstream States Will Not Be Degraded

The St. Louis River forms the northeastern border of the Fond du Lac Reservation (Reservation). The Fond du Lac Band of Lake Superior Chippewa (Band) has been granted “treatment as state” (TAS) status under the CWA, and the Band has developed its own water quality standards and antidegradation requirements.29 Tribal numeric water quality standards are the same as State of Minnesota numeric standards for parameters of concern other than mercury: the tribal mercury standard is lower than the state mercury standard. The Project is located approximately 116 river miles upstream of the Reservation, the northern border of which includes reaches of the St. Louis River. Information on potential effects of the WWTS discharge and related activities relative to the tribal standards has been included in this Antidegradation Evaluation.

PolyMet’s Antidegradation Evaluation indicated the WWTS discharge and related activities will result in no measurable change in concentration for any parameter of concern in the St. Louis River within the Reservation boundaries, and will in fact reduce loading of mercury in that reach of the river by approximately 10 grams per year (Section 10.2 of Appendix A).

Therefore, if the Band’s mercury water quality standards were applicable in this instance, the Project will not cause or contribute to a lowering of water quality within the Reservation boundaries, nor will the Project adversely affect any existing or designated uses of waters within the Reservation. Because the

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29 See FDL 12-98 § 105.
Project was estimated to reduce mercury loading in the reach of the St. Louis River within the Reservation boundaries, the differing mercury numeric standards of the State and Band do not affect the analysis.

The WWTS discharge and related activities also will not cause or contribute to a lowering of water quality of any other downstream TAS or state. Therefore, no additional analysis of other downstream states or tribes is required.
5.0 Compliance with 40 CFR 440

Pursuant to sections 304 and 306 of the Clean Water Act, 33 U.S.C. §§ 1314 & 1316, the USEPA has promulgated technology-based effluent limitation guidelines and new source performance standards applicable to numerous types of mining operations within the ore mining and dressing point source category (40 CFR part 440). These guidelines and standards set forth effluent limitations for various parameters (Section 5.1) as well as a general prohibition against discharging process wastewater to waters of the United States from new mills that use the froth-flotation process for the beneficiation of copper, lead, zinc, gold, silver, and molybdenum ores (40 CFR § 440.104(b)(1)) (Section 5.2). While this general prohibition is referred to as the "zero discharge" standard, the applicable law includes exceptions that allow a certain volume of discharge to account for specific conditions and does not prohibit discharge of mine drainage. The proposed NorthMet beneficiation plant and the proposed WWTS discharge can comply with this zero discharge standard.

5.1 Compliance with Federal Effluent Limitations

Three subparts of the ore mining and dressing point source category (40 CFR part 440) are applicable to the proposed WWTS discharge: subparts G (nickel ore), J (copper, lead, zinc, gold, silver, and molybdenum ores), and K (platinum ore). These subparts include technology-based effluent limitations for a limited number of parameters. Table 5-1 lists the applicable effluent limits from these three subparts and compares them to the WWTS discharge treatment targets in Table 2-2 of this volume. This shows that that the concentrations of all parameters in the WWTS discharge will be at or below the applicable federal effluent limits in 40 CFR part 440.
Table 5-1  Comparison of Waste Water Treatment System (WWTS) Discharge Treatment Targets and Federal Effluent Limitations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Federal Effluent Limit</th>
<th>WWTS Discharge Treatment Target</th>
<th>Regulatory Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1-day Maximum</td>
<td>30-day Average</td>
<td></td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>1,000</td>
<td>500</td>
<td>10</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>100</td>
<td>50</td>
<td>2.5</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>300</td>
<td>150</td>
<td>9.3</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>600</td>
<td>300</td>
<td>3.2</td>
</tr>
<tr>
<td>Mercury (total)</td>
<td>Hg</td>
<td>2,000</td>
<td>1,000</td>
<td>1.3</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>1,000</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>1,500</td>
<td>750</td>
<td>120</td>
</tr>
<tr>
<td>Solids, Total</td>
<td>TSS</td>
<td>30</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Suspended</td>
<td></td>
<td></td>
<td></td>
<td>40 CFR 440.72(d) and 40 CFR 440.104(a) and 40 CFR 440.113(b)</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.0 to 9.0</td>
<td>6.0 to 9.0</td>
<td>6.5 to 8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 CFR 440.72(d) and 40 CFR 440.10(a)</td>
</tr>
</tbody>
</table>

5.2 Compliance with Zero Discharge Standard

In addition to the effluent limitations in 40 CFR part 440, the proposed NorthMet WWTS discharge will be subject to the zero discharge standard, which prohibits the discharge of process wastewater generated from the processing of copper ore. Because the Project as currently designed will not have separate wastewater streams for copper and other ores, the zero discharge standard will apply to the combined process wastewater stream. Appendix B provides a detailed analysis of the “zero discharge” standard as it applies to the proposed WWTS discharge and demonstrates that the Project will comply with the zero discharge standard. This section provides a summary of the analysis and demonstration in Appendix B.

5.2.1 Regulatory Context

The zero discharge standard is a NSPS applicable to new copper mills and set forth in 40 CFR part 440. The terms “process wastewater” and “mine drainage” are specifically defined for purposes of the NSPS, and associated USEPA guidance provides additional insight on these terms. Section 5.2 uses the NSPS-specific terms because the zero discharge demonstration is based on the requirements of 40 CFR part 440 Table 5-2 lists the NSPS-specific terms, provides their definitions, and shows the corresponding NorthMet flows using the water terminology definitions for this Application.
### Table 5-2 Correlation of Water Terminology Between NSPS and NorthMet NPDES/SDS Application

<table>
<thead>
<tr>
<th>NSPS term (used in Section 5.2)</th>
<th>NSPS definition</th>
<th>Corresponding NorthMet water terminology definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process wastewater</td>
<td>“Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product.” 40 CFR § 401.11(q)</td>
<td>Process water</td>
</tr>
<tr>
<td>Mine drainage</td>
<td>“Any water drained, pumped, or siphoned from a mine.” 40 CFR § 440.132(h)</td>
<td>Mine water</td>
</tr>
</tbody>
</table>

The NSPS for new copper mills includes certain exceptions to the zero discharge standard, two of which are applicable to the Project:

1. **Net precipitation can be discharged.** A volume of water may be discharged equal to the annual net precipitation (precipitation minus evaporation) falling on the treatment facility and on the area contributing run-on to the treatment facility (40 CFR 440.104(b)(2)).

2. **Combined waste streams that include process wastewater can be discharged, subject to limitations.** Process wastewater can be discharged when it has been combined with other waste streams, such as mine drainage, that are not subject to the zero discharge standard. The volume and concentration of the combined discharge, however, may not exceed the volume and concentration of the allowable discharge of the other waste streams, and the combined discharge is subject to the NSPS effluent limitations for mine drainage (40 CFR § 440.131(a)).

#### 5.2.2 NorthMet Flows Relevant to the Zero Discharge Standard

The Project will generate process wastewater in the Beneficiation Plant, but the discharge to the environment will occur later as treated effluent from the WWTS. In between these steps, the process wastewater will be managed within the Tailings Basin. The link between process wastewater and discharge, illustrated in Figure 5-1, involves the following processes:

- The overall Project water management strategy involves pumping treated mine drainage to the FTB to serve as *process water* for the Beneficiation Plant. Process wastewater from the Plant will be recycled back to the FTB Pond, where it will mix with mine drainage and other waste streams. *Tailings basin water* will be a “combined waste stream” (40 CFR § 440.131(a)).

- Some *tailings basin water* will infiltrate and migrate to the toes of the Tailings Basin dams as *tailings basin seepage*. PolyMet will install FTB seepage capture systems around the Tailings Basin that are designed to capture the *tailings basin seepage*.
There will be a delay between the time water enters the FTB and the time that resulting seepage reports to the FTB seepage capture systems. GoldSim modeling for the FEIS indicates the time delay will be at least seven years.

Tailings basin seepage captured by the FTB seepage capture systems will either be recycled to the FTB Pond or pumped to the WWTS for treatment. PolyMet will determine how much seepage to recycle back to the FTB Pond, and how much to send to the WWTS for treatment and discharge, based on factors such as weather, operational needs, FTB size, and regulatory and augmentation requirements (such as the zero discharge standard and the need to avoid hydrologic impacts to Second Creek, Trimble Creek, and Unnamed Creek).

WWTS discharge, which will consist primarily of treated tailings basin seepage, will be conveyed to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek.

Figure 5-1 provides a conceptual schematic for Project flows and their relationship to the applicable zero discharge standard. A more detailed schematic is provided in Appendix B.

Figure 5-1  NorthMet Project Flows Relevant to NSPS Zero-Discharge Standard

Given these Project-specific flows and the applicable exceptions to the zero discharge standard, the allowable discharge volume (i.e., the volume of water combined with process wastewater associated with processing copper ore) that the Project may discharge can be calculated as:

\[
\text{Allowable Discharge Volume} = \text{net precipitation} + \text{mine drainage}
\]

Net precipitation includes precipitation minus evaporation over the area of the Tailings Basin plus runoff into the Tailings Basin, including the exterior slopes of the dams and the small area at the toes of the dams where runoff and infiltration is captured by the FTB seepage capture systems. Net precipitation over other portions of the Plant Site is not included.
Mine drainage is the only waste stream combined with process wastewater that PolyMet proposes to count toward the allowable discharge. Other waste streams are routed to the FTB Pond, but because of the extensive water recycling that is planned, recirculated flows are excluded to avoid “double counting” in a way that would increase the calculated allowable discharge volume. Also, for simplicity, PolyMet is excluding from its calculation certain de minimis additions to the FTB that are exempt from the zero discharge standard. In other words, PolyMet is using a conservative equation for calculating the allowable discharge volume and proposes to discharge less than it would otherwise be authorized to do. See Appendix B for details on the calculation of allowable discharge.

5.2.3 Compliance Under a Range of Weather Conditions

Because the allowable discharge equation includes net precipitation, the amount of allowable discharge is weather dependent. In fact, precipitation affects both the allowable discharge calculation and the actual discharge volume, but may not affect them during the same time period.

To evaluate the effect of a wide range of weather conditions on both allowable and actual discharge, for permitting, PolyMet adapted the FEIS GoldSim model to simulate the Plant Site and Mine Site experiencing a wide range of climatic conditions simultaneously. The model was run using the precipitation distribution from the most recent climate normal period (1980-2010). Results show that over the life of the Project, the total actual discharge is estimated to be less than the total allowable discharge. Modeling details and results are presented in Appendix B. Figure 5-2 compares the annual average actual discharge to the annual average allowable discharge during approximately the first two NPDES permit cycles.

![Flow Comparison Graph](image)

Flows shown are annual average mean flows from zero discharge modeling described in Appendix B

Figure 5-2 Allowable Discharge Compared to Actual Discharge: Estimated Annual Averages

5.2.4 Permitting Approach

The NSPS set forth in 40 CFR part 440 does not establish timeframes for calculating either allowable discharge or actual discharge for purposes of the zero discharge standard. PolyMet proposes that the NPDES/SDS permit adopt a multi-year approach for calculating these volumes so as to take into account timing considerations relative to variability in weather conditions and timeframes for water treatment.
Appendix B provides estimates of the allowable discharge and modeled actual discharge volumes for purposes of the zero discharge standard. Results demonstrate that the Project can comply with the NSPS zero discharge requirements over the range of modeled weather conditions.
6.0 References


11. —. Mercury Overview: A summary of potential mercury releases from the NorthMet Project and potential effects on the environment. Prepared for Poly Met Mining Inc. March 2015.


Waste Water Treatment System

AVERAGE FLOWS – MINE YEAR 1

Notes:
(1) This figure shows the Waste Water Treatment System flow configuration at the beginning of operations. Mine Year 1 is expected to be the year of minimal discharge and minimal loading from the WWTS.
(2) This figure shows average flows from sources of intake water, operations contributing wastewater to the effluent, and treatment units within the WWTS. It does not include flows that do not contribute to the effluent, such as water entrained within tailings and water in sludge from chemical precipitation units. Total flows may not equal the sum of their contributing parts because flows that do not contribute to the effluent are not shown and flows are rounded to the nearest 10 gpm.
(3) Flows are based on the GoldSim water model (Water Modeling Data Package – Mine Site v14 and Water Modeling Data Package – Plant Site v11).
(4) Consistent with the FEIS, average flows outside the WWTS are the annual average of the monthly mean flow rates.
(5) WWTS internal flows were estimated using the FEIS GoldPhreeqc model (Waste Water Treatment System Design and Operation Report v1). For this diagram, the GoldPhreeqc model influent values to the WWTS were the annual average of the monthly median values from the GoldSim model Mine Site and Plant Site flows.
(6) To be consistent with the values reported in the NPDES/SDS permit application on EPA Form 20, flow rates to the surface water discharge outfalls were not rounded to 10 gpm.
(7) Other inflows to the Beneficiation Plant include water in the raw ore, reagents, and gland seals of slurry pumps.

Legend
XX Annual average flow (rounded to 10 gpm)
XX Annual average membrane concentrate flow (rounded to 10 gpm)
XX Intermittent flows for filter cleaning (rounded to 10 gpm)
Notes:
1. This figure shows the Waste Water Treatment System flow configuration during Mine Year 10.
2. This figure shows average flows from sources of intake water, operations contributing wastewater to the effluent, and treatment units within the WWTS. It does not include flows that do not contribute to the effluent, such as water entrained within tailings and water in sludge from chemical precipitation units. Total flows may not equal the sum of their contributing parts because flows that do not contribute to the effluent are not shown and flows are rounded to the nearest 10 gpm.
WATER TREATMENT OVERALL FLOW SHEET

AVERAGE FLOWS – MINE YEAR 15

NorthMet Project
Poly Met Mining Inc.

Legend

Notes:
(1) Mine Year 15 represents the Waste Water Treatment System flow configuration when WWTF effluent is used to flood and flush the East Pit.
(2) This figure shows average flows from sources of intake water, operations contributing wastewater to the effluent, and treatment units within the WWTS. It does not include flows that do not contribute to the effluent, such as water entrained within tailings and water in sludge from chemical precipitation units. Total flows may not equal the sum of their contributing parts because flows that do not contribute to the effluent are not shown and flows are rounded to the nearest 10 gpm.
(3) Flows are based on the GoldSim water model (Water Modeling Data Package – Mine Site v14 and Water Modeling Data Package – Plant Site v11).
(4) Consistent with the FEIS, average flows outside the WWTS are the annual average of the monthly mean flow rates.
(5) WWTS internal flows were estimated using the FEIS GoldPhreeqc model (Waste Water Treatment System Design and Operation Report v1). For this diagram, the GoldPhreeqc model influent values to the WWTS were the annual average of the monthly mean values from the GoldSim model Mine Site and Plant Site flows.
(6) To be consistent with the values reported in the NPDES/SDS permit application on EPA Form 2D, flow rates to the surface water discharge outfalls were not rounded to 1 gpm.
(7) Other inflows to the Beneficiation Plant include water in the raw ore, reagents, and gland seals of slurry pumps.

Filtered sludge to HRF or disposal at a permitted solid waste facility

Large Figure 4
NPDES/SDS Permit Application Volume III: Waste Water Treatment System
Permit Application Update – October 2017
Refer to Large Figure 11 in Volume I for all Internal Waste Streams proposed at the Plant Site.

Proposed Monitoring Stations
- Internal Waste Stream Monitor Only
- Surface Water Discharge Stations
- Internal Performance Monitoring

FTB Water Return Pipe
FTB Tailings Discharge Pipe
Treated Water Pipe
Plant Reservoir Overflow
Mine to Plant Pipelines

FTB Seepage Containment System
EIS Project Areas
Watershed Divide
Embarrass River Subwatersheds
Partridge River Subwatersheds
Public Waters Inventory (PWI) Watercourses

National Hydrography Dataset (NHD) Rivers & Streams

1 These are provisional representations of PWI watercourses found on the current paper regulatory maps.
2 The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.
3 Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry
Internal Waste Stream Monitor Only

- EIS Project Areas
- Mine Year 1 Footprints
- Haul Roads
- Railroad
- Mine Pit
- Mine to Plant Pipelines
- Mine Water Pipes
- Active Stockpile
- Mine Water Ponds and Sumps
- Storage & Laydown Area

Public Waters Inventory (PWI) Watercourses¹

National Hydrography Dataset (NHD) Rivers & Streams²

¹These are provisional representations of PWI watercourses found on the current paper regulatory maps.

²The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.

Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Refer to Large Figure 10 in Volume I for all Internal Waste Streams proposed at the Mine Site.
Appendix A

Antidegradation Evaluation
Surface Water Antidegradation Evaluation – NorthMet Waste Water Treatment System (WWTS) Discharge

Prepared for Poly Met Mining, Inc.

Version 2
October 2017
Surface Water Antidegradation Evaluation
NorthMet Waste Water Treatment System (WWTS) Discharge
Version 2– October 2017

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<thead>
<tr>
<th>Acronym or Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band</td>
<td>Fond du Lac Band of Lake Superior Chippewa</td>
</tr>
<tr>
<td>BCC</td>
<td>Bioaccumulative Chemical of Concern</td>
</tr>
<tr>
<td>BSIC</td>
<td>Bioaccumulative Substance of Immediate Concern</td>
</tr>
<tr>
<td>BTPT</td>
<td>Best Technology in Process and Treatment</td>
</tr>
<tr>
<td>Cliffs Erie</td>
<td>Cliffs Erie, LLC</td>
</tr>
<tr>
<td>CWA</td>
<td>Clean Water Act</td>
</tr>
<tr>
<td>DEIS</td>
<td>Draft Environmental Impact Statement</td>
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<tr>
<td>FDL</td>
<td>Fond du Lac</td>
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<tr>
<td>FEIS</td>
<td>Final Environmental Impact Statement</td>
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<tr>
<td>FTB</td>
<td>Flotation Tailings Basin</td>
</tr>
<tr>
<td>g/yr</td>
<td>grams per year</td>
</tr>
<tr>
<td>GLI</td>
<td>Great Lakes Initiative</td>
</tr>
<tr>
<td>IAP</td>
<td>Impact Assessment Planning</td>
</tr>
<tr>
<td>LCS</td>
<td>Laboratory Control Sample</td>
</tr>
<tr>
<td>LSB</td>
<td>Lake Superior Basin</td>
</tr>
<tr>
<td>LTVSMC</td>
<td>LTV Steel Mining Company</td>
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<tr>
<td>MDH</td>
<td>Minnesota Department of Health</td>
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<tr>
<td>MDNR</td>
<td>Minnesota Department of Natural Resources</td>
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<tr>
<td>MEPA</td>
<td>Minnesota Environmental Policy Act</td>
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<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
</tr>
<tr>
<td>MMREM</td>
<td>MPCA Mercury Risk Estimation Method</td>
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<tr>
<td>MPCA</td>
<td>Minnesota Pollution Control Agency</td>
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<tr>
<td>NEPA</td>
<td>National Environmental Policy Act</td>
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<tr>
<td>ng/L</td>
<td>nanograms per liter</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<tr>
<td>NSPS</td>
<td>New Source Performance Standard</td>
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<tr>
<td>OIRW</td>
<td>Outstanding International Resource Water</td>
</tr>
<tr>
<td>ORVWW</td>
<td>Outstanding Resource Value Water</td>
</tr>
<tr>
<td>POC</td>
<td>Parameter of Concern</td>
</tr>
<tr>
<td>PolyMet</td>
<td>Poly Met Mining, Inc.</td>
</tr>
<tr>
<td>POTW</td>
<td>Publicly Owned Treatment Works</td>
</tr>
<tr>
<td>PQL</td>
<td>Practical quantification limit</td>
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<tr>
<td>Project</td>
<td>NorthMet Project</td>
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<tr>
<td>Reservation</td>
<td>Fond du Lac Reservation</td>
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<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
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<tr>
<td>SDS</td>
<td>State Disposal System</td>
</tr>
<tr>
<td>SONAR</td>
<td>Statement of Need and Reasonableness</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>--------------</td>
<td>-----------</td>
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<tr>
<td>TAS</td>
<td>Treated as State</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>TMDL</td>
<td>Total Maximum Daily Load</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>UCL</td>
<td>upper confidence limit</td>
</tr>
<tr>
<td>USACE</td>
<td>United States Army Corps of Engineers</td>
</tr>
<tr>
<td>USEPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>µg/L</td>
<td>micrograms per liter</td>
</tr>
<tr>
<td>WET</td>
<td>Whole Effluent Toxicity</td>
</tr>
<tr>
<td>WWTS</td>
<td>Waste Water Treatment System</td>
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</tbody>
</table>
Poly Met Mining, Inc. (PolyMet) has applied for an individual NPDES permit to authorize discharge from a Waste Water Treatment System (WWTS) constructed at the NorthMet Project (Project) Plant Site. PolyMet's NPDES/SDS Permit Application triggers antidegradation requirements under Minnesota Rules, part 7050.0250 through part 7050.0335 and Minnesota Rules, part 7052.0300 through part 7052.0380. The proposed activity evaluated in this Antidegradation Evaluation is the WWTS discharge and related activities that affect the quality and quantity of the WWTS discharge.

The WWTS will discharge to three receiving waters (Large Figure 1):

- wetlands in the headwater area of Trimble Creek
- wetlands in the headwater area of Unnamed Creek
- the headwater segment of Second Creek near the location of existing monitoring station PM-7/SD026

For purposes of this Antidegradation Evaluation, a “receiving water” is the segment of a water body which receives WWTS discharge from a surface water discharge outfall. “Downstream waters,” for this evaluation, are waterbodies downstream of a receiving water. Downstream waters include Trimble Creek, Unnamed Creek, Second Creek, the Partridge River, the Embarrass River, the St. Louis River, and Lake Superior, all of which are within the Lake Superior Basin. Large Figure 2 and Large Figure 3 depict the connections between the receiving waters and Lake Superior, and the evaluation points used for the Antidegradation Evaluation.

Receiving and downstream waters, like all waters of the state, are classified to protect specific designated beneficial uses. Water use classifications are listed for some, but not all, waterbodies in Minnesota Rules, part 7050.0470. Wetlands in the headwater areas of Trimble Creek and Unnamed Creek are not listed under Minnesota Rules, part 7050.0470, and thus as unlisted wetlands, are classified under Minnesota Rules, part 7050.0425 as Class 2D, 3D, 4C, 5, and 6 waters. Trimble Creek, Unnamed Creek, Second Creek, the Partridge River, the Embarrass River, and the St. Louis River downstream of the Project are not listed under Minnesota Rules, part 7050.0470 and thus as unlisted waters, are classified under Minnesota Rules, part 7050.0430 as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Existing conditions at the Project Plant Site, where the WWTS discharge will occur, are relevant to this Antidegradation Evaluation. The Plant Site includes the former taconite processing plant, tailings basin and other infrastructure previously operated by LTV Steel Mining Company (LTVSMC) and its predecessors. Cliffs Erie, L.L.C. (Cliffs Erie) acquired these facilities in connection with the 2001 LTVSMC

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1 The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052.
2 WWTS discharge and related activities” means the WWTS discharge and related activities that affect the quality and quantity of that discharge, including the FTB seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake.
3 Minnesota Rules, part 7050.0110
bankruptcy, but has not actively operated them for mining or production purposes. As part of a 2010 consent decree between Cliffs Erie and the Minnesota Pollution Control Agency (MPCA), pumpback systems were installed in 2011 to capture seepage from the existing tailings basin, at locations shown on Large Figure 4. Ferrous mining activities, which have taken place at the Plant Site and other nearby minelands since the 1950s, have impacted water quality in Trimble Creek, Unnamed Creek, Second Creek, the Embarrass River, and the Partridge River, as described in Section 3.1 of Volume V.

**Regulatory Context**

PolyMet is required to conduct an antidegradation assessment of potential surface water impacts in accordance with MPCA rules that became effective in November 2016 (Minnesota Rules, part 7050.0250 to 7050.0335, collectively, the "Revised Rule"). The Revised Rule repealed the state’s former general nondegradation rules (Minnesota Rules, parts 7050.0185 and 7050.0180, collectively, the "Former Rule"). Due to the timing of the implementation of these rules related to the timing of PolyMet’s NPDES/SDS Permit Application, PolyMet has conducted its Antidegradation Assessment\(^4\) to address the requirements of both the Former Rule and the Revised Rule. Antidegradation standards under the Revised Rule and the Former Rule apply to discharges of parameters other than mercury, which is subject to a separate set of requirements as discussed below.

The Revised Rule does not affect the antidegradation standards and procedures in Minnesota Rules, chapter 7052 (Minnesota Rules, parts 7052.0300 through 7052.0380) which address discharges of certain bioaccumulative chemicals to surface waters in the Lake Superior Basin (LSB), which is where the Project and all relevant waters are located. Based on the Project design specifications, which include limited discharge of mercury to receiving waters, PolyMet is also required to conduct an antidegradation demonstration\(^5\) to address standards in Minnesota Rules, chapter 7052 (the "LSB Rule").

The Revised Rule (November 2016) includes multiple antidegradation standards and procedures. The applicability of these specific standards and procedures is determined by the nature of the proposed activity and the type of "control document" required for authorization. PolyMet is applying for multiple authorizations that trigger antidegradation requirements: the individual NPDES wastewater permit, general NPDES permit coverage for industrial stormwater and construction stormwater,\(^6\) and Section 401 certification. For this Project, the Section 401 certification is required because PolyMet applied for a Clean Water Act (CWA) Section 404 permit from the U.S. Army Corps of Engineers (USACE). Under the Revised Rule, there is significant overlap in the antidegradation requirements that apply to individual NPDES permits and Section 401 certifications.

This Antidegradation Evaluation provides the data and analysis required by the antidegradation procedures for an individual NPDES wastewater permit (Minnesota Rules, part 7050.0280, subpart 2), and includes all information needed to demonstrate that the Project will meet the antidegradation requirements applicable to surface waters under the LSB Rule. The report also fulfills the antidegradation requirements of the Former Rule.

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\(^4\) The “Antidegradation Assessment” is PolyMet’s antidegradation analysis under Minnesota Rules, chapter 7050.

\(^5\) The “Antidegradation Demonstration” is PolyMet’s antidegradation analysis under Minnesota Rules, chapter 7052.

\(^6\) The general industrial and construction permits are discussed in more detail in Section 2.1. MPCA performed the required antidegradation analyses in connection with both general permits.
requirements for CWA Section 401 certification relating to compliance with applicable surface water quality requirements (Minnesota Rules, part 7050.0280, subpart 2, as required under Minnesota Rules, part 7050.0285, subpart 2).

PolyMet has prepared a separate Section 401 certification antidegradation report to address the requirements of the Revised Rule (Minnesota Rules, part 7050.0285, subpart 2) for the physical alteration of Project wetlands. PolyMet also has prepared separate groundwater antidegradation reports as required by Minnesota Rules, chapter 7060. In addition, the Project industrial and construction stormwater discharges will be governed by MPCA’s general NPDES permits for these activities, each of which includes its own antidegradation assessment conducted by MPCA in connection with issuance of the general permit.

Collectively, with these separate analyses, referenced in the two preceding paragraphs, all water discharges from the Project have received the requisite antidegradation evaluations required by federal and state law.

**Methods**

To a significant degree, antidegradation assessments are intended to evaluate the availability of alternatives to avoid or minimize any lowering of surface water quality, including both designated uses and numeric or narrative water quality standards. The Former, Revised, and LSB Rules all incorporate such alternative-analysis concepts into their specific requirements (former Minnesota Rules, part 7050.0185, subpart 4; Minnesota Rules, part 7050.0280, subpart 2; Minnesota Rules, part 7052.0320 subparts 2 and 3).

During the National Environmental Policy Act (NEPA) / Minnesota Environmental Policy Act (MEPA) review process for the Project, PolyMet and the Co-Lead Agencies identified and assessed available control-technology alternatives and mitigation measures to protect surface waters generally, and specifically to avoid where practicable, and minimize where avoidance was not practicable, degradation of high quality waters. The WWTS technology proposed for the Project was evaluated in the Final Environmental Impact Statement (FEIS) (Reference (1)). Accordingly, the FEIS alternatives analysis satisfies the requirements of the Former Rule, the Revised Rule, and the LSB rules, and no additional alternatives analysis is required.

More detail on the alternatives analysis is provided in Section 7.4. The analysis establishes that the Project as evaluated in the FEIS is the least degrading prudent and feasible alternative for all parameters of concern, including mercury, and incorporates by design the best technology in process and treatment for mercury.

For the Antidegradation Evaluation, PolyMet assessed the estimated effects of the WWTS discharge and related activities relative to a specific list of parameters of concern. Parameters of concern are the parameters that could reasonably be expected to be present in the WWTS discharge and for which promulgated numeric or narrative surface water quality standards are applicable to the receiving or downstream waters. Parameters of concern for this Antidegradation Evaluation are listed in Table ES-1. See Section 5.1 for additional details about the parameters of concern. As noted in Table ES-1, the list of parameters of concern includes mercury, which has bioaccumulative properties and is subject to special
requirements under the LSB Rule. Also, PolyMet plans an internal performance operating limit of 10 milligrams per liter (mg/L) for sulfate as part of the WWTS design. Although the WWTS receiving waters will not be subject to the existing or proposed "wild rice" rules, and hence, the wild-rice sulfate standard will not be applicable to the discharges, PolyMet will use the sulfate internal performance metric to evaluate the WWTS operation, as discussed in Appendix D of Volume I. Thus, PolyMet has incorporated a sulfate treatment target of 10 mg/L into the WWTS design.

Table ES-1 Parameters of Concern for the NorthMet Antidegradation Evaluation

<table>
<thead>
<tr>
<th>Metals</th>
<th>General Parameters</th>
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<tbody>
<tr>
<td>Aluminum</td>
<td>Lead</td>
</tr>
<tr>
<td>Antimony</td>
<td>Mercury</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Nickel</td>
</tr>
<tr>
<td>Boron</td>
<td>Selenium</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Silver</td>
</tr>
<tr>
<td>Chromium</td>
<td>Thallium</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Zinc</td>
</tr>
<tr>
<td>Copper</td>
<td>Total Dissolved Solids</td>
</tr>
</tbody>
</table>

Note: See Section 5.1 for the surface water quality standards associated with the parameters of concern.

The estimated effects of the WWTS discharge and related activities for this Antidegradation Evaluation are based on the estimated WWTS discharge quality evaluated for the FEIS (Section 3.1.1). The proposed WWTS design will be capable of meeting all applicable water quality standards and treatment targets, and delivering the discharge quality evaluated for the FEIS. Based on more recent modeling for the WWTS design process conducted during permitting, PolyMet anticipates that in practice the concentrations of most parameters in the discharge will be below the concentrations evaluated in the FEIS (Section 3.1.1). This is because operating the WWTS to remove enough sulfate to achieve the 10 mg/L internal performance operating limit will remove other parameters of concern to concentrations below—in some cases, substantially below—the concentrations evaluated in the FEIS. By using the higher FEIS-based concentrations (the estimated concentrations) rather than on the lower, more realistic, design modeling concentrations (the anticipated concentrations), this Antidegradation Evaluation overestimated the effects of the WWTS for all parameters of concern other than sulfate.

Antidegradation Assessment for Parameters of Concern other than Mercury under Minnesota Rules, Chapter 7050

The following subsections summarize the Antidegradation Assessment under the Former Rule and the Revised Rule for parameters of concern other than mercury. Details are provided in Sections 6.0 and 7.0.
**Existing Uses Will Be Maintained and Protected**

Existing uses in most sections of receiving and downstream waters co-exist with the waters’ designated uses, because the designated uses actually occur and the existing water quality meets numeric water quality standards associated with the designated uses. Existing uses that are also designated uses will be maintained and protected because estimated water quality will not interfere with the designated uses and will meet numeric (or if applicable, narrative) water quality standards associated with the designated uses. There is one undesignated existing use, referred to for this evaluation as natural wild rice stands, which has been observed in some downstream waters (Large Figure 5). This undesignated existing use, and the existing water quality necessary to support it, will be maintained and protected because the Project will decrease sulfate loading to these downstream waters. There are no other known undesignated existing uses; therefore, all existing uses of receiving and downstream waters will be maintained and protected in accordance with the requirements of the Former Rule and the Revised Rule.

**PolyMet Will Comply With Applicable Water Quality Standards**

The WWTS discharge will meet all applicable numeric and narrative water quality standards in Minnesota Rules, chapter 7050. PolyMet will also comply with effluent limits in Minnesota Rules, chapter 7053, including general prohibitions for discharges and specific restrictions for industrial discharges. In particular, these chapter 7053 requirements will be met because parameters of concern are not associated with nuisance conditions or excess nutrients, and the WWTS discharge will meet acute and chronic whole effluent toxicity (WET) standards. Finally, PolyMet will comply with all federal point source effluent limits in the applicable sections of 40 C.F.R. 440 at the surface water discharge outfalls. Therefore, PolyMet will comply with all applicable numeric and narrative water quality standards at these discharge outfalls.

**Discharge Will Not Permanently Preclude Attainment of Water Quality Standards**

With one potential exception, the receiving and downstream waters currently attain the water quality associated with their respective designated beneficial uses. The possible exception is at MNSW8 on Second Creek, where the existing values of hardness, total dissolved solids (TDS), and specific conductance are higher than the current numeric water quality standards for Class 3C and 4A waters. These conditions, however, are not precluding actual uses that conform to the designated uses. The location of MNSW8 is shown on Large Figure 2. The WWTS discharge and related activities will not degrade existing conditions or uses; rather, PolyMet estimated that the WWTS discharge and related activities will decrease the hardness at MNSW8, and will decrease the loading of constituents that contribute to the current values of TDS and specific conductance, although no measurable decrease in TDS or specific conductance is expected. These estimated improvements in water quality due to the WWTS discharge and related activities at MNSW8 further the protection of beneficial uses.
Degradation of High Water Quality Will Be Minimized, and the Project Will Have Social and Economic Benefits

The Revised Rule defines a water body as "high quality" if it "exceeds, on a parameter-by-parameter basis, levels necessary to support the protection and propagation of aquatic life and recreation in and on the water."\(^{11}\) The Project includes extensive management and treatment measures designed to minimize degradation and to protect high quality waters. PolyMet plans to implement an internal performance operating limit of 10 mg/L for sulfate. The net effect of the Project will be to reduce sulfate loading to the St. Louis River watershed by approximately 1,400 metric tons per year.

The Project FEIS alternatives assessment established that there are no prudent and feasible alternatives for avoiding degradation of high quality waters.\(^{12}\) Potential degradation of high quality water due to the Project will be minimized by application of the least degrading prudent and feasible alternative controls to the new discharge. The proposed waste water treatment technology and level of treatment incorporated into the Project are the least degrading prudent and feasible alternative. PolyMet’s review of other waste water treatment systems indicated that the Project WWTS will exceed the level of treatment that is currently in place for any known waste water system discharging to the Partridge River or Embarrass River, or any other streams within the St. Louis River watershed. In this regard, the proposed treatment is prudent, and is an example of advanced treatment.

Based on the estimated water quality information used for the Antidegradation Evaluation, the WWTS discharge and related activities were estimated to have no measurable effect on the average concentration of the parameters of concern at the evaluation point in Scanlon, Minnesota, prior to the St. Louis River’s entry into Lake Superior.\(^{14}\)

Outstanding Resource Value Waters Will Be Protected

The Former, Revised, and LSB Rules all create special protections for surface waters defined as "Outstanding Resource Value Waters" (ORVW). The Project will not directly discharge to any ORVWs. The first downstream ORVW is Lake Superior, located approximately 175 river miles downstream of the Project along the St. Louis River. Lake Superior is classified as a restricted ORVW, and limited segments of the lake are classified as prohibited ORVWs, with classifications defined in the Revised Rule.\(^{14}\) The WWTS discharge and related activities were estimated to have no measurable effect on the average concentration of the parameters of concern at the evaluation point in Scanlon, Minnesota, prior to the St. Louis River’s entry.

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\(^{11}\) See Minnesota Rules, part 7050.0255, subpart 21.
\(^{12}\) See Minnesota Rules, part 7050.0265, subpart 5(A).
\(^{13}\) See Minnesota Rules, part 7050.0265, subpart 5(B).
\(^{14}\) See Minnesota Rules, part 7050.0335.
into Lake Superior. As a result, the WWTS discharge and related activities will not degrade the existing water quality of a downstream ORVW.\textsuperscript{15} The Project’s proximity to Lake Superior is shown on Large Figure 3.

**Antidegradation Demonstration for Mercury under Minnesota Rules, Chapter 7052**

Minnesota Rules, chapter 7052 regulates the discharge of specified bioaccumulative substances\textsuperscript{16} to "outstanding international resource waters" (OIRWs)\textsuperscript{17} in the LSB. The receiving and downstream waters are classified as OIRWs, as are all surface waters of the LSB (apart from ORVWs and Class 7 waters),\textsuperscript{18} therefore, the WWTS discharge and related activities must comply with the LSB antidegradation requirements. Mercury is the only bioaccumulative parameter specified in Chapter 7052 that is anticipated to be present in PolyMet’s proposed discharge from the WWTS. Accordingly, mercury is the only parameter that PolyMet has evaluated under the antidegradation standards in chapter 7052. Details on the Antidegradation Demonstration for mercury are provided in Sections 8.0 and 9.0.

**Existing Uses Will Be Maintained and Protected**

In receiving and downstream waters (Class 2B waters), the existing uses with regard to mercury are “the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats” (Minnesota Rules, part 7050.0222 subpart 4). In the headwater segment of Second Creek, this existing use will be maintained and protected because the estimated water quality will meet the applicable mercury water quality standard of 1.3 nanogram per liter (ng/L) at the surface water discharge outfall.

At receiving and downstream evaluation points where existing mercury concentrations are above the applicable water quality standard of 1.3 ng/L, the existing use will be maintained and protected because the WWTS discharge and related activities will result in no measurable increase in water column mercury concentrations from the existing concentrations and will not change existing or designated uses. Potential effects on fish tissue mercury concentrations were estimated based on the concept of proportionality, as used by the MPCA and the U.S. Environmental Protection Agency (USEPA), (Reference (2)), wherein changes in fish tissue mercury concentration are expected to be proportional to changes in water column mercury concentration (Section 8.3.3). Using this approach, because no measurable change from existing water column mercury concentrations is expected, the WWTS discharge and related activities are estimated to result in no measurable change from background fish tissue mercury concentrations in receiving or downstream waters. Large Figure 6 compares the existing mercury concentrations with the estimated concentrations in Mine Year 10.

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\textsuperscript{15} See Minnesota Rules, part 7050.0265, subparts 6 and 7 and also former Minnesota Rules, part 7050.0180, subparts 3, 6, and 9.

\textsuperscript{16} See Minnesota Rules, part 7052.0010 defining “bioaccumulative chemical[s] of concern” and “bioaccumulative substances of immediate concern.”

\textsuperscript{17} See Minnesota Rules, part 7052.0300, subpart A(1).

\textsuperscript{18} See Minnesota Rules, part 7052.0010, subpart 3.
Discharge Will Not Lower Water Quality in Water Bodies That Are Impaired for Mercury

Although none of the receiving waters is on the State's 303(d) impaired waters list, or on the 2016 proposed list, several downstream lakes (e.g., Sabin Lake) and reaches of the Partridge, Embarrass, and St. Louis River are either listed or proposed for listing as impaired for mercury in the water column and/or mercury in fish tissue.19

The net effect of the WWTS discharge and related activities is estimated to slightly reduce mercury loading in the impaired water bodies and estimated to cause no measurable increase in mercury concentration. As a result, the WWTS discharge will not lower water quality in any receiving or downstream waters, including any impaired waters, relative to mercury. Further, because changes in fish tissue mercury concentration are considered to be proportional to changes in mercury concentration (Section 8.3.3), the WWTS discharge and related activities are estimated to result in no measurable change to the existing concentration of mercury in fish tissue in impaired waters.20 Therefore, no measurable change from background fish tissue concentrations attributable to the WWTS discharge and related activities is expected.

In addition, the FEIS confirms that the Project will be consistent with the requirements of Minnesota’s statewide Total Maximum Daily Load (TMDL) for mercury.21 In particular, the FEIS states that the Project "would not impede the [Minnesota] reduction goals" for mercury.22

Extent of Discharge Will Be Minimized Using Best Technology in Process and Treatment, and the Project Will Have Social and Economic Benefits

The Project will minimize mercury discharge by deploying the "best technology in process and treatment" (BTPT) as required by the LSB Rule.23 The BTPT was determined through an alternatives assessment as described in Section 9.3. The BTPT in this instance is comprised of multiple aspects of the Project’s integrated water management system, including filtration through Flotation Tailings and taconite tailings, capture of seepage in connection with the Tailings Basin, and membrane separation treatment by the WWTS. As a result of the BTPT the WWTS discharge and related activities are estimated to result in no measurable increase in mercury concentrations, and a small potential decrease in mercury loading in the receiving and downstream waters except for the Second Creek headwater segment. In the Second Creek headwater segment, the mercury concentration is estimated to increase from the existing concentration of 0.6 ng/L, to a level at or below the 1.3 ng/L water quality standard. This estimated increase in mercury concentration in the headwater segment of Second Creek is necessary to accommodate the important economic and social developments and benefits associated with the Project (Section 7.5).24 Moreover, the expected net effect of the WWTS discharge and related activities, downstream of the confluence of the

19 USEPA-approved 2014 303(d) impaired waters list and the MPCA proposed 2016 list.
20 See Minnesota Rules, part 7052.0300 subpart 2.
21 FEIS Appendix A, A – 421-22
22 FEIS Appendix A, A – 421.
23 See Minnesota Rules, part 7052.0320, subpart 3.
24 See Minnesota Rules, part 7052.0300, subpart 4.
Partridge River and the Embarrass River with the St. Louis River, is estimated to result in a potential small decrease in mercury loading to the St. Louis River (Section 8.3).

**Outstanding Resource Value Waters Will Be Protected**

The Project will not directly discharge to an ORVW, as described in Section 7.6, and accordingly will not degrade any downstream ORVW with respect to mercury.25

**Other Related Permitting Considerations**

Other considerations related to antidegradation of surface waters include the CWA prohibition of discharges that will “cause or contribute” to a violation water quality standards, and the requirement that discharges not degrade waters of downstream states.

**Project Will Not “Cause or Contribute to the Violation of Water Quality Standards”**

The CWA prohibits issuance of a permit for a new discharge or new discharger that will “cause or contribute to the violation of water quality standards.”26 PolyMet has designed the Project so that the concentration of parameters of concern in the WWTS discharge, including mercury, will be at or below applicable Minnesota numeric water quality standards. Because of this design, the effect of the WWTS discharge and related activities will be to either maintain compliance with Minnesota’s water quality standards in receiving and downstream waters or, through a reduction in pollutant concentrations and/or reduction of loading, actually improve water quality.

For most parameters of concern at evaluation points on receiving and downstream waters, the existing concentrations are below applicable numeric water quality standards, and future concentrations, during Project operations, were estimated to remain below applicable standards. In these situations, the WWTS discharge and related activities will not cause a violation of water quality standards.

Existing concentrations of a limited number of parameters of concern (i.e., mercury, hardness, TDS, and specific conductance) are above applicable numeric water quality standards at some evaluations points in receiving or downstream waters. The WWTS discharge and related activities will not contribute to these existing exceedances of water quality standards, because they were estimated to reduce mercury loading and decrease the concentrations of constituents that contribute to hardness, TDS, and specific conductance, although no measurable decrease in hardness, TDS, or specific conductance is expected. Therefore, the WWTS discharge and related activities will improve water quality with regard to the elevated parameters, and not contribute to the current exceedances.

**Water Quality of Downstream States Will Not Be Degraded**

The St. Louis River forms the northeastern border of the Fond du Lac Reservation (Reservation). The Fond du Lac Band of Lake Superior Chippewa (Band) has been granted “treatment as state” (TAS) status under the CWA, and the Band has developed its own water quality standards and antidegradation

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25 See Minnesota Rules, parts 7052.0300, subpart 1(B).
26 40 C.F.R. § 122.4(i).
requirements. Tribal numeric water quality standards are the same as State of Minnesota numeric standards for parameters of concern other than mercury: the tribal mercury standard is lower than the state mercury standard. The Project is located approximately 116 river miles upstream of the Reservation, the northern border of which includes reaches of the St. Louis River. Information on potential effects of the WWTS discharge and related activities relative to the tribal standards has been included in this Antidegradation Evaluation.

PolyMet's Antidegradation Evaluation indicated the WWTS discharge and related activities will result in no measurable change in concentration for any parameter of concern in the St. Louis River within the Reservation boundaries, and will in fact reduce loading of mercury in that reach of the river by approximately 10 grams per year (Section 10.2).

Therefore, if the Band's mercury water quality standards were applicable in this instance, the Project will not cause or contribute to a lowering of water quality within the Reservation boundaries, nor will the Project adversely affect any existing or designated uses of waters within the Reservation. Because the Project was estimated to reduce mercury loading in the reach of the St. Louis River within the Reservation boundaries, the differing mercury numeric standards of the State and Band do not affect the analysis.

The WWTS discharge and related activities also will not cause or contribute to a lowering of water quality of any other downstream TAS or state. Therefore, no additional analysis of other downstream states or tribes is required.

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27 See FDL 12-98 § 105.
1.0 Introduction

Poly Met Mining, Inc. (PolyMet) proposes to discharge treated effluent (discharge) from a Waste Water Treatment System (WWTS) that will be constructed at the proposed NorthMet Project (Project) Plant Site. The WWTS will discharge to three receiving waters (Large Figure 1):

- wetlands in the headwater area of Trimble Creek
- wetlands in the headwater area of Unnamed Creek
- the headwater segment of Second Creek near the location of existing monitoring station PM-7/SD026

Because the Project involves a “new or expanded discharge” to these waters, and the Project will be regulated by the Minnesota Pollution Control Agency (MPCA) under an individual NPDES/SDS wastewater permit, general NPDES permits for industrial stormwater and construction stormwater, and a Clean Water Act (CWA) Section 401 certification, PolyMet is required to conduct an antidegradation assessment under Minnesota Rules, parts 7050 and 7052 (collectively referred to as the Antidegradation Evaluation); this report was developed to document PolyMet’s Antidegradation Evaluation.28

This Antidegradation Evaluation covers more than just the WWTS discharge. It also covers related Project activities that will affect the quality and quantity of that discharge, such as operation of the Flotation Tailings Basin (FTB) seepage capture systems, the effects of watershed changes at the Mine and Plant Sites, and the effects of withdrawing make-up water from Colby Lake. There are separate antidegradation analyses for two other discrete areas where the Project has the potential to affect waters, specifically – stormwater, which will be governed by the Minnesota NPDES/SDS Industrial Stormwater General Permit and the Minnesota NPDES/SDS Construction Stormwater General Permit, which incorporate their own antidegradation evaluations, and wetlands, for which PolyMet has provided an additional antidegradation report to address physical alteration of Project wetlands for the Section 401 certification process. Collectively, with these separate analyses, all water discharges from the Project have received the requisite antidegradation evaluations required by federal and state law.

1.1 Organization of this Document

This document is organized as follows:

Section 1.0 Introduces the receiving streams, organization of the document, and key terminology and gives an overview of the Project.

Section 2.0 Presents a regulatory analysis that identifies antidegradation standards and antidegradation requirements for the parameters of concern subject to Minnesota

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28 Minnesota Rules, part 7050.0280, subpart 1; Minnesota Rules, part 7052.0300, subpart 1 (A); and former Minnesota Rules, part 7050.0185, subparts 3 and 4.
Rules, chapter 7050 and for mercury, which is governed by Minnesota Rules, chapter 7052.

Section 3.0 Describes the characteristics of the WWTS discharge.

Section 4.0 Identifies the receiving and downstream waters, their designated uses, and their actual uses.

Section 5.0 Details the methods used for the Antidegradation Evaluation.

Section 6.0 Describes existing water quality and estimated water quality for parameters of concern other than mercury.

Section 7.0 Presents the Antidegradation Assessment under Minnesota Rules, chapter 7050 for parameters of concern other than mercury.

Section 8.0 Describes existing water quality and estimated water quality for mercury.

Section 9.0 Presents the Antidegradation Demonstration under Minnesota Rules, chapter 7052 for mercury.

Section 10.0 Covers other permitting considerations related to antidegradation.

1.2 Terminology

PolyMet proposes to manage Project water in several specifically-defined categories; definitions are presented in Table 1-1 of Volume I. In the application, and in this document, these defined terms are italicized in text, for example tailings basin seepage.

Terminology relevant to the Tailings Basin also has specific definitions. PolyMet will place Flotation Tailings in the Flotation Tailings Basin (FTB), which will be placed on top of a portion of the existing former LTV Steel Mining Company (LTVSMC) tailings basin. In the NPDES/SDS Permit Application, and in this document, the “FTB” means the newly constructed NorthMet Flotation Tailings Basin, the “LTVSMC tailings basin” means the existing former LTVSMC tailings basin, and the “Tailings Basin” means the combined LTVSMC tailings basin and the FTB. Seepage from the Tailings Basin will be collected by the FTB Seepage Containment System and the FTB South Seepage Management System, which are collectively known as the FTB seepage capture systems.

In addition, the following terminology applies to this evaluation:

- A “receiving water” is the segment of a water body which receives the WWTS discharge from a surface water discharge outfall.
- “Downstream waters” are waterbodies downstream of a receiving water.
"Parameters of concern" are the parameters that could reasonably be expected to be present in the WWTS discharge and for which applicable promulgated numeric or narrative surface water quality standards exist. Parameters of concern are listed in Table 5-1.

"WWTS discharge and related activities" means the WWTS discharge and related activities that affect the quality and quantity of that discharge, including the FTB seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake. This term excludes stormwater discharges and wetlands impacts, each of which are subject to separate antidegradation evaluations as described in Section 2.1.

The "Antidegradation Assessment" is PolyMet's assessment of potential effects of the WWTS discharge and related activities relative to antidegradation requirements under Minnesota Rules, chapter 7050. As described in Section 2.1, this accounts for both the recently adopted "antidegradation" requirements of Minnesota Rules, part 7050.0250 to 7050.0335 (collectively, the "Revised Rule") and the former "nondegradation" requirements in Minnesota Rules, parts 7050.0185 and 7050.0180 (collectively, the "Former Rule") .

The "Antidegradation Demonstration" is PolyMet’s assessment of potential effects of the WWTS discharge and related activities relative to antidegradation requirements under Minnesota Rules, chapter 7052.

The "Antidegradation Evaluation" is PolyMet’s combined analysis under Minnesota Rules, chapters 7050 and 7052.

1.3 Project Overview

The Project will consist of a copper-nickel-platinum group elements mine and associated processing facilities, as described in the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) (Reference (1)) and pending permit applications. The Project includes the Mine Site, the Plant Site, the Transportation and Utility Corridors that connect them, and the Colby Lake Pipeline Corridor (Large Figure 2). The Mine Site is a greenfield site that will be developed into an open pit mine. The Plant Site, located west of the Mine Site, is a brownfield site formerly operated by LTVSMC as a taconite processing facility. Redevelopment of the Plant Site for the Project will include refurbishment of former LTVSMC processing facilities and construction of new facilities, including the FTB, seepage capture systems to collect tailings basin seepage, and the WWTS to treat tailings basin seepage prior to discharge.

Seepage capture systems will include the FTB Seepage Containment System, which will collect tailings basin seepage that migrates to the north, northwest, west, and east, and the FTB South Seepage Management System, which will collect tailings basin seepage that migrates to the south. A portion of the collected seepage will be recycled to the FTB Pond for reuse in the beneficiation process, and a portion will be routed to the WWTS for treatment prior to discharge.

The WWTS will use a multi-step water treatment process including membrane separation technology to treat the tailings basin seepage. The quantity of discharge from the WWTS will vary over time, depending on factors such as precipitation, mine pit dewatering, operational requirements, and regulatory
requirements. Water modeling conducted for the FEIS indicated that WWTS discharge volume will be greatest during Mine Year 10 (Section 6 of Reference (3)). For most parameters of concern (Table 5-1), including those that are expected to exhibit the greatest net increases in loading (cobalt, copper, lead, and nickel), modeling also demonstrates that mass loading will be greatest in Mine Year 10. Therefore, the Antidegradation Evaluation is based on expected conditions during Mine Year 10.

The WWTS is one component of PolyMet’s overall water management strategy, which is integrated across the Mine and Plant Sites. The Project maximizes water recycling in order to minimize pollutant discharge and reduce the amount of make-up water that will be withdrawn from Colby Lake. In addition to treating tailings basin seepage, the WWTS will also treat mine water before it is piped to the FTB to supply water for use in the beneficiation process. The WWTS design is fully integrated to treat both mine water and tailings basin seepage to minimize pollutant concentrations in the WWTS discharge.

Collection of tailings basin seepage is a key engineering control to minimize pollutant discharge; however, it will also reduce the quantity of water currently flowing from the Plant Site to the headwater areas of Trimble Creek, Unnamed Creek, Second Creek, and Unnamed (Mud Lake) Creek. Reduced streamflow levels could affect ecological functions, so PolyMet will augment flow in these four creeks for purposes of maintaining hydrology and existing aquatic ecology (Section 5.2.2.3.3 of Reference (1)).

To meet this objective, PolyMet will distribute WWTS discharge to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek in proportion to the amount of water that the FTB seepage capture systems will collect from each creek’s watershed. Unnamed (Mud Lake) Creek will be augmented with non-contact stormwater routed via a drainage swale (Section 2.4.3 of Volume V). This discharge strategy is referred to as “stream augmentation.”

The primary Project activities which will affect the quality and quantity of the WWTS discharge include the following:

- the WWTS, which will treat tailings basin seepage
- the FTB seepage capture systems, which will collect tailings basin seepage which originates from the FTB Pond, consisting of treated mine water, process water, construction mine water, and precipitation
- watershed changes at the Mine Site due to the mine pits and the mine water management systems, which will collect mine water for treatment and reuse at the Plant Site
- watershed changes at the Plant Site, which will affect the quantity of water flowing into the Tailings Basin and the quantity of water collected by the FTB seepage capture systems
- the pumping of make-up water from Colby Lake for use at the Plant Site

Full details on Project activities that may affect receiving water quality and quantity are presented in Volumes I through VII.
2.0 Regulatory Context

"Antidegradation" refers to the concept that water bodies with water quality better than applicable standards should be maintained at that existing high quality and not be degraded except in limited circumstances authorized by law. It has its roots in the goal of the CWA to "...restore and maintain the chemical, physical, and biological integrity of the Nation's waters."\textsuperscript{29} Under section 303 of the Act, each state has the responsibility to establish water quality standards for water bodies of the United States within its borders.\textsuperscript{30} The standards must include designated uses for the water bodies and water quality criteria necessary to protect the most sensitive designated uses. States must also have in place an antidegradation policy that is at least as stringent as the federal antidegradation policy in 40 C.F.R. § 131.12. The federal policy provides three levels or "tiers" of protection, which are reflected in Minnesota's antidegradation rules:

- The Tier 1 level is for the protection of existing uses. It requires that existing in-stream uses of a water body and the level of water quality necessary to protect the existing uses must be maintained and protected.
- The Tier 2 level protects waters where the quality of the water exceeds levels necessary to support propagation of fish, shellfish, and recreation. In this situation, a lowering of water quality is allowed, but only upon a showing that it is necessary to accommodate important economic or social development in the area in which the waters are located.
- The Tier 3 level applies to high quality waters that constitute an outstanding national resource, such as national parks and wildlife refuges; the high quality of these waters must be maintained and protected.

In addition to these antidegradation requirements, federal regulations also require states to have separate, more stringent antidegradation provisions for water bodies in the Great Lakes System, which particularly target "bioaccumulative chemicals of concern" (BCCs) and “bioaccumulative substances of immediate concern” (BSICs) in the Lake Superior Basin (LSB).\textsuperscript{31}

In accordance with the federal requirements, Minnesota has enacted one set of antidegradation standards and procedures that applies to all surface waters of the state (Minnesota Rules, parts 7050.0250 through 7050.0335) and a second set that applies to surface waters of the state in the LSB (Minnesota Rules, parts 7052.0300 through 7052.0330), which is where the Project and all relevant waters are located. Based on the specifics of the Project, Minnesota Rules, parts 7052.0300 through 7052.0330 apply to discharge of mercury, and Minnesota Rules, parts 7050.0250 through 7050.0335 apply to discharges of parameters other than mercury. Large Figure 3 shows the Project location, including downstream connections to Lake Superior.

\textsuperscript{29} 33 USC § 1251(a) (CWA 101(a)) (emphasis added).
\textsuperscript{30} 33 USC § 1313.
\textsuperscript{31} See 40 C.F.R. 132, app. E (establishing a similar three-tiered policy for the LSB and requiring that new or increased discharges of BSICs in the LSB are subject to best technology in process and treatment requirements).
2.1 General Antidegradation Standards

MPCA revised its antidegradation rules, effective November 2016 (Minnesota Rules, part 7050.0250 to 7050.0335, collectively, the “Revised Rule”). MPCA’s rulemaking, which does not affect the antidegradation provisions in Minnesota Rules, chapter 7052, repealed the state’s former general “nondegradation” requirements (Minnesota Rules, parts 7050.0185 and 7050.0180, collectively, the “Former Rule”). Due to the timing of the implementation of these rules related to the timing of PolyMet’s NPDES/SDS Permit Application, PolyMet has conducted its Antidegradation Assessment to address the requirements of both the Former Rule and the Revised Rule.

Antidegradation/nondegradation requirements apply to the WWTS discharge and related activities under both the Former Rule and the Revised Rule, although the triggers are slightly different. Under the Former Rule, nondegradation procedures apply because the discharge from the WWTS was not in existence before January 1, 1988, thus it will be considered a “new or expanded discharge”32. Under the Revised Rule, antidegradation procedures apply because the WWTS discharge and related activities will be regulated by specific “control documents” as defined in the regulations, including CWA authorizations used to administer individual NPDES permits and CWA Section 401 certifications.

The Revised Rule requires an antidegradation assessment for two separate regulatory processes applicable to the Project: NPDES/SDS permitting, for which MPCA has delegated regulatory authority under the CWA, and Section 401 certification, which is required when a federal permit is necessary for an applicant to conduct any activity that may result in a discharge to navigable waters. The federal permitting agency must be provided with the Section 401 certification from the state in which the discharge originates. The state must certify to the federal permitting agency that the proposed activity, as authorized, will comply with that state’s water quality standards. For this Project, the Section 401 certification is required because PolyMet applied for a CWA Section 404 permit from the U.S. Army Corps of Engineers (USACE).

Under the Revised Rule, there is significant overlap in the antidegradation requirements that apply to individual NPDES permits and Section 401 certifications. Specifically, activities regulated by individual Section 401 certifications and individual NPDES permits are both subject to the same substantive antidegradation standards, which are set out in Minnesota Rules, part 7050.0265. The antidegradation procedures applicable to Section 401 certifications (Minnesota Rules, part 7050.0285) require an applicant to submit all the same information required for individual NPDES permits (Minnesota Rules, part 7050.0280, subpart 2) plus additional information related to compensatory mitigation for physical alteration of surface waters.

This report provides MPCA with the evidence that the Project will satisfy all antidegradation requirements under the Revised Rule and the Former Rule applicable to Project activities that will be regulated by an

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32 Former Minnesota Rules, part 7050.0185, subpart 2(A); see also Minnesota Rules, part 7052.0010, subpart 32 ("new" discharges in Lake Superior Basin are those commencing after March 9, 1998). There is currently a permitted discharge from the Plant Site, under the terms of two Cliffs Erie, LLC. NPDES/SDS permits (MN0054089 Cliffs Erie – Hoyt Lakes Tailings Basin Area; and MN0042536 Hoyt Lakes Mining Area); however, discharges under those permits occur at different locations and exhibit different water quality than the proposed discharge from the WWTS.
individual NPDES/SDS permit. This includes the overlapping substantive standards in the Revised Rule that are applicable to both the individual NPDES/SDS permit and the CWA Section 401 certification (Minnesota Rules, parts 7050.0265). The report also provides information needed to satisfy the antidegradation procedural requirements for both permitting regimes under the Revised Rule (Minnesota Rules, parts 7050.0280, subpart 2 [NPDES permit] and 7050.0285, subpart 2 [401 certification]).

Because the Project design will result in wetland impacts, PolyMet also must provide additional information to satisfy the antidegradation CWA Section 401 certification standards under the Revised Rule that are applicable to physical alteration of wetlands (Minnesota Rules, part 7050.0285, subpart 2). Wetland impacts from the Project will be subject to the requirements of a Section 404 permit upon issuance by the USACE, as well as Minnesota Department of Natural Resources (MDNR) requirements under a Permit to Mine and the Wetland Conservation Act. Therefore, PolyMet is providing a separate Section 401 certification antidegradation assessment to address physical alteration of wetlands (Reference (4)). Additional studies conducted to support the Section 401 certification antidegradation assessment provide MPCA with the evidence that the cumulative Project effects will satisfy antidegradation requirements (Reference (5)). PolyMet also is providing separate antidegradation analyses for groundwater to meet the requirements of Minnesota Rules, chapter 7060.

PolyMet is requesting general NPDES permit coverage for construction and industrial stormwater discharges (Volume I). The antidegradation assessments for stormwater discharges covered under these general permits were conducted by the MPCA during development of the Minnesota NPDES/SDS Construction Stormwater General Permit (Permit No. MNR100001) and the Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000). Therefore, no further antidegradation procedures are required with respect to construction and industrial stormwater discharges.

### 2.2 Lake Superior Basin Antidegradation Standards

The antidegradation standards in Minnesota Rules, chapter 7052 (the “LSB Rule”) set forth separate antidegradation requirements for discharges of certain bioaccumulative chemicals to waters in the LSB. The LSB Rule applies to new and expanded discharges of “bioaccumulative substances of immediate concern” (BSICs) to “outstanding international resource waters” (OIRWs). Mercury is the only parameter included on the rule’s list of BSICs that is a parameter of concern in the WWTS discharge. The Project receiving and downstream waters are classified as OIRWs, as are all surface waters of the LSB (apart from Outstanding Resource Value Waters (ORVWs) and Class 7 waters). In this report, PolyMet provides the Antidegradation Demonstration for mercury to address the requirements of the LSB rule.

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33 Minnesota Rules, parts 7052.0300 to 7052.0380.
34 Minnesota Rules, part 7052.0300, subpart C(2). The LSB nondegradation standards also apply to new and expanded discharges of “bioaccumulative chemicals of concern” (BCCs) to high quality waters; and new or expanded discharges to Class 7 waters upstream of an OIRW or a high quality water.
35 See Minnesota Rules, part 7052.0010, subpart 5.
36 Minnesota Rules, part 7052.0010, subpart 34.
3.0 Characteristics of the Discharge

This section describes the WWTS discharge quality (Section 3.1), discharge locations (Section 3.2), and discharge rates (Section 3.3). However, the net effect of the Project on receiving and downstream waters depends not only on the quality and quantity of the WWTS discharge, but also on other engineering controls that are designed to avoid and minimize impacts to the receiving and downstream waters. The least degrading prudent and feasible alternative, which is the Project as proposed for the FEIS and in permit applications (Section 7.4.4), includes the following pollution prevention, minimization, and toxics reduction technologies and water management strategies, each of which is discussed in more detail in Section 7.4.4:

- collection and beneficial reuse of mine water
- management of water quality impacts from the Tailings Basin through engineered systems (e.g., seepage capture systems)
- management of hydrologic impacts on receiving and downstream waters
- withdrawal of water from Colby Lake

3.1 Expected Performance of the Waste Water Treatment System

The following sections describe expected water quality of the WWTS discharge (Section 3.1.1), as well as its stability and essentiality (Section 3.1.2), its temperature (Section 3.1.3), and how it complies with federal effluent limitations (Section 3.1.4).

3.1.1 Waste Water Treatment System Discharge Quality

The WWTS will be designed specifically to achieve a level of treatment such that the discharge will comply with applicable technology and surface water quality based standards and effluent limitations at the surface water discharge outfalls. WWTS treatment targets and their bases are presented in Table 2-2 of Volume III. The concentrations of parameters of concern in WWTS discharge will meet their respective treatment targets (Reference (6)). Further, even though sulfate is not an applicable numeric water quality limit, the WWTS will have an internal performance operating limit of 10 milligrams per liter (mg/L) for sulfate. The reasons for inclusion of this sulfate limit are further discussed in Appendix D of Volume I.

In practice, the concentrations of most parameters in the WWTS discharge are expected to be below their respective treatment targets. Operating the WWTS to remove enough sulfate to achieve the 10 mg/L internal operating limit will remove numerous other parameters to concentrations below—in some cases, substantially below—their treatment targets. This expectation is confirmed by pilot-testing and by WWTS design modeling (Reference (6)). The design modeling goes beyond the GoldSim modeling conducted for the FEIS, using industry standard geochemical modeling methods to estimate the performance of the specific sequence of treatment processes planned for the WWTS (Reference (6)). The WWTS discharge quality as estimated by design modeling is shown in Table 3-1. The design model generally estimated lower concentrations for parameters of concern than were estimated by the FEIS GoldSim model (FEIS...
The concentrations estimated by the design model represent the expected characteristics of the discharge during operations.

The WWTS discharge quality used for the Antidegradation Evaluation; however, is not based on the design modeling, but on the earlier FEIS modeling. PolyMet has carried the FEIS discharge quality forward so that the Antidegradation Evaluation is consistent with the FEIS, and so that FEIS modeling results can be used to represent estimated surface water quality in some downstream waters. The FEIS modeling used a very simple and protective approach to estimating discharge quality, based on the expected concentrations of parameters in the tailings basin seepage flowing into the WWTS (the influent). For parameters with influent concentrations above the treatment targets, the discharge concentration was equal to the FEIS model effluent limit. For parameters with influent concentrations below the treatment targets, the discharge concentration was equal to the influent concentration: for these parameters, the FEIS model in effect assumed no treatment. The discharge quality as estimated by FEIS modeling is also shown in Table 3-1. Accordingly, the FEIS model discharge quality is a protective upper limit for the WWTS discharge quality.

### Table 3-1 Comparison of FEIS Model Discharge Quality and Design Model Discharge Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Treatment Target</th>
<th>FEIS Model Discharge Quality</th>
<th>Design Model Discharge Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>125</td>
<td>6.3[4]</td>
<td>0.43</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>6.3[4]</td>
<td>0.38</td>
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<td>Arsenic (total)</td>
<td>µg/L</td>
<td>10</td>
<td>10</td>
<td>0.004</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>180[4]</td>
<td>210</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.5</td>
<td>0.71[4]</td>
<td>0.056</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11</td>
<td>5.3[4]</td>
<td>0.31</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>5</td>
<td>0.011</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3</td>
<td>9</td>
<td>0.87</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2</td>
<td>3</td>
<td>0.099</td>
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<tr>
<td>Mercury</td>
<td>ng/L</td>
<td>1.3</td>
<td>Not modeled</td>
<td>Not modeled</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
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<td>50</td>
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<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
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<td>Silver (total)</td>
<td>µg/L</td>
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<td>0.21[4]</td>
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<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
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<td>Zinc (total)</td>
<td>µg/L</td>
<td>120</td>
<td>57.1[4]</td>
<td>0.065</td>
</tr>
</tbody>
</table>

---

Footnote: FEIS model effluent limits were less than or equal to the treatment targets. See Large Table 28 of Reference (3).
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Treatment Target$^1$</th>
<th>FEIS Model Discharge Quality$^2$</th>
<th>Design Model Discharge Quality$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>Cl</td>
<td>230</td>
<td>1.3$^5$</td>
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<td>Hardness</td>
<td>mg/L</td>
<td>100</td>
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<td>SU</td>
<td>6.5-8.5</td>
<td>Not modeled</td>
<td>8.4$^6$</td>
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<tr>
<td>Sulfate</td>
<td>SO$_4$</td>
<td>10</td>
<td>9</td>
<td>9.84</td>
</tr>
</tbody>
</table>

FEIS – Final Environmental Impact Statement (Reference (1))
(1) WWTS treatment targets are described in Section 2.2 of Volume III.
(2) Discharge quality for Mine Year 10, the year of maximum loading. Concentrations are either FEIS model effluent limits or P50 influent values (Large Table 28 of Reference (3)).
(3) Discharge quality for Mine Year 10 peak flow P90 values, which means that there is a 90% likelihood that the actual value will be less than the value shown (Attachment H of Reference (6)).
(4) FEIS discharge value is the P50 influent value. The FEIS model assumes no treatment for these parameters.
(5) The value of chloride in the GoldSim modeling was based on the assumption that the treatment system would be primarily reverse osmosis membranes. The design of the WWTS has since evolved to include greater use of nanofiltration membranes, resulting in higher chloride values in the design modeling.
(6) WWTS design model results (Attachment H of Reference (3)) were adjusted to estimate pH after degasification by setting CO$_2$ at atmospheric equilibrium.

PolyMet has conducted this Antidegradation Evaluation using the WWTS discharge concentration shown in Table 3-2. Pollutant concentrations in the WWTS discharge used for the evaluation (Table 3-2) were derived from several sources:

- the FEIS model is the source for most parameters
- the design model concentrations were used if they were higher than the FEIS model concentrations (boron and chloride)
- the treatment target was used for mercury, because that parameter was not included in either model, and for sulfate, because it is the controlling parameter in treatment system design
- other parameters not included in the FEIS model were calculated or qualitatively assessed (total dissolved solids (TDS), total suspended solids (TSS), and specific conductance)

Table 3-2 details the discharge quality used for the Antidegradation Evaluation, and explains the rationale behind values that differ from the FEIS discharge quality. Comparing the lower concentrations of parameters estimated by the design modeling (Table 3-1) with the higher concentrations assumed for the Antidegradation Evaluation (Table 3-2) demonstrates that PolyMet has conducted a protective Antidegradation Evaluation.

Table 3-2 also demonstrates that concentrations of parameters of concern in the WWTS discharge will be at or below numeric water quality standards at the surface water discharge outfalls even where, as is the case with the wild-rice based sulfate number, the standard is not applicable at those outfalls.
### Table 3-2  Assumed Characteristics of the WWTS Discharge for the Antidegradation Evaluation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Antidegradation Discharge</th>
<th>Source of Antidegradation Discharge Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum (total)</td>
<td>Al</td>
<td>µg/L</td>
<td>125</td>
<td>6.3</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb</td>
<td>µg/L</td>
<td>31</td>
<td>6.3</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>µg/L</td>
<td>53</td>
<td>10</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B</td>
<td>µg/L</td>
<td>500(2)</td>
<td>210</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(4)</td>
<td>0.71</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>µg/L</td>
<td>11(5)</td>
<td>5.3</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co</td>
<td>µg/L</td>
<td>5.0</td>
<td>5</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.3(6)</td>
<td>9</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>µg/L</td>
<td>3.2(4)</td>
<td>3</td>
</tr>
<tr>
<td>Mercury (total)</td>
<td>Hg</td>
<td>ng/L</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni</td>
<td>µg/L</td>
<td>52(4)</td>
<td>50</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se</td>
<td>µg/L</td>
<td>5.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag</td>
<td>µg/L</td>
<td>1.0</td>
<td>0.21</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>Tl</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.16</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>µg/L</td>
<td>120(4)</td>
<td>57.1</td>
</tr>
<tr>
<td><strong>General Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl⁻</td>
<td>mg/L</td>
<td>230</td>
<td>23.4</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td></td>
<td>mg/L</td>
<td>500(7)</td>
<td>100</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>SU</td>
<td>6.5 to 8.5(7)</td>
<td>8.4</td>
</tr>
</tbody>
</table>
### Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Antidegradation Discharge</th>
<th>Source of Antidegradation Discharge Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids, Total Dissolved</td>
<td>TDS</td>
<td>700</td>
<td>356-464</td>
<td>Refer to (10)</td>
</tr>
<tr>
<td>Solids, Total Suspended</td>
<td>TSS</td>
<td>15</td>
<td>Refer to (11)</td>
<td>Refer to (11)</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>µmhos/cm</td>
<td>1,000</td>
<td>753-960</td>
<td>Refer to (12)</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO₄</td>
<td>10(13)</td>
<td>≤10</td>
<td>treatment target(14)</td>
</tr>
<tr>
<td>Temperature</td>
<td>°F</td>
<td>Variable(15)</td>
<td>Variable(15)</td>
<td>--(16)</td>
</tr>
<tr>
<td>Whole Effluent Toxicity</td>
<td>WET</td>
<td>Meet acute and chronic standards</td>
<td>Meet acute and chronic standards</td>
<td>WWTS pilot-testing</td>
</tr>
</tbody>
</table>

FEIS – Final Environmental Impact Statement (Reference (1))

1. The most stringent applicable surface water quality standard; except, where a Minnesota Rules, chapter 7052 standard exists, the Minnesota Rules, chapter 7052 standard is controlling over the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent. Large Table 1 details applicable standards.
2. Applicable to unlisted waters (Class 4A); no applicable standard for unlisted wetlands.
3. Design model value used because it is higher than the FEIS value (Attachment H of Reference (6)).
4. Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L.
5. Based on surface water quality standard for Cr(+6).
6. Treatment target used because the parameter was not included in FEIS or design modeling.
7. Applicable standard for unlisted waters, except wetlands; for unlisted wetlands, maintain background.
8. Treatment target chosen to establish targets for metals with a hardness-based standard.
9. Design model value used because pH was not modeled for the FEIS.
10. Estimated based on the sum of dissolved masses in the WWTS discharge assumed for the Antidegradation Evaluation, as discussed in Attachment A.
11. Total suspended solids (TSS) are expected to be very low in membrane effluent, due to size exclusion of particles and large dissolved molecules. Some TSS may be added during stabilization, but discharge values should remain below the federal effluent limit of 20 mg/L TSS.
12. Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated using two empirical methods from the calculated ionic strength of the overall WWTS discharge as assumed for the Antidegradation Evaluation. See Attachment A.
13. The sulfate standard for waters “used for production of wild rice” is 10 mg/L in certain circumstances, although Minnesota law limits the applicability of that standard. The receiving and downstream waters for the Project are not listed wild rice waters, and accordingly, the 10 mg/L standard is not applicable. Nonetheless, PolyMet plans to implement a 10 mg/L internal performance operating limit; this level will not be exceeded in the WWTS discharge due to the system design.
14. The sulfate internal performance operating limit will be protective, because the sulfate treatment level will cause concentrations of other parameters in the WWTS discharge to be at or below the concentrations assumed for the antidegradation discharge.
15. For unlisted waters, except wetlands: “5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 90°F.” (Minnesota Rules, part 7050.0222, subpart 4). For unlisted wetlands: maintain background.
16. Refer to Section 3.1.3.

### 3.1.2 Waste Water Treatment System Discharge Stability and Essentiality

The WWTS processes have been designed to produce discharge with the characteristics of essentiality and stability necessary to maintain biological activity. Table 3-3 provides an overview of stability, a chemical parameter, and essentiality, a biologic parameter. While stability and essentiality measure different functions of a water, they are related because both are products of the constituents that are dissolved in
the water and their associated concentrations. Both of these parameters suggest that a minimum value exists for dissolved constituents below which water is unstable and biological life is adversely affected.

Table 3-3  Stability and Essentiality Overview

<table>
<thead>
<tr>
<th>Description</th>
<th>Stability</th>
<th>Essentiality</th>
</tr>
</thead>
<tbody>
<tr>
<td>The amount of salts in a water and the potential for water, the universal solvent, to acquire more salts from the surrounding environment</td>
<td>The degree to which a water contains nutrients needed for biological growth</td>
<td></td>
</tr>
<tr>
<td>Type of parameter</td>
<td>chemical</td>
<td>biologic</td>
</tr>
<tr>
<td>Test method</td>
<td>Langlier saturation index</td>
<td>Whole Effluent Toxicity (WET test)</td>
</tr>
<tr>
<td>WWTS process to adjust</td>
<td>Addition of calcite (calcium and bicarbonate)</td>
<td></td>
</tr>
</tbody>
</table>

Because of the potential for WWTS discharge to impact aquatic life in the receiving waters, the stability and essentiality of the WWTS discharge are key aspects of the system's expected performance. Water that has been treated with a reverse osmosis (RO) or similar membrane separation process is not stable, and in some instances can be considered corrosive. Unstable water will not be in equilibrium with its surroundings when it is returned to a natural environment. If RO-treated water is not stabilized prior to discharge, it has an increased potential to dissolve solid surfaces and thus reintroduce dissolved solids into the water.

In addition, RO-treated water may not provide the essential micronutrients for biological activity throughout the food chain. In addition to the essential elements of carbon, hydrogen, oxygen, nitrogen, and phosphorus; living systems require varying concentrations of a variety of other elements including calcium, magnesium, sodium, potassium, sulfur, and iron for energy conversion and cell growth. Many other metals are also essential nutrients for specific functions or for catalyzing reactions within living organisms. Some of these potentially vital nutrients include aluminum, boron, chloride, chromium, cobalt, copper, iodine, manganese, molybdenum, nickel, sodium, selenium, vanadium, and zinc, which each sustain one or more important biological functions (Reference (7)). Removing too much of these dissolved constituents can result in an uninhabitable environment.

A typical graph of the effect of concentration versus toxicity for such constituents is shown on Figure 3-1. Concentrations above the minimum required concentration to support biological functions and below the toxic concentration is sometimes referred to as the ‘window of essentiality’.
Based on pilot-testing results, the WWTS discharge, if not properly treated, would be unstable and toxic to aquatic organisms because essential dissolved micronutrients required to maintain normal biological functions activity would be unavailable (Reference (8)).

Both essentiality and stability will be adjusted after membrane separation during the process referred to as stabilization. Stabilization adds only calcium and bicarbonate to the water. By adjusting the levels of calcium and bicarbonate in the water, the existing low concentrations of metals in the membrane permeate become bioavailable, and essentiality is improved. No metals will be added to the discharge.

Calcium and bicarbonate will be added during the stabilization process by running membrane permeate through a process unit referred to as a limestone contactor, where the permeate will pass over an engineered calcite medium that is certified for use in drinking water. The quality of the engineered calcite is tested and verified by the manufacturer. After leaving the limestone contactor, the discharge will pass through a degassifier which uses air to remove dissolved carbon dioxide.

Sampling conducted during the pilot-testing confirmed that this system produced an effluent that was stable, as evaluated using the Langlier saturation index, and within the window of essentiality, as evaluated using whole effluent toxicity testing (Reference (8)). Maintaining stability and essentiality in the WWTS discharge will allow for the maintenance of the receiving water bodies’ characteristics and maintenance of existing uses.

### 3.1.3 Temperature of Waste Water Treatment System Discharge

The WWTS will be operated such that the temperature of the discharge meets applicable standards for Class 2B waters at the Second Creek outfall and applicable standards for Class 2D waters at the Trimble Creek and Unnamed Creek outfalls. Generally, the WWTS processes add minimal heat to the influent, which will be approximately the temperature of shallow groundwater because it is primarily collected *tailings basin seepage*.
3.1.4 Compliance with Federal Effluent Limitations

The proposed WWTS discharge will be subject to compliance with federal categorical standards in 40 C.F.R. 440, subparts G (nickel ore), J (copper, lead, zinc, gold, silver, and molybdenum ores), and K (platinum ore). These subparts include technology-based effluent limitations for a limited number of parameters. Section 5.0 of Volume III demonstrates that the concentrations of parameters of concern in the WWTS discharge will be at or below federal effluent limits.

3.2 Surface Water Discharge Outfalls

The WWTS discharge will be piped to surface water discharge outfalls located downgradient of the FTB seepage capture systems, in the headwater areas of Trimble, Unnamed, and Second Creeks, as shown on Large Figure 1. The design of the surface water discharge system is described in Section 2.4.3 of Volume III and it is also depicted on permit application support drawings for the FTB Seepage Containment and Stream Augmentation Systems in Appendix A of Volume V. The surface water discharge system and the FTB Seepage Containment System will run parallel to the toe of the Tailings Basin dams with an approximately 200-foot separation; however, the exact distance may vary based on future geotechnical studies and conditions encountered during construction.

Surface water discharge outfall locations will be finalized based on the results of future geotechnical investigations. Conceptual surface water discharge outfalls, shown on Large Figure 1, will distribute WWTS discharge to the three receiving waters:

- Trimble Creek – Seven surface water discharge outfalls are planned to wetlands in the headwater area of Trimble Creek.
- Unnamed Creek – Two surface water discharge outfalls are planned to wetlands in the headwater area of Unnamed Creek.
- Second Creek – One surface water discharge outfall is planned to the historic channel in the headwater area of Second Creek near the location of existing monitoring station PM–7/SD026.

3.3 Discharge Rate

The WWTS discharge rate will vary during operations, with the rate generally increasing as the size and elevation of the FTB Pond increases. The discharge rate will comply with regulatory requirements, such as stream augmentation targets anticipated in the Project water appropriation permits and potential discharge limitations associated with the 40 C.F.R. 440 New Source Performance Standard (NSPS) “zero discharge” rule. In dry years, NSPS compliance may constrain the rate of flow than can be discharged, as described in Appendix D of Volume III.

The total annual average mean discharge rate from the WWTS and its distribution among the receiving waters, as estimated for the FEIS and included in both the NPDES/SDS Permit Application and the Consolidated Water Appropriation Permit Application, are shown in Figure 3-2. Mine Year 10 is estimated to be the year of maximum discharge, with the estimated discharge nearing the maximum allowable discharge for both the "zero discharge" rule and the water appropriation permit goals; therefore, it is the
year that was evaluated for this Antidegradation Evaluation. If dry weather conditions were to trigger discharge constraints to comply with “zero discharge” requirements, a lower required discharge rate would result in lower impacts to receiving and downstream waters than evaluated for this Antidegradation Evaluation. Thus, using the FEIS estimated Mine Year 10 discharge rate is a protective assumption for this Antidegradation Evaluation.

The discharge will be distributed between the surface water discharge outfalls roughly in proportion to the amount of tailings basin seepage captured by the FTB seepage capture systems, as described in Section 1.3. The Trimble Creek and Unnamed Creek headwater wetlands will receive most of the WWTS discharge. Relatively little tailings basin seepage flows toward Second Creek, so the discharge to the headwater segment of Second Creek will be proportionately small.

![Graph](image)

**Figure 3-2** Waste Water Treatment System Estimated Discharge Rate

### 3.4 Proposed Waste Water Treatment System Discharge Monitoring

PolyMet will monitor the quality and quantity of the WWTS discharge. Proposed surface water discharge outfalls are shown on Large Figure 1. For most parameters, water quality of the discharge will be monitored at the WWTS discharge point referred to as SD001. For sulfate and copper, water quality will be monitored at internal monitoring points, and no sulfate or copper will be added to the internal flow after the monitoring point, so the internal concentrations will equal the discharge concentrations. Flow (quantity) to each of the receiving waters will be monitored at the WWTS splitter structure where the WWTS discharge will be routed to Unnamed Creek wetlands (SD002 and SD003), Trimble Creek wetlands (SD004 through SD010), and Second Creek (SD011). Identical water quality in the WWTS discharge is anticipated at each surface water discharge outfall location. The monitoring plan is detailed in Volume I.
4.0 Receiving and Downstream Waters

The proposed receiving waters are the wetlands in the headwater area of Trimble Creek, the wetlands in the headwater area of Unnamed Creek, and the headwater segment of Second Creek, near existing monitoring station PM–7/SD026. Large Figure 1 shows these receiving-water locations.

The network of downstream waters includes two subwatersheds within the St. Louis River watershed: the Partridge River watershed and the Embarrass River watershed. Trimble Creek and Unnamed Creek are tributaries of the Embarrass River, and Second Creek is a tributary of Partridge River. The Project Mine Site is located in the Partridge River watershed, and the Plant Site spans the divide between the Partridge River watershed and the Embarrass River watershed. Further downstream, the Embarrass River and the Partridge River both flow into the St. Louis River, which flows into Lake Superior approximately 175 river miles downstream of the proposed discharge from the WWTS. Large Figure 3 depicts the connections between the receiving waters, downstream waters, and Lake Superior.

4.1 Classification and Designated Uses

Receiving and downstream waters, like all waters of the state, are classified to protect specific designated beneficial uses.38 Water use classifications are listed for some waterbodies in Minnesota Rules, part 7050.0470. Wetlands in the headwater areas of Trimble Creek and Unnamed Creek are not listed under Minnesota Rules, part 7050.0470, and thus are unlisted wetlands that are classified under Minnesota Rules, part 7050.0425 as Class 2D, 3D, 4C, 5, and 6 waters. Trimble Creek, Unnamed Creek, Second Creek, the Partridge River, the Embarrass River, and the portion of the St Louis River downstream of the Project are not listed under Minnesota Rules, part 7050.0470, and thus are unlisted waters that are classified under Minnesota Rules, part 7050.0430 as Class 2B, 3C, 4A, 4B, 5, and 6 waters.

Minnesota Rules, part 7050.0140 designates beneficial uses39 by water class:

- Class 2 – aquatic life and recreation;
- Class 3 – industrial consumption;
- Class 4 – agriculture and wildlife;
- Class 5 – aesthetic enjoyment and navigation; and
- Class 6 – other uses and protection of border waters.

Minnesota Rules, parts 7050.0222 to 7050.0227 further subdivide each water class (for example, Class 2 waters include waters classified as 2A, 2B, and 2D), establish distinct designated beneficial uses for each

38 Minnesota Rules, part 7050.0110.
39 For purposes of this Antidegradation Evaluation, the term “beneficial use” means a use designated by rule to a particular class of water, regardless of whether the use is an “existing use.” In addition, the term “designated beneficial use” or simply “designated use” should be read synonymously with “beneficial use,” and the term “existing beneficial use,” used in the context of part 7050.0185, should be read synonymously with “existing use.”
specific classification, and set specific water quality standards to protect those designated uses. Minnesota Rules, part 7050.0470, subpart 1 designates some Class 4A waters as wild rice waters. None of the proposed receiving or downstream waters are currently listed as wild rice waters under Minnesota Rules, part 7050.0470.

4.2 Actual Uses

Actual use is one factor used to determine the “existing uses” of the receiving and downstream waters, as explained in Section 7.1. PolyMet assessed the actual uses taking place in the receiving and downstream waters first by considering the designated uses as listed by rule, and then by considering historical and current observations to identify which of the designated uses actually occur and whether any undesignated uses exist. Designated uses were protectively assumed to be actually taking place unless they are known to not occur. This Antidegradation Evaluation considers all designated uses to be actual uses with the exception of Class 3C and 4A uses in Trimble Creek, Unnamed Creek, and Second Creek. Based on field observations from annual data collection surveys by PolyMet, Trimble Creek, Unnamed Creek, and Second Creek are not used for industrial cooling, materials transport, or irrigation purposes (Class 3C and 4A uses).

PolyMet identified one actual use that is not a designated use. Natural wild rice stands have been observed in some downstream waters that are not listed as wild rice waters in current Minnesota Rules, part 7050.0470. PolyMet used the results of annual wild rice surveys conducted in downstream waters around the Project site since 2009 (Reference (9)) and the Draft List of MPCA Wild Rice Waters40 to identify sections of downstream waters where natural wild rice stands have been documented or reported. Natural wild rice stands have been documented at locations in the Embarrass River downstream of its confluence with Trimble and Unnamed Creeks. In addition, wild rice has also been documented at the confluence of Second Creek and the Partridge River, and at locations on the Partridge River and St. Louis River further downstream. Large Figure 5 shows locations where natural wild rice stands have been identified on downstream waters.

Based on field observations from annual wild rice surveys, Trimble Creek, Unnamed Creek, and Second Creek are not known to support any additional actual uses (which are not also designated uses) related to aquatic life, recreational opportunities, or commercial activity that are dependent on water quality.

5.0 Antidegradation Evaluation Methods

The following sections describe the methods used for the Antidegradation Evaluation. These descriptions variously involve methods for determining existing water quality and for estimating future water quality during Project operation. Methods used both for the Antidegradation Assessment for parameters other than mercury and for the mercury Antidegradation Demonstration are described in Sections 5.1 through 5.7. Methods unique to the Antidegradation Assessment for parameters of concern other than mercury are presented in Section 5.8 and methods unique to the Antidegradation Demonstration for mercury are presented in Section 5.9.

5.1 Determination of Parameters of Concern and Applicable Water Quality Standards

PolyMet developed the list of parameters of concern for the Antidegradation Evaluation based on the requirements of the applicable statutory provisions and the Revised, Former, and LSB regulations, as well as the environmental review process, consultation with the MPCA, antidegradation guidance in the Statement of Need and Reasonableness (SONAR), and related contested case proceeding for the Revised Rule. The SONAR indicates that the Antidegradation Assessment should include parameters that:

- are reasonably expected to be present in the discharge
- have numeric or narrative standards

Parameters reasonably expected to be present in the WWTS discharge were determined during the environmental review process. The Final Scoping Decision for the EIS (Reference (10)) stated that surface water quality impacts should be evaluated against “the most restrictive water quality standards that apply to the respective waters being evaluated which, at a minimum, would be the chronic aquatic toxicity-based standards applicable to the respective waters being evaluated.” The Final Scoping Decision removed a few parameters from consideration because they are not expected to be of concern in the WWTS discharge: BOD, bacteria, and suspended solids. The list of parameters was reviewed and confirmed during the Impact Assessment Planning (IAP) process (Reference (11)). The list of parameters of concern for the Antidegradation Evaluation is based on Table 5.2.2-4 of the FEIS (Reference (1)), which lists surface water quality evaluation criteria.

Of the parameters reasonably expected to be present in the WWTS discharge, only those parameters for which a numeric surface water quality standard has been promulgated were selected as parameters of concern. Table 5-1 lists the parameters of concern for the Tier 1 Antidegradation Evaluation (maintenance and protection of existing uses).

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41 See page 88 of Reference (20)
Parameters of concern for the Tier 2 demonstration (protection of high quality waters) are the parameters likely to be present in the discharge for which Class 2 numeric standards have been promulgated. This approach is specified in the SONAR.\textsuperscript{42}

The Minnesota surface water quality standards applicable to unlisted waters (Class 2B, 3C, 4A, 4B, 5, and 6 waters) and unlisted wetlands (Class 2D, 3D, 4C, 5, and 6 waters) were compiled and compared, as shown in Large Table 1. For the parameters of concern, surface water quality standards for unlisted waters and unlisted wetlands differ only for four parameters of concern: boron, hardness, pH, and temperature. For boron, there is a Class 4A standard applicable to unlisted waters, but no standard applicable to unlisted wetlands. For the other three parameters, the wetland standards require that background be maintained; where “maintain background” means "the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses."\textsuperscript{43}

Minnesota Class 2 standards for metals are expressed as total metal, but the rules state that they must be converted to dissolved standards for application to surface water (Minnesota Rules, part 7050.0222 subpart 1(B), and Minnesota Rules, part 7052.0100 subpart 1(F)). Conversion factors for converting total to dissolved metal standards are provided for nine metals in Minnesota Rules, part 7050.0222, subpart 9 and Minnesota Rules, part 7052.0360 – for these metals the dissolved standard is slightly less than the total standard. For other metals, the conversion factor is 1, which means that the dissolved standard equals the total standard.

NPDES permitting primarily uses total metals. Water-quality based effluent limits for metals are expressed as total metal (Minnesota Rules, part 7050.0222 subpart 1(B)), and the MPCA’s customary practice is to require surface water monitoring for total metals. USEPA guidance states that the protective approach is to assume no difference between dissolved and total standards. In a 1996 guidance document, the USEPA indicated that:

\begin{quote}
\textit{...assuming no difference between dissolved and total recoverable metal concentrations...is} the most stringent approach, and would be appropriate in waters with low solids concentrations, situations where the discharged form of the metal was mostly in the dissolved phase, or where data to use other options are unavailable.” (Section 1.5.3 of Reference (12))
\end{quote}

Metals in the WWTS discharge, after the water has undergone membrane separation treatment, are expected to be entirely in the dissolved form because the membranes will remove solid particles. Therefore, it is valid to assume that there is no difference between dissolved and total metal concentrations in the WWTS discharge, and comparing the estimated discharge quality with standards in the form of total metal is appropriate at the outfalls where they discharge into receiving waters. In downstream waters, however, where the discharge mixes with surface water with higher suspended solids, the total metal concentration will also include a contribution from adsorbed metals. Therefore, in these

\textsuperscript{42} See page 88 pf Reference (15)

\textsuperscript{43} Minnesota Rules, part 7050.0222, subpart 6(B) and part 7050.0223, subpart 5
downstream waters, the dissolved metal concentration would be expected to be lower than the total metal concentration.

USEPA guidance recommends first evaluating whether the concentration of a metal in the discharge poses a reasonable potential to exceed the standard, using the protective assumption that total and dissolved concentrations are equal, then developing additional site-specific understanding of the relationship between dissolved and total forms as needed (Reference (12)). The Antidegradation Evaluation follows this approach, screening for existing or estimated total metal concentrations that exceed an applicable standard, then providing additional site-specific context for those metals. For the Project, aluminum is the only metal for which additional site-specific information is necessary (see Section 6.2.2).

Table 5-1 lists the parameters of concern used for this Antidegradation Evaluation and the most stringent of the applicable surface water quality standards, with standards for metals expressed as total metals, as discussed above. Because the Antidegradation Evaluation must assess whether the WWTS discharge is expected to result in measurable changes in water quality, Table 5-1 also presents typical detection limits and USEPA laboratory control sample (LCS) acceptance criteria for each parameter. These metrics are used to assess whether estimated water quality changes will represent measurable changes from existing conditions (Section 5.6).

The State’s current wild rice sulfate standard\(^\text{44}\) of 10 mg/L does not apply to the receiving or downstream waters because, as described in Section 4.1, none are listed wild rice waters. However, sulfate is included as a parameter of concern in the Antidegradation Assessment because PolyMet plans to implement an internal performance operating limit in the WWTS of 10 mg/L for sulfate.

\(^{44}\text{Class 4A standard “applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.” Minnesota Rules, part 7050.0224, subpart 2}\)
<table>
<thead>
<tr>
<th>Parameter (total)</th>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard$^{(1)}$</th>
<th>Laboratory Control Sample (LCS) Acceptance Criteria$^{(2)}$</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminum</td>
<td>Al</td>
<td>µg/L</td>
<td>125</td>
<td>125</td>
<td>2</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>µg/L</td>
<td>31</td>
<td>31</td>
<td>0.53</td>
</tr>
<tr>
<td>Arsenic</td>
<td>As</td>
<td>µg/L</td>
<td>53</td>
<td>53</td>
<td>0.5</td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>µg/L</td>
<td>500</td>
<td>..(3)</td>
<td>100</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(4)</td>
<td>2.5(4)</td>
<td>0.2</td>
</tr>
<tr>
<td>Chromium</td>
<td>Cr</td>
<td>µg/L</td>
<td>11(5)</td>
<td>11(5)</td>
<td>1</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co</td>
<td>µg/L</td>
<td>5.0</td>
<td>5.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.3(4)</td>
<td>9.3(4)</td>
<td>0.5</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb</td>
<td>µg/L</td>
<td>3.2(4)</td>
<td>3.2(4)</td>
<td>0.5</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg</td>
<td>ng/L</td>
<td>1.3</td>
<td>1.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
<td>µg/L</td>
<td>52(4)</td>
<td>52(4)</td>
<td>0.5</td>
</tr>
<tr>
<td>Selenium</td>
<td>Se</td>
<td>µg/L</td>
<td>5.0</td>
<td>5.0</td>
<td>1</td>
</tr>
<tr>
<td>Silver</td>
<td>Ag</td>
<td>µg/L</td>
<td>1.0</td>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Thallium</td>
<td>Tl</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.56</td>
<td>0.005</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>µg/L</td>
<td>120(4)</td>
<td>120(4)</td>
<td>6</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl$^{-}$</td>
<td>mg/L</td>
<td>230</td>
<td>230</td>
<td>5</td>
</tr>
<tr>
<td>Hardness (as CaCO$_3$)</td>
<td></td>
<td>mg/L</td>
<td>500</td>
<td>Maintain Background$^{(7)}$</td>
<td>10</td>
</tr>
</tbody>
</table>

$^{(1)}$ Unlisted Waters: Unlisted Wetlands

$^{(2)}$ LCS = Laboratory Control Sample

$^{(3)}$ ..(3) indicates missing or unspecified data.

$^{(4)}$ indicates regulatory limits are different for unlisted waters.

$^{(5)}$ indicates regulatory limits are different for unlisted wetlands.

$^{(6)}$ Regulations may vary depending on specific conditions.

$^{(7)}$ Background levels are typically lower than detection limits.

Note: The values provided are nominal and should be considered as guidelines or standards for specific types of water bodies.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Detection Limit</th>
<th>Laboratory Control Sample (LCS) Acceptance Criteria(2)</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>SU</td>
<td>Maintain Background(2)</td>
<td>0.01</td>
<td>+/- 0.2 SU</td>
<td>Minnesota Rules, part 7050.0222 Class 2B/D(6) and Minnesota Rules, part 7050.0224 Class 4A</td>
</tr>
<tr>
<td>Specific conductance</td>
<td>µmhos/cm at 25°C</td>
<td>None</td>
<td>0</td>
<td>+/-1%</td>
<td>Minnesota Rules, part 7050.0224 Class 4A</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>None(8)</td>
<td>1</td>
<td>+/- 10%</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>°F</td>
<td>5°F above natural(9)</td>
<td>0.18°F</td>
<td>+/- 0.18°F</td>
<td>Minnesota Rules, part 7050.0222 Class 2B/D(6)</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>+/- 20%</td>
<td>Minnesota Rules, part 7050.0224 Class 4A</td>
</tr>
</tbody>
</table>

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rules, chapter 7052 standard exists, the Minnesota Rules, chapter 7052 standard controls over the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) Laboratory Control Sample (LCS) acceptance criteria requirements of the U.S. Environmental Protection Agency (USEPA) analytical method. All parameters are analyzed by analytical method USEPA 200.7 or USEPA 200.8, with the exception of low-level mercury by USEPA 1631E and chloride and sulfate by USEPA 300. The analytical method requires the laboratory to perform quality assurance checks that the data reported is accurate within the range presented.
(3) No applicable standard for unlisted wetlands.
(4) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L.
(5) Based on surface water quality standard for Cr(+6).
(6) Chronic Standard
(7) Maintain background “means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses.” (Minnesota Rules, part 7050.0222, subpart 6(8) and part 7050.0223, subpart 5).
(8) There is no applicable surface water standard in the receiving streams; however, PolyMet plans to implement an internal performance operating limit of 10 mg/L for sulfate that will not be exceeded in the WWTS discharge.
(9) For unlisted waters, except wetlands: "5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 90°F." (Minnesota Rules, part 7050.0222, subpart 4).

### 5.2 Assessment of Existing Water Quality Conditions

The Former and Revised Rules define existing water quality differently. The Former Rule defines “baseline quality” as the “quality consistently attained by January 1, 1988”. The Revised Rule defines “existing water quality” as “the physical, chemical, biological, and radiological conditions of a surface water, taking into account natural variability, on the effective date” (of the control document).

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45 Minnesota Rules, part 7050.0185, subpart 2(C) (repealed November 2016)
46 Minnesota Rules, part 7050.0255, subpart 16
This distinction has little practical effect for this Project because water quality in the receiving and downstream waters was affected by mining operations prior to January 1, 1988 and remains affected to the present. The magnitude of effects may have varied somewhat over time; however, the receiving and downstream waters have been impacted by previous mining activities over this entire time period, and are reasonably expected to have exhibited similar concentrations of key parameters during the entire time period.

The Revised Rule describes the preferred methodology for determining existing water quality as “using commissioner-approved monitoring data which exists at the time the determination of existing water quality is undertaken”. Minnesota Rules, part 7050.0260, subpart 1. Because no water quality data is available from prior to 1988 to directly satisfy the Former Rule’s definition of “baseline quality”, Minnesota Rules, part 7050.0185, subpart 6 from the Revised Rule is used here. Subpart 6 provides that “if no data are available to determine baseline quality or the data collected after January 1, 1988, are of better quality, then the commissioner shall authorize the use of data collected after January 1, 1988”. Under the circumstances, therefore, PolyMet can reasonably use the same post-1988 water quality data set to satisfy the requirements of both the Former Rule and the Revised Rule.

For these reasons, PolyMet believes that results of the baseline surface water quality monitoring conducted as part of the Project environmental review process are representative of “baseline quality” under the Former Rule and “existing water quality” under the Revised Rule. Surface water quality monitoring conducted by PolyMet through 2015, described in Section 3.1.1 of Volume V, provides existing water quality data for many evaluation points. Existing water quality for evaluation points not included in the NorthMet FEIS was determined using publicly available data from the Mesabi Nugget NPDES permit monitoring (Reference (13)) and from the U.S. Geological Survey (USGS) (Reference (14); Reference (15)).

Baseline surface water quality monitoring began before pumpback systems were installed at the existing LTVSMC tailings basin in July 2011, as part of the consent decree between the MPCA and Cliffs Erie, L.L.C. (Cliffs Erie), to capture tailings basin seepage which flowed to Unnamed and Second Creeks. Generally, the use of the pumpback systems has slightly decreased the concentrations of parameters of concern in the receiving waters compared to the concentrations that existed before those temporary measures were installed. Average concentrations calculated over the entire monitoring period are slightly lower than average concentrations calculated for the period prior to the installation of the pumpback systems. The Antidegradation Evaluation considers existing condition concentrations to be the average concentrations over the entire monitoring period, to be consistent with the FEIS. It also is protective for assessing potential Project impacts because it depicts existing water quality as slightly better than it was prior to the installation of the pumpback systems.

Data for existing conditions are presented in this report as the average of monitoring results up through 2015. The average concentrations were calculated by averaging duplicate samples to a single value. For parameters other than mercury, averages were calculated as arithmetic means, using one half of the detection limit for samples reporting results of “non-detect.” For mercury, averages were calculated using the Kaplan-Meier method, as described in Section 5.9.3. Use of average values is discussed further in Section 5.5.
MPCA requested that PolyMet consider statistically evaluating existing conditions in certain datasets that contain results below the analytical reporting limit (non-detects) using either a nonparametric method (e.g., Kaplan Meier) or a parametric method, when appropriate, rather than using statistical substitution methods. This analysis is provided in Attachment B.

In the wetland headwater areas of Trimble Creek and Unnamed Creek, no monitoring has been conducted that includes laboratory analyses of a full list of the parameters of concern. The Revised Rule (Minnesota Rules, part 7050.0260, subpart 1(C)) specifies a method to describe existing water quality if monitoring data is not available.

Identifying reference surface waters with similar physical, chemical, and biological characteristics and with similar impacts from regulated and unregulated activities.

Following this approach, the first downstream surface water monitoring stations on Trimble Creek (TC–1a) and Unnamed Creek (PM–11) are reasonable reference points for the headwater wetland water quality. They are located directly downstream of the wetlands (1.5 miles and 1 miles, respectively) where the streams first exhibit channelized flow, and they are subject to similar impacts from regulated and unregulated activities (Large Figure 4).

Hydrologic conditions support the validity of these reference locations as proxies for the water quality in the receiving wetlands. Seepage from the existing LTVSMC tailings basin to the wetlands is distributed over a wide area. The influence of runoff and precipitation also varies within the wetlands, based on topography and the extent of upstream watershed area. Therefore, the relative contributions of seepage and precipitation are expected to vary over the wetland areas, resulting in a range of water quality at different points in the wetlands. The range of parameter concentrations that may be present in the wetlands is “averaged” in the water that reports to the first downstream surface water monitoring station.

### 5.3 Evaluation Points for Antidegradation Assessment

Evaluation points were selected to assess the effects of the WWTS discharge and related activities on receiving waters at the surface water discharge outfalls and in downstream waters. Table 5-2 lists the evaluation points, describes their purpose, notes the source of monitoring data used to describe existing conditions, and indicates the method used to estimate water quality. Additional information about evaluation points is presented in Section 5.9. The locations of evaluation points are shown on Large Figure 2 and Large Figure 3.
# Table 5-2 Evaluation Point Summary

<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>Purpose</th>
<th>Existing conditions monitoring data source</th>
<th>Mine Year 10 estimation method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water discharge outfalls to Trimble Creek</td>
<td>Effect of the WWTS discharge and related activities at the headwater of Trimble Creek</td>
<td>TC–1a (PolyMet)</td>
<td>Antidegradation assumed discharge quality (Section 5.6)</td>
</tr>
<tr>
<td>Surface water discharge outfalls to Unnamed Creek</td>
<td>Effect of the WWTS discharge and related activities at the headwater of Unnamed Creek</td>
<td>PM–11 (PolyMet)</td>
<td>Antidegradation assumed discharge quality (Section 5.6)</td>
</tr>
<tr>
<td>Surface water discharge outfall to Second Creek</td>
<td>Effect of the WWTS discharge and related activities at the headwater of Second Creek</td>
<td>PM–7/SD026 (PolyMet)</td>
<td>Antidegradation assumed discharge quality (Section 5.6)</td>
</tr>
<tr>
<td>TC–1a(1)</td>
<td>Effect of the WWTS discharge and related activities on Trimble Creek</td>
<td>TC–1(1) (PolyMet)</td>
<td>GoldSim Model (Section 5.8.2)</td>
</tr>
<tr>
<td>PM–11</td>
<td>Effect of the WWTS discharge and related activities on Unnamed Creek</td>
<td>PM–11 (PolyMet)</td>
<td>GoldSim Model (Section 5.8.2)</td>
</tr>
<tr>
<td>MNSW8</td>
<td>Cumulative effect of the WWTS discharge and related activities and Mesabi Nugget on Second Creek</td>
<td>MNSW8 (Mesabi Nugget)</td>
<td>Mass balance calculations (Section 5.8.3)</td>
</tr>
<tr>
<td>PM–13</td>
<td>Cumulative effect of the WWTS discharge and related activities and other past, present, and reasonably foreseeable future actions on the Embarrass River</td>
<td>PM–13 (PolyMet)</td>
<td>GoldSim Model (Section 5.8.2)</td>
</tr>
<tr>
<td>U. S. Geological Survey (USGS) 04016000 (MNSW12)</td>
<td>Cumulative effect of the WWTS discharge and related activities and other past, present, and reasonably foreseeable future actions on the Partridge Rivers</td>
<td>MNSW12 (Mesabi Nugget)</td>
<td>Mass balance calculations (Section 5.8.3)</td>
</tr>
<tr>
<td>USGS 04024000</td>
<td>Cumulative effect of the WWTS discharge and related activities and other past, present, and reasonably foreseeable future actions on the St Louis River adjoining the Fond du Lac Reservation upstream of Lake Superior</td>
<td>USGS 04024000 (USGS)</td>
<td>Mass balance calculations (Section 5.8.3)</td>
</tr>
</tbody>
</table>

(1) TC–1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC–1a, which is located less than one mile downstream of TC–1.

## 5.4 Time Frame for Evaluating Project Effects

The Antidegradation Evaluation compares existing water quality with estimated water quality in Mine Year 10 because that is the year of the highest expected discharge rate and mass loading from the WWTS. Figure 5-1 illustrates the relationship between flow rate and mass loading for copper in the discharge to Trimble Creek. The relationship between flow rate and mass loading for the total discharge and for other
parameters of concern follows the same pattern. Flow rate is illustrated out to Mine Year 15, to show that the discharge rate and mass loading decrease after Mine Year 10 (Section 6.1.4 of Reference (3)).

![Figure 5-1](image.png)

**Figure 5-1** Expected Discharge Rate and Mass Loading of Copper from the Waste Water Treatment System to Trimble Creek

### 5.5 Use of Probabilistic Modeling Results to Evaluate Project Effects

Probabilistic results from the GoldSim water models of the Mine Site and Plant Site, which were developed during the environmental review process, are used to estimate the effects of the WWTS discharge and related activities on receiving and downstream waters. Probabilistic modeling incorporates uncertainty and variability to produce a range of results (e.g., P10, P50, mean, P90); as a result, it is necessary to decide which probabilistic results to use for each portion of the Antidegradation Evaluation and how to average them to produce meaningful, representative values. A description of the probabilistic modeling is presented in Reference (3). Table 5-3 provides an overview of how probabilistic modeling results are used in the Antidegradation Evaluation, and they are further described in Sections 3.1.1, 5.8.2, and 5.8.3.

To PolyMet’s knowledge, there are no directly applicable state or federal laws specifying which probabilistic values to use in this permitting process. In general, MPCA, when determining water quality condition and compliance with water quality standards, uses such tests and analyses as the agency

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47 Consistent with other discussions in the NPDES/SDS Permit Application, detailed information is presented through Mine Year 10, and information after Mine Year 10 is shown for informational purposes only, because the first (and subsequent) permit terms will be 5 years in length.

48 P10 means 10th percentile, indicating that 10% of the model results are less than or equal to the P10 value. Likewise, P50 means the 50th percentile, and P90 means the 90th percentile. The mean is the mathematic average of the model results.
considers necessary “from the viewpoint of adequately reflecting the condition of the waters, the composition of the effluents, and the effects of the pollutants upon the specified uses” as per Minnesota Rules, part 7050.0150, subpart 8. A fundamental approach to understanding and “adequately reflecting” water quality and water quality impacts is the use of average concentrations based on sampling data. MPCA has consistently used average concentrations to determine receiving and downstream water quality in its permitting analysis. Consistent with MPCA past practice, PolyMet’s Antidegradation Evaluation uses average concentrations of various types to describe receiving and downstream water quality, including averages developed from sampling data to describe existing conditions and averages developed from probabilistic modeling results to describe estimated conditions in Mine Year 10.
<table>
<thead>
<tr>
<th>Role in Antidegradation Evaluation</th>
<th>Probabilistic result used in Antidegradation Evaluation</th>
<th>Rationale for choice of probabilistic result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters with influent concentrations below treatment targets, FEIS modeled discharge quality</td>
<td>Mine Year 10 annual average P50 influent concentrations from FTB seepage capture systems</td>
<td>• Process modeling confirms this is a protective representation of WWTS discharge quality.</td>
</tr>
<tr>
<td>Parameters with influent concentrations above treatment targets, treatment targets</td>
<td>Treatment targets, which are not probabilistic</td>
<td>• N/A</td>
</tr>
</tbody>
</table>
| Estimated water quality in downstream waters for parameters and evaluation points included in the FEIS GoldSim model | Mine Year 10 annual average P50 surface water concentration | • Average P50 concentrations reflect a protective estimate of WWTS discharge quality along with median values of variables such as precipitation and runoff quality.  
• Existing conditions are expressed as average concentrations. It is appropriate to compare the estimated average to the existing average.  
• It is appropriate to compare estimated average P50 values to baseline average monitoring data values.  
• Annual average P50 concentrations are appropriate for comparison with water quality standards based on chronic criteria. |
| Inputs to mass balance calculations | Annual average mean flow rates and concentrations | • Annual average mean values are used (instead of annual average P50 values) so that flows from different sources can be summed. When adding flows from multiple sources, mean flows from different sources sum to the mean total flow, however median (P50) flows from different sources do not necessarily sum to the median total flow. |
| Inputs for process modeling of the Waste Water Treatment System | Annual average P90 and peak P90 influent constituent concentrations and influent flow | • Annual average P90 influent flows and loads were used to confirm the ability to meet treatment targets, because they represent conditions near the upper limit of projected operating conditions. In addition, peak flow values based on pond design and P90 monthly influent flows were used to size equipment.  
• Annual average P90 flows were used to develop protective predictions for operations and maintenance requirements, including power and chemical usages rates. |
5.6 Methods for Determining Measurable Change

An antidegradation assessment must compare the existing water quality with the estimated future water quality resulting from the Project. This is an “apples to oranges” comparison – laboratory measurements must be compared to estimated outcomes based on modeling results. This comparison is reasonably straightforward if the estimated outcome is a large change – in this case the conclusion is that the Project will change the existing water quality. But the comparison is more difficult if the estimated outcome is a small change – in this case some method must be used to evaluate whether the estimated outcome would represent a “real change” from the existing water quality.

To PolyMet’s knowledge, there are no specific statutory or regulatory requirements or guidance yet in place on the method for making this comparison under MPCA’s recently-enacted Revised Rule. In particular, there is no precedent or guidance on the important regulatory definition of “degradation,” which is defined as a “measurable change in existing water quality” resulting in certain specified surface-water impacts as described below. In the absence of such information, PolyMet proposes a method for this Antidegradation Evaluation that is based on USEPA approved laboratory testing methods and on the revised Minnesota antidegradation rule.

The term “degradation” is defined in the Revised Rule as a “measurable change to existing water quality made or induced by human activity resulting in diminished chemical, physical, biological, or radiological qualities of surface water” (Minnesota Rules, part 7050.0255, subpart 11). In turn, “measurable change” is defined as “the practical ability to detect a variation in water quality, taking into account limitations in analytical technique and sampling variability” (Minnesota Rules, part 7050.0255, subpart 24). The challenge is to translate this narrative definition into a numerical value.

PolyMet considered a number of possible methods of quantifying whether a small estimated change would represent a measurable change (Attachment C). Of these options, PolyMet proposes using the practical quantification limit (PQL) to define measurable change where existing concentrations are so low that they are most commonly reported as “non-detect.” The PQL is the lowest concentration that can be reliably measured within the specified limits of precision and accuracy during routine laboratory operating conditions. Monitoring results below the PQL are typically reported as “non-detect.” PolyMet proposes that if both the existing and the estimated concentration values are below the PQL, the Project effect would not be considered a measurable change.

For circumstances where existing concentrations are usually detectable, PolyMet proposes using the LCS acceptance limit. The LCS acceptance limit is a measure of acceptable variability inherent in a USEPA-approved analytical testing method. PolyMet proposes that an estimated concentration that differs from the mean existing concentration by less than the LCS acceptance range would not be considered a measurable change.

Attachment C describes other potential approaches to defining measurable change that were considered and discusses tradeoffs between them. Overall, none of the options are perfect, but the LCS acceptance limit aligns with the regulatory definition and provides a practical method for quantifying measurable
change in the Antidegradation Evaluation. LCS acceptance criteria for the parameters of concern are listed in Table 5-1.

MPCA requested calculation of the 95% upper confidence limit (UCL) of baseline data as a potential alternative method for determining measurable change from existing conditions. This analysis is provided in Attachment B.

5.7 Estimating Water Quality in Receiving Waters During Project Operations

During Project operations, the water quality at the locations of the outfalls in the Trimble Creek and Unnamed Creek wetlands and the headwater segment of Second Creek is estimated to be the same as the estimated WWTS discharge quality, as described in Section 3.1.1 and shown in Table 3-2. It is assumed that WWTS discharge will not dilute the receiving waters at the outfalls. This assumption is appropriate because the FTB seepage capture systems will collect existing flows of runoff and tailings basin seepage, which are currently the headwaters of the receiving waters prior to construction and operation of the Project, and then during Project operations, the surface water discharge outfalls will become the headwaters of the receiving waters. In other words, by Mine Year 10 the WWTS discharge will have fully replaced existing headwater conditions at the outfalls.

As described in Section 3.1.1, design modeling indicated that concentrations of parameters of concern other than sulfate in the WWTS discharge may be significantly lower than in the discharge assumed for the Antidegradation Evaluation. As a result, this Antidegradation Evaluation likely overestimated concentrations of parameters of concern other than sulfate in the receiving waters.

5.8 Methods Unique to Antidegradation Assessment for Parameters other than Mercury

5.8.1 Estimating Cumulative Effects of the Project in Downstream Waters

The Former Rule and the Revised Rule require consideration of certain cumulative impacts,49 defined as "the impact on the environment that results from incremental effects of the project in addition to other past, present, and reasonably foreseeable future projects".50 The FEIS identified the Project actions that could contribute to cumulative effects (Section 6.2 of Reference (1)). Table 5-4 lists the actions identified by the FEIS and identifies their location relative to the proposed discharge from the WWTS.

The estimated effects presented in Section 6.3 represent cumulative effects. For the Embarrass River watershed, present and past cumulative effects are reflected in the monitoring and modeling conducted for the FEIS, and no reasonably foreseeable future actions have been identified in the Embarrass River watershed besides the Project. For the Partridge River watershed, this evaluation adds additional details to the cumulative analysis conducted for the FEIS. Second Creek, downstream of the Project surface water

49 Former Minnesota Rules, part 7050.0185 subpart 4 (repealed November 2016), and Minnesota Rules, part 7050.0280, subpart 2(C)(3)(a)
50 Minnesota Rules, part 4410.0200, subpart 11.
discharge outfall, receives discharges from the Mesabi Nugget project. Therefore, publicly available monitoring data from the Mesabi Nugget project were used to estimate cumulative effects of the WWTS discharge and related activities on Second Creek and in the Partridge River downstream of its confluence with Second Creek, as described further in Section 5.8.3.

Table 5-4  Past, Present, or Reasonably Foreseeable Actions that May Contribute to Cumulative Effects

<table>
<thead>
<tr>
<th>Action</th>
<th>Status</th>
<th>Receiving Water Body</th>
<th>Location relative to Project discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embarrass River Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Babbitt Publicly Owned Treatment Works (POTW)</td>
<td>Present</td>
<td>Upper Embarrass River</td>
<td>Upstream of confluences with Trimble and Unnamed creeks</td>
</tr>
<tr>
<td>LTV Steel Mining Company (LTVSMC) Pits (Cliffs Erie Pits)</td>
<td>Present</td>
<td>Upper Embarrass River</td>
<td>Upstream of confluences with Trimble and Unnamed creeks</td>
</tr>
<tr>
<td>Minorca Mine</td>
<td>Present</td>
<td>Lower Embarrass River</td>
<td>Downstream of confluences with Trimble and Unnamed creeks</td>
</tr>
<tr>
<td>City of Aurora POTW</td>
<td>Present</td>
<td>Lower Embarrass River</td>
<td>Downstream of confluences with Trimble and Unnamed creeks</td>
</tr>
<tr>
<td>City of Biwabik POTW</td>
<td>Present</td>
<td>Lower Embarrass River</td>
<td>Downstream of confluences with Trimble and Unnamed creeks</td>
</tr>
<tr>
<td><strong>Partridge River Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northshore Mine</td>
<td>Present</td>
<td>Upper Partridge River</td>
<td>Upstream of confluence with Second Creek</td>
</tr>
<tr>
<td>Northshore Mine Closure</td>
<td>Reasonably Foreseeable</td>
<td>Upper Partridge River</td>
<td>Upstream of confluence with Second Creek</td>
</tr>
<tr>
<td>City of Hoyt Lakes POTW</td>
<td>Present</td>
<td>Colby Lake</td>
<td>Upstream of confluence with Second Creek</td>
</tr>
<tr>
<td>Minnesota Power Laskin Energy Center</td>
<td>Present</td>
<td>Colby Lake</td>
<td>Upstream of confluence with Second Creek</td>
</tr>
<tr>
<td>LTVSMC Pits 3 and 5SW (Cliffs Erie Pits)</td>
<td>Present</td>
<td>Wyman Creek</td>
<td>Upstream of confluence with Second Creek</td>
</tr>
<tr>
<td>LTVSMC Pit 2W (Cliffs Erie Pit)</td>
<td>Present</td>
<td>Second Creek</td>
<td>Downstream of Project discharge to Second Creek</td>
</tr>
<tr>
<td><strong>Mesabi Mining Project</strong></td>
<td>Pending(1)</td>
<td>Second Creek</td>
<td>Downstream of Project discharge to Second Creek</td>
</tr>
<tr>
<td>Action</td>
<td>Status</td>
<td>Receiving Water Body</td>
<td>Location relative to Project discharge</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Mesabi Nugget Mining Area (Permit MN0069078)</td>
<td>Present</td>
<td>Second Creek</td>
<td>Downstream of Project discharge to Second Creek</td>
</tr>
<tr>
<td>Mesabi Nugget (Permit MN 0067687)</td>
<td>Present(2)</td>
<td>Second Creek</td>
<td>Downstream of Project discharge to Second Creek</td>
</tr>
</tbody>
</table>

1. Potential future loading not quantifiable due to preliminary nature of proposal.
2. Mesabi Nugget is currently idle, but this Antidegradation Assessment assumed operating conditions.

### 5.8.2 Estimating Water Quality Effects of the Project at Downstream Evaluation Points Included in FEIS GoldSim Modeling

Estimated water quality effects of the Project at downstream evaluation points on Trimble Creek, Unnamed Creek, and the Embarrass River are based on the GoldSim water modeling conducted for the FEIS. Water modeling methods are documented in the Water Modeling Data Package – Plant Site (Reference (3)).

The Antidegradation Assessment uses the GoldSim Mine Year 10 annual average P50 results to represent the estimated water quality for evaluation points and for constituents included in GoldSim models. The annual average P50 values are appropriate for comparison with existing conditions because existing conditions are described using the average concentrations from monitoring data collected over multiple years. It is appropriate to compare the existing average to an estimated average, to make an “apples to apples” comparison. Comparing annual average P50 values to applicable water quality standards is consistent with MPCA practices for establishing effluent limits, which use statistical methods that consider variability over time to assess compliance with water quality standards (Reference (16)).

The FEIS modeling took into account not just the quantity and quality of the WWTS discharge, but also other WWTS discharge related activities. Modeling accounted for estimated discharge flow rate and distribution between the receiving waters and other sources of load and flow at the evaluation points (Section 5.2 of Reference (3)).

Estimated specific conductance, TDS, and chloride concentration were not based on GoldSim modeling results. Specific conductance and TDS were calculated based on the total concentrations of other constituents in the modeled discharge, using the method described in Section 3.1.1. Effects of chloride were evaluated qualitatively because the design modeling estimated that the chloride concentration in the WWTS discharge will be higher than the concentration used for the FEIS GoldSim water modeling (Table 3-1).

Because the WWTS discharge and related activities are also expected to affect the hardness in the receiving waters and because this effect will persist for some distance downstream, PolyMet conducted additional analysis for cadmium, copper, lead, nickel, and zinc, which have water quality standards that depend on the hardness of the water. GoldSim modeling completed for the FEIS included probabilistic modeling of the likelihood that applicable water quality standards for hardness-dependent parameters of concern will be exceeded at TC-1/TC-1a, PM–11, and PM–13. The modeling accounted for potential
variability in flows and loads and calculated the expected hardness in the receiving water, the standards at that hardness, and the expected concentration of each parameter. Plots comparing expected concentrations to the hardness-adjusted standards are included as Attachment D. The following considerations underlie the comparison of existing and estimated conditions for hardness-dependent parameters:

- The numerical value of a hardness-based standard increases in a non-linear manner when hardness increases, and decreases in a non-linear manner when hardness decreases.

- Receiving waters currently exhibit high hardness (around 500 mg/L), which is likely due to the effects of legacy ferrous seepage from the existing LTVSMC tailings basin.

- Surface waters in the vicinity that do not appear to be affected by legacy seepage exhibit low hardness (approximately 50 mg/L, mostly below 100 mg/L and down to about 20 mg/L at PM-12 for example).

- When the FTB seepage capture systems cut off tailings basin seepage, hardness is expected to decrease in the receiving waters.

- WWTS discharge, which will have a stabilized hardness of about 100 mg/L, will be the dominant source of water at the evaluation points in Trimble Creek (TC-1/TC–1a) and Unnamed Creek (PM–11). Hardness at TC-1/TC–1a and PM–11 during Project operations is expected to be slightly below 100 mg/L, with the exact value depending on other inflows and the WWTS discharge volume.

As described in Section 3.1.1, WWTS design modeling indicated that concentrations of parameters of concern other than sulfate in the WWTS discharge may be significantly lower than in the discharge assumed for the Antidegradation Evaluation. As a result, the Antidegradation Evaluation likely overestimated concentrations of parameters of concern other than sulfate in receiving and downstream waters at evaluation points included in the FEIS GoldSim modeling.

5.8.3 Estimating Water Quality Effects of the Project at Downstream Evaluation Points Not Included in FEIS GoldSim Modeling

The geographic scope of the FEIS Plant Site GoldSim modeling effort was set by the Cooperating Agencies during the environmental review IAP process (Reference (11)). The agreed upon scope was to model water quality and flows from the Plant Site to the north and west, in the Embarrass River watershed, and from the Mine Site to the south and west in the Partridge River watershed, as far as Colby Lake. The Antidegradation Evaluation expanded upon that analysis to also estimate water quality in Mine Year 10 at evaluation points outside the designated scope of the FEIS modeling on Second Creek, the Partridge River, and the St. Louis River.

Estimated water quality at downstream evaluation points not included in FEIS GoldSim modeling was estimated using mass balance calculations, as detailed in Attachment E. The change in constituent loading due to the WWTS discharge and related activities was determined based on the FEIS GoldSim model.
results for Mine Year 10. Specifically, annual average mean flow rates and concentrations were used as inputs to the mass balance calculations. Annual average mean values were used instead of annual average P50 values so that flows from different sources could be summed. When adding flows from multiple sources, mean flows from different sources sum to the mean total flow; however, median (P50) flows from different sources do not necessarily sum to the median total flow. For these reasons, the average mean value is the mathematically appropriate metric to use in mass balance calculations.

5.9 Methods Unique to Antidegradation Demonstration for Mercury

The following sections describe methods unique to the mercury Antidegradation Demonstration under Minnesota Rules, parts 7052.0300 through 7052.0380., including the selection of evaluation points for the mercury Antidegradation Demonstration as well as the methods used to determine existing water quality and to estimate potential effects of the water quality.

5.9.1 Applicable Standards

Receiving and downstream waters classifications and actual uses with regard to mercury are the same as described for other parameters in Section 4.2. Designated beneficial uses of the receiving and downstream waters (including those necessary to support the propagation of fish, shellfish, and wildlife and recreation in and on the water) are protected by the Great Lakes Initiative (GLI) mercury water column standard of 1.3 nanogram per liter (ng/L) (Minnesota Rules, part 7052.0100, subpart 5) and the mercury fish tissue standard of 2 mg/kg (Minnesota Rules, part 7050.0222, subpart 4).

MPCA has determined that the concentration of mercury in fish tissue generally is proportional to the concentration of mercury in the water column (Reference (17)). Waters that meet the mercury water column standard of 1.3 ng/L are understood to meet the mercury fish tissue standard of 2 mg/kg. Therefore, where the existing concentration of mercury in the receiving water is lower (better) than 1.3 ng/L, the water is deemed “high quality” for mercury for purposes of Minnesota Rules, chapter 7052.

5.9.2 Evaluation Points

Evaluation points for receiving and downstream waters are the same for mercury as for other parameters (Section 5.2), with the addition of two evaluation points: one on the upper Partridge River (SW004a) and one on the St. Louis River near Forbes at the location of USGS 04018750 (EP–1).

5.9.3 Assessment of Existing Water Quality for Mercury

5.9.3.1 Mercury Concentrations

Existing mercury concentrations are mainly based on surface water monitoring conducted for the FEIS (evaluation points TC–1a, PM–11, PM–13, PM–7/SD026, SW004a). Concentrations for the additional downstream evaluation points were based on reports submitted to the MDNR for nearby projects (evaluation points MNSW8, USGS 04016000) (Reference (18)) and published studies of mercury in the St. Louis River watershed (EP–1 and EP–2) (Reference (19)), as detailed in Attachment F. For evaluation points where all measurements are above the analytical detection limits, existing mercury concentrations were
calculated as arithmetic averages of total mercury concentrations from samples collected at each evaluation point. For evaluation points with measurements below analytical detection limits, averages were computed using the Kaplan-Meier method (Reference (20)).

In the receiving wetlands near the Trimble Creek and Unnamed Creek outfalls, no mercury monitoring has been conducted, so mercury concentrations were estimated using the same approach used for other parameters of concern, as described in Section 5.2. Monitoring stations TC–1a and PM–11 were used as reference waters for the Trimble Creek and Unnamed Creek headwater wetland mercury concentrations, respectively.

### 5.9.3.2 Mercury Loading

Existing mercury loading was calculated as the product of existing concentrations and existing flows. Flows used in the calculation of loads are the annual average modeled flows from the FEIS GoldSim water modeling, from discharge measurements from USGS stream gages, and additional flows to Second Creek associated with Mesabi Nugget and Cliffs Erie mine pits (Attachment F). Existing flows at the evaluation points are for the conditions that existed before the seepage pumpback systems at the LTVSMC tailings basin were installed in 2011 under the Consent Decree between MPCA and Cliffs Erie (Section 6.1). The seepage pumpback systems capture a portion of the flow that would have previously reported to the evaluation points. The short-term mitigation measures currently required as part of the Consent Decree are not intended to be long-term solutions. The Project will eliminate the pumpback systems, (with one possible exception), and long-term mitigation will be provided by the controls and systems include in the Project. This approach of using pre-Consent Decree flows as existing conditions flows is consistent with the analysis presented in the FEIS.

For the Antidegradation Demonstration, PolyMet did not calculate the existing mercury load for the wetlands near the headwaters of Trimble Creek and Unnamed Creek, because the wetland hydrologic conditions are inconsistent with the assumptions underlying the mercury mass balance calculation method. However, this does not affect the analysis. Specifically, the calculation of mercury load from the Plant Site to the Embarrass River does not require knowledge of flow and load specifically in the receiving wetlands, because the mercury mass flux from the Plant Site through the wetlands reports to nearby evaluation points further downstream and is accounted for in the mercury load calculations at TC–1a, PM–11, and PM–13. These data points are sufficient to conduct the mercury Antidegradation Demonstration.

### 5.9.4 Estimation of Water Quality Effects of the Project for Mercury

Potential effects of the WWTS discharge and related activities with respect to mercury were estimated using a mass balance spreadsheet model. Estimated mercury concentrations and loading were calculated for Mine Year 10, the year that is expected to have the highest estimated WWTS discharge and the lowest pumping rate from Colby Lake, and thus the greatest potential for net mercury loading. Pumping water from Colby Lake for use as make-up water will have the effect of removing mercury from the Partridge

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51 The mercury mass balance method is based on flow and concentration at a stream cross-section, which is assumed to be representative of all watershed loading to that point. One assumption of this method is that the various water sources (e.g., runoff, groundwater, WWTS discharge) become well-mixed within the stream channel. Diffuse, subsurface flow, as in the wetlands, is not consistent with this method, and so the load for the headwater wetlands cannot be estimated by the methods used for streams.
River watershed, because some of the mercury in the make-up water will end up sequestered in the Flotation Tailings and the taconite tailings in the Tailings Basin (Attachment F). Full details on the spreadsheet model methods, assumptions, and consistency with FEIS modeling are provided in Attachment F. Generally, the calculations follow these steps:

1. Separate the total load under existing conditions at each evaluation point into the contributions from the individual sources that report to that point. Loads associated with the individual sources were derived from existing concentrations and from average flow rates estimated for the GoldSim Continuation of Existing Conditions model developed for the FEIS.

2. Calculate the estimated total load from the Project at each evaluation point by summing the loads contributed by the individual sources that will report to that point in Mine Year 10. Loads associated with the individual sources were derived from estimated concentrations and from flow rates estimated for Mine Year 10 by the Project model developed for the FEIS.

3. Calculate the concentration at each evaluation point in Mine Year 10 based on the total load (calculated in step 2) and the total average flow, calculated as the sum of the component flows estimated by the GoldSim model.

Mercury loading using this approach provides an estimate of the cumulative effect of the WWTS and related activities plus past and present actions that affect the downstream waters (Section 5.8.1), because the model is based on monitoring results that capture the effects of past and present actions, including the Mesabi Nugget Project. No reasonably foreseeable future actions have been identified for which potential future loading can be quantified (Section 5.8.1).
6.0 Existing (Pre-Project) and Estimated (Project) Water Quality: Parameters of Concern Other Than Mercury

This section begins with background information on existing conditions at the Plant Site (Section 6.1) in order to provide context for the discussion of existing water quality before construction of the Project (Section 6.2) and the estimated effects of the WWTS discharge and related activities during Project operations (Section 6.3).

6.1 Background on Existing Conditions

The Plant Site, where the WWTS will be constructed, is located at the site of the former taconite processing plant and tailings basin previously operated by LTVSMC, which halted operations in 2001. Existing conditions at the Plant Site are described in Section 2.1 of Volume V, and shown on Large Figure 4. Several aspects of existing conditions are of particular importance for the Antidegradation Evaluation:

- Ferrous mining activities, which have taken place at the Plant Site since the 1950s, have impacted water quality in Trimble Creek, Unnamed Creek, and Second Creek, as described in Section 3.0 of Volume V.

- Cliffs Erie currently holds two NPDES/SDS permits at the Plant Site which regulate discharge of surface seepage from the existing LTVSMC tailings basin.
  - Cliffs Erie NPDES/SDS Permit MN0054089 (Hoyt Lakes Tailings Basin Area) authorizes surface discharge stations SD001, SD004, SD005, and SD006, in the headwater area of Unnamed Creek, and surface discharge station SD002, in the headwater area of Trimble Creek.
  
    - Cliffs Erie NPDES/SDS Permit MN0042536 (Hoyt Lakes Mining Area) authorizes surface discharge station SD026, at the headwater area of Second Creek.

- Surface seepage collection began in 2011 when Cliffs Erie installed pumpback systems at surface discharge stations SD004, SD006, and SD026 under the terms of a 2010 Consent Decree with the MPCA. The pumpback systems collect surface seepage that emerges near the toes of the LTVSMC tailing basin dams and return it to the tailings basin pond. Prior to installation of the pumpback systems, this surface seepage flowed to the headwaters of Unnamed Creek (SD004 and SD006) and Second Creek (SD026).

- Even with the pumpback systems operating, some seepage from the existing tailings basin remains in the ground at the northern, northwestern, and western toes of the tailing basin dams and flows to wetlands that are the headwater areas of Trimble Creek and Unnamed Creek.
6.2 Existing Water Quality

6.2.1 Concentrations of Parameters of Concern other than Mercury

Existing water quality in the receiving waters is presented in Large Table 2. In the three receiving waters, average concentrations of the parameters of concern other than mercury are below applicable standards when calculated using monitoring results over a period that includes both pre- and post-pumpback data (Section 5.2). Average concentrations of many parameters are below typical detection limits (Sb, Cd, Cr, Pb, Ni, Se, Ag, Tl, Zn).

Existing water quality in the downstream waters is presented in Large Table 3 and Large Table 4. At evaluation points on downstream waters, average concentrations of the parameters of concern other than mercury are below applicable numeric standards based on available monitoring data, except at MNSW8 on Second Creek, where existing values of hardness, TDS, and specific conductance are higher than applicable Class 3 and Class 4 standards (Section 6.2.2).

Existing water quality information calculated with an alternative methodology as requested by the MPCA is presented in Attachment B.

6.2.2 Discussion of Specific Parameters

This section provides additional information on existing concentrations of aluminum in the Embarrass River and on values of hardness, TDS, and specific conductance in Second Creek.

6.2.2.1 Aluminum Concentration in the Embarrass River Watershed

Additional site-specific analysis was conducted to determine whether total or dissolved aluminum concentrations are more appropriate for use in the Antidegradation Evaluation. Because the average total aluminum concentration for existing conditions at PM–13 is above the total aluminum Class 2B standard. PolyMet compiled additional monitoring data on the dissolved and total aluminum concentrations at that evaluation point and other monitoring stations in the Embarrass River watershed, consistent with USEPA guidance, as described in Section 5.1. The Class 2B standard is 125 micrograms (µg/L) for both total and dissolved aluminum using the recommended conversion factor for aluminum of 1 (Minnesota Rules, part 7050.0222 subpart 1(B)). Dissolved and total aluminum monitoring data for monitoring stations on Trimble Creek, Unnamed Creek, and the Embarrass River are summarized in Table 6-1.

The ratio of average dissolved to average total aluminum provides evidence that adsorbed aluminum is a significant contribution to the total aluminum concentrations in these streams. The ratio of dissolved to total aluminum is higher in Trimble Creek and Unnamed Creek than in the Embarrass River, and the ratio in the Embarrass decreases downstream as the river flows from PM–12 to PM–13. This pattern is consistent because these waterbodies pick up more suspended solids as they flow downstream. Monitoring results confirm that values of TSS increase downstream in the Embarrass River (average TSS increases from 2.1 to 6.8 mg/L as the Embarrass River flows from PM–12 to PM–13). This data indicated that the dissolved aluminum concentrations, rather than the total aluminum concentrations, represent the appropriate existing conditions data to compare to the standard for determination of whether these waterbodies are high quality for aluminum. Large Table 3 includes both the dissolved and total aluminum concentrations for existing conditions.
### Table 6-1  Dissolved and Total Aluminum Monitoring Results for Monitoring Stations in the Embarrass River Watershed

<table>
<thead>
<tr>
<th></th>
<th>Dissolved(^{(1)})</th>
<th>Total(^{(1)})</th>
<th>Ratio dissolved/total(^{(2)})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># samples</td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td><strong>Unnamed Creek</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM–11</td>
<td>54</td>
<td>&lt; 10</td>
<td>83.9</td>
</tr>
<tr>
<td><strong>Trimble Creek</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC–1(^{(3)})</td>
<td>4</td>
<td>25.6</td>
<td>48</td>
</tr>
<tr>
<td>TC–1a(^{(3)})</td>
<td>38</td>
<td>&lt; 10</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>PM–19</td>
<td>54</td>
<td>&lt; 10</td>
<td>67.3</td>
</tr>
<tr>
<td><strong>Embarrass River</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM–12</td>
<td>52</td>
<td>23.2</td>
<td>184</td>
</tr>
<tr>
<td>PM–12.2</td>
<td>47</td>
<td>15.5</td>
<td>160</td>
</tr>
<tr>
<td>PM–12.3</td>
<td>26</td>
<td>&lt; 20</td>
<td>133</td>
</tr>
<tr>
<td>PM–12.4</td>
<td>26</td>
<td>&lt; 20</td>
<td>133</td>
</tr>
<tr>
<td>PM–13</td>
<td>52</td>
<td>15.3</td>
<td>138</td>
</tr>
</tbody>
</table>

For each water body, monitoring stations are listed from upstream to downstream (e.g., in the Embarrass River, PM–12 is furthest upstream and PM–13 is furthest downstream).

\(^{(1)}\) Data Source: Monitoring results through 2015, Large Table 2 of Volume V

\(^{(2)}\) Calculated for sampling events when both dissolved and total aluminum were measured and detected.

\(^{(3)}\) TC–1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC–1a, which is located less than one mile downstream of TC–1.
6.2.2.2 Hardness, Total Dissolved Solids, and Specific Conductance in Second Creek

Average values of hardness, TDS, and specific conductance currently exceed numeric standards in Second Creek downstream of the Mesabi Nugget Project at MNSW8. In addition, the average values of these parameters approach but do not exceed numeric standards in Second Creek at PM–7/SD026. The elevated levels of hardness, TDS, and specific conductance in Second Creek are the result of previous taconite mining activities at the Plant Site as well as the effects of the Mesabi Nugget Project downstream. Note that hardness, TDS, and specific conductance are among the parameters being addressed by the ongoing mitigation activities being conducted pursuant to in the Consent Decree between Cliffs Erie and the MPCA.

6.2.3 Identification of Existing High Quality Receiving and Downstream Waters

Antidegradation assessment procedures under the Revised Rule require determination, on a parameter by parameter basis, of whether receiving and relevant downstream waters are “of high quality,” as defined in Minnesota Rules, part 7050.0255, subpart 21 as “water quality that exceeds, on a parameter-by-parameter basis, levels necessary to support the propagation of aquatic life and recreation in and on the water.” The SONAR for the Revised Rule explains that the term “levels necessary to support the propagation of aquatic life and recreation in and on the water” refers to Class 2 standards (page 41 of Reference (21)). In other words, the concept of “high quality” only applies to parameters for which there are Class 2 standards. Where the existing concentration of a parameter of concern is lower than the Class 2 standard (i.e., it “exceeds” the standard), the water is deemed “high quality” for that parameter. Data on existing water quality (Large Table 2, Large Table 3 and Large Table 4) indicate that for the parameters of concern other than mercury for which there are applicable Class 2 standards, the receiving and downstream waters are “of high quality” within the meaning of the Revised Rule.

6.2.4 Existing Physical Habitat and Biological Diversity

The Revised Rule’s definition of “existing water quality” includes the “physical” and “biological conditions of a receiving water” (Minnesota Rules, part 7050.0255, subpart 16). Cliffs Erie and PolyMet have gathered data to describe the existing physical and biological conditions of Trimble Creek, Unnamed Creek, and Second Creek and of the wetlands at the headwaters of Trimble and Unnamed creeks.

6.2.4.1 Trimble, Unnamed, and Second Creeks

Surveys of the existing physical habitat and biological diversity of Trimble, Unnamed, and Second creeks were conducted in 2010 and 2011 using the MPCA Physical Habitat and Water Quality Assessment Protocol for Wadeable Stream Monitoring Sites (Reference (22)). Biological diversity was assessed using a range of indicators. For macroinvertebrates, the indicators used included:

- abundance
- richness
- Shannon-Weiner Diversity Index
- evenness
- Hilsenhoff Biotic Index
Fish community health was assessed based on the total number of species, the Simpsons’ Diversity Index, and the proportion of individuals considered to be tolerant, insectivores, omnivores, or DELT (diseased, eroded fins, lesions, or tumors). The results of these assessments were reported to the MPCA in the NPDES Field Studies Report - Tailings Basin (Reference (23)) and the NPDES Field Studies Report – SD026 (Reference (24)).

The results of the baseline physical habitat and biological diversity studies for Trimble, Unnamed, and Second Creeks, which have been affected by previous mining activities, were compared to a reference stream, Bear Creek, which is a tributary of the Embarrass River in the vicinity of the receiving waters that has not been affected by previous mining activities. This comparison is presented in Table 6-2. The receiving waters show similar habitat characteristics and comparable biological diversity to the reference stream, which suggests that although the receiving waters have been affected by previous mining activities, their overall water quality is suitable for supporting a level of biological activity comparable to unaffected streams in the area.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Bear Creek (Reference Stream)</th>
<th>Unnamed Creek (PM11)</th>
<th>Trimble Creek (PM19)</th>
<th>Second Creek (PM–7/SD026)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative Habitat Evaluation Index</td>
<td>---</td>
<td>44</td>
<td>---</td>
<td>46</td>
</tr>
<tr>
<td>Shannon-Wiener Diversity Index (H')</td>
<td>2.91</td>
<td>2.42</td>
<td>2.78</td>
<td>3.25</td>
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<tr>
<td>Evenness</td>
<td>0.75</td>
<td>0.64</td>
<td>0.78</td>
<td>0.79</td>
</tr>
<tr>
<td>Hilsenhoff Biotic Index (HBI)</td>
<td>6.36</td>
<td>5.94</td>
<td>6.54</td>
<td>5.91</td>
</tr>
<tr>
<td>Richness (Class)</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Richness (Order)</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Richness (Family)</td>
<td>32</td>
<td>34</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>Richness (Genera)</td>
<td>46</td>
<td>43</td>
<td>32</td>
<td>55</td>
</tr>
<tr>
<td>Abundance (Total Organisms)</td>
<td>2,787</td>
<td>1,113</td>
<td>2,484</td>
<td>1,077</td>
</tr>
</tbody>
</table>

**Percentage of Class (bold represents dominant classes)**

<table>
<thead>
<tr>
<th>Class</th>
<th>Bear Creek (Reference Stream)</th>
<th>Unnamed Creek (PM11)</th>
<th>Trimble Creek (PM19)</th>
<th>Second Creek (PM–7/SD026)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecta</td>
<td>62.7%</td>
<td>61.5%</td>
<td>64.6%</td>
<td>87.8%</td>
</tr>
<tr>
<td>Crustacea</td>
<td>12.8%</td>
<td>19.6%</td>
<td>12.9%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Malacostraca</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Entoprocta (Phylum)</td>
<td>0.6%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Annelida</td>
<td>21.2%</td>
<td>14.8%</td>
<td>20.6%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Gastropoda</td>
<td>1.9%</td>
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<td>4.0%</td>
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<tr>
<td>Parameter</td>
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<td>Trimble Creek (PM19)</td>
<td>Second Creek (PM–7/SD026)</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>--------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Bivalvia</td>
<td>0.8%</td>
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<td>0.6%</td>
<td>2.7%</td>
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<tr>
<td>Hydrozoa</td>
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<td>0.4%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Nematoda</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### Richness of Genera

<table>
<thead>
<tr>
<th># of Insect Genera</th>
<th>38</th>
<th>33</th>
<th>28</th>
<th>46</th>
<th>24</th>
<th>34</th>
<th>26</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Insects of total individuals present at site</td>
<td>63%</td>
<td>61%</td>
<td>65%</td>
<td>88%</td>
<td>91%</td>
<td>78%</td>
<td>83%</td>
<td>96%</td>
</tr>
<tr>
<td># Ephemeroptera, Plecoptera and Trichoptera (EPT) Genera</td>
<td>14</td>
<td>9</td>
<td>8</td>
<td>16</td>
<td>12</td>
<td>14</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>% EPT of total individuals present at site</td>
<td>24%</td>
<td>37%</td>
<td>31%</td>
<td>27%</td>
<td>42%</td>
<td>42%</td>
<td>72%</td>
<td>77%</td>
</tr>
<tr>
<td># Ephemeroptera, Plecoptera and Trichoptera (EPTO) Genera</td>
<td>19</td>
<td>12</td>
<td>10</td>
<td>20</td>
<td>14</td>
<td>16</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>% EPTO of total individuals present at site</td>
<td>28%</td>
<td>38%</td>
<td>35%</td>
<td>27%</td>
<td>42%</td>
<td>45%</td>
<td>74%</td>
<td>77%</td>
</tr>
<tr>
<td>% Diptera (true flies) of total individuals present at site</td>
<td>30%</td>
<td>23%</td>
<td>25%</td>
<td>53%</td>
<td>49%</td>
<td>32%</td>
<td>8%</td>
<td>19%</td>
</tr>
<tr>
<td>% Chironomids (bloodworms) of Diptera</td>
<td>53%</td>
<td>31%</td>
<td>53%</td>
<td>50%</td>
<td>4%</td>
<td>78%</td>
<td>47%</td>
<td>0%</td>
</tr>
<tr>
<td>% Simulidae of total individuals present at site</td>
<td>11%</td>
<td>15%</td>
<td>9%</td>
<td>26%</td>
<td>47%</td>
<td>6%</td>
<td>1%</td>
<td>13%</td>
</tr>
</tbody>
</table>

### 6.2.4.2 Receiving Wetlands

Wetlands within the vicinity of the Unnamed Creek and Trimble Creek outfalls were field reviewed and classified according to Eggers and Reed wetland community types (Reference (25)). The overall quality of the wetlands was evaluated using the Minnesota Routine Assessment Method (Reference (26)). Wetlands in this area are generally of low quality due to beaver activity and effects of previous mining activities.

The Unnamed Creek outfall will discharge into an alder thicket wetland community. This community is seasonally saturated or flooded, and is dominated by speckled alder (*Alnus incana*). The ground layer is dominated by grasses, sedges, and forbs. Soils in alder thickets are typically fibric and hemic peat at the surface underlain by bedrock or mineral soil.

The wetlands in the vicinity of the Trimble Creek outfalls consist of shallow and deep marshes, coniferous swamps, and alder thickets. Shallow and deep marshes in the vicinity of the Trimble Creek outfalls are generally associated with disturbances, such as beaver activity. Shallow marshes are generally inundated...
with up to 6 inches during the growing season, while deep marshes are generally inundated with 6 inches to 3 feet during the growing season. Both shallow and deep marshes are dominated by cattails (Typha sp.), with other sedges, bulrushes, and aquatic plants also present. Soils in shallow and deep marshes are typically organic at the surface and underlain by mineral soils.

Coniferous swamps in the vicinity of the Trimble Creek outfalls are generally saturated within 12 inches of the surface throughout much of the growing season. These communities are dominated by black spruce (Picea mariana) and tamarack (Larix laricina), with other coniferous and deciduous trees also present, such as balsam fir (Abies balsamea) and black ash (Fraxinus nigra). The shrub layer is typically dominated by speckled alder and willows (Salix sp.). The ground layer commonly includes grasses, sedges, and forbs. Sphagnum mosses are also present in the ground layer; however, a continuous sphagnum mat is usually absent. Soils in the coniferous swamps are typically organic.

As described above for Unnamed Creek, alder thickets are seasonally saturated or flooded and dominated by speckled alder, with grasses, sedges, and forbs present in the ground layer. Soils in are typically fibric and hemic peat at the surface underlain by bedrock or mineral soil.

6.3 Estimated Water Quality during Project Operations
This section describes the estimated water quality in receiving waters (Section 6.3.1) and downstream waters (Sections 6.3.2, 6.3.3, and 6.3.4) that will result from the WWTS discharge (as assumed for purposes of this Antidegradation Evaluation) and related activities. It also describes estimated Project effects on high quality waters (Section 6.3.5) and ORVWs (Section 6.3.6). Estimated water quality during Project operations calculated using the statistical methods requested by the MPCA is presented in Attachment B.

6.3.1 Effect of Discharge upon Receiving Waters
Large Table 2 compares existing water quality with the estimated water quality in the receiving waters as a result of the WWTS discharge and related activities. Overall, the WWTS discharge quality assumed for the Antidegradation Evaluation and the result of the related activities were estimated to have the following effects on water quality of the receiving waters at the surface water discharge outfalls:

- Concentrations of the parameters of concern will be at or below applicable water quality standards.
- Concentrations of sulfate are expected to decrease by an order of magnitude from existing conditions to below 10 mg/L.
- Concentrations of several parameters are expected to show no measurable change (boron, silver) or to decrease (aluminum, hardness, TDS, specific conductance).
- Concentrations of most metals (antimony, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, selenium, thallium, and zinc) and of chloride will measurably increase; however, as noted above, concentrations will be at or below applicable numeric water quality standards.
• No existing uses of the receiving waters will be affected by any of the changes in concentrations referenced above.

• The alternative statistical approach requested by the MPCA (Attachment B) supports these conclusions. It resulted in minor variations in which parameters were estimated to exhibit measurable changes from existing conditions, but in all cases both statistical approaches resulted in concentrations at or below applicable numeric water quality standards.

Additional discussion of specific parameters is presented in Section 6.3.4.

6.3.2 Effect of Discharge upon Downstream Waters: Embarrass River Watershed

Large Table 3 compares existing water quality with estimated water quality associated with WWTS discharge and related activities at downstream evaluation points in the Embarrass River watershed. Overall, the discharge quality assumed for the Antidegradation Evaluation was estimated to have the following effects on water quality at evaluation points on Trimble Creek (TC–1a),Unnamed Creek (PM–11), and the Embarrass River (PM–13):

• Concentrations of the parameters of concern are expected to be at or below applicable water quality standards.

• Concentrations of sulfate are expected to decrease by an order of magnitude in Trimble and Unnamed Creeks to levels below 10 mg/L, and to measurably decrease in the Embarrass River at PM–13.

• Values of specific conductance are expected to measurably decrease, in large part due to the substantial decrease in sulfate concentrations.

• Concentrations of several parameters are expected to show no measurable change or to decrease (e.g., silver, boron, and hardness).

• Concentrations of most metals (antimony, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, selenium, and zinc) could measurably increase. However, as noted above, concentrations will be at or below applicable water quality standards at the evaluation points.

• No existing uses of these downstream waters will be affected by any of the changes in concentrations referenced above.

• The alternative statistical approach (Attachment B) supports these conclusions. It resulted in minor variations in which parameters are estimated to exhibit measurable change from existing conditions, but in all cases both statistical approaches resulted in concentrations at or below applicable numeric water quality standards.

Additional discussion of specific parameters is presented in Section 6.3.4.
6.3.3 Effect of Discharge upon Downstream Waters: Partridge River Watershed

Large Table 4 compares existing water quality with estimated water quality associated with WWTS discharge and related activities at downstream evaluation points in the Partridge River watershed. Overall, the discharge quality assumed for the Antidegradation Evaluation was estimated to have the following effects on water quality at evaluation points on Second Creek (MNSW8) and the Partridge River (MNSW12):

- Water quality in Second Creek at MNSW8 will continue to be affected by the Mesabi Nugget Project, which operates under a NPDES permit (MN0067687) that includes variances for hardness, specific conductance, and TDS. Estimated cumulative effects at MNSW8 vary by parameter:
  - No measurable change from existing conditions is expected for most parameters (aluminum, antimony, arsenic, boron, cadmium, chromium, lead, silver, sulfate, thallium, and hardness).
  - Concentrations of several metals (cobalt, copper, nickel, selenium, and zinc) will measurably increase; however, as noted above, concentrations will be below applicable water quality standards.

- In the Partridge River at MNSW12, concentrations of parameters of concern are expected to be at or below applicable water quality standards, and no measurable change from existing conditions is expected.

- No existing uses of these downstream waters will be affected by any of the changes in concentrations referenced above.

- The alternative statistical approach (Attachment B) supports these conclusions. It results in minor variations in which parameters are estimated to exhibit measurable change from existing conditions, but in all cases both statistical approaches resulted in concentrations at or below applicable numeric water quality standards.

Additional discussion of specific parameters is presented in Section 6.3.4.

6.3.4 Discussion of Estimated Water Quality for Specific Parameters

This section provides additional information on the estimated effect of the WWTS discharge and related activities with respect to sulfate loading, the aluminum concentration in the Embarrass River at PM–13, the pH in the headwater wetlands of Trimble and Unnamed creeks, and parameters with hardness based standards.

6.3.4.1 Sulfate

For sulfate, the WWTS discharge and related activities are expected to provide a significant environmental benefit. The Project will significantly reduce sulfate loading to the Embarrass River watershed. The sulfate load due to seepage from the LTVSMC tailings basin, which has a sulfate concentration of approximately 300 mg/L, will be cut off by the FTB seepage capture systems. After treatment at the WWTS using
advanced treatment technology, the sulfate load in the WWTS discharge will drop by an order of magnitude to a concentration of less than 10 mg/L. Water modeling conducted for the FEIS indicated that in Mine Year 10, the average sulfate loading rate to the Embarrass River watershed will be reduced by approximately 1,600 tons per year from existing loading. Sulfate interactions in the environment are complex, and this report does not attempt to directly translate the decreased sulfate loading to an estimated change in sulfate concentration in the water column; however, the significant decrease in sulfate loading is expected to provide an environmental benefit.

6.3.4.2 Aluminum at PM–13

Background total aluminum concentrations are relatively high in surface waters in the Project vicinity. Total aluminum concentrations in the Embarrass River both upstream and downstream of the Project approach or exceed the total aluminum standard, as shown in Table 6-1. However, dissolved aluminum concentrations are significantly less than total concentrations in the Embarrass River, as discussed in Section 6.2.2, and dissolved aluminum concentrations are less than the dissolved aluminum standard.\(^{52}\)

Given the complex relationship between total and dissolved aluminum in the Embarrass River, the comparison between existing (pre-Project) and estimated (Project) aluminum concentrations at PM–13 requires additional analysis. The GoldSim model, as approved for the FEIS, under predicts the total aluminum concentration at PM–13, likely due to the influence of adsorbed aluminum at that location, as described in Section 6.2.2.1. At PM-13, the GoldSim model estimated existing conditions total aluminum concentration at approximately 74 µg/L, a concentration midway between the average monitoring results for dissolved (49 µg/L) and total (187 µg/L) aluminum. Therefore, for aluminum at this evaluation point, the potential effect of the WWTS discharge and related activities should not be evaluated by comparing average monitoring results to the estimated aluminum concentration derived from GoldSim modeling results.

Instead, the change in aluminum concentrations due to the Project can be estimated by comparing the GoldSim model results for continuation of existing conditions with the GoldSim model result for Project conditions. Figure 6-1 shows the annual average P50 aluminum concentrations at PM–13, from the FEIS continuation of existing conditions model and the FEIS Project model, through Mine Year 20. In Mine Year 10, the timeframe for this Antidegradation Evaluation, no change is expected from existing conditions. Before and after Mine Year 10, the Project is estimated to increase aluminum concentrations by up to approximately 5 µg/L from existing conditions (from approximately 75 µg/L to 80 µg/L). This change would not likely represent a measurable change from existing conditions, using the criteria described in Section 5.6 with respect to calculation of a measurable change.

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\(^{52}\) The water quality standard is 125 µg/L for both dissolved and total aluminum because the conversion factor for aluminum is 1 (Minnesota Rules, part 7050.0222, subpart 1(B)).
Figure 6-1  Annual Average Aluminum Concentration in the Embarrass River at PM–13

Qualitative assessment of the Project’s effect on aluminum concentrations at PM–13 supports the conclusion that no measurable change in aluminum concentration is expected. The Project’s effect on aluminum concentrations is best understood in terms of the combined effect of the FTB Seepage Containment System and the WWTS discharge. The FTB Seepage Containment System will collect tailings basin seepage that currently flows indirectly to Embarrass River tributaries, and the WWTS discharge will be distributed to the headwaters of the tributaries to replace the captured seepage, thereby avoiding hydrologic or ecologic impacts in the creeks. The concentration of aluminum in the WWTS discharge (~6 µg/L, as shown in Table 3-2) is expected to be similar to, but less than current tailings basin seepage (P50 concentration of approximately 12 to 20 µg/L, as shown in Figure 6-37 and Figure 6-43 of Reference (3)). Both the WWTS discharge and the existing seepage have lower aluminum concentrations than background groundwater (concentrations of 50 µg/L to 90 µg/L) and natural surface water runoff (concentrations have a greater than 30% probability of exceeding 125 µg/L (Section 6.7.5.1 of Reference (3)).

The low-aluminum seepage (existing conditions) and WWTS discharge (estimated Mine Year 10 conditions) have a diluting effect on higher-aluminum natural background conditions. Conceptually, if the seepage capture rate and the WWTS discharge rate are roughly equal, the Project will not be expected to change the aluminum concentration at PM–13. If the WWTS discharge rate is less than the seepage capture rate, the net effect will be for aluminum concentrations at PM–13 to move toward higher natural background conditions. This effect is apparent on Figure 6-1, which shows that for most years, when the planned WWTS discharge rate is slightly less than the existing seepage rate, Mine Year 10 aluminum concentrations are estimated to be slightly higher than existing conditions, trending toward higher background levels because there is less dilution with low aluminum water. During the period around Mine
Year 10, when the planned WWTS discharge rate is highest, the estimated aluminum concentration dips, showing the effect of dilution with low aluminum WWTS discharge.

This qualitative assessment indicated that – based on the expectation that the aluminum concentration in the WWTS discharge will not be higher than in the current tailings basin seepage, and that the WWTS discharge rate will be approximately the same as the current seepage flow rate – the Project is not expected to have a measurable effect on the concentration of aluminum at PM–13.

### 6.3.4.3 Total Dissolved Solids and Specific Conductance at MNSW8

Estimated values of TDS and specific conductance were not quantitatively assessed at MNSW8, because the mass balance method used to estimate Mine Year 10 water quality at MNSW8 includes only a limited list of constituents, not the comprehensive suite necessary to calculate those parameters. Instead, TDS and specific conductance were evaluated qualitatively.

The WWTS discharge will replace the legacy ferrous seepage flow from the existing Tailings Basin to the Second Creek headwater segment. The values of TDS and specific conductance will be lower in the WWTS discharge than they are in the legacy ferrous tailings basin seepage (Table 6-3). Assuming that the discharge rate will be approximately equal to the seepage flow rate (as is planned for stream augmentation, see Section 7.4.4.1), the effect of the discharge will be to decrease the values of these parameters in the Plant Site flow to Second Creek. However, at MNSW8, the effect on the values of TDS and specific conductance will be minimal because the WWTS discharge (0.5 cfs, see Section 5.2.2.9.1 of Reference (3)) will be a relatively minor contributor to the flow of Second Creek at MNSW8 (21.5 cfs, see Section 4 of Attachment E). This qualitative evaluation indicated the discharge will cause values of TDS and specific conductance at MNSW8 to trend lower, but that the effect will be minimal (likely not measurable).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WWTS discharge (1)</th>
<th>Existing Water Quality (PM–7/SD026) (2)</th>
<th>MNSW8 (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids (TDS) (mg/L)</td>
<td>356-464</td>
<td>650</td>
<td>967</td>
</tr>
<tr>
<td>Specific conductance (µmhos/cm at 25°C)</td>
<td>753-960</td>
<td>997</td>
<td>1336</td>
</tr>
</tbody>
</table>

(1) Table 3-2
(2) Large Table 2
(3) Large Table 4

### 6.3.4.4 pH in the Receiving Wetlands

The pH standard for Class 2D wetlands is to maintain background; where “maintain background” means the pH shall not deviate from the range of natural background pH values such that there is a potential significant adverse impact to the designated uses (Minnesota Rules, part 7050.0222 subpart 6(B)). Wetland surveys have determined that the wetland community types adjacent to the WWTS surface water discharge outfalls are primarily shallow/deep marshes, with smaller areas of coniferous swamp, alder
thicket/shrub-carr, and hardwood swamp. Based on typical pH ranges for these wetland community types, the background pH is estimated to range from less than 5.5 to 8.5 (Table 6-4). The pH of the WWTS discharge will be approximately 8.4 (Table 3-2), which is within the background pH range, indicating that aquatic and terrestrial biologic communities of the wetlands will not be adversely impacted by the pH of the WWTS discharge. Accordingly, the discharge is expected to comply with the Class 2D pH standard.

Table 6-4  Expected pH of wetlands near the NorthMet Project

<table>
<thead>
<tr>
<th>Eggers and Reed Wetland Community Types(1)</th>
<th>pH range(2)</th>
<th>Typical Soil Series may include(3)</th>
<th>pH range of surface soil(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coniferous bog</td>
<td>&lt;5.5</td>
<td>Greenwood</td>
<td>3.5 to 4.4</td>
</tr>
<tr>
<td>Open bog</td>
<td>&lt;5.5</td>
<td>Greenwood</td>
<td>3.5 to 4.4</td>
</tr>
<tr>
<td>Coniferous swamp</td>
<td>&gt;5.5 (&gt;6.0 for cedar)</td>
<td>Rifle/Tacoosh</td>
<td>6.6 to 7.3 / 5.6 to 6.0</td>
</tr>
<tr>
<td>Hardwood swamp</td>
<td>6.0 to 8.0</td>
<td>Cathro/Rifle/Tacoosh</td>
<td>6.8 / 6.6 to 7.3 / 5.6 to 6.0</td>
</tr>
<tr>
<td>Alder thicket/Shrub-carr</td>
<td>5.5 to 7.5</td>
<td>Rifle/Tacoosh</td>
<td>6.6 to 7.3 / 5.6 to 6.0</td>
</tr>
<tr>
<td>Shallow/Deep marsh</td>
<td>6.5 to 8.5</td>
<td>Rifle/Cathro</td>
<td>6.6 to 7.3 / 6.8</td>
</tr>
<tr>
<td>Wet meadow</td>
<td>5.5 to 7.5</td>
<td>Rifle</td>
<td>6.6 to 7.3</td>
</tr>
</tbody>
</table>

(1) Reference (25)  
(2) Reference (27)  
(3) Large Figure 12 of Reference (28)  
(4) Reference (29)

6.3.4.5 Parameters with Hardness-Based Standards

PolyMet conducted further analysis on parameters with hardness-based standards (cadmium, copper, lead, nickel, and zinc) to take into account potential effects of the WWTS discharge and related activities on hardness in the receiving and downstream waters. Probabilistic modeling conducted for the FEIS, which calculated the applicable water quality standards based on the modeled hardness of the receiving and downstream waters, confirms that at TC-1/TC-1a, PM–11, and PM–13, average concentrations of these parameters are expected to be less than applicable water quality standards (Attachment D of this document). For Second Creek at PM–7/SD026, applicable water quality standards do not require adjustment because the flow at this evaluation point will consist almost entirely of WWTS discharge, with hardness of 100 mg/L. Attachment D shows that at PM–7/SD026 the concentrations of parameters with hardness-dependent standards are expected to be at or below applicable water quality standards.

6.3.5 Effect of Discharge Upon High Quality Waters

The Project’s estimated effect on high quality waters is illustrated in Figure 6-2 (Trimble Creek), Figure 6-3 (Unnamed Creek), and Figure 6-4 (Second Creek). For each creek, the figure shows the estimated effects of the WWTS discharge and related activities on concentrations of Class 2 parameters of concern at the surface water discharge outfall and at the first downstream evaluation point. In these figures, parameter concentrations are normalized as a percentage of the applicable standard. The characteristics of the WWTS design discharge, which represents the expected quality of the discharge during operations, is shown for comparison with the discharge quality assumed for the Antidegradation Evaluation. The figures
illustrate how protective the antidegradation assumptions are, and how the effect of the Project diminishes with distance from the surface water discharge outfalls.

As Figure 6-2, Figure 6-3, and Figure 6-4 make clear, in all three receiving waters, at the surface water discharge outfalls, water quality will continue to meet applicable numeric standards. Nonetheless, because the Project could result in degradation of high quality waters for some Class 2 parameters of concern, PolyMet has conducted a “Tier 2” antidegradation assessment, providing information on the social and economic benefits of the Project (Section 7.5).
Notes:

- "nd" ("non detect") means monitoring results have been below detection limits, the average is below the typical detection limit, or the estimated value is below the typical detection limit.
- Dissolved concentration for aluminum, total concentration for other parameters. See Section 6.2.2.1.
- Surface water standards for cadmium (Cd), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) are hardness dependent. Values shown on this figure are based on hardness of 100 mg/L.
- Estimated concentrations at the outfall are based on the antidegradation assumed discharge quality (no mixing), and estimated concentrations at TC–1a are based on the GoldSim Mine Year 10 Project model (Section 5.8.2)
- TC–1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC–1a, which is located less than one mile downstream of TC–1.

Figure 6-2  Estimated Effects on High Water Quality: Trimble Creek
Notes:

- “nd” ("non detect") means monitoring results have been below detection limits, the average is below the typical detection limit, or the estimated value is below the typical detection limit.
- Dissolved concentration for aluminum, total concentration for other parameters (Section 6.2.2.1).
- Surface water standards for cadmium (Cd), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) are hardness dependent. Values shown on this figure are based on hardness of 100 mg/L.
- Estimated concentrations at the outfall are based on the antidegradation assumed discharge quality (no mixing), and estimated concentrations at PM-11 are based on the GoldSim Mine Year 10 Project model (Section 5.8.2)

Figure 6-3 Estimated Effects on High Water Quality: Unnamed Creek
Notes:

- “nd” (“non detect”) means monitoring results have been below detection limits, the average is below the typical detection limit, or the estimated value is below the typical detection limit.
- Dissolved concentration for aluminum, total concentration for other parameters Section 6.2.2.1.
- Surface water standards for cadmium (Cd), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) are hardness dependent. Values shown on this figure are based on hardness of 100 mg/L.
- Estimated concentrations at the outfall are based on the antidegradation assumed discharge quality (no mixing) because GoldSim modeling did not include Second Creek.

Figure 6-4  Effects on High Water Quality: Second Creek
6.3.6 Outstanding Resource Value Waters

The Project will not discharge to an ORVW; however, Lake Superior, to which the St. Louis River drains approximately 175 river miles downstream of the Project, is classified as a restricted ORVW, and limited segments of the lake are classified as prohibited ORVWs. The WWTS discharge and related activities are expected to have no measurable effect for any parameter of concern in the St. Louis River at USGS 04024000 at Scanlon (Large Table 4). As a result, it is reasonable to conclude that there will likewise be no measurable effect for any parameter of concern at the confluence of the St. Louis River and Lake Superior, approximately 30 river miles downstream of Scanlon. Details of the mass balance calculations used to estimate the Project’s effect on water quality at USGS 04024000 at Scanlon are provided in Attachment E.
7.0 Antidegradation Assessment: Parameters of Concern Other Than Mercury

PolyMet’s Antidegradation Assessment for parameters other than mercury under Chapter 7050 (Former Rule and Revised Rule) demonstrates the following:

- existing uses will be maintained and protected (Tier 1; Section 7.1)
- PolyMet will comply with applicable water quality standards at the WWTS surface water discharge outfalls (Section 7.2)
- the WWTS discharge and related activities will not “permanently preclude” attainment of water quality standards (Section 7.3)
- degradation of high quality waters will be avoided where practical, and minimized where avoidance is not achievable; and the Project will result in important economic or social development (Tier 2; Sections 7.4 and 7.5)
- ORVWs will not be degraded (Tier 3; Section 7.6)
- the WWTS discharge will comply with Section 316 of the CWA, United States Code, title 33, section 1326 regarding thermal discharges (Section 7.7)

7.1 Existing Uses Will Be Maintained and Protected

The Revised Rule, in Minnesota Rules, part 7050.0255, subpart 15, defines “existing uses” as “those uses actually attained in the surface water on or after November 28, 1975.” USEPA guidance clarifies that a use is “actually attained” when (a) the water quality necessary to support a particular use has been attained, and (b) the use has actually occurred in the water body. Existing uses differ from designated uses: whereas designated uses “focus on the attainable conditions,” existing uses “focus on the past or present condition.” Designated uses identify the highest attainable uses of the water body, even if the uses and the water quality necessary to support the uses, are not currently attained. Existing uses identify uses that have actually occurred in or on the water body, regardless of whether they are designated, as well as the corresponding water quality that has allowed the uses to occur.

PolyMet assessed existing uses along specific sections of each receiving and downstream water, defining the sections based upon the evaluation points and the confluences of the streams. Existing uses in each section of the receiving and downstream waters were determined based observations of actual past or present usage (Section 4.2), and on existing water quality (Large Table 2, Large Table 3, and Large Table 4). Existing water quality was assumed to be the minimum quality necessary to allow the existing uses to occur. PolyMet also compared existing water quality to water quality standards associated with the designated uses of the waters, to identify, on a parameter by parameter basis, waters that attain

55 USEPA letter to Mr. Derek Smithee, September 5, 2008.
the quality necessary to support their designated uses. The determination of existing uses is presented in Large Table 5 and Large Table 6 and summarized in Table 7-1.

Existing uses in most sections of receiving and downstream waters are coextensive with the waters’ designated uses; that is, the designated uses of the waters were found to have actually occurred on or after November 28, 1975, and the waters’ existing quality meets water quality standards associated with the designated uses. Exceptions are as follows:

- First, for certain waters, the designated uses were not found to have actually occurred on or after November 28, 1975. Specifically, while industrial cooling, materials transport (Class 3C uses) and irrigation (Class 4A use) are designated uses for Trimble Creek, Unnamed Creek, Second Creek, and the reach of the Embarrass River upstream of PM–13, these uses do not actually occur in these waters (and are not known to have occurred on or after November 28, 1975). The closest known industrial water intake downstream of the Project is located greater than 30 river miles downstream, and there are no known agricultural operations in the area that will use the water for irrigation.

- Second, an undesignated existing use, referred to for this Antidegradation Evaluation as “natural wild rice stands”, occurs in some downstream waters: portions of Second Creek downstream of MNSW8, portions of the Embarrass River downstream of PM–13, and portions of the Partridge River downstream of the confluence with Second Creek. Sulfate is the parameter of concern associated with wild rice. Existing sulfate concentrations range from 18 to 375 mg/L at evaluation points on these waters.

To demonstrate that the Project will maintain and protect existing uses, PolyMet compared the estimated water quality at evaluation points with the existing uses for those sections of the streams. Existing uses are considered to be maintained and protected if the WWTS discharge and related activities will not cause a measurable increase in concentration for the parameters of concern associated with the existing use and will not otherwise affect the use of the receiving and downstream waters. Table 7-1 demonstrates that the Project will maintain and protect the existing uses in receiving and downstream waters in terms of the numeric standards. Additional discussion of designated uses follows Table 7-1.
<table>
<thead>
<tr>
<th>Water body and reach</th>
<th>Existing uses that are also designated uses</th>
<th>Existing uses that are not designated uses</th>
<th>Designated uses that are not existing uses</th>
<th>Maintenance and protection of existing uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands at headwater area of Trimble Creek</td>
<td>2D, 4C, 5</td>
<td>none</td>
<td>3D</td>
<td>Water quality for parameters of concern (POCs) other than Hg will meet Class 2D, Class 4C, and Class 5 standards at outfalls to wetlands.</td>
</tr>
<tr>
<td>Wetlands at headwater area of Unnamed Creek</td>
<td>2B, 4B, 5</td>
<td>none</td>
<td>3C, 4A</td>
<td>Water quality for POCs other than Hg will meet Class 2B, Class 4B, and Class 5 standards at TC-1a, PM-11, and PM-7/SD026.</td>
</tr>
<tr>
<td>Trimble Creek Unnamed Creek Embarrass River from confluence of Trimble Creek to PM–13 Second Creek upstream of MNSW8</td>
<td>2B, 4B, 5</td>
<td>natural wild rice stands</td>
<td>3C, 4A</td>
<td>Water quality for POCs other than Hg will meet Class 2B, Class 4B, and Class 5 standards at MNSW8. Discharge will decrease SO₄ loading, thus protecting existing water quality with regard to SO₄.</td>
</tr>
<tr>
<td>Second Creek downstream of MNSW8 to confluence with Partridge River.</td>
<td>2B, 4B, 5</td>
<td>natural wild rice stands</td>
<td>3C, 4A</td>
<td>Water quality for POCs other than Hg will meet Class 2B, Class 4B, and Class 5 standards at PM–13, MNSW12, and USGS 04024000, and also Class 3B standards at USGS 04024000. Discharge will decrease SO₄ loading, thus protecting existing water quality with regard to SO₄.</td>
</tr>
<tr>
<td>Embarrass River downstream of PM–13 Partridge River downstream of confluence with Second Creek</td>
<td>2B, 3C, 4A, 4B, 5</td>
<td>natural wild rice stands</td>
<td>none</td>
<td>Water quality for POCs other than Hg will meet Class 2B, Class 3C, Class 4A, Class 4B, and Class 5 standards at PM–13, MNSW12, and USGS 04024000, and also Class 3B standards at USGS 04024000. Discharge will decrease SO₄ loading, thus protecting existing water quality with regard to SO₄.</td>
</tr>
<tr>
<td>St. Louis River downstream of confluences with Embarrass and Partridge Rivers</td>
<td>2B, 3C, 4A, 4B, 5</td>
<td>natural wild rice stands</td>
<td>none</td>
<td>Water quality for POCs other than Hg will meet Class 2B, Class 3C, Class 4A, Class 4B, and Class 5 standards at PM–13, MNSW12, and USGS 04024000, and also Class 3B standards at USGS 04024000. Discharge will decrease SO₄ loading, thus protecting existing water quality with regard to SO₄.</td>
</tr>
</tbody>
</table>
Minnesota Rules, part 7050.0265, subpart 2 specifically requires that evaluation of the maintenance and protection of existing uses shall include consideration of aquatic life, recreational opportunities, hydrologic conditions, and commercial activity. This Antidegradation Assessment has demonstrated the following:

- Aquatic life related existing uses will be maintained and protected in the receiving and downstream waters because the applicable Class 2 surface water quality standards protective of aquatic life will be met (Large Table 2, Large Table 3, and Large Table 4) and the WWTS discharge will have characteristics of stability and essentiality necessary to maintain aquatic life (Section 3.1.2).

- Recreational opportunity related existing uses will be maintained and protected in the receiving and downstream waters because the applicable Class 2 surface water quality standards protective of this use will be met (Large Table 2, Large Table 3, and Large Table 4).

- Hydrologic conditions will be maintained and protected in the receiving and downstream waters by maintaining annual average stream flow within 20% of existing conditions (Section 7.4.4.1).

- Where commercial activity-related existing uses are present in downstream waters, they will be maintained and protected because the applicable Class 3, 4, and 5 surface water quality standards protective of commercial activity will be maintained (Large Table 3, and Large Table 4). Trimble, Unnamed, and Second Creeks are not actually used for commercial purposes (Section 4.2), so there is no existing commercial use to maintain.

### 7.2 PolyMet Will Comply with Applicable Water Quality Standards

The Former Rule, in Minnesota Rules, part 7050.0185, subpart 3 required that “Any person authorized to maintain a new or expanded discharge....shall comply with applicable water quality standards of this chapter and effluent limits in chapter 7053 and other applicable federal and state point source treatment requirements.”

PolyMet will comply with water quality standards of Minnesota Rules, chapter 7050, because the WWTS discharge will meet the applicable numeric standards at the surface water discharge outfalls (Section 3.1.1), and all existing and designated uses will be maintained and protected after the WWTS discharges and related activities commence. PolyMet will also comply with effluent limits in Minnesota Rules, chapter 7053, including general prohibitions for discharges (7053.0205)—e.g., no nuisance conditions) and specific restrictions for industrial discharges (7053.0225—nutrient control, toxicity). In particular, these Chapter 7053 requirements will be met because parameters of concern are not associated with nuisance conditions or excess nutrients, and the effluent will meet acute and chronic WET standards (Table 3-2). Finally, PolyMet will comply with federal point source effluent limits in the applicable sections of 40 C.F.R. 440 at the surface water discharge outfalls (Section 3.1.4).

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56 No comparable requirement exists in the Revised Rule
7.3 The WWTS Discharge and Related Activities Will Not Permanently Preclude Attainment of Water Quality Standards

The Revised Rules, in Minnesota Rules, part 7050.0265, subpart 4, prohibits the MPCA commissioner from approving activities that would “permanently preclude attainment of water quality standards.” PolyMet’s proposed WWTS discharge and related activities will not permanently preclude attainment of water quality standards in the receiving and downstream waters.

With one potential exception, the receiving and downstream waters currently attain the water quality associated with their respective designated beneficial uses, as such uses are established in Minnesota Rules, chapter 7050, and will continue to meet the standards with the addition of the WWTS discharge and related activities (Large Table 2). The exception occurs at MNSW8 on Second Creek, downstream of the Mesabi Nugget facilities, where existing values of hardness, TDS, and specific conductance are higher than current numeric water quality standards for Class 3C and 4A waters, which apply to Second Creek. The WWTS discharge and related activities will not permanently preclude attainment of the standards for these parameters in Second Creek because values of hardness, TDS, and specific conductance in the WWTS discharge will be lower than in the existing conditions seepage flow to Second Creek (Section 6.3.4.3), and lower than the existing values at MNSW8. The effect of the WWTS discharge and related activities is estimated to decrease the hardness at MNSW8 (Large Table 4), and to decrease the concentrations of constituents that contribute to values of TDS and specific conductance (Section 6.3.4.3), although no measurable decrease in TDS or specific conductance is expected (Large Table 4). These estimated improvements in water quality at MNSW8 further the protection of beneficial uses.

7.4 The Project will Minimize Degradation of High Quality Waters

Antidegradation procedures in the Revised Rule require “an analysis of alternatives that avoid net increases in loading or other causes of degradation through prudent and feasible prevention, treatment, or loading offsets” (emphasis added). Minnesota Rules, part 7050.0280, subpart 2(A). When there are no prudent and feasible alternatives to avoid net increases in loading, an analysis of prudent and feasible alternatives to minimize degradation is required (Minnesota Rules, part 7050.0280 subpart (C)(1)), as well as identification of the least degrading prudent and feasible alternatives. As explained in more detail below, PolyMet and the Co-Lead Agencies, and the Cooperating Agencies for the EIS process have, through the decade-long environmental review process for the Project, thoroughly analyzed alternatives to avoid or minimize degradation of high quality waters. As a result of this process, PolyMet determined that although there are no prudent and feasible alternatives to completely avoid degradation of all high quality waters, there are prudent and feasible measures available to minimize degradation. The majority of these measures have been incorporated into the Project design, and PolyMet has concluded that the Project, as finally proposed in the FEIS, constitutes the least degrading prudent and feasible alternative because it avoids degradation where prudent and feasible, and minimizes such degradation when avoidance is not practical.
7.4.1 Overview of Alternatives Analysis Process

The analysis of alternatives to a proposed action is “the heart of the environmental impact statement” (40 C.F.R. § 1502.14). From 2006 through 2015, PolyMet, the Co-Lead Agencies, and the Cooperating Agencies conducted detailed and extensive analyses of alternatives to avoid and minimize environmental impacts from the Project as part of the environmental review process under National Environmental Policy Act (NEPA) and Minnesota Environmental Policy Act (MEPA) and associated regulations. This process included preparation of the 2009 draft Environmental Impact Statement (DEIS), the 2013 supplemental draft EIS (SDEIS), and the 2015 FEIS; each of which addressed Project alternatives. A fundamental component of the NEPA/MEPA alternatives analysis for the Project was the analysis of alternatives and measures that could avoid or minimize degradation of high quality waters. As explained below, this process fulfills the requirements of the alternatives analyses under the Revised Rules, part 7050.0280.57

The environmental review process identified a broad range of alternatives in addition to the proposed action and screened the alternatives against the following factors:

- purpose and need
- technical feasibility
- economic feasibility
- availability
- environmental and socioeconomic benefits58

Each Project alternative represented an assemblage of various operating techniques and technologies that when combined into a single alternative represented a consistent and unified approach for completing the proposed activity while, to the extent practicable, cumulatively minimizing impacts to various environmental medias – air, soil, water, wetlands, etc. The components or technologies of a Project alternative used for protection of a specific media (e.g., water) were selected based on their overall compatibility with the other components of the Project. For example, water treatment technologies that had a negative impact on air quality were avoided. Alternatives that did not meet the screening criteria were not considered reasonable and were eliminated from detailed NEPA/MEPA analysis.

57 For this reason, PolyMet concluded that preparation of a stand-alone antidegradation alternatives analysis would be duplicative and that a more efficient approach—one equally justifiable under the Revised Rule—is to highlight how the NEPA/MEPA alternatives analysis meets the requirements of the Revised Rule. See MPCA, SONAR, Attachment 4, Conducting antidegradation alternatives analyses for individual NPDES wastewater permits—a suggested approach (explaining that although MPCA has outlined a suggested approach for conducting alternatives analyses under the Revised Rule, the approach is “in no way binding and may be replaced or supplemented with other sufficiently justified methods of analysis” (emphasis added)).

58 These factors are consistent with the relevant considerations for alternatives analyses under the Revised Rule, which limits the alternatives that must be considered to those that are “prudent and feasible.” The Revised Rule’s definitions of these terms includes similar concepts of technical and economic feasibility (e.g., “consistent with sound engineering practices and affordable” (definition of “feasible,” Minnesota Rules 7050.0255, subpart 17)) and the necessity of meeting the Project’s purpose and need (“can be successfully put into practice to accomplish the task” (Minnesota Rules 7050.0255, subpart 17)).
The following sections briefly summarize aspects of the NEPA/MEPA alternatives analysis that specifically addressed the avoidance/minimization of degradation of high quality water by Project parameters of concern (Sections 7.4.2 and 7.4.3), and describe the least degrading prudent and feasible alternative (Section 7.4.4). Full details on the process of developing and evaluating Project alternatives is documented in Section 2 of the FEIS (Reference (1)). Section 3.2.3 of the FEIS (Reference (1)) details the many alternatives to avoid or minimize water quality impacts that were identified and evaluated, and documents the results of the evaluation.

### 7.4.2 Alternatives to Avoid Degradation

Because the discharge of treated waste water is a fundamental, inherent aspect of the Project, the only alternative identified as part of the alternatives analysis process for the Project that would completely avoid further degradation of high water quality is the No Action Alternative. Other alternatives evaluated in the NEPA/MEPA process would have the effect of minimizing rather than avoiding degradation of high quality water, when taking into account effects to various environmental media. If the No Action Alternative were required to be considered for antidegradation purposes, which is not clear under the applicable laws and regulations, that alternative was thoroughly screened during the NEPA/MEPA process. The environmental review process rejected the No Action Alternative as neither feasible nor prudent because it would not meet the purpose and need for the Project, (Section 1.3 of Reference (1)), which is for PolyMet to exercise its mineral leases to mine the NorthMet Deposit, thereby producing copper, nickel, cobalt, and PGEs to help meet domestic and global demand and to contribute to economic development in northeastern Minnesota (refer to Section 7.5.1 of this document for description of Project economics). Although the alternatives analysis process identified no prudent and feasible alternatives to avoid all degradation of high quality waters, the analysis did identify prudent and feasible alternatives or measures to minimize degradation. As discussed below, PolyMet has incorporated many of these alternatives into the final design of the Project (Section 7.4.3).

### 7.4.3 Alternatives to Minimize Degradation

The detailed NEPA/MEPA process, discussed above, analyzed alternatives that minimize degradation of high quality waters through prudent and feasible prevention, treatment, or loading offsets. Further, alternatives were evaluated in a manner that considered various aspects of the environment concurrently. With specific regard to water treatment to minimize loading of parameters of concern, the NEPA/MEPA review process included a technology screening process as well as bench testing and pilot-testing of proposed treatment technologies to demonstrate the treatment performance for the parameters of concern. Testing results were subsequently used in environmental modeling completed during the environmental review process to provide feedback on the adequacy of treatment targets for minimizing degradation.

In response to public comments on the DEIS, PolyMet and the agencies identified and assessed additional alternatives and mitigation measures. Many modifications were incorporated into the Project that resulted in further minimization of loading of parameters of concern. Compared to the Project as originally proposed for the 2009 DEIS, the Project proposed in the FEIS incorporates numerous additional prevention and treatment measures (alternatives) to minimize degradation of high quality waters.
7.4.3.1 Prevention

The Project design incorporates a number of features which are designed to avoid and then minimize degradation by preventing the release of pollutants to the environment.

- The number of autoclaves to be operated at the Plant Site was reduced. This measure reduces loading by reducing the amount of water used for mineral processing.

- A low-hydraulic-conductivity bentonite layer was added to the design for the exterior FTB dams as they are constructed, and for the FTB beaches and the FTB Pond bottom during reclamation. This minimizes loading by minimizing oxidation of the tailings, thereby reducing the pollutant load that reports to the FTB seepage capture systems and must subsequently be removed at the WWTS.

- The FTB Seepage Containment System was added to the Project to surround the western, northern, and a portion of the eastern sides of the Tailings Basin to capture approximately 99% of tailings basin seepage. The FTB Seepage Containment System consists of over four miles of cutoff wall and seepage collection trench. This feature reduces impacts to surface water and groundwater downgradient of the Tailings Basin by blocking the migration of seepage and removing it from the environment.

- Three permanent waste rock stockpiles, containing the more reactive types of waste rock, were eliminated from the Project design. Instead of being permanently stockpiled, the more potentially reactive waste rock will be relocated to the mine pits when mining is completed, and the reclaimed pits will be flooded. This reduces potential pollutant load to surface water because oxidation is prevented when waste rock is stored under water, and drainage from stockpile liners is eliminated as a long-term influent source to the WWTS or the flooded West Pit.

- A groundwater containment system was added surrounding the one permanent (least potentially reactive) waste rock stockpile, which will collect runoff from the stockpile slopes and precipitation that infiltrates through the stockpile and send it to the WWTS for treatment. This reduces potential groundwater impacts and potential loading to surface water because drainage and runoff will be collected and sent for treatment.

- A geomembrane cover system, which will be applied incrementally during Project operations, was added to the one permanent (least potentially reactive) waste rock stockpile. This reduces pollutant load by reducing infiltration of precipitation through the reclaimed stockpile, reducing the load that reports to the WWTS.

7.4.3.2 Treatment

Water treatment is a key component of the approach for minimizing degradation of high quality waters.

- The Project will employ a state-of-the-art treatment system. The WWTS will be designed to remove mass (sulfate and metals) from mine water through chemical precipitation. It will reduce loading of parameters of concern to high quality waters by treating tailings basin seepage using
filtration and advanced water treatment membrane separation technology to remove sulfate, metals, and other constituents prior to discharge. The WWTS will provide an advanced level of treatment for the Project, as described in Section 9.3.4.

- Adaptive management strategies have been incorporated that anticipate uncertainty and natural variability by using flexible engineering controls that can be adjusted to continue achieving compliance with applicable water quality standards and permit conditions when site-specific conditions vary (Section 2.3.3 of Volume III).

### 7.4.3.3 Loading Offsets

Loading offsets were not among the categories of alternatives considered during the NEPA/MEPA alternatives analysis (Section 3.2.3.1 of Reference (1)), so for this Antidegradation Assessment, PolyMet evaluated opportunities to offset loading of parameters of concern to high quality waters, as described here.

The Revised Rule states that "loading offset means reductions in loading from regulated or unregulated activities, which reductions create additional capacity for proposed net increases in loading." It is preferred that offsets occur upstream of the proposed net increase in loading (Section 5B of Reference (21)). The Project will discharge to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek; as a result, it is not possible for PolyMet to offset net loading of parameters of concern from regulated or unregulated sources upstream of these high quality waters.

In addition to loading to the receiving waters, the Antidegradation Assessment indicated that the WWTS discharge and related activities are estimated to result in measurable increases in concentration of Class 2 parameters of concern (antimony, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc) in the Embarrass River at PM–13. No opportunities to offset the net increase in loading of these parameters are available, because there are no known regulated or unregulated dischargers of these parameters to the Embarrass River upstream of PM–13.

### 7.4.4 The Project Constitutes the Least Degrading Prudent and Feasible Alternative

The Revised Rule requires that the Antidegradation Assessment identify the least degrading prudent and feasible alternative, and describe its design, expected performance, design considerations, costs, and reliability (Minnesota Rules, part 7050.0280, subpart 2(C)). PolyMet has concluded that the Project as proposed for the FEIS and permitting, which avoids and/or minimizes degradation through a combination of management measures, environmental controls, and treatment measures, constitutes the least degrading prudent and feasible alternative. The following subsections contain the required descriptions of the Project.

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59 Minnesota Rules part 7050.0255, subpart 23.
7.4.4.1 Design

The net effect of the Project on receiving and downstream waters depends not only on the WWTS discharge quality and quantity, but also on other engineering controls that will avoid and minimize impacts to the receiving and downstream waters. The least degrading prudent and feasible alternative, which is the Project as proposed for the FEIS and permitting, includes the following pollution prevention, minimization, and toxics reduction technologies and water management strategies, each of which is discussed in more detail below:

- collection and beneficial reuse of mine water and tailings basin seepage
- engineered systems to manage water quality impacts from the Mine Site and Plant Site, including the Tailings Basin
- WWTS
- management of hydrologic and ecologic impacts on downstream waters
- withdrawal of water from Colby Lake

Collection and Beneficial Reuse of Mine Water and Tailings Basin Seepage

Mine water, including water from pit dewatering and stockpile and haul road drainage, will be collected, treated at the WWTS, and conveyed to the FTB for reuse in the beneficiation process, as described in Volume III. Likewise, tailings basin seepage will be collected by the FTB seepage capture systems, as described in Volume V. This strategy minimizes impacts to surface water quality, and the use of mine water and tailings basin seepage to supply the Beneficiation Plant water demand reduces the subsequent need for withdrawal of make-up water from Colby Lake.

Management of Water Quality Impacts from the Mine Site and Plant Site, including Tailings Basin

Several environmental engineering controls are included in the Project to avoid and minimize potential water quality impacts from the Mine Site and Plant Site, including the Tailings Basin, as described in Volumes II and V.

- Engineered systems have been designed to collect drainage from the permanent stockpile, the three temporary stockpiles, and the ore handling area. In addition, stormwater management systems will collect and route stormwater in a manner that reduces potential impacts to mining activities, protects the environment, and maintains existing flow patterns to the extent practicable.
- Long-term disposal of the Category 2, 3, and 4 waste rock into the East Pit will reduce further oxidation of the materials, which will substantially reduce the long-term need for water treatment at the Mine Site.
• Measures to reduce tailings oxidation such as minimizing the area of exposed beaches and adding bentonite to dams, beaches, and the pond bottom will minimize the concentration of the vast majority of the pollutants in tailings basin seepage.

• The FTB seepage capture systems will minimize pollutant loading to receiving waters from tailings basin seepage. These systems will also reduce flow in these streams. Project activities to manage the potential hydrologic and ecologic impacts of the FTB seepage capture systems on receiving and downstream waters are discussed below.

Waste Water Treatment System
The design of the WWTS will be fully integrated to remove pollutants from mine water and tailings basin seepage, as described in Reference (6). There will be no discharge to the environment at the Mine Site during operations: treated water from the WWTS will be the only discharge to surface waters. The combined water treatment processes of the WWTS, which will include membrane separation technology, will result in WWTS discharge that meets the applicable water quality standards at the surface water discharge outfalls (Section 3.1.1).

Management of Hydrological and Ecologic Changes in Receiving and Downstream Waters
As described in Section 1.3, operation of the FTB seepage capture systems will reduce the quantity of water flowing from the Plant Site to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek. Reduction in streamflow could in theory affect ecological functions in the receiving waters, so, PolyMet will augment flow in Trimble Creek, Unnamed Creek, and Second Creek to maintain average annual flow within ±20% of natural streamflow for purposes of maintaining hydrology and existing aquatic ecology (Section 5.2.2.3.3 of Reference (1)).

To meet this objective, PolyMet will route WWTS discharge to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek to replace flow captured by the FTB seepage capture systems. PolyMet proposes to discharge to each subwatershed a volume proportionate to the volume that is collected by the FTB seepage capture systems. This discharge strategy is referred to as “stream augmentation.” Flow in receiving waters will be monitored under the terms of Project water appropriation permits. Ecological functions are proposed to be monitored in Trimble Creek, Unnamed Creek, and Second Creek on an annual basis, and compared to baseline monitoring results, to determine if ecological changes are occurring.

Withdrawal of Water From Colby Lake
As described in Section 5.9.4, pumping water from Colby Lake for use as make-up water will remove mercury from the Partridge River watershed, because some of the mercury in the make-up water will end up sequestered in the Flotation Tailings and the taconite tailings in the Tailings Basin.

7.4.4.2 Expected Performance
The expected performance of the WWTS is detailed in Section 3.1. PolyMet’s review of other waste water treatment systems indicated that the WWTS will exceed the level of treatment that is currently in place for
any known waste water system discharging to the Partridge River or Embarrass River, or to any other streams within the St. Louis River watershed. In this regard, the proposed treatment is more than simply prudent, it is an example of advanced treatment that advances the best available technology and provides excellent protection of the environment.

7.4.4.3 Design Considerations, Reliability, and Costs

Information on design considerations and constraints and reliability of the least degrading prudent and feasible alternative has been provided in previous reports, as indicated below.

- Design considerations and reliability for the WWTS are detailed in Reference (6).
- Design considerations and reliability for the FTB Seepage Containment System are detailed in Section 2.1.4 of Reference (29).
- Costs were not the determining factor in the selection of the least degrading prudent and feasible alternative. PolyMet has selected an advanced waste water treatment system, as described in Sections 7.4.4.1 and 7.4.4.2. The initial construction cost of the WWTS is estimated to be approximately $105 million, with annual operation and maintenance costs of approximately $5 million in Mine Year 1, not including labor or equipment replacement (which are estimated to be about 3.5% of the cost, annually).

7.5 The Project Will Result in Important Social and Economic Development

The Revised Rule states that “degradation of high water quality shall be minimized and allowed only to the extent necessary to accommodate important economic or social development” (Minnesota Rules, part 7050.0250). As explained below, and as outlined in the FEIS, the Project will be an important economic and social development project for the surrounding communities and region, including the geographic area in which degradation of existing high water quality is reasonably anticipated.

Minnesota Rules, part 7050.0280, subpart 2(C)(3)(c) requires that the Antidegradation Assessment include “for the geographic area in which high water quality degradation is reasonably anticipated, a comparison of existing and expected economic conditions and social services when the proposed activity is fully implemented”. This comparison should include the factors identified in Minnesota Rules, part 7050.0265, subpart 5(B), which are as follows and described in the referenced sections below:

- “Economic gains or losses attributable to the proposed activity, such as changes in the number and types of jobs, median household income, productivity, property values, and recreational, tourism and other commercial opportunities” (Section 7.5.1);
- “Contribution to social services” (Section 7.5.2);
- “Prevention or remediation of environmental or public health threats” (Section 7.5.3);
- “Trade-offs between environmental media” (Section 7.5.4);
• “The value of the water resource (Section 7.5.5) including:
  o the extent to which the resources adversely impacted by the proposed activity are unique or rare within the locality, state, or nation;
  o benefits associated with high water quality for uses such as ecological services and high water quality preservation for future generations to meet their own needs; and
  o factors, such as aesthetics, that cannot be reasonably quantified” and

• “Other relevant environmental, social, and economic impacts of the proposed activity” (Section 7.5.6).

Similarly, the Former Rule required that when determining whether additional control measures beyond those required to achieve minimum treatment60 “can reasonably be taken to minimize the impact of the discharge on the receiving water”, the MPCA shall consider factors which include “the importance of economic and social development impacts of the project,”61 where “economic or social development” is defined as “the jobs, taxes, recreational opportunities, and other impacts on the public at large that will result from a new or expanded discharge.”62 Also, the Antidegradation Demonstration related to mercury requires identification of “the economic or social development and the benefits to the area in which the waters are located that will not occur if the lowering of water quality is not allowed.”63

7.5.1 Economic Gains

The Project will include substantial economic gains related to job growth, industrial productivity, other commercial opportunities, and household income. The Arrowhead region of northeastern Minnesota, which includes Cook, Lake, St. Louis, and Carlton Counties, contains the well-known Mesabi Iron Range. Precious metal mining in this region can be dated to the late 1800s, with St. Louis County in particular having a long mining heritage. Many local communities were established to support these iron mining operations and continue to provide workers and services to the local mines. Due to the closure of LTVSMC and other job losses in northeastern Minnesota, there is a need for jobs and economic development in the area.

According to the FEIS (Reference (1)) the Project will generate as many as 500 direct jobs during peak construction and 360 direct jobs during operation. These direct jobs will generate additional indirect and induced employment, estimated to be 332 additional construction-phase jobs and 631 additional operations-phase jobs. While some skilled workers will be involved only temporarily and possibly relocate from outside the region, the majority of the related jobs are expected to be filled by those currently residing in the Arrowhead region.

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60 Minnesota Rules, part 7050.0185, subpart 3
61 Minnesota Rules, part 7050.0185, subpart 4
62 Minnesota Rules, part 7050.0185, subpart 2.E and part 7052.0100, subpart 13
63 Minnesota Rules, part 7052.0320, subpart 2.C.
Federal, state, and local taxes are expected generate an estimated $80 million annually. During operations, approximately $231 million per year in direct value will be added to the State economy through wages and rents and approximately $332 million per year in direct output related to the value of the extracted minerals. As with employment, these direct economic contributions will create indirect and induced contributions estimated at $99 million in value added and $182 million in output. Although, the total value that will be dedicated to employee salaries is not precisely known, employee pay is assumed to be a substantial share and is anticipated to be considerable compared to the current statewide value added from nonferrous mining.

The Project will also create slightly increased demand for housing and public services in cities and towns near the Project area. A detailed discussion of the economic and social benefits of the Project is provided in Section 5.2.10 of the FEIS (Reference (1)). The FEIS evaluated the economic and social effects from the IMPLAN model, which models the economic effects of changes in baseline conditions and reports direct, indirect, and induced effects in terms of employment, value of production, and value added due to the Project (Reference (30)).

### 7.5.2 Contribution to Social Services

The Project will contribute to the support of social services in the local area. As described in Section 7.5.1, federal, state, and local taxes associated with the Project are expected to generate an estimated $80 million annually. The increase in local tax revenue will provide the local governmental units with the means to expand the social services of importance to their communities. Additionally, a substantial portion of state taxes will be returned to area school systems, local governments, and local general funds (Reference (1)).

### 7.5.3 Prevention or Remediation of Environmental or Public Health Threats

The Project is expected to provide an environmental benefit by decreasing sulfate loading to the Embarrass River watershed. The Project will capture seepage impacted by previous ferrous mining activities which contains relatively high concentrations of sulfate (approximately 300 mg/L) that currently flows indirectly to tributaries of the Embarrass River. Seepage will be treated using membrane separation technology, and PolyMet has voluntarily agreed to an internal performance operating limit of 10 mg/L even though the receiving and downstream waters are not listed wild rice waters. Water modeling conducted for the FEIS indicated that in Mine Year 10, the average sulfate loading rate to the Embarrass River watershed will be reduced by approximately 1,600 tons per year from existing loading (Section 6.7.5.3 of Reference (3)). Sulfate loading is a concern for waters used for the production of wild rice, and presence of wild rice has been documented downstream of the Project in the Embarrass River and Embarrass River chain of lakes (Reference (31)). Sulfate interactions in the environment are complex, so it is not possible to directly translate the decreased sulfate loading to an estimated change in sulfate concentration in the water column; however, the significant decrease in sulfate loading is expected to provide an environmental benefit.

The expected net reduction in mercury loading due to the Project is another environmental benefit. While this reduction is small, it nonetheless furthers state efforts to reduce mercury in the environment.
7.5.4 Trade-Offs Between Environmental Media

The Project has been designed to appropriately balance a potential trade-off between the preservation of water quantity versus water quality. To manage potential water quality impacts from tailings basin seepage, the Project includes construction and operation of the FTB seepage capture systems, which will reduce the quantity of water flowing to the headwaters of Trimble Creek, Unnamed Creek, and Second Creek. The quality of the water currently flowing to these creeks has been impacted by previous ferrous mining activities. However, reduction in streamflow levels is a concern because ecological functions in the receiving waters may be impacted if flows increase or decrease more than 20% from baseline flow levels. Therefore, as discussed in Section 1.3, the proposed discharge strategy has been specifically designed to avoid significant hydrologic impacts by distributing WWTS discharge to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek in proportion to the amount of water that the FTB seepage capture systems will collect from each creek’s watershed. The water quality of the WWTS discharge will meet applicable water quality standards as detailed in this Antidegradation Evaluation.

Another trade-off between environmental media is the transfer of mercury from water to tailings deposits in the Tailings Basin. Filtration through tailings is a component of the treatment process to reduce mercury loading from the Project. The mercury will be sequestered in the tailings, as described in Section 9.3.5.

7.5.5 Value of the Water Resources

The Revised Rule, in Minnesota Rules, part 7050.0265, subpart 5(B)(5), specifies that evaluation of the “the value of the water resource” includes consideration of the following:

- the extent to which the resources adversely impacted by the proposed activity are unique or rare within the locality, state, or nation
- benefits associated with high water quality for uses such as ecological services and high water quality preservation for future generations to meet their own needs
- factors, such as aesthetics, that cannot be reasonably quantified

The receiving waters and downstream segments of Trimble Creek, Unnamed Creek, and Second Creek, are not known to be unique or rare within the locality, state, or nation. The creeks are relatively small streams that have been previously impacted by the construction and presence of the former LTVSMC tailings basin and other mining-related activities since the 1950s; these impacts have been both physical and chemical. The wetlands are deep and shallow marshes, the most common type of wetland delineated in the Embarrass River watershed near the Plant Site (Section 3.2 of Reference (32)). The wetlands have also been previously impacted by the LTVSMC tailings basin and other mining-related activities.

Although Trimble Creek, Unnamed Creek and, and Second Creek have been previously impacted by the existing LTVSMC tailings basin and other mining-related activities, they are currently “of high quality”64 for the parameters of concern except mercury (as discussed in Section 6.2.3) and also support ecological

64 Minnesota Rules, part 7050.0310, subpart 23
communities similar to a nearby, unimpacted reference stream (as discussed in Section 6.2.4.1). The proposed WWTS discharge and related activities will result in net increases in loading for some parameters; however, existing uses will be maintained and protected (Section 7.1). The net effect of the WWTS discharge and related activities will also reduce both mercury\textsuperscript{65} and sulfate loading to the receiving and downstream waters. Therefore, it is anticipated that the receiving and downstream waters will continue to support existing ecology and that water quality will be preserved for the needs of future generations.

The aesthetics of the receiving and downstream waters are not expected to change as a result of the Project. This most notably includes waters designated for recreation and aesthetic enjoyment of scenery. Recreational and visual resources with the potential to be aesthetically impacted, and the strong ties between recreation and the aesthetic condition of the landscape, are described in Section 4.2.11 of the FEIS (Reference (1)). The FEIS concludes in Section 5.2.11.2.1 that the presence of the Project will not impact the public’s ability to hunt, fish, and conduct other recreational activities (Reference (1)). Furthermore, water quality standards associated with the water’s taste, color, and odor will be maintained (Section 7.2) and therefore, aesthetic values of the receiving and downstream waters, including those with designated recreational uses, will not be negatively impacted.

Overall, it is estimated that the Project will have negligible to no effect on the value of the receiving and downstream waters.

### 7.5.6 Other Relevant Environmental, Social, and Economic Impacts

The minerals found in this location are rare and important natural resources, and are needed locally, nationally, and internationally. It is the policy of the State of Minnesota to facilitate the development of such mineral resources. Minnesota Statutes, section 93.001,

It also is the policy of the State to promote the repurposing and redevelopment of brownfield sites with existing environmental impacts (Minnesota Statutes, sections 93.44 and 115B.175 to .178. Both the ferrous and nonferrous mining regulations of the MDNR encourage preservation of mineral and natural resources, implementation of sound planning practices, and the orderly development of mining (Minnesota Rules, parts 6130.0200 and 6132.0200). The repurposing and redevelopment of the former LTVSMC facilities advances these public policy purposes, and will give effect to the goals the State has had in place since the 2001 LTVSMC bankruptcy, of returning the former Erie plant and other infrastructure to productive mining use.

The Project will also remediate existing environmental conditions of concern at the former LTVSMC taconite processing plant and tailings basin. In addition to the legacy water quality issues, there are also other legacy conditions that need to be addressed including mining features that have not been appropriately reclaimed and areas of concern that need to be evaluated for various contaminants. The Project will remediate these conditions.

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\textsuperscript{65} With the exception of the headwater segment of Second Creek, where mercury concentrations will increase, but remain in compliance with the applicable water quality standard (1.3 ng/L).
7.6 Outstanding Resource Value Waters Will Be Protected

The Project will not directly discharge to an ORVW. Downstream, Lake Superior is classified as a restricted ORVW, and limited segments of the lake are classified as prohibited ORVWs with varying requirements. The discharge will have no measurable effect on the average concentrations of the parameters of concern at the evaluation point on the St. Louis River at Scanlon, prior to the river’s entry into Lake Superior (Section 6.3.6).

As a result, the discharge will protect the existing water quality of any downstream ORVW (any portion of Lake Superior), and will not degrade “the existing water quality necessary to maintain and protect the exceptional characteristics for which” Lake Superior was designated as a restricted ORVW.66

7.7 Waters Will Be Protected from Thermal Discharges

Thermal discharges are regulated by Minnesota Rules, part 7050.0265, subpart 8, which establishes that "when there is potential for water quality impairment associated with thermal discharges, the commissioner’s allowance for existing water quality degradation shall be consistent with section 316 of the CWA", which states that effluent temperature must be controlled to “assure the projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made” (33 USC § 1326).

The WWTS discharge will present no reasonable potential for water quality impairment associated with thermal discharge. The WWTS processes add minimal heat to the influent (seepage), which will be approximately the temperature of shallow groundwater, therefore, no water quality impairment associated with thermal discharges is expected. The WWTS will be operated such that the temperature of the discharge meets applicable standards for Class 2B waters at the Second Creek outfall and applicable standards for Class 2D waters at the Trimble Creek and Unnamed Creek outfalls. It is not expected that the temperature of the discharge will be 5°F above natural, or deviate from the range of natural background temperatures such that there are significant adverse impacts. Further, non-mechanical options are available to cool the discharge in the winter if necessary. Other non-mechanical options could be developed during design, however the temperature difference between the discharge and the receiving waters is not expected to cause significant adverse impacts in any season. Therefore, there will be no degradation of receiving waters due to temperature.

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66 See Minnesota Rules, part 7050.0265, subparts 6 and 7, and former Minnesota Rules, part 7050.0180, subparts 3, 6, and 9 (repealed November 2016)
8.0 Existing (Pre-Project) and Estimated (Project) Water Quality: Mercury

This section begins with some background on mercury in surface water (Section 8.1) in order to provide context for the discussion of existing mercury concentrations and loading before the Project is constructed (Section 8.2), and of the estimated mercury concentrations and loading during Project operations in Mine Year 10 (Section 8.3).

8.1 Background on Mercury in Surface Water

Mercury differs from other parameters of concern for the Project, not just with respect to applicable regulations, but also with respect to its measurement, characteristics, and sources. To provide context for the mercury Antidegradation Demonstration, this section summarizes key considerations with regard to mercury.

- Mercury was not one of the parameters included in the GoldSim water modeling for the FEIS. Mercury was not included because it behaves differently than other parameters (for example, it can volatilize from the aqueous to the gaseous phase). PolyMet and the Co-Lead Agencies for environmental review agreed that a spreadsheet-based mass balance model was preferred for mercury for the FEIS, because this approach can incorporate the important input and removal processes for mercury, is very transparent with regard to data inputs, and allows easy assessment of the effects of changing parameter values on mercury concentrations (Section 6.9 of Reference (3)). For these same reasons, PolyMet determined it was appropriate to employ spreadsheet-based mass balance modeling for the Antidegradation Demonstration (Attachment F).

- There are two numerical water quality standards in Minnesota for mercury:
  - mercury in the water column – 1.3 ng/L (Minnesota Rules, part 7052.0100)
  - mercury in fish tissue – 0.2 mg/kg (Minnesota Rules, part 7050.0222)

- Atmospheric deposition is the primary source of the mercury in Minnesota surface water (Reference (17)). The average mercury concentration in precipitation is 9 to 12 ng/L. Existing mercury concentrations in many surface water bodies in the St. Louis River watershed are well above the applicable standard of 1.3 ng/L, primarily due to mercury loading from atmospheric deposition.

- Minnesota has developed a statewide mercury Total Maximum Daily Load (TMDL); however, not all water bodies with mercury levels above the standard are included in the TMDL (Reference (17)). The receiving and downstream waters relevant to the Project are among the water bodies not included.
• The analytical detection limit for mercury is very close to the applicable water quality standard. The analytical detection limit is typically around 0.5 ng/L, but can vary by laboratory and by sampling event. Detection limits in the existing conditions data for mercury range from 0.1 – 25 ng/L. The mercury monitoring data for the Project contains a high percentage of “non-detects,” especially near the headwater areas of the receiving waters, where mercury concentrations are very low. Because of these factors, the Kaplan-Meier method is a more statistically appropriate method to calculate averages of data sets that include “non-detects” than the method that was used for other parameters (for which “non-detect” was averaged as one half the detection limit (Reference (20)).

• Project Flotation Tailings will have lower concentrations of mercury than the existing LTVSMC taconite tailings (Section 6.9 of Reference (3)).

• Filtration through Flotation Tailings and taconite tailings has the effect of removing mercury from water (Section 6.9 of Reference (3)), resulting in seepage with lower mercury concentrations. In the receiving and downstream waters, mercury concentrations increase with distance downstream from the Tailings Basin due largely to atmospheric deposition unrelated to the Project.

• The net effect of the Project on mercury loading in the St. Louis River watershed is a function of more than just the mercury content of the WWTS discharge, as described in Section 1.3.

### 8.2 Existing (Pre-Project) Water Quality

Existing mercury concentrations, summarized in Table 8-1 and depicted on Large Figure 6, are generally lower in the receiving waters, closer to the former LTVSMC tailings basin, than in downstream waters. This is because filtration through tailings removes mercury from tailings basin seepage, as described in Sections 8.1 and 9.3.1. Further downstream, mercury concentrations increase because of the increasing mercury load from atmospheric deposition and subsequent runoff from sources unrelated to the Project. High quality water for mercury is found only in the headwater segment of Second Creek, at PM–7/SD026. At the other evaluation points, including the receiving headwater wetlands of Trimble and Unnamed Creeks, existing mercury concentrations are above 1.3 ng/L.

Existing conditions mercury loads are presented on Large Figure 7.
### Table 8-1 Existing Mercury Concentrations

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Evaluation Location</th>
<th>Existing Average Mercury Concentration (ng/L)</th>
<th>High Quality Water for Mercury&lt;sup&gt;(1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands near Trimble Creek outfalls</td>
<td>TC–1a</td>
<td>2.1&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>Wetlands near Unnamed Creek outfall</td>
<td>PM–11</td>
<td>1.7&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>Second Creek near outfall</td>
<td>PM–7/SD026</td>
<td>0.6&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>Yes</td>
</tr>
<tr>
<td>Trimble Creek</td>
<td>TC–1a</td>
<td>2.1</td>
<td>No</td>
</tr>
<tr>
<td>Unnamed Creek</td>
<td>PM–11</td>
<td>1.7&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>Second Creek</td>
<td>MNSW8</td>
<td>2.4</td>
<td>No</td>
</tr>
<tr>
<td>Embarrass River</td>
<td>PM–13</td>
<td>3.4&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>Upper Partridge River</td>
<td>SW004a</td>
<td>3.8</td>
<td>No</td>
</tr>
<tr>
<td>Colby Lake</td>
<td>various</td>
<td>5.3</td>
<td>No</td>
</tr>
<tr>
<td>Lower Partridge River</td>
<td>USGS 040160000 (MNSW12)</td>
<td>4.3</td>
<td>No</td>
</tr>
<tr>
<td>St. Louis River near Forbes</td>
<td>USGS 04018750 (EP–1)</td>
<td>4.1</td>
<td>No</td>
</tr>
<tr>
<td>St. Louis River near Cloquet</td>
<td>USGS 04024000 (EP–2)</td>
<td>4.6</td>
<td>No</td>
</tr>
</tbody>
</table>

<sup>(1)</sup> “High quality waters” mean waters having mercury concentrations at or below 1.3 ng/L (Minnesota Rules, part 7052.0300 subpart 2, and Minnesota Rules part 7050.0255 subpart 21)

<sup>(2)</sup> Concentrations in wetlands are assumed to be represented by the values at the first downstream monitoring station as described in Section 5.9.3.

<sup>(3)</sup> Averages were computed using the Kaplan-Meier method (Reference (20)) to account for values below analytical detection limits

### 8.3 Comparison of Existing (Pre-Project) and Estimated (Project) Water Quality for Mercury

PolyMet’s mercury Antidegradation Demonstration included comparing existing and estimated Mine Year 10 mercury concentrations and loading in order to understand the Project’s impact upon the receiving and downstream waters. Specifically, PolyMet evaluated the potential effect of the WWTS discharge and related activities upon:

- mercury concentration and load in the receiving waters (Section 8.3.1)
- mercury concentration and load in downstream waters, including ORVWs (Section 8.3.2)
- methylation of mercury and accumulation in fish tissue in receiving and downstream waters (Section 8.3.3)
- waters impaired for mercury (Section 8.3.4)
The analysis of the Project’s potential effects on mercury concentrations and loading in downstream waters is detailed in Attachment F. Existing and estimated mercury concentrations and loads are compared in Table 8-2 and Table 8-3, respectively, depicted on Large Figure 6 and Large Figure 7, and described in the following sections.

Table 8-2, which compares existing and estimated mercury concentrations, also shows the LCS acceptance criteria, as described in Section 5.6, and the range of natural variability (lowest and highest measured values) for each baseline value. This allows assessment of whether the modeled concentration during Mine Year 10 will represent a measurable change from baseline values, and whether the change is within the range of natural variability.
<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>Existing Mercury Concentration (ng/L)</th>
<th>Estimated Mine Year 10 Mercury Concentration (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>LCS Acceptance Range&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Wetlands at Trimble Creek outfalls</td>
<td>2.1</td>
<td>1.6 – 2.6</td>
</tr>
<tr>
<td>Wetlands at Unnamed Creek outfall</td>
<td>1.7</td>
<td>1.3 – 2.1</td>
</tr>
<tr>
<td>Second Creek at PM–7/SD026</td>
<td>0.6</td>
<td>0.5 – 0.7</td>
</tr>
<tr>
<td>Trimble Creek, TC–1a&lt;sup&gt;(6)&lt;/sup&gt;</td>
<td>2.1</td>
<td>1.6 – 2.6</td>
</tr>
<tr>
<td>Unnamed Creek, PM–11</td>
<td>1.7</td>
<td>1.3 – 2.1</td>
</tr>
<tr>
<td>Upper Embarrass River, PM–13</td>
<td>3.4</td>
<td>2.6 – 4.2</td>
</tr>
<tr>
<td>Second Creek, MNSW8</td>
<td>2.4</td>
<td>1.8 – 3.0</td>
</tr>
<tr>
<td>Upper Partridge River, SW004a</td>
<td>3.8</td>
<td>2.9 – 4.7</td>
</tr>
<tr>
<td>Lower Partridge River, USGS 04016000 (MNSW12)</td>
<td>4.3</td>
<td>3.3 – 5.3</td>
</tr>
<tr>
<td>St. Louis River near Forbes – EP–1&lt;sup&gt;[1]&lt;/sup&gt;</td>
<td>4.1</td>
<td>3.2 – 5.1</td>
</tr>
<tr>
<td>St. Louis River in Cloquet – EP–2&lt;sup&gt;[1]&lt;/sup&gt;</td>
<td>4.6</td>
<td>3.5 – 5.7</td>
</tr>
</tbody>
</table>

**Bold text** indicates a value above the applicable mercury water column standard of 1.3 ng/L.

<sup>(1)</sup>Average existing concentrations from monitoring data as described in Section 5.9.3.1.

<sup>(2)</sup>LCS acceptance range is calculated from the average existing condition concentration using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each USEPA-approved test method. For USEPA method 1631 for low-level mercury, the LCS acceptance criteria are ±23%.

<sup>(3)</sup>Range shown is minimum measured value to maximum measured value.

<sup>(4)</sup>Average concentrations as estimated in Attachment F.

<sup>(5)</sup>Estimated values within the LCS acceptance range are not considered measurable changes from existing conditions (Section 5.6. Assessment of measurable change using the 95% Upper Confidence Limit, as requested by MPCA, is presented in Attachment B.

<sup>(6)</sup>See Section 3.3.1.1 of Attachment F for discussion of the use of estimated flows at TC–1 to develop the estimated mercury concentration. TC–1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, TC–1 was used for water quality monitoring in 2012 only. Water quality monitoring was moved in 2012 to TC–1a, which is located less than one mile downstream of TC–1. Mercury was not included in the GoldSim model, and all Trimble Creek mercury water quality data used in Attachment F was collected at TC–1a.

<sup>(7)</sup>The estimated Hg concentration at PM–11 is slightly higher than the existing concentration (even though the load decreases), because the flow also decreases. The apparent increase in concentration is exaggerated by rounding. The difference between existing and estimated concentrations is 0.06 ng/L.
### Table 8-3 Comparison of Existing and Estimated Mercury Loading

<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>Existing Mercury Load (grams per year (g/yr))</th>
<th>Estimated Mine Year 10 Mercury Load (g/yr)</th>
<th>Change in Mercury Load (g/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Creek, PM–7/SD026</td>
<td>0.3</td>
<td>0.8</td>
<td>+ 0.5</td>
</tr>
<tr>
<td>Trimble Creek, TC–1a(1)</td>
<td>9.3</td>
<td>7.7</td>
<td>- 1.5</td>
</tr>
<tr>
<td>Unnamed Creek, PM–11</td>
<td>5.3</td>
<td>5.0</td>
<td>- 0.2</td>
</tr>
<tr>
<td>Upper Embarrass River, PM–13</td>
<td>265.9</td>
<td>264.6</td>
<td>- 1.3</td>
</tr>
<tr>
<td>Second Creek, MNSW8</td>
<td>83.4</td>
<td>83.9</td>
<td>+ 0.5</td>
</tr>
<tr>
<td>Upper Partridge River, SW004a</td>
<td>168.0</td>
<td>161.6</td>
<td>- 6.4</td>
</tr>
<tr>
<td>Lower Partridge River, USGS 04016000</td>
<td>469.3</td>
<td>460.6</td>
<td>- 8.7</td>
</tr>
<tr>
<td>St. Louis River near Forbes – EP–1</td>
<td>2,070.0</td>
<td>2,060.0</td>
<td>- 10.0</td>
</tr>
<tr>
<td>St. Louis River in Cloquet – EP–2</td>
<td>9,389.0</td>
<td>9,379.0</td>
<td>- 10.0</td>
</tr>
</tbody>
</table>

(1) See Section 3.3.1.1 of Attachment F for discussion of the use of estimated flows at TC–1 to develop the estimated mercury loading. TC–1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, TC–1 was used for water quality monitoring in 2012 only. Water quality monitoring was moved in 2012 to TC–1a, which is located less than one mile downstream of TC–1. Mercury was not included in the GoldSim model, and all Trimble Creek mercury water quality data used in Attachment F was collected at TC–1a.

#### 8.3.1 Receiving Waters

During Project operations, the mercury concentration in the receiving waters at the outfalls is expected to be equal to the mercury concentration in the WWTS discharge, which will be at or below 1.3 ng/L. The mercury concentration in the receiving waters is estimated to be equal to the WWTS discharge concentration because the operation of the FTB seepage capture systems will eliminate flow from the watersheds upstream of the surface water discharge outfalls. The surface water discharge outfalls will be the furthest upstream flows in the Trimble Creek, Unnamed Creek, and Second Creek watersheds.

As shown in Table 8-2 and Table 8-3, the WWTS discharge and related activities are expected to have the following effect on mercury in receiving waters:

- Mercury concentrations will comply with the applicable numeric water quality standards in the receiving waters.
- In the wetlands at the Trimble Creek and Unnamed Creek outfalls, there will be no measurable increase in mercury concentrations.
- In the headwater segment of Second Creek (at PM–7/SD026), the mercury load will increase and result in a measurable increase in mercury concentration.
- Mercury loading to the wetlands at the Trimble Creek and Unnamed Creek outfalls was not calculated, as explained in Section 5.9.3.2. The mercury mass flux from the Tailings Basin through
these wetlands reports to downstream evaluation points, and is accounted for in the mercury load calculations at TC-1a, PM-11, and PM-13.

- Changes in mercury loading attributable to the Project are not expected to cause any changes in existing uses of the receiving waters.
- The alternative statistical approach (Attachment B) produces the same conclusions.

### 8.3.2 Downstream Waters

As summarized in Table 8-2 and Table 8-3, the WWTS discharge and related activities are expected to have the following effect on mercury in downstream waters:

- No measurable increases in mercury concentrations are expected at the evaluation points on downstream waters in the St. Louis River Basin.
- The mercury load to Trimble Creek, Unnamed Creek, and the Embarrass River is expected to decrease.
- The mercury load to Second Creek is expected to increase by 0.5 grams per year, but the mercury load to the Partridge River is expected to decrease, due to the effects of the Project on the Partridge River upstream of the confluence with Second Creek.
- The mercury load to the St. Louis River is expected to decrease.
- The mercury load to Lake Superior, which is classified as a restricted ORVW, and limited segments of which are classified as prohibited ORVWs, is expected to decrease, as discussed further in Section 9.0.
- Changes in mercury loading attributable to the Project are not expected to cause any changes in existing uses of the receiving waters.
- The alternative statistical approach (Attachment B) produces the same conclusions.

#### 8.3.2.1 Mercury Concentrations

While the Project is expected to result in a measurable increase in the mercury concentration in Second Creek at PM–7/SD026, this effect will not persist further downstream. PolyMet’s analysis indicated that at the next evaluation point on Second Creek downstream of PM–7/SD026, which is MNSW8, the Project is not expected to result in a measurable increase in mercury concentration (Attachment F).

Existing mercury concentrations are above the mercury water column standard of 1.3 ng/L at downstream evaluation points in Trimble Creek, Unnamed Creek, Second Creek, and downstream evaluation points on the Partridge, Embarrass, and St. Louis rivers. At downstream locations where the existing mercury concentrations are above the mercury water column standard, the WWTS discharge, which will meet the 1.3 ng/L standard, is not expected to cause a measurable increase in mercury concentrations. (Table 8-2 and Large Figure 6).
8.3.2.2 Mercury Loading

The WWTS discharge and related activities will reduce mercury loading to the St. Louis River watershed by 10.0 grams per year (Large Figure 7). Importantly, this is a protective loading estimate, because it assumes a mercury concentration of 1.3 ng/L in the WWTS discharge, as described in Section 9.3.4. WWTS discharge mercury concentration during operations may be less than 1.3 ng/L.

8.3.3 Methylmercury and Mercury Accumulation in Fish Tissue

Generally, changes in mercury concentration in fish tissue are expected, based on the regulatory approaches developed by the responsible state agencies, to be proportional to changes in mercury loading. This concept of “proportionality” is the basis of the Mercury Risk Estimation Method (MMREM) developed by MPCA and the Minnesota Department of Health (MDH), which is the agency with oversight responsibility for health-related aspects of fish consumption (Reference (2)). Mercury in fish tissue is mainly in the form of methylmercury, an organic form of mercury that is known to bioaccumulate through aquatic food chains, potentially resulting in levels with negative health effects to humans and wildlife. Other forms of mercury can be converted to methylmercury through microbial activity that occurs more efficiently in certain environments, such as in wetlands. Because the area around the Project contains numerous wetlands, PolyMet has assessed the potential effects of the Project on methylmercury concentrations.

Research has shown that mercury methylation is driven by the activity of sulfate-reducing bacteria (Reference (33)), which are microbes that metabolize sulfate, reducing it to sulfide. Therefore, environments that are favorable for these bacteria are also favorable for production of methylmercury from inorganic mercury. There are a number of conditions that can influence this process (Reference (34), Reference (35), Reference (36), Reference (37)). Inorganic mercury, generally as Hg(II), is required, as suggested by the concept of “proportionality” (Reference (2)). Sulfate-reducing bacteria also require a source of sulfate for respiration. In northern Minnesota, wetlands are often sulfate-limited, and studies have shown that the addition of sulfate to wetlands can result in increased methylmercury production (Reference (33), Reference (38), Reference (39)). These bacteria are generally anaerobic, and are thus found in anoxic (oxygen-poor) environments such as wetlands and lake sediments.

After being produced in wetlands, methylmercury can be transported through the watershed. Studies have found that there is little, if any, relationship between methylmercury and sulfate in northern Minnesota stream channels (Reference (37)) and suggest that the methylmercury in streams in the region comes from wetlands during storm-related flushing events (Reference (40), Reference (41), Reference (42)). In addition, methylmercury in natural waters is often bound to organic carbon, and their concentrations can therefore be related (Reference (34)).

Characteristics of the WWTS discharge and the receiving waters (headwater wetlands of Trimble and Unnamed Creeks, and the headwater segment of Second Creek) do not provide particularly favorable conditions for mercury methylation by sulfate-reducing bacteria. As described in Section 6.3.4.1, sulfate loading is expected to decrease substantially due to the installation of the FTB seepage capture systems and removal of sulfate by membrane filtration at the WWTS. Mercury loading at most surface water
discharge outfalls is also expected to decrease. Organic carbon is generally low in mining-related waters and may be further reduced by the RO filtration process, and the WWTS discharge will be oxygenated. Because of these factors, discharge from the WWTS will be unlikely to stimulate microbial mercury methylation in receiving waters or other wetlands.

Downstream evaluation points are located in stream channels. As noted above, methylmercury in northern Minnesota streams and lakes likely comes from storm-related flushing from hydrologically connected wetlands. As described in the previous paragraph, the WWTS discharge is not likely to increase mercury methylation in the headwater wetlands in the vicinity of the Project. Lakes and potentially areas of stream sediments containing favorable environments for microbial mercury methylation are present along the Embarrass, Partridge, and St. Louis rivers downstream of the site. Compared to existing conditions, PolyMet’s modeling indicated that the WWTS and related activities are expected to decrease both the mercury load and the sulfate load to these waters. Given this decreased loading in streams and lakes due to the Project, as is the case with the headwater wetlands, the WWTS discharge is not likely to increase mercury methylation in downstream waters and, subsequently, it is not likely to increase mercury in fish tissue in these waters. PolyMet also evaluated other potential sources of methylmercury changes that theoretically could be attributed to the Project, but found that even under assumptions designed to include multiple levels of protectiveness, no measurable changes in methylmercury concentrations are expected in receiving waters, downstream waters, or in fish tissue.

8.3.4 Waters Impaired for Mercury
Two types of mercury impairments are included on the MPCA Section 303(d) impaired waters list; mercury in the water column and mercury in fish tissue. The receiving waters (headwater wetlands of Trimble Creek, headwater wetlands of Unnamed Creek, and the headwater segment of Second Creek) are not listed on the USEPA-approved 2014 303(d) impaired waters list nor on the proposed MPCA 2016 list. Mercury impairments in downstream waters and the estimated effect of the WWTS discharge and related activities on these waters are summarized in Table 8-4. The locations of lakes listed on Table 8-4 are shown on Large Figure 2.
### Table 8-4  Downstream Waters Listed as Mercury Impaired

<table>
<thead>
<tr>
<th>Stream</th>
<th>Reach</th>
<th>Mercury Impairment</th>
<th>Impact of WWTS discharge and related activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabin Lake</td>
<td>--</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td>Wynne Lake</td>
<td>--</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td>Embarrass Lake</td>
<td>--</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td>Esquagama Lake</td>
<td>--</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td>Embarrass River</td>
<td>Embarrass Lake to confluence with St. Louis River</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in water column</td>
<td>No measurable impact(3)</td>
</tr>
<tr>
<td>Partridge River</td>
<td>Confluence with Second Creek to confluence with St. Louis River</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in water column</td>
<td>No measurable impact(3)</td>
</tr>
<tr>
<td>St. Louis River</td>
<td>Partridge River to Artichoke River</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td></td>
<td>Cloquet River to Pine River</td>
<td>Mercury in water column</td>
<td>No measurable impact(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(3)</td>
</tr>
<tr>
<td></td>
<td>Pine River to Fond du Lac Dam</td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
<tr>
<td></td>
<td>Mission Creek to Oliver Bridge</td>
<td>Mercury in water column</td>
<td>No measurable impact(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in fish tissue</td>
<td>No measurable impact(2)</td>
</tr>
</tbody>
</table>

(1) Minnesota’s Proposed 2016 Impaired Waters List, available at https://www.pca.state.mn.us/sites/default/files/wq-iw1-55.xls  
(2) See Section 8.3.4.2  
(3) See Section 8.3.4.1

### 8.3.4.1 Water Bodies with Water Column Impairments

Downstream of the Project, there are two reaches of the St. Louis River, one reach of the Embarrass River, and one reach of the Partridge River that are listed as impaired for mercury in the water column on MPCA’s 2014 303(d) list or proposed on MPCA 2016 303(d) list. The expected effect of the WWTS discharge and related activities, taking into account the modeled changes in loading in the watersheds for both the Embarrass River and the Partridge River, will be to slightly lower the mercury load in the St. Louis River, as discussed in Section 8.3.2 and shown on Large Figure 7. Because there will be no addition of mercury to the impaired waters attributable to the WWTS discharge and related activities, the Project is not expected to lower water quality in downstream waters listed as impaired for mercury in the water column. Thus, to the extent the requirements of Minnesota Rules, part 7052.0300, subpart 2 regarding impaired waters are applicable, the Project will meet those requirements.

### 8.3.4.2 Water Bodies with Fish Tissue Impairments

Downstream of the Project, there are four lakes, four reaches of the St. Louis River, one reach of the Embarrass River, and one reach of the Partridge River that are listed as impaired for mercury in fish tissue.
on MPCA's 2014 303(d) list or proposed on MPCA 2016 303(d) list. As described in Section 8.3.3, changes in mercury concentration in fish tissue are generally considered by MPCA and MDH to be proportional to changes in mercury loading (Reference (2)). The effect of the WWTS discharge and related activities is estimated to slightly decrease the mercury load to downstream water bodies listed as impaired for fish tissue mercury (Section 8.3.2). Based on the MMREM concept of proportionality, this slight decrease in mercury loading to the impaired water bodies due to the Project is expected to result in a slight decrease in mercury fish tissue concentrations, although this fish-tissue concentration decrease is not expected to be a measurable change. Evaluation of site-specific factors, as described in Section 8.3.3, that can affect mercury methylation also indicated that the WWTS discharge and related activities are not expected to increase mercury in fish tissue in these waters. Because the Project is not expected to have any measurable effect on fish tissue mercury concentrations in downstream waters listed as impaired for mercury in fish tissue, it will comply with Minnesota Rules, part 7052.0300, subpart 2 to the extent the requirements of that rule are applicable here.
9.0 Antidegradation Demonstration for Mercury

PolyMet’s Antidegradation Demonstration for mercury under Chapter 7052 (LSB Rule) establishes the following:

- existing uses will be maintained and protected (Tier I; Section 9.1)
- the WWTS discharge and related activities will not result in lowering of water quality in waters that are listed as impaired for mercury by MPCA (Section 9.2)
- the Project will use the Best Technology in Process and Treatment (BTPT) for mercury, and the Project will have social and economic benefits (Sections 9.3 and 9.4)
- ORVWs will be protected (Tier III, Section 9.5)
- waters will be protected from thermal discharges (Section 9.6)

9.1 Existing Uses Will Be Maintained and Protected

The applicable mercury water quality standards are Class 2D and Class 2B standards, associated with the designated uses listed in Large Table 5 and Large Table 6. PolyMet knows of no other actual uses related to mercury besides the designated uses. Determination of existing use, however, requires evaluation of actual uses and the existing water quality supporting those uses, as described in Section 7.1. For the headwater segment of Second Creek at PM–7/SD026, where the existing mercury concentration is lower than the Class 2B standard of 1.3 ng/L, the designated use is also the existing use. At PM–7/SD026 the existing use will be maintained and protected, because the estimated water quality will meet the applicable numeric water quality standard and there will be no effect on uses of receiving or downstream waters (Section 8.3.1).

For the wetlands in the headwater area of Trimble and Unnamed creeks, and for downstream evaluation points, existing uses are supported by existing mercury concentrations greater than the Class 2B and 2D standard of 1.3 ng/L. At these locations, the existing use, described based on the actual use and the actual water quality supporting that use, is referred to for this evaluation as cool or warm water sport or commercial fish and associated aquatic life in waters with elevated mercury concentrations. This existing use will be maintained and protected at these locations because the Project will not increase mercury concentrations from the existing concentrations and the Project will not cause any changes in actual or designated uses (Section 8.3.2.1). Further, based on the MPCA and MDH concept of proportionality, wherein changes in mercury concentration in fish tissue are considered to be proportional to changes in mercury loading (Section 8.3.3), the Project is not expected to create any measurable change from background fish tissue mercury concentrations in receiving or downstream waters. Table 9-1 demonstrates that the Project will maintain and protect the existing uses with regard to mercury in receiving and downstream waters.

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67 Formulation of site-specific existing use is based on USEPA letter to Mr. Derek Smithee, September 5, 2008. Reference (41)
### Table 9-1  Existing Uses Associated with Mercury

<table>
<thead>
<tr>
<th>Water body and reach</th>
<th>Classification</th>
<th>Designated Use that is Actual Use</th>
<th>Existing Water Quality</th>
<th>Existing Use</th>
<th>Maintenance and Protection of Existing Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands at headwater area of Trimble Creek</td>
<td>2D</td>
<td>“healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats.”</td>
<td>&gt;1.3 ng/L</td>
<td>healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats, in waters with elevated mercury concentrations(1)</td>
<td>Mercury concentration in discharge will be at or below 1.3 ng/L; there will be no effect on use.</td>
</tr>
<tr>
<td>Wetlands at headwater area of Unnamed Creek</td>
<td>2D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headwater segment of Second Creek</td>
<td>2B</td>
<td>“...cool or warm water sport or commercial fish and associated aquatic life, and their habitats”.</td>
<td>&lt;1.3 ng/L</td>
<td>“...cool or warm water sport or commercial fish and associated aquatic life, and their habitats”(2)</td>
<td>Mercury concentration in discharge will be at or below 1.3 ng/L; there will be no effect on use.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“aquatic recreation of all kinds, including bathing...”</td>
<td></td>
<td>“aquatic recreation of all kinds, including bathing...”</td>
<td></td>
</tr>
<tr>
<td>Downstream waters</td>
<td>2B</td>
<td>“...cool or warm water sport or commercial fish and associated aquatic life, and their habitats”.</td>
<td>&gt;1.3 ng/L</td>
<td>cool or warm water sport or commercial fish and associated aquatic life, and their habitats in waters with elevated mercury concentrations(1)</td>
<td>Project will not increase mercury concentration; there will be no effect on use.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“aquatic recreation of all kinds, including bathing...”</td>
<td></td>
<td>aquatic recreation of all kinds, including bathing in waters with elevated mercury concentrations(1)</td>
<td></td>
</tr>
</tbody>
</table>

(1) The existing use, for this Antidegradation Demonstration, is described based on the actual use and the actual water quality supporting that use. Formulation of site-specific existing use is based on United States Environmental Policy Act letter to Mr. Derek Smithee, September 5, 2008 (Reference (43)).

(2) The applicable water column mercury standard is 1.3 ng/L. A mercury fish tissue standard also applies to the receiving and downstream waters. Based on the concept of proportionality, as described in Section 8.3.4.2, where the mercury water column standard is met, the mercury fish tissue standard of 0.2 mg/kg will also be met.
9.2 Discharge Will Not Lower Water Quality in Water Bodies That Are Impaired for Mercury

Although Minnesota has not listed or proposed to list any of the receiving waters as impaired on the State’s 303(d) impaired waters list, several downstream lakes and reaches of the Embarrass River, Partridge River, and St. Louis River are listed as impaired for mercury in the water column and/or mercury in fish tissue 68 (Section 8.3.4). To the extent these downstream waters are relevant here, Minnesota Rules, part 7052.0300 subpart 2 states that “[w]here designated uses of the water body are impaired, there must be no lowering of the water quality with respect to the GLI pollutants causing the impairment.”

For purposes of the LSB antidegradation rules, “lowering of water quality,” is defined as “a new or expanded point source discharge of a BSIC to an outstanding international resource water...” (Minnesota Rules, part 7052.0300, subpart 1). A “discharge” means “the addition of any pollutant to the waters of the state.” (Minnesota Statute, section 115.01, subdivision 4).

The Project will not add mercury to waters listed as impaired. The effect of the WWTS discharge and related activities is estimated to slightly reduce mercury loading in the impaired water bodies compared to existing conditions. As a result, the Project will not add any mercury to the downstream waters, and it will not lower water quality in any receiving or downstream waters, including any impaired waters, relative to mercury.69 Further, the Project will not add to the concentration of mercury in fish tissue in impaired waters. Because changes in fish tissue mercury concentration are considered by the MPCA to be proportional to changes in mercury loading (Section 8.3.3), and the Project is estimated to slightly decrease mercury loading to the downstream waters, there will be no measurable change from background fish tissue attributable to the Project.

In addition, the FEIS confirms that the Project will be consistent with the requirements of Minnesota’s statewide TMDL for mercury.70 In particular, the FEIS states that the Project “would not impede the [Minnesota] reduction goals” for mercury.71

9.3 Discharge Will Be Subject to Best Technology in Process and Treatment

Minnesota Rules, part 7052.0320, subpart 3(A) require PolyMet to conduct a BTPT analysis to evaluate options to reduce the extent of new mercury discharge.

The comprehensive identification and assessment of alternatives conducted by the NEPA/MEPA Co-Lead Agencies, Cooperating Agencies, and PolyMet during the environmental review process, described in Section 7.4, provided a thorough assessment of alternatives in connection with the Project to reduce mercury loading. The Project, as proposed in the FEIS and subsequent permit applications, is the BTPT for reduction of mercury loading, and is the most advanced technology available and viable in the

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68 USEPA-approved 2014 303(d) impaired waters list and the MPCA proposed 2016 list.
69 See Minnesota Rules, part 7052.0300 subpart 2.
70 FEIS Appendix A, A – 421-22.
71 FEIS Appendix A, A – 421.
marketplace, as required by Minnesota Rules, part 7052.0320, subpart 3(E). The elements of the BTPT are summarized in Sections 9.3.1 through 9.3.5.

As a result of the use of BTPT and additional Project activities, the estimated effect of the Project will be no measurable increase in mercury concentrations—and in most cases a decrease in mercury loading—in the receiving and downstream waters except for the Second Creek headwater segment (Large Figure 6 and Large Figure 7). In the Second Creek headwater segment, where mercury concentrations are currently below the 1.3 ng/L standard, the mercury concentration is estimated to increase as a result of the WWTS discharge but to remain at or below the 1.3 ng/L standard. Multiple aspects of the Project’s integrated water management strategy will function as a whole to reduce mercury loading. The BTPT for mercury includes pollution prevention, minimization, and toxics reduction through the following technologies and water management strategies. PolyMet will develop a Mercury Minimization Plan following the requirements presented in MPCA guidance to manage mercury reduction activities (Reference (23)).

9.3.1 Filtration Through Tailings

Filtration through tailings will remove mercury from tailings basin water. The Tailings Basin will serve as a central collection point for Project water. Process water will be recycled through the FTB Pond, and treated mine water will be routed from the WWTS to the FTB. Some tailings basin water will seep downward and be filtered through the tailings deposits. Several studies have shown that filtration through taconite tailings effectively reduces mercury concentrations, and that seepage from taconite tailings basins contains lower concentrations of mercury than water in tailings basin ponds, background surface water, or precipitation (Reference (44), Reference (45)). Tailings adsorb mercury from tailings basin water, which results in long-term sequestration of mercury within the tailings deposit (Reference (46)).

PolyMet conducted a bench-scale study to determine the effectiveness of filtration through Flotation Tailings in removing mercury from water (Reference (45)). The study focused on determining the rate and stability of adsorption of mercury by Flotation Tailings. The bench tests clearly demonstrated the ability of the Flotation Tailings to adsorb mercury and result in a significantly lower final dissolved mercury concentration. The ability of the Flotation Tailings to adsorb mercury, in conjunction with the proven ability of taconite tailings to absorb mercury (as demonstrated in the existing tailings basin and in literature), demonstrates that filtration through tailings can be expected to effectively remove mercury from tailings basin water, decreasing the mercury load in tailing basin seepage.

Existing mercury concentrations at the proposed Plant Site show the effect of tailings filtration and mercury sequestration. The lowest concentrations of mercury in Unnamed Creek, Trimble Creek, and Second Creek are generally measured at evaluation points closest to the headwaters, which are fed by seepage from the existing tailings basin. Existing mercury concentrations are higher at evaluation points further downstream, which have greater mercury inputs from atmospheric deposition and runoff (Table 8-1). Mercury concentrations in seepage are observed to vary somewhat depending on the seepage flow path, with slightly lower mercury concentrations in seepage to the south and slightly higher mercury concentrations in seepage to the north (Attachment F). Overall, filtration through tailings is expected to result in an average mercury concentration in seepage collected by the FTB seepage capture systems of approximately 1.0 ng/L (Section 6.9 of Reference (3)).
9.3.2 Seepage Capture

The FTB seepage capture systems will prevent nearly all the *tailings basin seepage* from reaching receiving and downstream waters (Reference (29)). They will also capture runoff from the exterior slopes of the tailings basin dams and from the narrow strip of land between the toe of the dams and the FTB seepage capture systems. The FTB Seepage Containment System will block seepage flow from reaching the Trimble Creek and Unnamed Creek subwatersheds. The South Seepage Management System will block seepage flow from reaching the Second Creek subwatershed. Collected seepage and runoff will be returned to the FTB Pond or routed to the WWTS for treatment.

The FTB Seepage Containment System will consist of a cutoff wall (a low–hydraulic-conductivity barrier) extending through the existing surficial deposits to bedrock, with a drainage collection system installed on the upgradient side, as shown in Figure 2-1 of Reference (29). Vertical risers extending above ground surface will collect runoff and surface seepage discharging upgradient of the cutoff wall. Refer to Sections 2.1.4 and 4.1.4 of Reference (29) for additional information on the design and operation of the FTB Seepage Containment System. The FTB Seepage Containment System permit application support drawings are included in Appendix A of Volume V.

Groundwater flow modeling indicated that the FTB Seepage Containment System will collect nearly all (at least 93%) of the *tailings basin seepage* that would otherwise flow to the north and west, and 100% of the *tailings basin seepage* that would otherwise flow to the east of the Tailings Basin (Attachment C of Reference (29)). Therefore, once the FTB Seepage Containment System is operational, tailings basin seepage and runoff from the areas upgradient of the cutoff wall will no longer flow to the wetlands north and west of the Tailings Basin, and seepage will be prevented from flowing to the east of the Tailings Basin.

PolyMet will continue to operate the existing SD026 pumpback system installed as part of the Consent Decree between Cliffs Erie and the MPCA, or will upgrade or replace this system, to collect seepage from the southern side of the Tailings Basin. This system will be called the FTB South Seepage Management System. Refer to Sections 2.1.3 and 4.1.3 of Reference (29) for additional information on the design and operation of the FTB South Seepage Management System.

9.3.3 Collection of Mine Site Water

Collection and treatment of *mine water*, which includes runoff from Mine Site areas with the potential to have higher mercury concentrations (such as the mine pits and the stockpiles), will prevent mercury associated with Mine Site activities from entering surface waters of the LSB. Mine water management and infrastructure are described in Section 2.2 of Volume II. The collected *mine water* will be routed to the WWTS for treatment.

9.3.4 Waste Water Treatment

The Project’s waste water treatment system is fully integrated to remove pollutants from *mine water* and *tailings basin seepage*, as described in Reference (6).
PolyMet’s review of other waste water treatment systems indicated that the combined water treatment processes of the WWTS, which will include membrane separation technology, exceed the level of treatment that is currently in place for any known waste water system discharging to the Partridge River or Embarrass River, or to any other streams within the St. Louis River watershed. In this regard, the proposed treatment is an example of advanced treatment that exceeds the best available technology and provides excellent protection of the environment.

The WWTS will treat tailings basin seepage and runoff collected by the FTB seepage capture systems. The design and expected performance of the WWTS are documented in Reference (6). The WWTS will be designed to achieve the mercury treatment target of 1.3 ng/L (Reference (6)).

In practice, the concentration of mercury in the WWTS discharge may be lower than 1.3 ng/L for several reasons. First, it is expected that the discharge concentration of mercury will be no greater than the influent concentration. The influent to the WWTS will be primarily tailings basin seepage, and the concentration of mercury in the future FTB seepage is expected to be similar to the concentration in the seepage from the existing LTVSMC tailings basin, which is approximately 1.0 ng/L (Section 6.9 of Reference (3)). Second, greensand filtration technology, combined with the use of an organic metal scavenger upstream, has been demonstrated to be capable of achieving the water column mercury standard through full-scale implementation by other industries in the Iron Range.

However, despite the expectation that the concentration of mercury in WWTS discharge will be similar to the concentration in tailings basin seepage, the Antidegradation Demonstration protectively assumes that the WWTS discharge will have a mercury concentration of 1.3 ng/L.

### 9.3.5 Transfer of Pollutants to Other Media

Minnesota Rules, part 7052.0320, subpart 3(B) requires that the BTPT analysis evaluate the effects of the transfer of pollutants to other media. The BTPT will result in transfer of mercury from water to the tailings deposits, where it will be sequestered through adsorption to solids. Sequestered mercury will become immobile and not affect groundwater. Waste water treatment at the WWTS will also result in transfer of mercury to WWTS residuals, which will be hauled to the Hydrometallurgical Residue Facility at the Plant Site or disposed in an approved off-site disposal facility as described in Section 4.3.6.3 of Reference (6).

### 9.4 The Project Will Support Important Social and Economic Development in the Area

Section 7.5 demonstrates that the Project will support important social and economic development in the surrounding communities and the Arrowhead Region.

### 9.5 Outstanding Resource Value Waters Will Be Protected

The Project will not directly discharge to an ORVW. Lake Superior, which is located approximately 175 river miles downstream of the Project, is classified as a restricted ORVW, and limited segments of the lake are classified as prohibited ORVWs. The WWTS discharge and related activities will have no measurable effect on the average mercury concentration at the evaluation point on the St. Louis River at Scanlon,
which is approximately 32 river miles upstream of Lake Superior (Table 8-2). Furthermore, the estimated effect of the Project will be to slightly reduce mercury loading to the St. Louis River, as shown on Large Figure 7. Therefore, the Project will not degrade any downstream ORVW (any portion of Lake Superior) with respect to mercury, in accordance with Minnesota Rules, part 7052.0300, subpart 1(B) and Minnesota Rules, part 7050.0265, subparts 6 and 7.

9.6 Waters Will Be Protected from Thermal Discharges

Section 7.7 demonstrates that waters will be protected from thermal discharges.
10.0 Other Permitting Considerations Related to Antidegradation

10.1 Prohibition Against Causing or Contributing to a Violation of Water Quality Standards

The CWA prohibits issuance of a permit for a new discharge or new discharger that will “cause or contribute to the violation of water quality standards” in certain waterbodies (40 C.F.R. 122.4(i)). PolyMet has designed the Project so that the concentration of all parameters of concern in the WWTS discharge, including mercury, will be at or below applicable water quality standards. Because of this design, as explained in more detail below, the Project’s effect will be to either maintain compliance with Minnesota’s water quality standards in receiving and downstream waters or, through a reduction in pollutant concentrations and/or reduction of loading, to actually improve water quality (Table 3-2).

For most parameters of concern, at evaluation points on receiving and downstream waters the existing concentrations are below applicable standards and estimated Mine Year 10 concentrations are below applicable standards (Large Table 2, Large Table 3, and Large Table 4). In these situations, the discharge will not cause a violation of water quality standards.

Existing concentrations of a limited number of parameters of concern are above applicable water quality standards at some evaluation points. The WWTS discharge and related activities will not contribute to these existing exceedances of water quality standards, as discussed below:

- Existing mercury concentrations are above the applicable standard in two of the receiving waters: the wetlands near the Trimble Creek outfalls and the wetlands near the Unnamed Creek outfalls. After application of BTPT to the discharge and operation of the FTB Seepage Containment System, it is estimated that mercury concentrations in the receiving waters at the outfalls will be at or below the applicable mercury water column standard of 1.3 ng/L (Table 8-2). There is an estimated decrease in mercury concentration in the wetlands at the Trimble Creek outfalls and the wetlands at the Unnamed Creek outfalls, and while this decrease is not expected to be measurable, the estimated decrease nonetheless confirms that the Project will not contribute to any of the current exceedances.

- Existing mercury concentrations are also above the applicable Minnesota numeric standard at evaluation points on downstream waters, largely due to atmospheric deposition unrelated to the Project, as explained previously. The WWTS discharge and related activities are expected to have no measurable effect upon mercury concentrations in these waters; however, the Project is estimated, through application of BTPT to the discharge and operation of the FTB Seepage Containment System, to reduce mercury loading to these waters (Section 8.3.2). In this way, the Project is expected to improve water quality with regard to mercury at evaluation points on downstream waters, not contribute to the current exceedances.
Existing values of hardness, TDS, and specific conductance are higher than applicable Class 3 and 4 numeric standards at MNSW8 on Second Creek. As with all parameters of concern, the concentrations of hardness, TDS, and specific conductance in the WWTS discharge will be at or below all applicable water quality standards and will thus be lower than the existing conditions values at evaluation points in Second Creek (PM–7/SD026 and MNSW8) (Large Table 2 and Large Table 4), respectively. Because of the lower values in the discharge, the discharge will have a diluting effect upon existing values of hardness, TDS, and specific conductance. The effect of the discharge is estimated to decrease the hardness at MNSW8, and to decrease the concentrations of constituents that contribute to values of TDS and specific conductance, although no measurable decrease in TDS or specific conductance is expected. Therefore, the Project is expected to improve water quality with regard to hardness, TDS, and specific conductance at MNSW8, not contribute to the current exceedances.

10.2 Waters of Downstream States

The St. Louis River forms the northeastern border of the Fond du Lac (FDL) Reservation (Reservation) (Large Figure 3). The Fond du Lac Band of Lake Superior Chippewa (Band) has been granted “treatment as state” (TAS) status under the CWA, and the Band has developed its own water quality standards and antidegradation requirements. The Band has designated the St. Louis River within the Reservation boundaries as a Class B (wildlife) water, with water quality standards as listed in Table 10-1. Tribal standards are generally the same as State of Minnesota standards for corresponding parameters with one exception; mercury. While the Minnesota mercury standard is 1.3 ng/L, the tribal standard is lower: 0.77 ng/L. To the extent the Band’s requirements need to be considered in connection with the Project, which may not be the case, PolyMet’s analysis follows:

Table 10-1 Surface Water Standards of the Fond du Lac Reservation and the State of Minnesota

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>State of Minnesota</th>
<th>FDL Reservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>Al</td>
<td>µg/L</td>
<td>125(3)</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb</td>
<td>µg/L</td>
<td>31(3)</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>µg/L</td>
<td>53(4)</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B</td>
<td>µg/L</td>
<td>500(6)</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(4)(5)</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>µg/L</td>
<td>11(4)</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co</td>
<td>µg/L</td>
<td>5.0(3)</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.3(4)(5)</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>µg/L</td>
<td>3.2(3)(5)</td>
</tr>
<tr>
<td>Mercury (total)</td>
<td>Hg</td>
<td>ng/L</td>
<td>1.3(4)</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni</td>
<td>µg/L</td>
<td>52(4)(5)</td>
</tr>
<tr>
<td>Parameter</td>
<td>Units</td>
<td>State of Minnesota</td>
<td>FDL Reservation</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------</td>
<td>--------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se µg/L</td>
<td>5.0 (4)</td>
<td>5.0</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag µg/L</td>
<td>1.0 (3)</td>
<td>None</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>Tl µg/L</td>
<td>0.56 (3)</td>
<td>None</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn µg/L</td>
<td>120 (4)(5)</td>
<td>120</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl - mg/L</td>
<td>230 (3)</td>
<td>None</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>500 (7)</td>
<td>None</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5 (3)</td>
<td>Not permitted to fluctuate in excess of 1.0 unit over 24 hours</td>
</tr>
<tr>
<td>Specific conductance</td>
<td>µmhos/cm at 25°C</td>
<td>1,000 (6)</td>
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</tr>
<tr>
<td>Sulfate</td>
<td>SO₄²⁻ mg/L</td>
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<td>10 (8)</td>
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<td>Temperature</td>
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<td>Variable (10)</td>
</tr>
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<td>Total Dissolved Solids</td>
<td>TDS mg/L</td>
<td>700 (6)</td>
<td>None</td>
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</table>

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rules, chapter 7052 standard exists, the Minnesota Rules, chapter 7052 standard governs over the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) Appendix 1 of Fond du Lac (FDL) Band of Lake Superior Chippewa Water Quality Standards of the FDL Reservation, Ordinance #12/98 as amended.
(3) Minnesota Rules, part 7050.0222 Class 2B
(4) Minnesota Rules, part 7052.0100 Class 2B
(5) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L.
(6) The sulfate standard of 10 mg/L for waters “used for production of wild rice” applies, subject to various conditions, to waters listed as wild rice waters. None of the receiving or downstream waters are listed as wild rice waters.
(7) Minnesota Rules, part 7050.0223 Class 3C
(8) Per subpart m in the general standards provided in Section 301 of FDL Band of Lake Superior Chippewa Water Quality Standards of the FDL Reservation Ordinance #12/98: “Any lake or stream which supports wild rice growth shall not exceed instantaneous maximum sulfate levels of 10 mg/L.”
(9) For unlisted waters, except wetlands: “5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 86°F.” (Minnesota Rules, part 7050.0222, subpart 4). For unlisted wetlands: maintain background.
(10) The introduction of heat by other than natural causes shall not increase the temperature of Reservation waters by more than 3°F from ambient temperatures for Reservation lakes, and 5°F from ambient temperatures for Reservation streams above that which existed before the addition of heat, based upon the monthly average of daily maximum temperature. The normal daily and seasonal variations that were present before the addition of heat from other than natural sources, and which are outside the mixing zone, shall be maintained.

For parameters other than mercury, the potential effects of the WWTS discharge and related activities on the reach of the St. Louis River within the Reservation boundaries were assessed using the results of the Antidegradation Assessment for USGS 04024000 at Scanlon, which is located on the St. Louis River near the downstream boundary of the Reservation. Section 6.3.6 demonstrates that at Scanlon, the Project is expected to have no measurable effects for the parameters of concern for which the Band has designated water quality standards (arsenic, cadmium, chromium, copper, nickel, selenium, zinc, pH, sulfate, and temperature, as shown in Large Table 4). Therefore, for these parameters of concern, there will be no
“lowering of water quality,” (as defined by FDL 12-98 § 105 (b)(2)) in the reach of the St. Louis River within the Reservation boundaries.

For mercury, the potential effects of the WWTS discharge and related activities on the reach of the St. Louis River within the Reservation boundaries were assessed using the results of the mercury Antidegradation Demonstration for EP–1, in Forbes, which is upstream of the Reservation, and EP–2 in Cloquet, which is downstream of the Reservation. Section 8.3.2 demonstrates that at those evaluation points, the Project is expected to result in a reduction in annual mercury loading, and not to cause any measurable increase in mercury water column concentrations. Because the Project is estimated to reduce mercury loading in the reach of the St. Louis River within the Reservation boundaries, the differing mercury standards of the State and Band do not affect the analysis. Therefore, if the Band's mercury water quality standards were applicable in this instance, the Project will not cause or contribute to any violation of the FDL mercury standard, and there will be no “lowering of water quality” (as defined by FDL 12-98 § 105 (b)(2)) in the reach of the St. Louis River within the Reservation boundaries.

The WWTS discharge and related activities also will not cause or contribute to a lowering of water quality of any other downstream TAS or state. Therefore, no additional analysis of other downstream states or tribes is required.
11.0 References


4. —. Antidegradation Assessment - NorthMet Project Section 401 Certification. forthcoming.


30. **University of Minnesota, Duluth, Bureau of Business and Economic Research; Labovitz School of Business and Economics.** NorthMet Economic Impact 2011 Update: Economic Impact of PolyMet’s NorthMet Project on St. Louis County, Minnesota. Revised April 2012.


Large Tables
<table>
<thead>
<tr>
<th>Parameter(1)</th>
<th>Units</th>
<th>Substances, Characteristics, or Pollutants</th>
<th>Class 2B(2)</th>
<th>Class 3C</th>
<th>Class 4A</th>
<th>Class 4B</th>
<th>Class S</th>
<th>Class 2D(3)</th>
<th>Class 3D</th>
<th>Class 4C</th>
<th>Class S</th>
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<td>mg/L</td>
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<td>60% of total cations</td>
<td>None</td>
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<td>None</td>
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<td>None</td>
<td>60% of total cations</td>
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<td>(MN Rules, part 7050.0224, subpart 6)</td>
<td>(MN Rules, part 7050.0225, subpart 5)</td>
<td>(MN Rules, part 7050.0226, subpart 4)</td>
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<td>Metals and Elements</td>
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<tr>
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<td>125</td>
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<tr>
<td>Antimony, total</td>
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<td>31</td>
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<tr>
<td>Arsenic, total</td>
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<tr>
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<tr>
<td>Cadmium, total</td>
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<td>20(17)</td>
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<td>20(17)</td>
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<td>Chromium +6, total</td>
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<td>11</td>
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<tr>
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<td>5.0</td>
<td>5.0</td>
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<tr>
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<td>9.8(17)</td>
<td>9.3(17)</td>
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<td>3.2(17)</td>
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<td>Mercury, total in water</td>
<td>ng/L</td>
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<td>1.3</td>
<td>1.3</td>
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<td>0.2</td>
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<td>15(17)</td>
<td>15(17)</td>
<td>15(17)</td>
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<td>1.0</td>
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<td>Zinc, total</td>
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<td>120(17)</td>
<td>120(17)</td>
<td>120(17)</td>
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</tbody>
</table>

Bold text designates parameters of concern for the Antidegradation Evaluation, as described in Section 5.1.

(1) Water quality standards have also been promulgated for specific organic pollutants or characteristics; these organic parameters are not included in this table because they are not reasonably expected to be present in the discharge.

(2) The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, the Minnesota Rules, chapter 7052 standard supersedes the Minnesota Rules, chapter 7050 standards, even if the Minnesota Rules, chapter 7052 standard is less stringent.

(3) All surface waters of the state that have not been listed in part 7050.0186 and that are not wetlands as defined in part 7050.0186, subpart 1a, are hereby classified as Class 2B, 3C, 4A, 4B, 5, and 6 waters. (Minnesota Rules, part 7050.0430)

(4) Those waters of the state that are wetlands as defined in part 7050.0186, subpart 1a, and that are not listed in part 7050.0470 are classified as Class 2D, 3D, 4C, 5, and 6 waters. (Minnesota Rules, part 7050.0425)

(5) Class 2 water quality standards in Minnesota Rules, parts 7050.0222 and 7050.0100 include chronic standards (CS), maximum standards (MS), and final acute values (FAV); the most stringent of these standards is listed for each parameter.

(6) Water quality standards for surface waters of the state in the Lake Superior Basin.

(7) Maintain background means the concentration of the water quality substances, concentrations or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses. (Minnesota Rules, part 7050.0226, subpart 4)

(8) "Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31." (Minnesota Rules, part 7050.0223, subpart 4)

(9) "5.0 mg/L daily minimum. This dissolved oxygen standard may be modified on a site-specific basis according to part 7050.0220, subpart 7, except that no site-specific standard shall be less than 5 mg/L as a daily average and 4 mg/L as a daily minimum. Compliance with this standard is required 50 percent of the days at which the flow of the receiving water is equal to the 7Q10." (Minnesota Rules, part 7050.0222, subpart 4)

(10) "If background is less than 5.0 mg/L as a daily minimum, maintain background." (Minnesota Rules, part 7050.0222, subpart 6(A))
(11) "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." (Minnesota Rules, part 7050.0222, subpart 4 and part 7050.0224, subparts 2 and 3)
(12) "Shall not be allowed in concentrations sufficient to create the potential for significant adverse impacts on one or more designated uses." (Minnesota Rules, part 7050.0224, subpart 4)
(13) The proposed receiving and downstream waters are not listed wild rice waters, so the sulfate standard of 50 mg/L for waters "used for production of wild rice" is not applicable.
(14) "Applicable to water 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)
(15) "5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperatures, except in no case shall it exceed the daily average temperature of 86°F." (Minnesota Rules, part 7050.0222, subpart 4)
(16) "None at levels harmful either directly or indirectly" (Minnesota Rules, part 7050.0224, subpart 3)
(17) The Class 2 water quality standards for cadmium, chromium +3, copper, lead, nickel, and zinc are hardness dependent. The listed values assume a hardness of 100 mg/L.
## Table 1: Existing and Estimated Mine Year 10 Water Quality in Receiving Waters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(a)</th>
<th>Reporting Limit (PQL) or LCS Acceptance Limit</th>
<th>Second Creek Headwater Segment (DiD06/PM-7)</th>
<th>Trimble Creek Headwater Wetlands(b)</th>
<th>Unnamed Creek Headwater Wetlands(c)</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Range</td>
<td></td>
<td>Range</td>
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<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
<td>mg/L</td>
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<td>mg/L</td>
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<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
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<td>2</td>
<td>18.4</td>
<td>15.6 - 21.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.3</td>
<td>0.86</td>
<td>0.7 - 1</td>
<td>0.3</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>0.62</td>
<td>0.5 - 0.7</td>
<td>10</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>None</td>
<td>100</td>
<td>210</td>
<td>179 - 242</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.3</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.71</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11</td>
<td>1</td>
<td>n.d.</td>
<td>N/A</td>
<td>5.3</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5.0</td>
<td>0.2</td>
<td>0.54</td>
<td>0.46 - 0.62</td>
<td>5</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.1</td>
<td>0.5</td>
<td>1.11</td>
<td>0.9 - 1.3</td>
<td>9</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2</td>
<td>0.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.31</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>52</td>
<td>0.5</td>
<td>1.32</td>
<td>1.1 - 1.5</td>
<td>50</td>
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<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5.0</td>
<td>1</td>
<td>n.d.</td>
<td>N/A</td>
<td>1.6</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>1.0</td>
<td>0.2</td>
<td>0.25</td>
<td>0.21 - 0.29</td>
<td>0.21</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>0.26</td>
<td>0.22 - 0.3</td>
<td>0.16</td>
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<tr>
<td>Zn (total)</td>
<td>µg/L</td>
<td>120</td>
<td>10</td>
<td>8.20</td>
<td>7 - 9.4</td>
<td>57</td>
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<td></td>
<td></td>
<td>mg/L</td>
<td></td>
<td>mg/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>11.5</td>
<td>10.3 - 12.5</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>500</td>
<td>Maintain Background</td>
<td>10</td>
<td>439</td>
<td>373.2 - 504.9</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>Maintain Background</td>
<td>0.01</td>
<td>7.83</td>
<td>7.67 - 7.99</td>
</tr>
<tr>
<td>Solids, total dissolved</td>
<td>mg/L</td>
<td>700</td>
<td>None</td>
<td>10</td>
<td>650</td>
<td>520 - 780</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO₄²⁻</td>
<td>mg/L</td>
<td>None</td>
<td>1</td>
<td>173</td>
<td>154.8 - 188.2</td>
</tr>
</tbody>
</table>

**n.d.**  - All measured values are below reporting limits or the average value is below the reporting limit.

**N/A** - The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(a) Existing conditions estimated based on stream monitoring data from TC-1a (2012 - 2015) as discussed in Section 5.5.
(b) Existing conditions estimated based on stream monitoring data from PM-11 (2004 – 2015) as discussed in Section 5.5.
(c) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure using the LCS acceptable criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.5.

*Estimated Water Quality is equal to the average value of monitoring results, calculated using the LCS acceptable criteria.*
<table>
<thead>
<tr>
<th></th>
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</tr>
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<tr>
<td><strong>Metals</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Aluminum (total) or dissolved (total)</td>
<td>Al</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>16.1 / 22.4</td>
<td>N/A</td>
<td>19.6</td>
<td>17.0 / 29.5</td>
<td>N/A</td>
<td>39.2</td>
<td>49.0 / 187</td>
<td>N/A</td>
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<tr>
<td>Antimony (total)</td>
<td>Sb</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>n.d.</td>
<td>N/A</td>
<td>5.2(7)</td>
<td>n.d.</td>
<td>N/A</td>
<td>3.9(7)</td>
<td>n.d.</td>
<td>N/A</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>µg/L</td>
<td>15</td>
<td>0.5</td>
<td>0.87</td>
<td>0.74 -</td>
<td>1</td>
<td>8.9(7)</td>
<td>0.87</td>
<td>0.74 -</td>
<td>1</td>
<td>7(7)</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>138</td>
<td>117 - 159</td>
<td>159</td>
<td>207</td>
<td>176 - 238</td>
<td>124</td>
<td>n.d</td>
<td>N/A</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(9)</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.6(10)</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.46(20)</td>
<td>n.d.</td>
<td>N/A</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>0.23</td>
<td>0.2 - 0.26</td>
<td>4.5(11)</td>
<td>0.30</td>
<td>0.26 - 0.35</td>
<td>1.7(11)</td>
<td>0.44</td>
<td>0.37 - 0.51</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.3(11)</td>
<td>0.5</td>
<td>0.52</td>
<td>0.44 - 0.6</td>
<td>7.9(11)</td>
<td>0.93</td>
<td>0.79 - 1.07</td>
<td>6(11)</td>
<td>1.32</td>
<td>1.12 - 1.52</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>µg/L</td>
<td>3.2(12)</td>
<td>0.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>2(7)</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.76(7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni</td>
<td>µg/L</td>
<td>52(12)</td>
<td>0.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>41.1(12)</td>
<td>0.68</td>
<td>0.58 - 0.78</td>
<td>31.9(7)</td>
<td>1.46</td>
<td>1.2 - 1.7</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.2 (n.d.)</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.2 (n.d.)</td>
<td>n.d.</td>
<td>N/A</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>Tl</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>n.d.</td>
<td>N/A</td>
<td>0.14(9)</td>
<td>0.12</td>
<td>0.1 - 0.14</td>
<td>0.11</td>
<td>0.135</td>
<td>0.11 - 0.16</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>µg/L</td>
<td>120(12)</td>
<td>6</td>
<td>n.d.</td>
<td>N/A</td>
<td>48.3(12)</td>
<td>n.d.</td>
<td>N/A</td>
<td>37.1(7)</td>
<td>6.97</td>
<td>5.9 - 8</td>
</tr>
<tr>
<td><strong>General Parameters</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>17.3</td>
<td>15.6 - 19</td>
<td>Not Available(8)</td>
<td>17.0</td>
<td>15.3 - 18.7</td>
<td>Not Available(8)</td>
<td>7.28</td>
<td>6.6 - 8</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td></td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>331</td>
<td>281 - 381</td>
<td>114</td>
<td>373</td>
<td>317 - 429</td>
<td>85.4</td>
<td>139</td>
<td>118 - 160</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>SU</td>
<td>6.5-8.5</td>
<td>0.01</td>
<td>7.37</td>
<td>7.17 - 7.57</td>
<td>Not Available(8)</td>
<td>7.56</td>
<td>7.36 - 7.76</td>
<td>Not Available(8)</td>
<td>7.42</td>
<td>7.22 - 7.62</td>
</tr>
<tr>
<td>Solids, total dissolved</td>
<td></td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>474</td>
<td>379 - 569</td>
<td>111-145(31)</td>
<td>492</td>
<td>394 - 590</td>
<td>157-204(31)</td>
<td>227</td>
<td>182 - 272</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C</td>
<td>μhos/cm</td>
<td>1,000</td>
<td>0</td>
<td>723</td>
<td>716 - 730</td>
<td>148-181(12)</td>
<td>793</td>
<td>785 - 801</td>
<td>246-304(12)</td>
<td>284</td>
<td>281 - 287</td>
<td>170-208(12)</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO4</td>
<td>mg/L</td>
<td>None(14)</td>
<td>1</td>
<td>51.4</td>
<td>46.3 - 56.5</td>
<td>8.3</td>
<td>115</td>
<td>103 - 125</td>
<td>7</td>
<td>53.3</td>
<td>48 - 58.6</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits, the average value is below the reporting limit, or the estimated value is below the typical reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit. Also, the LCS acceptance range is not presented for aluminum, because assessment of whether the Project will cause a measurable change from existing concentrations is made by an alternate method, as described in Section 6.2.1.1.

(1) GoldSim modeling used historical monitoring location TC-1. Existing water data were collected at the TC-1 evaluation point which is located less than a mile downstream of the location of TC-1.

(2) The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(3) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Laboratory control sample (LCS) acceptance range is calculated from the existing concentration using LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6.

(6) Average of P50 monthly results for Mine Year 10 from the GoldSim water modeling conducted for the FEIS. Mine Year 10 is used because it is the year of maximum discharge from the WWTS.

(7) Anticipated value would likely represent a measurable increase from average existing water quality. A measurable increase is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(8) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the discharge.

(9) Anticipated chloride values are not available at TC-1a, PM-11, and PM-13 because FEIS water modeling results at these evaluation points are not representative of anticipated conditions. See Table 3-1.

(10) pHe was not included in GoldSim Modeling.

(11) Based on mass of median anticipated dissolved water quality parameters based on GoldSim modeling downstream of WWTP discharge. Estimated TDS values were adjusted for uncertainty based on monitoring data (Appendix A).

(12) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall projected water quality using several empirical methods and adjusted for uncertainty based on monitoring data (Appendix A).

(13) Trimble Creek, Unnamed Creek and the Embarrass River at PM-13 are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(a)</th>
<th>Reporting Limit (PQL(b))</th>
<th>Existing Water Quality(c) (2008-2009 Data)</th>
<th>LCS Acceptance Range(d)</th>
<th>Estimated Water Quality Year 2010(e)</th>
<th>Existing Water Quality Year 2009(f)</th>
<th>LCS Acceptance Range(g)</th>
<th>Estimated Water Quality Year 2010(h)</th>
<th>Existing Water Quality Year 2009(i)</th>
<th>LCS Acceptance Range(j)</th>
<th>Estimated Water Quality Year 2010(k)</th>
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<tbody>
<tr>
<td><strong>Metals</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>35.9</td>
<td>N/A</td>
<td>35.6</td>
<td>96.5</td>
<td>N/A</td>
<td>96.3</td>
<td>100</td>
<td>N/A</td>
<td>100</td>
</tr>
<tr>
<td>Antimony</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>0.11 (n.d.)</td>
<td>N/A</td>
<td>0.29 (n.d.)</td>
<td>0.12 (n.d.)</td>
<td>N/A</td>
<td>0.15 (n.d.)</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>Argentic</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>1.42</td>
<td>1.11 – 1.63</td>
<td>1.61</td>
<td>1.04</td>
<td>0.88 – 1.18</td>
<td>1.08</td>
<td>1.47</td>
<td>1.25 – 1.69</td>
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</tr>
<tr>
<td>Boron</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>107</td>
<td>91 – 123</td>
<td>105</td>
<td>108</td>
<td>91.8 – 124</td>
<td>108</td>
<td>112</td>
<td>95.2 – 129</td>
<td>111</td>
</tr>
<tr>
<td>Cadmium</td>
<td>µg/L</td>
<td>2.5</td>
<td>0.2</td>
<td>0.08 (n.d.)</td>
<td>N/A</td>
<td>0.10 (n.d.)</td>
<td>0.09 (n.d.)</td>
<td>N/A</td>
<td>0.09 (n.d.)</td>
<td>1.36</td>
<td>1.16 – 1.56</td>
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<tr>
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<td>µg/L</td>
<td>11</td>
<td>1</td>
<td>0.71 (n.d.)</td>
<td>N/A</td>
<td>0.85 (n.d.)</td>
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<td>N/A</td>
<td>0.62 (n.d.)</td>
<td>6.40</td>
<td>5.44 – 7.36</td>
<td>6.42</td>
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<tr>
<td>Cobalt</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>0.73</td>
<td>0.62 – 0.84</td>
<td>0.84</td>
<td>0.50</td>
<td>0.43 – 0.58</td>
<td>0.52</td>
<td>1.49</td>
<td>1.27 – 1.71</td>
<td>1.50</td>
</tr>
<tr>
<td>Copper</td>
<td>µg/L</td>
<td>9.3</td>
<td>0.5</td>
<td>1.18</td>
<td>1.00 – 1.36</td>
<td>1.40</td>
<td>3.17</td>
<td>2.69 – 3.65</td>
<td>3.24</td>
<td>7.50</td>
<td>6.37 – 8.63</td>
<td>7.53</td>
</tr>
<tr>
<td>Lead</td>
<td>µg/L</td>
<td>3.2</td>
<td>0.5</td>
<td>0.27 (n.d.)</td>
<td>N/A</td>
<td>0.33 (n.d.)</td>
<td>0.29 (n.d.)</td>
<td>N/A</td>
<td>0.30 (n.d.)</td>
<td>1.77</td>
<td>1.50 – 2.04</td>
<td>1.78</td>
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<tr>
<td>Nickel</td>
<td>µg/L</td>
<td>5.2</td>
<td>0.5</td>
<td>4.12</td>
<td>3.50 – 4.74</td>
<td>5.54</td>
<td>3.64</td>
<td>3.09 – 4.19</td>
<td>3.95</td>
<td>1.15</td>
<td>0.98 – 1.52</td>
<td>1.27</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>5</td>
<td>1</td>
<td>0.97 (n.d.)</td>
<td>N/A</td>
<td>1.00</td>
<td>0.85 (n.d.)</td>
<td>N/A</td>
<td>0.66 (n.d.)</td>
<td>1.00</td>
<td>0.85 – 1.15</td>
<td>1.00</td>
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<tr>
<td>Silver</td>
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<td>0.2</td>
<td>0.07 (n.d.)</td>
<td>N/A</td>
<td>0.08 (n.d.)</td>
<td>0.05 (n.d.)</td>
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<td>0.05 (n.d.)</td>
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<td>Not Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>Thallium</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>0.20</td>
<td>0.17 – 0.23</td>
<td>0.20</td>
<td>0.20</td>
<td>0.17 – 0.23</td>
<td>0.20</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>Zinc</td>
<td>µg/L</td>
<td>120</td>
<td>6</td>
<td>5.11 (n.d.)</td>
<td>N/A</td>
<td>6.60</td>
<td>3.81 (n.d.)</td>
<td>N/A</td>
<td>4.03 (n.d.)</td>
<td>18.8</td>
<td>16.0 – 21.6</td>
<td>18.9</td>
</tr>
<tr>
<td><strong>General Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>16.5</td>
<td>14.8 – 18.3</td>
<td>15.9</td>
<td>7.1</td>
<td>6.4 – 7.8</td>
<td>7.0</td>
<td>8.2</td>
<td>7.4 – 9</td>
<td>8.2</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>806</td>
<td>685 – 927</td>
<td>795</td>
<td>356</td>
<td>303 – 409</td>
<td>361</td>
<td>80</td>
<td>68 – 92</td>
<td>78.7</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>6.5 – 8.5</td>
<td>0.01</td>
<td>7.99</td>
<td>N/A</td>
<td>Not Available</td>
<td>7.66</td>
<td>N/A</td>
<td>Not Available</td>
<td>7.40</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>µhos/cm</td>
<td>1,000</td>
<td>0</td>
<td>1336</td>
<td>N/A</td>
<td>Not Available</td>
<td>700</td>
<td>N/A</td>
<td>Not Available</td>
<td>189</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>None</td>
<td>1</td>
<td>472</td>
<td>425 – 539</td>
<td>464</td>
<td>202</td>
<td>182 – 222</td>
<td>205</td>
<td>19.7</td>
<td>17.7 – 21.7</td>
<td>19.1</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>967</td>
<td>N/A</td>
<td>Not Available</td>
<td>452</td>
<td>N/A</td>
<td>Not Available</td>
<td>150</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
</tbody>
</table>

**Notes:**
- N/A = Not available.
- Bold text – value is above the applicable standard

(b) The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7052 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(c) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting USEPA criteria for laboratory accuracy and precision).
(d) Includes estimated constituent mass flux and flow from average discharge from Area 1 Pit and Area 2W Pit and seepage from Area 6 Pit, added to average value of monitoring results, calculated using average values of duplicate samples and including results below analytical detection limits at half the value of the detection limit, average mass flux and flow in stream monitoring data (See Attachment C).
(e) Laboratory control sample (LCS) acceptance range is calculated from the existing concentration using the LCS acceptable criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value.
(f) Calculated using mass balance methods described in Attachment C.
(g) Not Available
(h) Total metals at MNMRW and MNMRW2, and dissolved metals at USGS #04024000.
(i) Existing conditions monitoring data for Sn and Tl not available at USGS #04024000.
(j) Anticipated value would likely represent a measurable increase from existing water quality. A measurable increase is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. Please refer to Section 5.6.
(k) Surface water quality standards are hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the discharge.
(l) Existing conditions monitoring data for Sn and Tl not available at USGS #04024000.
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimble Creek</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>designated use (48)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 472 mg/L at MNSW8</td>
</tr>
<tr>
<td>Unnamed Creek</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>designated use (48)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 472 mg/L at MNSW8</td>
</tr>
<tr>
<td>Second Creek upstream of MNSW8</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>designated use (48)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 122 mg/L at PM-13</td>
</tr>
<tr>
<td>Second Creek downstream of MNSW8</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>designated use (48)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 122 mg/L at PM-13</td>
</tr>
<tr>
<td>Embarrass River from confluence Trimble Creek to PM-13</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (3C)</td>
<td>yes</td>
<td>designated use (4A)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 202 mg/L at NM5SW12</td>
</tr>
<tr>
<td>Embarrass River downstream of PM-13</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (3C)</td>
<td>yes</td>
<td>designated use (4A)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 19.7 mg/L at USGS #04024000</td>
</tr>
<tr>
<td>Partridge River downstream of confluence with Second Creek</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (3C)</td>
<td>yes</td>
<td>designated use (4A)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 19.7 mg/L at USGS #04024000</td>
</tr>
<tr>
<td>St. Louis River downstream of confluence with Partridge River</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2B)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (3C)</td>
<td>yes</td>
<td>designated use (4A)</td>
<td>yes</td>
<td>yes</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>natural wild rice stands</td>
<td>SO₄ 19.7 mg/L at USGS #04024000</td>
</tr>
</tbody>
</table>
### Table 6: Determination of Existing Uses at Surface Water Discharge Outfalls in Receiving Wetlands

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands at headwater area of Trimble Creek</td>
<td>yes</td>
<td>yes</td>
<td>No</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2D)</td>
<td>yes</td>
<td>no</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands at headwater area of Unnamed Creek</td>
<td>yes</td>
<td>yes</td>
<td>No</td>
<td>yes</td>
<td>yes</td>
<td>designated use (2D)</td>
<td>yes</td>
<td>no</td>
<td>designated use (5)</td>
<td>none</td>
<td>N/A</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Designated Beneficial Uses**
- Healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats
- General industrial purposes, except for food processing
- Suitable for erosion control, groundwater recharge, low flow augmentation, stormwater retention, and stream sedimentation
- Aesthetic enjoyment of scenery
- Avoid any interference with navigation or damaging effects on property

**Parameters associated with designated beneficial uses**
- Al, Sb, As, Cd, Cr, Co, Pb, Ni, Se, Ti, Zn, Cl, Temp, pH
- Cl, Hardness, pH
- pH

**undesignated uses**
- Actual uses which are not designated uses
Large Figures
These are provisional representations of PWI watercourses found on the current paper regulatory maps.

The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.

Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.

Surface Water Discharge Outfalls and Antidegradation Evaluation Points
NorthMet Project
Poly Met Mining Inc.

Large Figure 1
Surface Water Nondegradation/Antidegradation Evaluation Points
NorthMet Waste Water Treatment System (WWTS) Discharge
Permit Application Update - October 2017
These are provisional representations of PWI watercourses found on the current paper regulatory maps. The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps. Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.
PROJECT LOCATION IN LAKE SUPERIOR BASIN
NorthMet Project
Poly Met Mining Inc.

Large Figure 3
Surface Water Nondegradation/Antidegradation Evaluation
NorthMet Waste Water Treatment System (WWTS) Discharge
Permit Application Update - October 2017

- USGS Monitoring Station Evaluation Location
- Major Rivers
- EIS Project Areas
- Reservation
- St. Louis River Watershed
- Partridge River Watershed
- Embarrass River Watershed
1 These are provisional representations of PWI watercourses found on the current paper regulatory maps.

2 The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.

Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.
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MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.

The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from

National Hydrography Dataset (NHD)

Public Waters Inventory (PWI) Watercourses

MPCA Recommendation to PolyMet (Aug.1, 2012)

Proposed Railroad Track

Existing Private Railroad

Electric Transmission Lines

EIS Project Areas

These are provisional representations of PWI watercourses found on the current paper regulatory maps.

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The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from

National Hydrography Dataset (NHD)

Public Waters Inventory (PWI) Watercourses

MPCA Recommendation to PolyMet (Aug.1, 2012)

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YEAR 10 COMPARED TO EXISTING CONDITIONS

PUBLIC WATERS INVENTORY (PWI) WATERCOURSES

Surface Water Nondegradation/Antidegradation Evaluation

Permit Application Update - October 2017

MERCURY CONCENTRATIONS DURING MINE YEAR 10 COMPARED TO EXISTING CONDITIONS

NorthMet Project
Poly Met Mining Inc.

Large Figure 6
Surface Water Nondegradation/Antidegradation Evaluation
NorthMet Waste Water Treatment System (WWTS) Discharge
Permit Application Update - October 2017
Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.
Attachments
Attachment A

Total Dissolved Solids and Specific Conductance Estimates
Technical Memorandum

To: Melisa Pollak
From: Alison Ling
Subject: NorthMet Antidegradation Evaluation Total Dissolved Solids and Specific Conductance Estimates
Date: August 14, 2017
Project: 23690862
cc: Don Richard, Jeff Ubl, Tina Pint, Keith Hanson

1.0 Introduction and Background

This memo describes methods and associated assumptions and sources of uncertainty for estimation of total dissolved solids (TDS) and specific conductance at 25°C in Waste Water Treatment System (WWTS) discharge and at three locations in the Embarrass River Watershed downstream of the WWTS surface water discharge outfalls. TDS and specific conductance are bulk water quality parameters that reflect the cumulative quantity and character of dissolved constituents. Table 1-1 identifies the source of the estimated water quality that was used for the TDS and specific conductance calculations.

Table 1-1 Sources of Estimated Water Quality Used for TDS and Specific Conductance Calculations

<table>
<thead>
<tr>
<th>Location</th>
<th>Source of Estimated Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS Anticipated Discharge</td>
<td>WWTS discharge quality as assumed for the antidegradation evaluation(1)</td>
</tr>
<tr>
<td>Trimble Creek at TC-1(2)</td>
<td>Projected median (P50) concentrations of individual constituents from GoldSim model results for Mine Year 10(3)</td>
</tr>
<tr>
<td>Unnamed Creek at PM-11</td>
<td></td>
</tr>
<tr>
<td>Embarrass River at PM-13</td>
<td></td>
</tr>
</tbody>
</table>

(1) Refer to Table 3-2 of Appendix A of Volume III of the NPDES/SDS Permit Application
(2) TC-1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC-1a, which is located less than one mile downstream of TC-1. Average water quality data presented in this report are based on TC-1a monitoring results.
(3) Reference (1)

2.0 TDS Estimation

TDS is analyzed by heating a sample to just over 100°C until all liquid is evaporated. The resulting solids are massed and the TDS is calculated as the solid mass divided by the original volume of liquid. TDS includes inorganic molecules and salts, dissolved organics and non-filterable colloids, plus some water that remains in crystalline form as waters of hydration (Reference (2)).

2.1 Method Used

TDS was estimated as the sum of all projected inorganic salt concentrations. This is a reasonable estimate because the majority of the residue accounting for TDS measurements in natural waters is inorganic salts (Reference (2)).
2.2 Assumptions and Sources of Uncertainty

This method makes the following assumptions:

- Waters of hydration that can remain closely associated with inorganic salts upon drying are not included. As a result, estimated TDS values may be lower than actual values.
- Organic material is not included, but can contribute to TDS measurements in natural waters. As a result, estimated TDS values may be lower than actual values.

To estimate the percentage of uncertainty associated with this method, existing data from the three monitoring stations that include measurements of all of the individual dissolved constituents were used to calculate a TDS value for comparison to the corresponding, measured TDS. The data used for this analysis was obtained from Reference (3). Actual TDS values ranged from 2% to 33% higher than values estimated using this method, with the highest uncertainty observed in PM-13 calculations. This is consistent with higher turbidity measurements (>4 NTU) in PM-13 data, which reflects a higher concentration of organic material that contributes to TDS measurements, but is not accounted for in this estimation method.

2.3 Estimated TDS Values

The following TDS values, shown in Table 2-1, were estimated based on the sum of dissolved salts method. Estimated values were then adjusted to a range reflecting the uncertainty observed in estimations using historical monitoring data at the three downstream locations (2% to 33%).

<table>
<thead>
<tr>
<th>Location</th>
<th>Monitoring Average(1)</th>
<th>Estimated TDS from Sum of Dissolved Salts</th>
<th>Predicted TDS range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS discharge</td>
<td>N/A</td>
<td>349 mg/L</td>
<td>356 to 464 mg/L</td>
</tr>
<tr>
<td>Trimble Creek at TC-1(2)</td>
<td>474 mg/L</td>
<td>109 mg/L</td>
<td>111 to 145 mg/L</td>
</tr>
<tr>
<td>Unnamed Creek at PM-11</td>
<td>492 mg/L</td>
<td>154 mg/L</td>
<td>157 to 204 mg/L</td>
</tr>
<tr>
<td>Embarrass River at PM-13</td>
<td>227 mg/L</td>
<td>125 mg/L</td>
<td>127 to 166 mg/L</td>
</tr>
</tbody>
</table>

(1) Monitoring averages are from 2012-2015 for TC-1a and from 2004-2015 for PM-11 and PM-13
(2) TC-1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC-1a, which is located less than one mile downstream of TC-1. Average water quality data presented in this report are based on TC-1a monitoring results.

3.0 Specific Conductance at 25°C Estimation

Specific conductance is a measure of a water’s ability to conduct an electrical current at 25°C and is measured in units of microsiemens per centimeter (µS/cm) or micromhos per centimeter (µmhos/cm), which are equivalent. These units reflect the inverse of electrical resistance per unit of length. Specific conductance was estimated based on calculated ionic strength, using two empirical methods, the Miller estimation, and the Russell estimation.
To evaluate the accuracy of the estimation methods used, calculations were applied to monitoring data (Reference (3)) to compare the calculated specific conductance with the measured value. For each downstream monitoring location, calculations were applied to results of two monitoring events conducted in 2014 or 2015. Monitoring events for evaluating variance were selected that have specific conductance similar to the historical averages from each location, in order to be representative of each site.

3.1 Miller Estimations

This specific conductance estimation follows a USGS-developed methodology presented below (Reference (4)).

3.1.1 Method Used

Miller and colleagues (Reference (4)) proposed an estimation of specific conductance in mixed salt solutions based on the equivalent conductance and concentration of each ionic constituent as follows:

\[ K = \sum (a_i \lambda_i C_i)^f \]

Where \( K \) = specific conductance, \( a_i \) is the fraction of the \( i \)th constituent present in the ionized form, \( \lambda_i \) is the equivalent conductance of ion \( I \) in \( \mu S/cm \) per meq/L, \( C \) is the concentration of the \( i \)th constituent in meq/L, and \( f \) is an exponential correction factor.

For the purposes of this analysis, all salts were assumed to be 100% dissociated (\( a_i = 1.0 \)). Table 5 of Reference (4) supplies values for \( \lambda \) of major ions, as shown in Table 3-1.

### Table 3-1 Equivalent Conductances (\( \lambda \)) of Major Ions

<table>
<thead>
<tr>
<th>Cations</th>
<th>( \lambda ) (( \mu S/cm ) per meq/L)</th>
<th>Anions</th>
<th>( \lambda ) (( \mu S/cm ) per meq/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca(^{2+})</td>
<td>59.50</td>
<td>Cl(^-)</td>
<td>76.35</td>
</tr>
<tr>
<td>H(^+)</td>
<td>349.8</td>
<td>F(^-)</td>
<td>55.32</td>
</tr>
<tr>
<td>K(^+)</td>
<td>73.52</td>
<td>HCO(_3)^-</td>
<td>44.5</td>
</tr>
<tr>
<td>Mg(^{2+})</td>
<td>53.06</td>
<td>OH(^-)</td>
<td>197.8</td>
</tr>
<tr>
<td>Na(^+)</td>
<td>50.11</td>
<td>SO(_4)(^{2-})</td>
<td>80.0</td>
</tr>
</tbody>
</table>

3.1.1.1 Conductance Ranges Correction Factor

Different values for \( f \) were determined empirically for natural waters with specific conductance ranging from 0 to 150 \( \mu S/cm \), 150 to 300 \( \mu S/cm \), 300 to 450 \( \mu S/cm \), and 450 to 600 \( \mu S/cm \). Values for \( K \) were estimated using an \( f \) value selected for the expected conductance range. If the final conductance did not match the range for the \( f \) value used, a different \( f \) value was selected and used. This iterative process was repeated until the empirical range matched the calculated specific conductance value.
3.1.1.2 Monovalent Ion Ratio Correction Factor

In addition, Reference (4) (Miller et al.) describes an empirical linear relationship between the fraction of monovalent ions and the $f$ value. Values for $K$ were estimated using $f$ values calculated from this empirical relationship.

3.1.2 Assumptions and Sources of Uncertainty

This method makes the following assumptions:

- 100% of parameters are present in the ionized form. This could result in estimate specific conductance higher than actual values, because it does not account for losses due to complexation.
- Minor ions (other than the ten with listed equivalent conductance values) do not contribute significantly to the specific conductance. This could result in specific conductance values lower than actual values if other ions are present in concentrations that will affect the conductance.
- The empirical relationship outlined by Miller is accurate for the estimated water quality analyzed here. This could either contribute uncertainty in the specific conductance estimate in either direction.

In order to evaluate the range of variability expected, measured and calculated specific conductance values were compared for historical monitoring events at the three downstream sites. The data used for this analysis included measurements for all major ions and for specific conductance and was obtained from Reference (3). When the Miller method was applied to monitoring data, the difference between measured and estimated specific conductance values ranged from -2% to 20% and 2% to 23% with the range-selected correction and the monovalent ion correction, respectively. The highest uncertainty was observed in TC-1a calculations. These uncertainty ranges were then applied to calculated specific conductance data for anticipated future conditions as shown in Table 3-3.

3.2 Russell Estimation

Reference (5) outlines an empirical relationship between ionic strength and specific conductance.

3.2.1 Method Used

Ionic strength was calculated as:

$$ I = \sum C_i Z_i^2 $$

Where $I$ is ionic strength, $C_i$ is the concentration of the $i$th ion in mol/L, and $Z_i$ is the molar equivalency or charge of the $i$th ion in meq/mol (Reference (2)).

Specific conductance was then estimated from the Russell correlation, based on their study of 13 natural waterbodies with varied composition (Reference (5)):

$$ Specific\ Conductance = \frac{I}{1.6\times10^{-5}} $$
3.2.2 Assumptions and Sources of Uncertainty

This method makes the following assumptions:

- 100% of parameters are present in the ionized form. This could lead to a lower than actual specific conductance, because it does not account for losses due to complexation.

  The empirical relationship outlined by Russell is accurate for the estimated water quality analyzed here. This could contribute uncertainty in the specific conductance in either direction.

Similar to the analyses used for the TDS estimation and the Miller method specific conductance estimation, measured and calculated specific conductance values were compared for historical monitoring events at the three downstream sites. The data used for this analysis included measurements for all major ions and for specific conductance and was obtained from Reference (3). When the Russell method was applied to monitoring data, measured specific conductance values ranged from 3% to 18% higher than calculated estimates, with the highest uncertainty observed in TC-1a calculations. These uncertainty ranges were then applied to calculated specific conductance data for anticipated future conditions as shown in Table 3-3.

3.3 Estimated Specific Conductance Values

Table 3-2 presents the TDS values that were estimated based on the two Miller estimations and the Russell estimation.

Table 3-2 Estimated Specific Conductance Values

<table>
<thead>
<tr>
<th>Location</th>
<th>Monitoring Average(1)</th>
<th>Estimated specific conductance from Miller (conductance ranges f)</th>
<th>Estimated specific conductance from Miller (monovalent ions f)</th>
<th>Estimated specific conductance from Russell</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWTS discharge</td>
<td>N/A</td>
<td>768 µS/cm</td>
<td>740 µS/cm</td>
<td>813 µS/cm</td>
</tr>
<tr>
<td>Trimble Creek at TC-1(2)</td>
<td>723 µS/cm</td>
<td>151 µS/cm</td>
<td>146 µS/cm</td>
<td>153 µS/cm</td>
</tr>
<tr>
<td>Unnamed Creek at PM-11</td>
<td>793 µS/cm</td>
<td>253 µS/cm</td>
<td>242 µS/cm</td>
<td>255 µS/cm</td>
</tr>
<tr>
<td>Emarrass River at PM-13</td>
<td>284 µS/cm</td>
<td>173 µS/cm</td>
<td>168 µS/cm</td>
<td>176 µS/cm</td>
</tr>
</tbody>
</table>

(1) Monitoring averages are from 2012-2015 for TC-1a and from 2004-2015 for PM-11 and PM-13
(2) TC-1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 to TC-1a, which is located less than one mile downstream of TC-1. Average water quality data presented in this report are based on TC-1a monitoring results.

Estimated values were adjusted to a range reflecting the uncertainty observed in estimations of each method using historical monitoring data at the three downstream locations. These ranges are listed in Table 3-3.
Table 3-3 Estimated Specific Conductance Ranges

<table>
<thead>
<tr>
<th>Location</th>
<th>Monitoring Average</th>
<th>Predicted Specific Conductance Range from Miller (Conductance Ranges f)</th>
<th>Predicted Specific Conductance Range from Miller (Monovalent Ions f)</th>
<th>Predicted Specific Conductance Range from Russell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Uncertainty</td>
<td>N/A</td>
<td>-2% to 20%</td>
<td>2% to 23%</td>
<td>-3% to 18%</td>
</tr>
<tr>
<td>WWTS discharge</td>
<td>N/A</td>
<td>753 to 922 µS/cm</td>
<td>756 to 911 µS/cm</td>
<td>790 to 960 µS/cm</td>
</tr>
<tr>
<td>Trimble Creek at TC-1</td>
<td>723 µS/cm</td>
<td>148 to 181 µS/cm</td>
<td>149 to 180 µS/cm</td>
<td>148 to 181 µS/cm</td>
</tr>
<tr>
<td>Unnamed Creek at PM-11</td>
<td>793 µS/cm</td>
<td>248 to 304 µS/cm</td>
<td>246 to 297 µS/cm</td>
<td>247 to 301 µS/cm</td>
</tr>
<tr>
<td>Embarrass River at PM-13</td>
<td>284 µS/cm</td>
<td>170 to 208 µS/cm</td>
<td>172 to 206 µS/cm</td>
<td>171 to 208 µS/cm</td>
</tr>
</tbody>
</table>

(1) Monitoring averages are from 2012-2015 for TC-1a and from 2004-2015 for PM-11 and PM-13
(2) TC-1 was used as an evaluation point for the GoldSim probabilistic modeling as conducted for the FEIS. Due to access issues, it was only used for water quality monitoring in 2012. Water quality monitoring was moved in 2012 TC-1a, which is located less than one mile downstream of TC-1. Average water quality data presented in this report are based on TC-1a monitoring results.

4.0 Discussion

4.1 TDS Estimate

The estimation of TDS, based on the sum of measurements (or modeled estimates) of individual dissolved constituents, was shown to provide an underestimate of the actual TDS based on measured values. When this uncertainty factor was applied to the estimated values for TDS, the resulting values were still well below the water quality standard for TDS of 700 mg/L for Mine Year 10 of the Project. In addition, the estimated ranges are well below the average TDS concentration observed in the historical monitoring stations, as expected following the installation of the FTB Seepage Containment System and discharge from the WWTS.

4.2 Specific Conductance Estimate

The variability of specific conductance estimation procedures was quantified relative to site-specific data and observed to be similar for both the Miller and Russell methods. The full range from all three methods was used in the nondegradation evaluation as the estimated range of specific conductance. The estimated ranges of values for specific conductance at 25°C, including the maximum amount of anticipated variability based on site-specific data, are well below the water quality standard of 1,000 µS/cm specific conductance at downstream locations for Mine Year 10 of the Project. In addition, the estimated ranges are well below the average specific conductance observed in historical monitoring stations, as expected following the installation of the FTB Seepage Containment System and discharge from the WWTS.
5.0 References


Attachment B

Statistical Supplement
Technical Memorandum

To: Christie Kearney, Poly Met Mining, Inc. and Greg Fontaine, Stinson Leonard Street LLP  
From: Melisa Pollak, Stephanie Theriault, and Denise Levitan  
Subject: Antidegradation Evaluation Statistical Supplement  
Date: September 22, 2017  
Project: 23690862.04

The Minnesota Pollution Control Agency (MPCA) requested that Poly Met Mining, Inc. (PolyMet) consider statistically evaluating certain datasets that contain results below the analytical reporting limit (non-detects) using either a nonparametric method (e.g., Kaplan-Meier) or a parametric method, when appropriate, rather than using statistical substitution methods. MPCA also requested calculation of the 95% upper confidence limit (UCL) of the mean of baseline data for certain datasets. To address MPCA’s requests, PolyMet directed Barr Engineering Co. (Barr) to evaluate the Antidegradation Evaluation datasets using the ProUCL software, which was developed for the US Environmental Protection Agency (USEPA) specifically to analyze datasets that contain non-detect values. As part of this exercise, Barr compared the results of the ProUCL analyses with the result of the Antidegradation Evaluation.

1.0 Statistical Methods

For this exercise, Barr used ProUCL as the basis for the supplemental statistical analysis. The primary sources used as the basis for the statistical methods in this statistical supplement are the USEPA “Unified Guidance” (Reference (1)) and the ProUCL Version 5.1.002 Technical Guide (Reference (2)).

1.1 Measures of Central Tendency

Table 1 summarizes the nonparametric methods used in this exercise requested by the MPCA to determine a measure of central tendency (an average or an alternate measure for datasets for which there may be limitations affecting calculations of averages). For datasets with no non-detects, the arithmetic mean was used as the measure of central tendency; for datasets with no non-detects, the arithmetic mean is equal to the Kaplan-Meier mean (Reference (3)). For datasets with less than or equal to 50% non-detects, guidance and statistical literature recommend the Kaplan-Meier method (Section 15.1 of Reference (1); Section 1.11.1 of Reference (2); Section 6.7.1 of Reference (3)).

When the number of non-detects exceeds 50% of a dataset, USEPA guidance documents generally recommend nonparametric options (Section 15.6 of Reference (1)). However, neither the Unified Guidance nor the ProUCL Technical Guide are prescriptive on which nonparametric methods to use to estimate the measure of central tendency in this circumstance. Rather, guidance recommends that for datasets with a

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1 The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052.
low number of detected concentrations, the project team consult other statistical literature and develop a site-specific approach (Section 15.6 of Reference (1); Section 1.12 of Reference (2)). Guidance does identify use of the median value as an appropriate site-specific alternative. The ProUCL Technical Guide notes that “when most (e.g., >95%) of the observations for a constituent lie below the DLs [detection limits], the sample median or the sample mode (rather than the sample average) may be used as an estimate of the [central tendency]” (Section 1.12 of Reference (2)). Additionally, the Unified Guidance states that the median “can be very useful as alternative estimates of data centrality and dispersion to the mean and standard deviation, especially when samples are drawn from a highly skewed (i.e., non-symmetric) distribution or when one or more outliers is present” (Section 3.3 of Reference (1)). Datasets with a high number of non-detect values typically do not follow a normal, or symmetric, distribution (or any known distribution), and are thus characterized as nonparametric. Therefore, reporting the median value (which will be a non-detect value) is a useful site-specific alternative measure of central tendency for datasets containing greater than 50% non-detects.

### Table 1  Summary of Non-Substitution Approaches for Measures of Central Tendency

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Non-Detect Frequency</th>
<th>Measure of Central Tendency</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0%</td>
<td>Arithmetic mean</td>
<td>For datasets with no non-detects, the Kaplan-Meier mean is equal to the arithmetic mean (Reference (3))</td>
</tr>
</tbody>
</table>
| All         | ≤50%                 | Kaplan-Meier mean           | • Kaplan-Meier recommended (Section 15.1 of Reference (1))  
  “The guidance generally favors the use of the ...Kaplan-Meier or Robust ROS [regression on order statistics] methods which can address the problem of multiple detection limits”  
  • Robust ROS ruled out (Section 8.3 of Reference (1))  
  • Robust ROS underlying assumptions: “Data must be normal or normalized...”  
  • Limit at 50% non-detects (Section 8.3 of Reference (1))  
  “Kaplan-Meier should not be used when more than 50% of the data are non-detects.” |
|             | >51%                 | Median value. If median is a non-detect, report as a less-than value\(^{(1)}\) | • Site-specific method (Section 1.12 of Reference (2)):  
  “For data sets with low detection frequencies, other measures such as the median or mode represent better estimates (with lesser uncertainty) of the population measure of central tendency.” |

\(^{(1)}\) For mass balance calculations, when the central tendency of the baseline data was a non-detect value, PolyMet used the median detection limit as the baseline concentration to which Project loading was added.

### 1.2 95% Upper Confidence Limits

Table 2 summarizes the methods used in this exercise requested by the MPCA to determine the 95% upper confidence limit (UCL).
Recommended methods for computing 95% UCLs based on data distribution, sample size, detection frequency, and skewness are presented in Section 9.1 of Reference (4). Those USEPA recommendations are largely incorporated into the ProUCL software, which evaluates the characteristics of the dataset and indicates the preferred measure of the UCL. The ProUCL software provides alternative suggestions if the UCL exceeds the maximum detected concentration (Section 1.10 of Reference (2)).

However, if there is an insufficient number of detected values (<4 detects), ProUCL cannot calculate a reliable 95% UCL (Section 1.12 of Reference (2)). Thus, the ProUCL Guidance states that for datasets with a small number of detects, the highest detected value may be used in place of a UCL (Section 1.10 of Reference (2)). Therefore, in these cases, for this exercise Barr generally used the highest detected value as a site-specific alternative UCL measure. However, there were a few cases where the highest detected value was less than the median (non-detect value), which would not make sense for a metric to evaluate measurable change. This can occur for parameters that have had multiple reporting limits over time. In these cases, and in cases with no detected values, Barr used the highest non-detect value as a site-specific alternative UCL measure.

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Non-Detect Frequency</th>
<th>95% UCL Method</th>
<th>Citation for recommended UCL approach</th>
</tr>
</thead>
</table>
| All         | <100%                | ProUCL recommended 95% UCL, or highest detected value if: | • Basic approach (Section 1.10 of Reference (2))
|             |                      | 1. ProUCL program indicates that there are too few detects to calculate a 95% UCL; or 2. the recommended UCL is less than the median | “ProUCL computes 95% UCLs of the mean using several methods based upon normal, gamma, lognormal, and non-discernible distributions.”
|             |                      |                | • Description of how ProUCL evaluates dataset and recommends a UCL method (Section 4.6 of Reference (2)) |
|             |                      |                | • Use of highest detected value when there are too few detects to calculate a UCL (Section 1.10 of Reference (2)) |
|             |                      |                | “Some practitioners use the maximum detected value as an estimate of the EPC term... when the sample size is small or when a UCL95 exceeds the maximum detected value.” |
|             | 100%                 | Maximum reporting limit | • Approach if 100% non-detects (Section 1.12 of Reference (2)): |
|             |                      |                | “…when all of the sampled values are reported as NDs, the [UCL] and other statistical limits should also be reported as a ND [non-detect] value, perhaps by the maximum RL [reporting limit] or the maximum RL/2. The project team will need to make this determination” |

(1) Highest non-detect value used if highest detect value is less than median.
1.3 Duplicate Sample Handling

Duplicate samples are not statistically independent, so they must be specially handled in calculation of a UCL (Section 6.3.1 of Reference (1)). Where duplicates exist in the Antidegradation Evaluation datasets, for the ProUCL analysis, only the primary result was used in the calculation of the central tendency and the 95% UCL.

2.0 ProUCL Results

The central tendency and the 95% UCL (or site-specific alternative) of baseline monitoring data are presented in Large Table 1 through Large Table 10.

3.0 Comparison of Antidegradation Evaluation Results with ProUCL Results

Large Table 1 through Large Table 9 compare the Antidegradation Evaluation results with the ProUCL results for parameters other than mercury. Large Table 10 compares these results for mercury, and Large Table 11 summarizes the comparison for the other antidegradation parameters. The Antidegradation Evaluation evaluated whether the Project would result in a measurable increase by comparing the estimated future concentration with the upper Laboratory Control Sample (LCS) limit. For the ProUCL analysis, the potential for a measurable increase was evaluated using the UCL instead of the LCS, as requested by MPCA. The conclusions about whether the Project may result in a measurable increase in concentration using the LCS method and the UCL method were compared for each parameter at each monitoring station considered in the Antidegradation Evaluation; a total of approximately 200 comparisons. Of these approximately 200 comparisons, in only 12 instances was the conclusion about measurable change reached using the UCL method different than the conclusion reached by the LCS method:

- In 5 instances the LCS method indicated no measurable increase in concentration, whereas the UCL method indicated that the concentration increase could be measurable.
- In 7 instances the LCS method indicated that the concentration increase could be measurable, whereas the UCL method indicated no measurable increase in concentration.

Notably, the two methods for evaluating potential measurable increase produced identical conclusions for mercury at all stations, and for all parameters at Scanlon on the St. Louis River (USGS Station #04024000).
4.0 References


### Large Table 1 SD026, Parameters Other than Mercury, Antidegradation Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 20(3)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>Upper LCS Limit(5)</th>
<th>Measurable Increase by LCS method(6)</th>
<th>Existing Water Quality Central Tendency(7)</th>
<th>95th Percentile UCL(8)</th>
<th>Measurable Increase by UCL Method(9)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>Al</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>55</td>
<td>55%</td>
<td>6.3</td>
<td>18.4</td>
<td>21.2</td>
<td>No</td>
<td>23.3</td>
<td>63.7</td>
<td>No</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>11</td>
<td>100%</td>
<td>6.3</td>
<td>0.86</td>
<td>1</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>µg/L</td>
<td>5</td>
<td>0.3</td>
<td>41</td>
<td>54%</td>
<td>10</td>
<td>0.62</td>
<td>0.70</td>
<td>Yes</td>
<td>0.31</td>
<td>0.69</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>98</td>
<td>2%</td>
<td>230</td>
<td>210</td>
<td>242</td>
<td>No</td>
<td>211</td>
<td>211</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(11)</td>
<td>0.2</td>
<td>27</td>
<td>93%</td>
<td>0.71</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.2</td>
<td>0.2</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>µg/L</td>
<td>12(11)</td>
<td>1</td>
<td>20</td>
<td>85%</td>
<td>5.3</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 1</td>
<td>1.7</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>102</td>
<td>52%</td>
<td>5</td>
<td>0.54</td>
<td>0.62</td>
<td>Yes</td>
<td>&lt; 0.48</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.8(11)</td>
<td>0.5</td>
<td>68</td>
<td>26%</td>
<td>9</td>
<td>1.11</td>
<td>1.3</td>
<td>Yes</td>
<td>0.96</td>
<td>1.04</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>µg/L</td>
<td>3.0(11)</td>
<td>0.5</td>
<td>54</td>
<td>96%</td>
<td>3</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni</td>
<td>µg/L</td>
<td>5.2(11)</td>
<td>0.5</td>
<td>60</td>
<td>40%</td>
<td>50</td>
<td>1.32</td>
<td>1.5</td>
<td>Yes</td>
<td>1.11</td>
<td>2.81</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se</td>
<td>µg/L</td>
<td>0.5</td>
<td>1</td>
<td>31</td>
<td>90%</td>
<td>1.6</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 1</td>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>17</td>
<td>94%</td>
<td>0.21</td>
<td>0.25</td>
<td>0.29</td>
<td>No</td>
<td>&lt; 0.24</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>Tl</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>21</td>
<td>90%</td>
<td>0.16</td>
<td>0.26</td>
<td>0.3</td>
<td>No</td>
<td>&lt; 0.005</td>
<td>0.2</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>µg/L</td>
<td>120(11)</td>
<td>6</td>
<td>68</td>
<td>63%</td>
<td>57.1</td>
<td>8.2</td>
<td>9.4</td>
<td>Yes</td>
<td>7.3</td>
<td>16.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloride (total)</td>
<td>Cl</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>155</td>
<td>0%</td>
<td>23.4</td>
<td>11.5</td>
<td>12.5</td>
<td>Yes</td>
<td>11.5</td>
<td>12</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td></td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>220</td>
<td>0%</td>
<td>100</td>
<td>439</td>
<td>505</td>
<td>No</td>
<td>466</td>
<td>479</td>
<td>No</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>296</td>
<td>0%</td>
<td>8.4</td>
<td>7.83</td>
<td>8.0</td>
<td>Yes</td>
<td>7.8</td>
<td>7.9</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved(10)</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>155</td>
<td>0%</td>
<td>464</td>
<td>650</td>
<td>780</td>
<td>No</td>
<td>No</td>
<td>650</td>
<td>669</td>
<td>No</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(11)</td>
<td>µS/cm</td>
<td>1,000</td>
<td>0</td>
<td>299</td>
<td>0%</td>
<td>960</td>
<td>997</td>
<td>1007</td>
<td>No</td>
<td>No</td>
<td>1005</td>
<td>1020</td>
<td>No</td>
</tr>
<tr>
<td>Sulfate (total)</td>
<td>SO₄</td>
<td>mg/L</td>
<td>none(12)</td>
<td>1</td>
<td>154</td>
<td>1%</td>
<td>10</td>
<td>173</td>
<td>189.2</td>
<td>No</td>
<td>173</td>
<td>179</td>
<td>No</td>
</tr>
</tbody>
</table>

**Notes:**

(1) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of Antidegradation Evaluation.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, by a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 300 mg/L, which is the expected hardness of the WWTS discharge.

(11) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.
A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL. 95% UCL determined as described in Table 2.

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

Sulfate
Specific Conductance @ 25°C
Solids, total dissolved
pH
Chloride
Silver (total)
Nickel (total)
Zinc (total)
Thallium (total)
Cobalt (total)
Cadmium (total)
Chromium (total)
Copper (total)
Lead (total)

Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.

The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.

Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.

Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.

(10) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.

(11) Maintain background “means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses.” (Minnesota Rules, part 7050.022, subdivision 6B) and part 7050.023, subdivision 5).

(12) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.

(13) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

Parameter | Units | Applicable Standard(1) | Typical Reporting Limit (PQL)(2) | Number of Samples | Percentage Measurable Decrease | Estimated Future Water Quality | Standard Additive | Upper UCL Limit(3) | Measurable Increase by UCL Method(3) | Existing Average Water Quality (substitution method)(3) | Measurable Increase by LCS | Conclusion Same? | Central Tendency Measurable Increase Conclusion Same? | 95th Percentile Reporting Limit(3) | Measurable Increase by LCS Method(4) | LSC and UCL Measurable Increase Conclusion Same? |
---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
Aluminum (total) | µg/L | 125 | 2 | 38 | 26% | 6.3 | n.d. | N/A | Yes | 22.4 | 25.8 | No | < 0.5 | 0.5 | Yes | Yes | 23.6 | 26.9 | No | Yes |
Antimony (total) | µg/L | 31 | 0.3 | 17 | 100% | 6.3 | n.d. | N/A | Yes | < 0.5 | 0.5 | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
Arsenic (total) | µg/L | 53 | 0.5 | 38 | 47% | 10 | n.d. | N/A | Yes | 0.87 | 1 | Yes | 0.90253 | 1.23 | Yes | Yes | Yes | Yes | Yes | Yes |
Boron (total) | µg/L | None | 100 | 12 | 8% | 2.30 | 13.8 | 159 | Yes | 142 | 155 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Cadmium (total) | µg/L | 2.5(12) | 0.2 | 12 | 100% | 0.71 | n.d. | N/A | Yes | < 0.2 | 0.2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Chromium (total) | µg/L | 12(10) | 1 | 12 | 100% | 5.3 | n.d. | N/A | Yes | < 1 | 1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Cobalt (total) | µg/L | 5 | 0.2 | 38 | 53% | 5 | 0.23 | 0.26 | Yes | < 0.2 | 0.33 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Copper (total) | µg/L | 9.3(11) | 0.5 | 38 | 55% | 9 | 0.52 | 0.6 | Yes | < 0.5 | 0.80 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Lead (total) | µg/L | 3.2(11) | 0.5 | 38 | 100% | 3 | n.d. | N/A | Yes | < 0.5 | 0.5 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Nickel (total) | µg/L | 52(11) | 0.5 | 38 | 74% | 50 | n.d. | N/A | Yes | < 0.5 | 0.61 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Selenium (total) | µg/L | 1 | 0.2 | 24 | 100% | 1.6 | n.d. | N/A | Yes | < 1 | 1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Silver (total) | µg/L | 1 | 0.2 | 10 | 50% | 0.21 | n.d. | N/A | Yes | < 0.2 | 0.2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Thallium (total) | µg/L | 0.56 | 0.005 | 24 | 100% | 0.16 | n.d. | N/A | Yes | < 0.005 | 0.02 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Zinc (total) | µg/L | 120(10) | 6 | 38 | 95% | 57 | n.d. | N/A | Yes | < 6 | 11.5 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Chloride | mg/L | 23(10) | 5 | 38 | 0% | 23.4 | 17.3 | 13 | Yes | 27.3 | 29.5 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
Sulfate | SO₄²⁻ | mg/L | None | 0 | 38 | 0% | 960 | 723 | 730 | Yes | 723 | 795 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Notes:
1. N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.
2. The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
3. The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.
4. Existing conditions estimated based on stream monitoring data from TC-1a as discussed in Section 5.5 of the Antidegradation Evaluation. Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.
5. Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.
6. A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.
7. Central Tendency determined as described in Table 1.
8. 95% UCL determined as described in Table 2.
9. A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
10. Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.
11. Maintain background “means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses.” (Minnesota Rules, part 7050.022, subdivision 6B) and part 7050.023, subdivision 5).
12. The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.
13. Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
14. Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

Table 2: Timble Headwater Wetlands, Parameters Other than Mercury, Antidegradation Evaluation Results and ProUCL Results
### Table 3  
Unnamed Creek Headwater Wetlands, Parameters Other than Mercury, Antidegradation Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(8)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 10 (10)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>ProUCL (Non-substitution methods)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>66</td>
<td>27%</td>
<td>6.3</td>
<td>29.5 N/A</td>
<td>No</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>35</td>
<td>100%</td>
<td>6.3</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>0.5</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>58</td>
<td>40%</td>
<td>10</td>
<td>0.87 I</td>
<td>Yes</td>
<td>0.92</td>
</tr>
<tr>
<td>Barium (total)</td>
<td>µg/L</td>
<td>None</td>
<td>100</td>
<td>23</td>
<td>4%</td>
<td>230</td>
<td>207 238</td>
<td>No</td>
<td>210 232</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>0.2</td>
<td>2.5(10)</td>
<td>26</td>
<td>81%</td>
<td>0.71</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11(10)</td>
<td>1</td>
<td>26</td>
<td>81%</td>
<td>5.3</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 1.1</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>64</td>
<td>73%</td>
<td>5</td>
<td>0.3 0.35</td>
<td>Yes</td>
<td>&lt; 0.2 0.83</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3(10)</td>
<td>0.5</td>
<td>66</td>
<td>20%</td>
<td>9</td>
<td>0.93 1.07</td>
<td>Yes</td>
<td>0.84 0.92</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2(10)</td>
<td>0.5</td>
<td>60</td>
<td>90%</td>
<td>3</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 0.5 1.00</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>52(10)</td>
<td>0.5</td>
<td>66</td>
<td>62%</td>
<td>50</td>
<td>0.68 0.78</td>
<td>Yes</td>
<td>0.57 0.74</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
<td>1</td>
<td>42</td>
<td>93%</td>
<td>1.6</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 1.6</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>21</td>
<td>100%</td>
<td>0.21</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 0.2 1</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>47</td>
<td>89%</td>
<td>0.16</td>
<td>0.12 0.14</td>
<td>Yes</td>
<td>0.0075 0.0092</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>1.2(10)</td>
<td>6</td>
<td>66</td>
<td>89%</td>
<td>5.1</td>
<td>n.d. N/A</td>
<td>Yes</td>
<td>&lt; 6 41.2</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>81</td>
<td>0%</td>
<td>23.4</td>
<td>17 18.7</td>
<td>Yes</td>
<td>17.0 18.6</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>7.6</td>
<td>0.01</td>
<td>76</td>
<td>0%</td>
<td>8.4</td>
<td>7.6 7.8</td>
<td>Yes</td>
<td>7.6 7.6</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(6)</td>
<td>µS/cm</td>
<td>None</td>
<td>10</td>
<td>66</td>
<td>0%</td>
<td>644</td>
<td>492 590</td>
<td>No</td>
<td>492 542</td>
</tr>
<tr>
<td>Sulfate SO₄</td>
<td>mg/L</td>
<td>None</td>
<td>0</td>
<td>70</td>
<td>0%</td>
<td>960</td>
<td>793 801</td>
<td>Yes</td>
<td>793 849</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.
(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) The practical quantification method (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
(3) Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.
(4) Existing conditions estimated based on stream monitoring data from TC-1a as discussed in Section 5.5 of the Antidegradation Evaluation. Average value of monitoring results, calculated using average values of replicate samples and including results below analytic detection limits at half the value of the detection limit.
(5) Antidegradation Results calculated using the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.
(7) Central Tendency determined as described in Table 1.
(8) 95% UCL determined as described in Table 2.
(9) A measurable increase using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.
(11) Maintain background "means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses." (Minnesota Rules, part 7050.0222, subpart 6(B) and part 7050.0223, subpart 5).
(12) Background "means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses." (Minnesota Rules, part 7050.0222, subpart 6(B) and part 7050.0223, subpart 5).
(13) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(14) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated for the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.3) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
### Large Table 4: TC-1a, Parameters Other than Mercury, Antidegradation Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 10 (8)</th>
<th>Existing Average Water Quality (substitution method)(9)</th>
<th>Upper LCS Limit(5)</th>
<th>Measurable Increase by LCS method(10)</th>
<th>Existing Water Quality Central Tendency(7)</th>
<th>95th Percentile UCL(6)</th>
<th>Measurable Increase by UCL Method? (9)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>Al</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>38</td>
<td>26%</td>
<td>19.6</td>
<td>22.4</td>
<td>No</td>
<td>&lt; 0.5</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb</td>
<td>µg/L</td>
<td>3</td>
<td>0.53</td>
<td>17</td>
<td>100%</td>
<td>5.2</td>
<td>n.d.</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As</td>
<td>µg/L</td>
<td>5</td>
<td>0.5</td>
<td>38</td>
<td>47%</td>
<td>8.9</td>
<td>0.87</td>
<td>1</td>
<td>Yes</td>
<td>&lt; 0.90</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>12</td>
<td>8%</td>
<td>159</td>
<td>138</td>
<td>159</td>
<td>No</td>
<td>142</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd</td>
<td>µg/L</td>
<td>2.5(11)</td>
<td>0.2</td>
<td>12</td>
<td>100%</td>
<td>0.6</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 0.2</td>
<td>0.2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr</td>
<td>µg/L</td>
<td>11(12)</td>
<td>1</td>
<td>12</td>
<td>100%</td>
<td>4.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 1</td>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>38</td>
<td>53%</td>
<td>4.5</td>
<td>0.23</td>
<td>0.26</td>
<td>Yes</td>
<td>&lt; 0.2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu</td>
<td>µg/L</td>
<td>9.3(13)</td>
<td>0.5</td>
<td>38</td>
<td>55%</td>
<td>7.9</td>
<td>0.52</td>
<td>0.6</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb</td>
<td>µg/L</td>
<td>2.2(14)</td>
<td>0.5</td>
<td>38</td>
<td>100%</td>
<td>2.6</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni</td>
<td>µg/L</td>
<td>5.2(14)</td>
<td>0.5</td>
<td>38</td>
<td>74%</td>
<td>4.31</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 0.5</td>
<td>0.61</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se</td>
<td>µg/L</td>
<td>5</td>
<td>1</td>
<td>24</td>
<td>100%</td>
<td>1.4</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 1</td>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>5</td>
<td>100%</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 0.2</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>Tl</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>24</td>
<td>100%</td>
<td>0.14</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 0.005</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn</td>
<td>µg/L</td>
<td>120(15)</td>
<td>6</td>
<td>38</td>
<td>95%</td>
<td>48.3</td>
<td>n.d.</td>
<td>N/A</td>
<td>&lt; 6</td>
<td>11.5</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl</td>
<td>mg/L</td>
<td>280</td>
<td>5</td>
<td>38</td>
<td>0%</td>
<td>Not Available</td>
<td>17.3</td>
<td>19</td>
<td>N/A</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Hardness (as CaCO3)</td>
<td></td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>38</td>
<td>0%</td>
<td>114</td>
<td>331</td>
<td>381</td>
<td>No</td>
<td>366</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>pH</td>
<td></td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>38</td>
<td>0%</td>
<td>Not Available</td>
<td>7.4</td>
<td>7.6</td>
<td>N/A</td>
<td>7.37</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved(16)</td>
<td></td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>38</td>
<td>0%</td>
<td>145</td>
<td>474</td>
<td>569</td>
<td>No</td>
<td>474</td>
<td>511</td>
<td>No</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(17)</td>
<td>µS/cm</td>
<td>1,000</td>
<td>0</td>
<td>38</td>
<td>0%</td>
<td>181</td>
<td>723</td>
<td>730</td>
<td>No</td>
<td>723</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO4</td>
<td>mg/L</td>
<td>none(18)</td>
<td>1</td>
<td>38</td>
<td>5%</td>
<td>8.3</td>
<td>51.4</td>
<td>56.5</td>
<td>No</td>
<td>51</td>
<td>62</td>
<td>No</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.  
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.  
(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.  
(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).  
(3) Estimated future water quality is from the FIS GoldSim water modeling results.  
(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.  
(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.  
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.  
(7) Central Tendency determined as described in Table 1.  
(8) 95% UCL determined as described in Table 2.  
(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.  
(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.  
(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters “used for production of wild rice” is not applicable.  
(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.  
(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.  
(14) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 10(3)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>Upper LCS Limit(5)</th>
<th>Measurable Increase by LCS method(6)</th>
<th>Existing Water Quality Central Tendency(7)</th>
<th>95th Percentile UCL(8)</th>
<th>Measurable Increase by UCL Method(9)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>126</td>
<td>2</td>
<td>66</td>
<td>27%</td>
<td>39.2</td>
<td>29.5</td>
<td>N/A</td>
<td>No</td>
<td>&lt; 0.5</td>
<td>3</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.5</td>
<td>35</td>
<td>100%</td>
<td>3.9</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>58</td>
<td>40%</td>
<td>7.0</td>
<td>0.87</td>
<td>1</td>
<td>Yes</td>
<td>0.92</td>
<td>1.03</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>23</td>
<td>4%</td>
<td>124</td>
<td>207</td>
<td>238</td>
<td>No</td>
<td>210</td>
<td>232</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.5(10)</td>
<td>0.2</td>
<td>26</td>
<td>81%</td>
<td>0.46</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.2</td>
<td>0.2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11(10)</td>
<td>1</td>
<td>26</td>
<td>81%</td>
<td>3.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 1</td>
<td>2.3</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>64</td>
<td>73%</td>
<td>3.7</td>
<td>0.3</td>
<td>0.35</td>
<td>Yes</td>
<td>&lt; 0.2</td>
<td>0.83</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3(24)</td>
<td>0.5</td>
<td>66</td>
<td>20%</td>
<td>6.0</td>
<td>0.93</td>
<td>1.07</td>
<td>Yes</td>
<td>0.84</td>
<td>0.92</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2(24)</td>
<td>0.5</td>
<td>60</td>
<td>90%</td>
<td>6.0</td>
<td>0.5</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>1.00</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>52(24)</td>
<td>0.5</td>
<td>66</td>
<td>62%</td>
<td>31.9</td>
<td>0.68</td>
<td>0.78</td>
<td>Yes</td>
<td>0.57</td>
<td>0.74</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
<td>1</td>
<td>42</td>
<td>93%</td>
<td>1.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 1</td>
<td>3.6</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>21</td>
<td>100%</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
<td>&lt; 0.2</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>47</td>
<td>89%</td>
<td>0.11</td>
<td>0.12</td>
<td>0.14</td>
<td>No</td>
<td>0.0075</td>
<td>0.0092</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>120(24)</td>
<td>6</td>
<td>66</td>
<td>89%</td>
<td>31.3</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 6</td>
<td>41.2</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Chloride (aq)</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>81</td>
<td>0%</td>
<td>Not Available</td>
<td>17.0</td>
<td>18.7</td>
<td>N/A</td>
<td>Not Available</td>
<td>18.6</td>
<td>N/A</td>
<td>Yes</td>
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<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>66</td>
<td>0%</td>
<td>85.4</td>
<td>373</td>
<td>429</td>
<td>No</td>
<td>373</td>
<td>407</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Total Sulfate</td>
<td>mg/L</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>76</td>
<td>0%</td>
<td>Not Available</td>
<td>7.6</td>
<td>7.8</td>
<td>N/A</td>
<td>7.6</td>
<td>7.6</td>
<td>N/A</td>
<td>Yes</td>
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<tr>
<td>Solids, total dissolved(10)</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>66</td>
<td>0%</td>
<td>Not Available</td>
<td>204</td>
<td>492</td>
<td>No</td>
<td>492</td>
<td>532</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(13)</td>
<td>µS/cm</td>
<td>1,000</td>
<td>0</td>
<td>70</td>
<td>0%</td>
<td>304</td>
<td>793</td>
<td>801</td>
<td>No</td>
<td>793</td>
<td>849</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>none(13)</td>
<td>1</td>
<td>85</td>
<td>0%</td>
<td>7.0</td>
<td>115</td>
<td>125</td>
<td>No</td>
<td>115</td>
<td>146</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s); even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
(3) Estimated future water quality is from the FEIS GoldSim water modeling results.
(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.
(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6
(7) Central Tendency determined as described in Table 2.
(8) 95% UCL determined as described Table 2.
(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.
(11) The water body is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.
(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis
(14) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
Large Table 6  PM-13, Parameters Other than Mercury, Antidegradation Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(i)</th>
<th>Typical Reporting Limit (PQL)(ii)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 10(3)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>Upper LCS Limit(iii)</th>
<th>Measurable Increase by LCS method(iv)</th>
<th>Existing Water Quality Tendency(v)</th>
<th>95th Percentile UCL(vi)</th>
<th>Measurable Increase by UCL Method? (vii)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>64</td>
<td>0%</td>
<td>72.5</td>
<td>187</td>
<td>--(14)</td>
<td>No</td>
<td>&lt; 0.2</td>
<td>0.26</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>26</td>
<td>100%</td>
<td>1.3</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>47</td>
<td>26%</td>
<td>2.9</td>
<td>1.1</td>
<td>1.27</td>
<td>Yes</td>
<td>1.1</td>
<td>2.7</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>18</td>
<td>83%</td>
<td>61.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
<td>59.5</td>
<td>68.9</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.5(13)</td>
<td>0.2</td>
<td>21</td>
<td>90%</td>
<td>0.2</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.2</td>
<td>0.26</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11(13)</td>
<td>1</td>
<td>21</td>
<td>76%</td>
<td>1.5</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 1</td>
<td>4.3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>68</td>
<td>38%</td>
<td>1.8</td>
<td>0.44</td>
<td>0.51</td>
<td>Yes</td>
<td>0.43</td>
<td>0.45</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3(13)</td>
<td>0.5</td>
<td>70</td>
<td>6%</td>
<td>2.5</td>
<td>1.3</td>
<td>1.52</td>
<td>Yes</td>
<td>1.2</td>
<td>1.3</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2(13)</td>
<td>0.5</td>
<td>54</td>
<td>94%</td>
<td>0.76</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
<td>&lt; 0.5</td>
<td>0.63</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>5.2(13)</td>
<td>0.5</td>
<td>70</td>
<td>14%</td>
<td>10.2</td>
<td>1.46</td>
<td>1.7</td>
<td>Yes</td>
<td>1.4</td>
<td>1.5</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
<td>1</td>
<td>38</td>
<td>100%</td>
<td>0.74</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
<td>&lt; 1</td>
<td>3.6</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>16</td>
<td>100%</td>
<td>0.11</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
<td>&lt; 0.22</td>
<td>1</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>38</td>
<td>79%</td>
<td>0.06</td>
<td>0.13</td>
<td>0.16</td>
<td>No</td>
<td>&lt; 0.005</td>
<td>0.051</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>120(13)</td>
<td>6</td>
<td>98</td>
<td>89%</td>
<td>15.9</td>
<td>7.0</td>
<td>8</td>
<td>Yes</td>
<td>&lt; 6</td>
<td>61.0</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl</td>
<td>230</td>
<td>5</td>
<td>83</td>
<td>0%</td>
<td>Not Available</td>
<td>7.3</td>
<td>8</td>
<td>N/A</td>
<td>7.0</td>
<td>11.9</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>68</td>
<td>0%</td>
<td>76.1</td>
<td>139</td>
<td>160</td>
<td>No</td>
<td>139</td>
<td>156</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>71</td>
<td>0%</td>
<td>Not Available</td>
<td>7.4</td>
<td>7.62</td>
<td>N/A</td>
<td>7.4</td>
<td>7.5</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved (vi)</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>68</td>
<td>0%</td>
<td>166</td>
<td>227</td>
<td>272</td>
<td>No</td>
<td>227</td>
<td>248</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(13)</td>
<td>µS/cm</td>
<td>1.000</td>
<td>0</td>
<td>71</td>
<td>0%</td>
<td>208</td>
<td>284</td>
<td>287</td>
<td>No</td>
<td>284</td>
<td>317</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO4</td>
<td>none(14)</td>
<td>1</td>
<td>87</td>
<td>0%</td>
<td>47.7</td>
<td>53</td>
<td>59</td>
<td>No</td>
<td>51</td>
<td>88.5</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.
(i) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(ii) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
(iii) Estimated future water quality is from the FEIS GoldSim water modeling results.
(iv) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.
(v) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.
(vi) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.
(vii) Central Tendency determined as described in Table 1.
(viii) 95% UCL determined as described in Table 2.
(ix) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(x) Surface water quality standard is hardness dependent. The listed value assumes hardness of 200 mg/L, which is the expected hardness of the WWTS discharge.
(xi) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.
(xii) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(xiii) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(xiv) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
Table 7 MNSW8, Parameters Other than Mercury Antidegradation, Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality (3)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>Upper LCS Limit(5)</th>
<th>Measurable Increase by LCS method(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>12</td>
<td>0%</td>
<td>35.6</td>
<td>35.9</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.3</td>
<td>8</td>
<td>13%</td>
<td>0.29</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>12</td>
<td>42%</td>
<td>1.61</td>
<td>1.42</td>
<td>1.63</td>
<td>No</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>8</td>
<td>0%</td>
<td>105</td>
<td>107</td>
<td>123</td>
<td>No</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.5&lt;sup&gt;(7)&lt;/sup&gt;</td>
<td>0.2</td>
<td>8</td>
<td>75%</td>
<td>0.1</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11&lt;sup&gt;(8)&lt;/sup&gt;</td>
<td>1</td>
<td>8</td>
<td>25%</td>
<td>0.85</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>8</td>
<td>0%</td>
<td>0.84</td>
<td>0.73</td>
<td>0.84</td>
<td>No</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3&lt;sup&gt;(9)&lt;/sup&gt;</td>
<td>0.5</td>
<td>8</td>
<td>25%</td>
<td>1.4</td>
<td>1.18</td>
<td>1.36</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>2.2&lt;sup&gt;(10)&lt;/sup&gt;</td>
<td>0.5</td>
<td>8</td>
<td>38%</td>
<td>0.33</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>52&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>0.5</td>
<td>8</td>
<td>0%</td>
<td>5.34</td>
<td>4.12</td>
<td>4.74</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
<td>1.2</td>
<td>8</td>
<td>13%</td>
<td>1</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>1</td>
<td>0.2</td>
<td>8</td>
<td>38%</td>
<td>0.08</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Titanium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>8</td>
<td>100%</td>
<td>0.2</td>
<td>0.2</td>
<td>0.23</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>120&lt;sup&gt;(11)&lt;/sup&gt;</td>
<td>6</td>
<td>16</td>
<td>6%</td>
<td>6.6</td>
<td>n.d.</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>23</td>
<td>0%</td>
<td>15.9</td>
<td>16.5</td>
<td>18.3</td>
<td>No</td>
</tr>
<tr>
<td>Hardness (as CaCO&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>12</td>
<td>0%</td>
<td>795</td>
<td>806</td>
<td>927</td>
<td>No</td>
</tr>
<tr>
<td>pH</td>
<td>SI</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>13</td>
<td>0%</td>
<td>Not Available</td>
<td>7.99</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Solids, total dissolved&lt;sup&gt;(12)&lt;/sup&gt;</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>12</td>
<td>0%</td>
<td>Not Available</td>
<td>967</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C&lt;sup&gt;(13)&lt;/sup&gt;</td>
<td>µS/cm</td>
<td>1,000</td>
<td>0</td>
<td>13</td>
<td>0%</td>
<td>Not Available</td>
<td>1336</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>none&lt;sup&gt;(14)&lt;/sup&gt;</td>
<td>1</td>
<td>12</td>
<td>0%</td>
<td>464</td>
<td>472</td>
<td>519</td>
<td>No</td>
</tr>
</tbody>
</table>

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

(1) The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality estimated with mass balance calculations.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after their monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N

(8) Central Tendency determined as described in Table 1.

(9) 95% UCL determined as described in Table 2.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters 'used for production of wild rice' is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment C.

(15) Existing water quality central tendency plus the change due to LTVSMC pits.

(16) 95th percentile UCL plus the change due to LTVSMC pits.

(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

- **Antidegradation Results**
  - Estimated Future Water Quality
  - Existing Average Water Quality (substitution method)
  - Upper LCS Limit
  - Measurable Increase by LCS method

- **Parameters**
  - Aluminum, Antimony, Arsenic, Boron, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel, Selenium, Silver, Titanium, Zinc, Chloride, Hardness, Solids, Specific Conductance, Sulfate

- **Units**
  - µg/L, mg/L, µS/cm, SI

- **Applicable Standard**
  - The most stringent applicable surface water quality standard, except where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

- **Typical Reporting Limit (PQL)**
  - The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

- **Number of Samples (n)**
  - The number of duplicate samples used in the calculation.

- **Percentage Non-Detect**
  - The percentage of samples that were non-detectable.

- **Estimated Future Water Quality**
  - Calculated using mass balance calculations.

- **Existing Average Water Quality**
  - The average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after their monitoring data was collected.

- **Upper LCS Limit**
  - Calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.

- **Measurable Increase by LCS method**
  - Defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.
Large Table 7 (cont.)  MNSW8, Parameters Other than Mercury Antidegradation, Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Alternative Estimated Future Water Quality</th>
<th>Existing Water Quality Central Tendency</th>
<th>95th Percentile UCL</th>
<th>Estimated Change in Existing Central Tendency due to LTVSMC Pits</th>
<th>Estimated Adjusted Central Tendency</th>
<th>Estimated Adjusted 95th Percentile UCL</th>
<th>Measurable Increase by UCL Method</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>35.6</td>
<td>60</td>
<td>113</td>
<td>-23.8</td>
<td>35.9</td>
<td>89.2</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>0.28</td>
<td>0.064</td>
<td>0.080</td>
<td>+0.03</td>
<td>0.10</td>
<td>0.11</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>1.69</td>
<td>1.84</td>
<td>1.97</td>
<td>+0.14</td>
<td>1.58</td>
<td>1.81</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>105</td>
<td>85</td>
<td>95.5</td>
<td>+21.8</td>
<td>107</td>
<td>121</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>0.16</td>
<td>&lt;</td>
<td>0.2</td>
<td>-0.06</td>
<td>0.14</td>
<td>0.14</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>0.88</td>
<td>0.57</td>
<td>0.79</td>
<td>+0.13</td>
<td>0.71</td>
<td>0.92</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>0.84</td>
<td>0.77</td>
<td>0.88</td>
<td>-0.05</td>
<td>0.73</td>
<td>0.84</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>1.40</td>
<td>0.78</td>
<td>0.95</td>
<td>+0.45</td>
<td>1.23</td>
<td>1.40</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>0.36</td>
<td>0.23</td>
<td>0.94</td>
<td>+0.01</td>
<td>0.24</td>
<td>0.29</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>5.51</td>
<td>5.73</td>
<td>6.73</td>
<td>-0.20</td>
<td>5.09</td>
<td>5.10</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>1.02</td>
<td>0.77</td>
<td>0.96</td>
<td>+0.05</td>
<td>0.97</td>
<td>1.16</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>0.06</td>
<td>0.0083</td>
<td>0.012</td>
<td>+0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.30</td>
<td>&lt;</td>
<td>0.4</td>
<td>-0.09</td>
<td>0.31</td>
<td>0.31</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>6.36</td>
<td>4.2</td>
<td>5.08</td>
<td>+0.66</td>
<td>4.86</td>
<td>5.74</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>15.9</td>
<td>8.45</td>
<td>8.76</td>
<td>+8.04</td>
<td>16.5</td>
<td>16.8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>Not Available</td>
<td>806</td>
<td>887</td>
<td>-20.6</td>
<td>785</td>
<td>866</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved</td>
<td>mg/L</td>
<td>Not Available</td>
<td>949</td>
<td>1058</td>
<td>+21.6</td>
<td>970</td>
<td>1080</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C</td>
<td>µS/cm</td>
<td>Not Available</td>
<td>1323</td>
<td>1442</td>
<td>+12.1</td>
<td>1336</td>
<td>1454</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>464</td>
<td>473</td>
<td>529</td>
<td>-1.09</td>
<td>471</td>
<td>528</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>n.d. – All measured values are below reporting limits or the average value is below the reporting limit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.</td>
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<tr>
<td>(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).</td>
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</tr>
<tr>
<td>(3) Estimated future water quality estimated with mass balance calculations.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after they were collected. (See Section 5.6 of Antidegradation Evaluation for details).</td>
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<tr>
<td>(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of acceptable variability inherent in each EPA approved test method; expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.</td>
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</tr>
<tr>
<td>(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(8) Central Tendency determined as described in Table 1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(9) 95% UCL determined as described in Table 2.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters &quot;used for production of wild rice&quot; is not applicable.</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2-1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2-1) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment C.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15) Existing water quality central tendency plus the change due to LTVSMC pits.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(16) 95th percentile UCL plus the change due to LTVSMC pits.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| (18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
Large Table 8  MNSW12, Parameters Other than Mercury Antidegradation, Evaluation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>2016 Draft Estimated Future Water Quality (i)</th>
<th>Existing Average Water Quality (substitution method)(4)</th>
<th>Upper LCS Limit(b)</th>
<th>Measurable Increase by LCS method(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>125</td>
<td>2</td>
<td>10</td>
<td>0%</td>
<td>96.3</td>
<td>96.5</td>
<td>124</td>
<td>No</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>31</td>
<td>0.53</td>
<td>7</td>
<td>14%</td>
<td>0.15</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>53</td>
<td>0.5</td>
<td>10</td>
<td>10%</td>
<td>1.08</td>
<td>1.04</td>
<td>1.16</td>
<td>No</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>µg/L</td>
<td>500</td>
<td>100</td>
<td>8</td>
<td>0%</td>
<td>108</td>
<td>108</td>
<td>124</td>
<td>No</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>2.5</td>
<td>0.2</td>
<td>8</td>
<td>88%</td>
<td>0.09</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>11</td>
<td>1</td>
<td>8</td>
<td>38%</td>
<td>0.62</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>5</td>
<td>0.2</td>
<td>8</td>
<td>0%</td>
<td>0.52</td>
<td>0.5</td>
<td>0.58</td>
<td>No</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>9.3</td>
<td>0.5</td>
<td>8</td>
<td>0%</td>
<td>3.24</td>
<td>3.17</td>
<td>3.65</td>
<td>No</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>3.2</td>
<td>0.5</td>
<td>8</td>
<td>25%</td>
<td>0.3</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>52</td>
<td>0.5</td>
<td>8</td>
<td>0%</td>
<td>3.95</td>
<td>3.64</td>
<td>419</td>
<td>No</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>5</td>
<td>8</td>
<td>13%</td>
<td>0%</td>
<td>0.66</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>0.2</td>
<td>0.2</td>
<td>0%</td>
<td>10%</td>
<td>0.05</td>
<td>0.04</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>7</td>
<td>100%</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>120</td>
<td>6</td>
<td>16</td>
<td>0%</td>
<td>4.03</td>
<td>n.d.</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Chloride Cl</td>
<td>mg/L</td>
<td>230</td>
<td>5</td>
<td>19</td>
<td>0%</td>
<td>7</td>
<td>7.1</td>
<td>7.8</td>
<td>No</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>10</td>
<td>0%</td>
<td>304</td>
<td>306</td>
<td>409</td>
<td>No</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>11</td>
<td>0%</td>
<td>Not Available</td>
<td>7.66</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>0%</td>
<td>0%</td>
<td>Not Available</td>
<td>452</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(9)</td>
<td>µS/cm</td>
<td>1,000</td>
<td>0</td>
<td>11</td>
<td>0%</td>
<td>Not Available</td>
<td>700</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>N.d.</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
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(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.
(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N
(8) Central Tendency determined as described in Table 1.
(9) 95% UCL determined as described in Table 2.
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(11) The waterbody is not an wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.
(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
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(15) Existing water quality central tendency plus the change due to LTVSMC pits.
(16) 95th percentile UCL plus the change due to LTVSMC pits.
(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Alternative Estimated Future Water Quality</th>
<th>Existing Water Quality Central Tendency</th>
<th>95th Percentile UCL</th>
<th>Estimated Change in Existing Central Tendency due to LTVSMC Pits</th>
<th>Estimated Adjusted Central Tendency</th>
<th>Estimated Adjusted 95th Percentile UCL</th>
<th>Measurable Increase by UCL Method</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>µg/L</td>
<td>96.4</td>
<td>105</td>
<td>136</td>
<td>-8.07</td>
<td>96.7</td>
<td>127.9</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>µg/L</td>
<td>0.13</td>
<td>0.09</td>
<td>0.11</td>
<td>+0.004</td>
<td>0.09</td>
<td>0.11</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>µg/L</td>
<td>1.06</td>
<td>0.99</td>
<td>1.24</td>
<td>+0.03</td>
<td>1.02</td>
<td>1.27</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Barion (total)</td>
<td>µg/L</td>
<td>104</td>
<td>101.01</td>
<td>122</td>
<td>+25.0</td>
<td>104</td>
<td>124</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>µg/L</td>
<td>0.20</td>
<td>&lt;0.20</td>
<td>0.2</td>
<td>-0.01</td>
<td>0.19</td>
<td>0.19</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Chromium (total)</td>
<td>µg/L</td>
<td>0.81</td>
<td>0.58</td>
<td>0.95</td>
<td>+0.02</td>
<td>0.61</td>
<td>0.97</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>µg/L</td>
<td>0.50</td>
<td>0.46</td>
<td>0.55</td>
<td>+0.02</td>
<td>0.48</td>
<td>0.57</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Copper (total)</td>
<td>µg/L</td>
<td>3.28</td>
<td>3.35</td>
<td>4.01</td>
<td>-0.14</td>
<td>3.21</td>
<td>3.87</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Lead (total)</td>
<td>µg/L</td>
<td>0.41</td>
<td>0.27</td>
<td>0.41</td>
<td>-0.002</td>
<td>0.27</td>
<td>0.41</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Nickel (total)</td>
<td>µg/L</td>
<td>3.82</td>
<td>3.63</td>
<td>4</td>
<td>-0.11</td>
<td>3.51</td>
<td>3.89</td>
<td>No</td>
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<tr>
<td>Selenium (total)</td>
<td>µg/L</td>
<td>0.63</td>
<td>0.57</td>
<td>0.73</td>
<td>+0.05</td>
<td>0.63</td>
<td>0.78</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>µg/L</td>
<td>0.11</td>
<td>0.006</td>
<td>0.007</td>
<td>+0.009</td>
<td>0.02</td>
<td>0.02</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Thallium (total)</td>
<td>µg/L</td>
<td>0.39</td>
<td>0.4</td>
<td>0.4</td>
<td>-0.02</td>
<td>0.38</td>
<td>0.38</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>µg/L</td>
<td>4.50</td>
<td>4.16</td>
<td>4.97</td>
<td>+0.12</td>
<td>4.28</td>
<td>5.09</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>6.6</td>
<td>4.91</td>
<td>5.68</td>
<td>+1.73</td>
<td>6.6</td>
<td>7.4</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>336</td>
<td>291</td>
<td>388</td>
<td>+40.2</td>
<td>331</td>
<td>428</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>Not Available</td>
<td>7.61</td>
<td>7.71</td>
<td>+0.05</td>
<td>7.66</td>
<td>7.76</td>
<td>Not Available</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved</td>
<td>mg/L</td>
<td>Not Available</td>
<td>375</td>
<td>492</td>
<td>+52.7</td>
<td>428</td>
<td>543</td>
<td>Not Available</td>
<td>Yes</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C</td>
<td>µS/cm</td>
<td>Not Available</td>
<td>793</td>
<td>1173</td>
<td>+47.4</td>
<td>840</td>
<td>1220</td>
<td>Not Available</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>193</td>
<td>164</td>
<td>224</td>
<td>+26.1</td>
<td>190</td>
<td>250</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.
(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
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(9) 95% UCL determined as described in Table 2.
(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.
(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for water “used for production of wild rice” is not applicable.
(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment C.
(15) Existing surface quality central tendency plus the change due to LTVSMC pits.
(16) 95th percentile UCL plus the change due to LTVSMC pits.
(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Large Table 8 (cont.) MNSW12, Parameters Other than Mercury Antidegradation, Evaluation Results and ProUCL Results
La Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

95th percentile UCL plus the change due to LTVSMC pits.

Existing water quality central tendency plus the change due to LTVSMC pits.

Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality parameters. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2)

Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

Existing water quality central tendency plus the change due to LTVSMC pits.

95th percentile UCL plus the change due to LTVSMC pits.

A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method.

Average value of monitoring results, calculated using average values of duplicate samples and including results below detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after the monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)

Antidegradation Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard</th>
<th>Typical Reporting Limit (PQL)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>2016 Draft Estimated Future Water Quality</th>
<th>Existing Average Water Quality (substitution method)</th>
<th>Upper LCS Limit</th>
<th>Measurable Increase by LCS method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>Al (µg/L)</td>
<td>125</td>
<td>2</td>
<td>50</td>
<td>2%</td>
<td>100</td>
<td>100</td>
<td>~-(18)</td>
<td>No</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb (µg/L)</td>
<td>81</td>
<td>0.53</td>
<td>50</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As (µg/L)</td>
<td>53</td>
<td>0.5</td>
<td>67</td>
<td>34%</td>
<td>1.49</td>
<td>1.47</td>
<td>1.69</td>
<td>No</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B (µg/L)</td>
<td>500</td>
<td>100</td>
<td>91</td>
<td>0%</td>
<td>111</td>
<td>112</td>
<td>129</td>
<td>No</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd (µg/L)</td>
<td>2.5(12)</td>
<td>0.2</td>
<td>48</td>
<td>81%</td>
<td>1.36</td>
<td>1.36</td>
<td>1.56</td>
<td>No</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr (µg/L)</td>
<td>11(18)</td>
<td>1</td>
<td>50</td>
<td>48%</td>
<td>6.42</td>
<td>6.4</td>
<td>7.36</td>
<td>No</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co (µg/L)</td>
<td>5</td>
<td>0.2</td>
<td>52</td>
<td>96%</td>
<td>1.5</td>
<td>1.49</td>
<td>1.71</td>
<td>No</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu (µg/L)</td>
<td>9.2(12)</td>
<td>0.5</td>
<td>33</td>
<td>18%</td>
<td>7.53</td>
<td>7.5</td>
<td>8.63</td>
<td>No</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb (µg/L)</td>
<td>3.2(12)</td>
<td>0.5</td>
<td>34</td>
<td>79%</td>
<td>1.78</td>
<td>1.77</td>
<td>2.04</td>
<td>No</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni (µg/L)</td>
<td>52(12)</td>
<td>0.5</td>
<td>39</td>
<td>56%</td>
<td>1.27</td>
<td>1.15</td>
<td>1.32</td>
<td>No</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se (µg/L)</td>
<td>5</td>
<td>1</td>
<td>73</td>
<td>96%</td>
<td>1</td>
<td>1</td>
<td>1.15</td>
<td>No</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag (µg/L)</td>
<td>1</td>
<td>0.2</td>
<td>53</td>
<td>98%</td>
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<td>0.52</td>
<td>0.6</td>
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<tr>
<td>Thallium (total)</td>
<td>Tl (µg/L)</td>
<td>0.56</td>
<td>0.005</td>
<td>0</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>Zinc (total)</td>
<td>Zn (µg/L)</td>
<td>120(12)</td>
<td>6</td>
<td>55</td>
<td>18%</td>
<td>18.9</td>
<td>18.8</td>
<td>21.6</td>
<td>No</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl (mg/L)</td>
<td>230</td>
<td>5</td>
<td>387</td>
<td>0%</td>
<td>8.2</td>
<td>8.2</td>
<td>9</td>
<td>No</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>267</td>
<td>0%</td>
<td>78.7</td>
<td>80</td>
<td>82</td>
<td>No</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>316</td>
<td>0%</td>
<td>Not Available</td>
<td>7.4</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Solids, total dissolved(13)</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>249</td>
<td>0%</td>
<td>Not Available</td>
<td>150</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Specific Conductance @ 25°C(14)</td>
<td>µS/cm</td>
<td>1,000 (11)</td>
<td>0</td>
<td>319</td>
<td>0%</td>
<td>Not Available</td>
<td>189</td>
<td>N/A</td>
<td>Not Available</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO4 (mg/L)</td>
<td>none(11)</td>
<td>1</td>
<td>268</td>
<td>0%</td>
<td>19.1</td>
<td>19.7</td>
<td>21.7</td>
<td>No</td>
</tr>
</tbody>
</table>

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality estimated with mass balance calculations.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after the monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N

(8) Central Tendency determined as described in Table 1.

(9) 95% UCL determined as described in Table 2.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

(15) Existing water quality central tendency plus the change due to LTVSMC pits.

(16) 95th percentile UCL plus the change due to LTVSMC pits.

(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Large Table 9  St. Louis River at Scanlon (USGS 04024000), Parameters Other than Mercury Antidegradation, Evaluation Results and ProUCL Results
Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

95th percentile UCL plus the change due to LTVSMC pits.

Existing water quality central tendency plus the change due to LTVSMC pits.

Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

Existing water quality central tendency plus the change due to LTVSMC pits.

The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard is less stringent.

LCS and UCL Measurable Increase Conclusion Same?

<table>
<thead>
<tr>
<th>Parameter (total)</th>
<th>Unit</th>
<th>Alternative Estimated Future Water Quality (1)</th>
<th>Existing Water Quality Central Tendency (2)</th>
<th>95th Percentile UCL (3)</th>
<th>Estimated Change in Existing Central Tendency due to LTVSMC Pits (4)</th>
<th>Estimated Adjusted Central Tendency (5)</th>
<th>Estimated Adjusted 95th Percentile UCL (6)</th>
<th>Measurable Increase by UCL Method(7,8)</th>
<th>LCS and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>µg/L</td>
<td>Not Available</td>
<td>10.0</td>
<td>10.1</td>
<td>-0.41</td>
<td>10.0</td>
<td>208.6</td>
<td>No</td>
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<tr>
<td>Antimony</td>
<td>µg/L</td>
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<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic</td>
<td>µg/L</td>
<td>1.66</td>
<td>1.64</td>
<td>2.92</td>
<td>-0.01</td>
<td>1.64</td>
<td>2.92</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron</td>
<td>µg/L</td>
<td>111</td>
<td>126</td>
<td>+0.09</td>
<td>112</td>
<td>1.26</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Cadmium</td>
<td>µg/L</td>
<td>1.00</td>
<td>1.67</td>
<td>-0.004</td>
<td>1.00</td>
<td>1.67</td>
<td>No</td>
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</tr>
<tr>
<td>Chromium</td>
<td>µg/L</td>
<td>6.25</td>
<td>10.8</td>
<td>-0.02</td>
<td>6.24</td>
<td>10.8</td>
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</tr>
<tr>
<td>Cobalt</td>
<td>µg/L</td>
<td>3.00</td>
<td>5</td>
<td>-0.01</td>
<td>2.99</td>
<td>4.99</td>
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<tr>
<td>Copper</td>
<td>µg/L</td>
<td>7.44</td>
<td>22</td>
<td>-0.03</td>
<td>7.41</td>
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<tr>
<td>Lead</td>
<td>µg/L</td>
<td>2.00</td>
<td>4</td>
<td>-0.01</td>
<td>1.99</td>
<td>3.99</td>
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<td>Yes</td>
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<tr>
<td>Nickel</td>
<td>µg/L</td>
<td>1.13</td>
<td>1.52</td>
<td>+0.01</td>
<td>1.01</td>
<td>1.53</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>1.00</td>
<td>20</td>
<td>+0.001</td>
<td>1.00</td>
<td>2.00</td>
<td>No</td>
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<tr>
<td>Silver</td>
<td>µg/L</td>
<td>1.00</td>
<td>1</td>
<td>-0.004</td>
<td>1.00</td>
<td>1.00</td>
<td>No</td>
<td>Yes</td>
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</tr>
<tr>
<td>Thallium</td>
<td>µg/L</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Yes</td>
</tr>
<tr>
<td>Zinc</td>
<td>µg/L</td>
<td>18.9</td>
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<td>18.7</td>
<td>29.9</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>8.2</td>
<td>9.33</td>
<td>+0.08</td>
<td>8.2</td>
<td>9.4</td>
<td>No</td>
<td>Yes</td>
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</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>78.5</td>
<td>98</td>
<td>+3.09</td>
<td>90.9</td>
<td>102</td>
<td>No</td>
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</tr>
<tr>
<td>pH</td>
<td></td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>Not Available</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved (10)</td>
<td>mg/L</td>
<td>146</td>
<td>150</td>
<td>+3.82</td>
<td>150</td>
<td>154</td>
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</tr>
<tr>
<td>Specific Conductance @ 25°C (11)</td>
<td>µS/cm</td>
<td>Not Available</td>
<td>183</td>
<td>+5.26</td>
<td>188</td>
<td>193</td>
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<tr>
<td>Sulfate</td>
<td>mg/L</td>
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<td>18.3</td>
<td>+2.04</td>
<td>20.1</td>
<td>20.4</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(4) Estimated future water quality estimated with mass balance calculations

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N

(8) Central Tendency determined as described in Table 1.

(9) 95% UCL determined as described in Table 2.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(12) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

(14) Existing water quality central tendency plus the change due to LTVSMC pits.

(15) 95th percentile UCL plus the change due to LTVSMC pits.

(16) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(17) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.
### Mercury at all Stations, Antidegradation Results and ProUCL Results

<table>
<thead>
<tr>
<th>Monitoring Station</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Number of Samples (n)</th>
<th>Percentage Non-Detect</th>
<th>Estimated Future Water Quality Mine Year 10 (3)</th>
<th>Existing Average Water Quality (4)</th>
<th>Upper LCS Limit (5)</th>
<th>Measurable Increase by LCS method (6)</th>
<th>Existing Water Quality Central Tendency (7)</th>
<th>95th Percentile UCL (8)</th>
<th>Estimated Change in Existing Central Tendency due to LTVSMC Pits (9)</th>
<th>Estimated Adjusted Central Tendency (10)</th>
<th>95th Percentile UCL (11)</th>
<th>Measurable Increase by UCL method (12)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN5W12</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>3</td>
<td>0%</td>
<td>4.3</td>
<td>4.3</td>
<td>5.3</td>
<td>No</td>
<td>4.7</td>
<td>5.5</td>
<td>-0.4</td>
<td>4.3</td>
<td>9.1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>MN5W8</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>7</td>
<td>0%</td>
<td>2.4</td>
<td>2.4</td>
<td>3</td>
<td>No</td>
<td>1.7</td>
<td>2.1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>PM-11</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>38</td>
<td>16%</td>
<td>1.8</td>
<td>1.7</td>
<td>2.1</td>
<td>No</td>
<td>1.7</td>
<td>2.1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>PM-13</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>43</td>
<td>28%</td>
<td>3.4</td>
<td>3.4</td>
<td>4.2</td>
<td>No</td>
<td>3.4</td>
<td>4.2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>SD026</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>89</td>
<td>47%</td>
<td>3.3</td>
<td>0.6</td>
<td>0.7</td>
<td>Yes</td>
<td>0.6</td>
<td>0.7</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SW004a</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>19</td>
<td>0%</td>
<td>3.8</td>
<td>3.8</td>
<td>4.7</td>
<td>No</td>
<td>3.8</td>
<td>5.1</td>
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<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>TC-1A</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>12</td>
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<td>2.1</td>
<td>2.6</td>
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<td>2.1</td>
<td>2.8</td>
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<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Forbes</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>3</td>
<td>0%</td>
<td>4.1</td>
<td>4.1</td>
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<td>4.1</td>
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<td>8.9</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Scanlan</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>4</td>
<td>0%</td>
<td>4.6</td>
<td>4.6</td>
<td>5.7</td>
<td>No</td>
<td>4.6</td>
<td>9.4</td>
<td>0.0</td>
<td>4.6</td>
<td>9.4</td>
<td>No</td>
<td>Yes</td>
</tr>
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<td>Trimble Creek</td>
<td>ng/L</td>
<td>1.3</td>
<td>0.5</td>
<td>89</td>
<td>47%</td>
<td>1.3</td>
<td>2.1</td>
<td>2.6</td>
<td>No</td>
<td>2.1</td>
<td>2.8</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Unnamed Creek</td>
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<td>0.5</td>
<td>89</td>
<td>47%</td>
<td>1.3</td>
<td>1.7</td>
<td>2.1</td>
<td>No</td>
<td>1.7</td>
<td>2.1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
(3) Estimated using mass balance calculations.
(4) Mean calculated using the Kaplan-Meier method.
(5) Upper Laboratory Control Sample (LCS) Limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation.
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.
(7) Central Tendency determined as described in Table 1.
(8) 95% UCL determined as described in Table 2.
(9) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment F.
(10) Existing water quality central tendency plus the change due to LTVSMC pits.
(11) 95th percentile UCL plus the change due to LTVSMC pits.
(12) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
### Summary, Parameters Other Than Mercury, Antidegradation Results and ProUCL Results

#### Large Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Applicable Standard(1)</th>
<th>Typical Reporting Limit (PQL)(2)</th>
<th>Existing Average Water Quality (substitution method)(3)</th>
<th>ProUCL Existing Water Quality Central Tendency(4)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
<th>Existing Average Water Quality (substitution method)(3)</th>
<th>ProUCL Existing Water Quality Central Tendency(4)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
<th>Existing Average Water Quality (substitution method)(3)</th>
<th>ProUCL Existing Water Quality Central Tendency(4)</th>
<th>LSC and UCL Measurable Increase Conclusion Same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (total)</td>
<td>Al µg/L</td>
<td>125</td>
<td>2</td>
<td>18.4</td>
<td>23.3</td>
<td>Yes</td>
<td>22.4</td>
<td>23.6</td>
<td>Yes</td>
<td>17</td>
<td>29.9</td>
<td>Yes</td>
</tr>
<tr>
<td>Antimony (total)</td>
<td>Sb µg/L</td>
<td>31</td>
<td>0.9</td>
<td>0.86</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
</tr>
<tr>
<td>Arsenic (total)</td>
<td>As µg/L</td>
<td>53</td>
<td>0.5</td>
<td>0.62</td>
<td>0.51</td>
<td>Yes</td>
<td>0.87</td>
<td>0.90253</td>
<td>Yes</td>
<td>0.87</td>
<td>0.92</td>
<td>Yes</td>
</tr>
<tr>
<td>Boron (total)</td>
<td>B µg/L</td>
<td>500</td>
<td>100</td>
<td>220</td>
<td>211</td>
<td>No - UCL indicates measurable change</td>
<td>138</td>
<td>142</td>
<td>Yes</td>
<td>207</td>
<td>210</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium (total)</td>
<td>Cd µg/L</td>
<td>2.9(5)</td>
<td>0.2</td>
<td>n.d.</td>
<td>&lt; 0.2</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.2</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.2</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Cr µg/L</td>
<td>11(5)</td>
<td>1</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt (total)</td>
<td>Co µg/L</td>
<td>5</td>
<td>0.2</td>
<td>0.54</td>
<td>&lt; 0.48</td>
<td>No - change not measurable using UCL</td>
<td>0.23</td>
<td>&lt; 0.2</td>
<td>Yes</td>
<td>0.3</td>
<td>&lt; 0.2</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper (total)</td>
<td>Cu µg/L</td>
<td>9.3(5)</td>
<td>0.5</td>
<td>1.11</td>
<td>0.96</td>
<td>Yes</td>
<td>0.52</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>0.93</td>
<td>0.84</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead (total)</td>
<td>Pb µg/L</td>
<td>3.2(5)</td>
<td>0.5</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
</tr>
<tr>
<td>Nickel (total)</td>
<td>Ni µg/L</td>
<td>52(5)</td>
<td>0.5</td>
<td>1.32</td>
<td>1.11</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.5</td>
<td>Yes</td>
<td>0.68</td>
<td>0.57</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium (total)</td>
<td>Se µg/L</td>
<td>5</td>
<td>1</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>No - change not measurable using UCL</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 1</td>
<td>No - change not measurable using UCL</td>
</tr>
<tr>
<td>Silver (total)</td>
<td>Ag µg/L</td>
<td>1</td>
<td>0.2</td>
<td>0.25</td>
<td>&lt; 0.24</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.2</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.2</td>
<td>Yes</td>
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<tr>
<td>Thallium</td>
<td>Tl µg/L</td>
<td>0.56</td>
<td>0.005</td>
<td>0.26</td>
<td>&lt; 0.005</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 0.005</td>
<td>Yes</td>
<td>0.12</td>
<td>0.0075</td>
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<tr>
<td>Zinc (total)</td>
<td>Zn µg/L</td>
<td>120(5)</td>
<td>6</td>
<td>8.2</td>
<td>7.5</td>
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<td>n.d.</td>
<td>&lt; 6</td>
<td>Yes</td>
<td>n.d.</td>
<td>&lt; 6</td>
<td>Yes</td>
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<tr>
<td>Chloride</td>
<td>Cl mg/L</td>
<td>230</td>
<td>5</td>
<td>11.5</td>
<td>11.5</td>
<td>Yes</td>
<td>17.3</td>
<td>17.3</td>
<td>Yes</td>
<td>17</td>
<td>17.0</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>mg/L</td>
<td>500</td>
<td>10</td>
<td>439</td>
<td>466</td>
<td>Yes</td>
<td>331</td>
<td>331</td>
<td>Yes</td>
<td>373</td>
<td>373</td>
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<tr>
<td>pH</td>
<td>SU</td>
<td>6.5 to 8.5</td>
<td>0.01</td>
<td>7.8</td>
<td>7.8</td>
<td>Yes</td>
<td>7.4</td>
<td>7.4</td>
<td>Yes</td>
<td>7.6</td>
<td>7.6</td>
<td>Yes</td>
</tr>
<tr>
<td>Solids, total dissolved(8)</td>
<td>mg/L</td>
<td>700</td>
<td>10</td>
<td>650</td>
<td>600</td>
<td>Yes</td>
<td>474</td>
<td>474</td>
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<td>492</td>
<td>492</td>
<td>Yes</td>
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<tr>
<td>Specific Conductance @ 25°C(10)</td>
<td>µS/cm</td>
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<td>0</td>
<td>997</td>
<td>1005</td>
<td>Yes</td>
<td>723</td>
<td>723</td>
<td>Yes</td>
<td>793</td>
<td>793</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO4 mg/L</td>
<td>none(8)</td>
<td>1</td>
<td>173</td>
<td>173</td>
<td>Yes</td>
<td>51.4</td>
<td>51.4</td>
<td>Yes</td>
<td>114</td>
<td>115</td>
<td>Yes</td>
</tr>
</tbody>
</table>

(1) The most stringent applicable surface water quality standard, except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(4) Central Tendency determined as described in Table 2.

(5) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after the monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details).

(6) Central Tendency determined as described in Table 1, adjusted for flows from the LTVSMC pits that began after the monitoring data was collected.

(7) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(8) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(9) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(10) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
**Parameter** | **Units** | **Applicable Reporting Limit (PQL)** | **Existing Average Water Quality (substitution method)** | **ProUCL Existing Water Quality Central Tendency** | **LSC and UCL Measurable Increase Conclusion Same?** | **Existing Average Water Quality (substitution method)** | **ProUCL Existing Water Quality Central Tendency** | **LSC and UCL Measurable Increase Conclusion Same?** | **Existing Average Water Quality (substitution method)** | **ProUCL Existing Water Quality Central Tendency** | **LSC and UCL Measurable Increase Conclusion Same?** |
---|---|---|---|---|---|---|---|---|---|---|---|---|
Aluminum (total) | Al | µg/L | 125 | 2 | 22.4 | 23.6 | No | 29.5 | 29.9 | Yes | 187 | 180.84 | No |
Antimony (total) | Sb | µg/L | 31 | 0.53 | n.d. | < 0.50 | Yes | n.d. | < 0.5 | Yes | n.d. | < 0.50 | Yes |
Arsenic (total) | As | µg/L | 53 | 0.5 | 0.87 | 0.90 | No | 0.87 | 0.92 | Yes | 1.1 | 1.1 | Yes |
Boron (total) | B | µg/L | 500 | 100 | 138 | 142 | No - UCL indicates measurable change | 207 | 210 | Yes | n.d. | 59.5 | Yes |
Cadmium (total) | Cd | µg/L | 2.5(7) | 0.2 | n.d. | < 0.2 | Yes | n.d. | < 0.2 | Yes | n.d. | < 0.2 | Yes |
Chromium (total) | Cr | µg/L | 11(3) | 1 | n.d. | < 1 | Yes | n.d. | < 1 | Yes | n.d. | < 1 | Yes |
Cobalt (total) | Co | µg/L | 5 | 0.2 | 0.23 | < 0.2 | Yes | 0.3 | < 0.2 | Yes | 0.44 | 0.41 | Yes |
Copper (total) | Cu | µg/L | 9.3(5) | 0.5 | 0.52 | < 0.5 | Yes | 0.93 | 0.84 | Yes | 1.22 | 1.2 | Yes |
Lead (total) | Pb | µg/L | 3.7(8) | 0.5 | 0.5 | < 0.5 | Yes | n.d. | < 0.5 | Yes | n.d. | < 0.5 | Yes |
Nickel (total) | Ni | µg/L | 52(7) | 0.5 | n.d. | < 0.5 | Yes | 0.68 | 0.57 | Yes | 1.46 | 1.4 | Yes |
Selenium (total) | Se | µg/L | 5 | 1 | n.d. | < 1 | Yes | n.d. | < 1 | No - change not measurable using UCL | n.d. | < 1 | Yes |
Silver (total) | Ag | µg/L | 1 | 0.2 | n.d. | < 0.2 | Yes | n.d. | < 0.2 | Yes | n.d. | < 0.22 | Yes |
Thallium | Tl | µg/L | 0.56 | 0.005 | n.d. | < 0.005 | Yes | 0.0075 | 0.0075 | No - UCL indicates measurable change | 0.135 | < 0.005 | No - UCL indicates measurable change |
Zinc (total) | Zn | µg/L | 120(7) | 6 | n.d. | < 6 | Yes | n.d. | < 6 | No - UCL indicates measurable change | 7.0 | < 6 | Yes |
Chloride | Cl | mg/L | 230 | 5 | 17.3 | 17.3 | Yes | 17 | 17.0 | Yes | 7.3 | 7.0 | Yes |
Hardness (as CaCO3) | | mg/L | 500 | 10 | 331 | 331 | Yes | 373 | 373 | Yes | 139 | 139 | Yes |
EPA | SO4 | 6.5 to 8.5 | 0.01 | 7.4 | 7.37 | Yes | 7.6 | 7.6 | Yes | 7.4 | 7.4 | Yes |
Solids, total dissolved(9) | | mg/L | 700 | 10 | 474 | 474 | Yes | 492 | 492 | Yes | 227 | 227 | Yes |
Specific Conductance @25°C(10) | µS/cm | 1.000 | 0 | 723 | 723 | Yes | 793 | 793 | Yes | 284 | 284 | Yes |
Sulfate | SO4 | mg/L | none(8) | 1 | 51.4 | 51 | Yes | 115 | 115 | Yes | 53 | 51 | Yes |

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(4) Central Tendency determined as described in Table 2.

(5) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after their monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details).

(6) Central Tendency determined as described in Table 1, adjusted for flows from the LTVSMC pits that began after their monitoring data was collected.

(7) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(8) The water body is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(9) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(10) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
### Large Table 11 (cont.) Summary, Parameters Other Than Mercury, Antidegradation Results and ProUCL Results

| Parameter                        | Units | Applicable Standard (PQL) | Typical Reporting Limit (PQL) | Existing Average Water Quality (substitution method) | ProUCL Existing Water Quality Central Tendency | LSC and UCL Measurable Increase Conclusion Same? | Existing Average Water Quality (substitution method) | ProUCL Existing Water Quality Central Tendency | LSC and UCL Measurable Increase Conclusion Same? | Existing Average Water Quality (substitution method) | ProUCL Existing Water Quality Central Tendency | LSC and UCL Measurable Increase Conclusion Same? | Scanlon |
|----------------------------------|-------|---------------------------|-------------------------------|----------------------------------------------------|-----------------------------------------------|------------------------------------------------|------------------------------------------------|-----------------------------------------------|------------------------------------------------|------------------------------------------------|------------------------------------------------|-----------------------------------------------|------------------------------------------------|------------------------------------------------|--------|
| Aluminum (total)                 | Al    | µg/L                      |                               | 125                                               | 2                                             | 3.59                                           | 3.59                                           | 96.5                                          | 96.7                                          | 100                                           | 101                                           | Yes                                             |        |
| Antimony (total)                 | Sb    | µg/L                      |                                | 31                                                | 0.53                                          | n.d.                                           | 0.10                                           | n.d.                                          | 0.1                                           | Not Available                                | Not Available                                | No - UCL indicates measurable change               |        |
| Arsenic (total)                  | As    | µg/L                      |                               | 53                                                | 0.5                                           | 1.42                                           | 1.50                                           | Yes                                          | 1.04                                          | 1.02                                          | Yes                                          | 1.47                                           | 1.64                                           |        |
| Boron (total)                    | B     | µg/L                      |                               | 500                                               | 100                                           | 107                                            | 107                                           | Yes                                          | 108                                           | 104                                          | Yes                                          | 112                                           | 112                                           | Yes     |
| Cadmium (total)                  | Cd    | µg/L                      |                                | 2.9(7)                                            | 0.2                                           | n.d.                                           | < 0.14                                         | Yes                                          | n.d.                                          | < 0.19                                         | Yes                                          | 1.36                                           | < 1.00                                         | Yes     |
| Chromium (total)                 | Cr    | µg/L                      |                                | 11(7)                                             | 1                                             | n.d.                                           | 0.71                                           | Yes                                          | n.d.                                          | 0.61                                          | Yes                                          | 6.4                                            | 6.2                                            | Yes     |
| Cobalt (total)                   | Co    | µg/L                      |                               | 5                                                 | 0.2                                           | 0.73                                           | 0.73                                           | Yes                                          | 0.5                                           | 0.48                                          | Yes                                          | 1.49                                           | < 2.99                                         | Yes     |
| Copper (total)                   | Cu    | µg/L                      |                                | 9.3(7)                                            | 0.5                                           | 1.18                                           | 1.23                                           | No - change not measurable using UCL            | 3.17                                          | 3.2                                           | Yes                                          | 7.5                                            | 7.4                                            | Yes     |
| Lead (total)                     | Pb    | µg/L                      |                                | 3.2(7)                                            | 0.5                                           | n.d.                                           | 0.24                                           | Yes                                          | n.d.                                          | 0.27                                          | Yes                                          | 1.77                                           | < 1.99                                         | Yes     |
| Nickel (total)                   | Ni    | µg/L                      |                                | 52(7)                                             | 0.5                                           | 4.12                                           | 4.09                                           | Yes                                          | 3.64                                          | 3.51                                          | Yes                                          | 1.15                                           | < 1.01                                         | Yes     |
| Selenium (total)                 | Se    | µg/L                      |                                | 5                                                 | 1                                             | n.d.                                           | 0.97                                           | Yes                                          | n.d.                                          | 0.6                                           | Yes                                          | 1.0                                            | < 1.00                                         | Yes     |
| Silver (total)                   | Ag    | µg/L                      |                                | 1                                                 | 0.2                                           | n.d.                                           | 0.06                                           | Yes                                          | n.d.                                          | 0.52                                          | Yes                                          | < 1.00                                         | Yes                                             |        |
| Thallium (total)                 | Ti    | µg/L                      |                                | 0.56                                              | 0.005                                         | 0.2                                            | < 0.31                                         | Yes                                          | 0.2                                           | < 0.4                                         | No - UCL indicates measurable change              | Not Available                                  | Not Available                                  | Yes     |
| Zinc (total)                     | Zn    | µg/L                      |                                | 120(7)                                            | 6                                             | n.d.                                           | 4.86                                           | Yes                                          | n.d.                                          | 4.3                                           | Yes                                          | 18.8                                           | 18.7                                           | Yes     |
| Chloride                         | Cl    | mg/L                      |                                | 230                                               | 5                                             | 16.5                                           | 16.5                                           | Yes                                          | 7.3                                           | 6.6                                           | Yes                                          | 8.2                                            | 8.2                                            | Yes     |
| Hardness (as CaCO₃)              |       | mg/L                      |                                | 500                                               | 10                                            | 806                                            | 785                                            | Yes                                          | 356                                           | 331                                          | Yes                                          | 80                                             | 80                                             | Yes     |
| pH                               |       | g/L                       |                                | 6.5 to 8.5                                        | 0.01                                          | 7.99                                           | 7.99                                           | Yes                                          | 7.66                                          | 7.7                                           | No                                            | 7.4                                            | 7.4                                            | Yes     |
| Solids, total dissolved(8)(7)    |       | mg/L                      |                                | 700                                               | 10                                            | 967                                            | 970                                            | Yes                                          | 452                                           | 428                                          | No                                            | 150                                           | 150                                           | Yes     |
| Specific Conductance @25°C(8)(7) | µS/cm |                           |                                | 1,000                                             | 0                                             | 1336                                           | 1336                                           | Yes                                          | 700                                           | 840                                          | No                                            | 189                                           | 188                                           | Yes     |
| Sulfate                          | SO₄²⁻ | mg/L                      |                                | none(7)                                           | 1                                             | 472                                            | 471                                            | Yes                                          | 202                                           | 190                                          | Yes                                          | 19.7                                           | 20.1                                           | Yes     |

n.d. = All measured values are below reporting limits or the average value is below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL) or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(4) Central Tendency determined as described in Table 1.

(5) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTIVSMC pits that began after their monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details).

(6) Central Tendency determined as described in Table 1, adjusted for flows from the LTIVSMC pits that began after their monitoring data was collected.

(7) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(8) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(9) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was for the antidegradation analysis.

(10) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
Attachment C

Methods for Determining Measurable Change
Technical Memorandum

To: Christie Kearney, Poly Met Mining, Inc.
From: Melisa Pollak, Dana Pasi, Barr Engineering Co.
Subject: Recommended Methods to Define Measurable Change
Date: August 14, 2017
Project: 23690862.12

1.0 Introduction and Summary

An antidegradation assessment must compare the existing water quality with the estimated future water quality resulting from a project. This is an “apples to oranges” comparison – laboratory measurements of existing conditions must be compared to estimated outcomes of planned future conditions based on modeling results. This comparison is reasonably straightforward if the estimated outcome is a large change – in this case the conclusion is that the project will change the existing water quality. But the comparison is more difficult if the estimated outcome is a small change – in this case some method must be used to evaluate whether the estimated outcome would represent a “real change” from the existing water quality.

To Barr Engineering Co.’s (Barr’s) knowledge, there are no specific statutory or regulatory requirements or guidance yet in place on the method for making this comparison for antidegradation assessments under the Minnesota Pollution Control Agency’s (MPCA’s) recently-enacted Revised Rule. In particular, there is no MPCA precedent or guidance on the important regulatory definition of “degradation,” which is defined in the Revised Rule as a “measurable change in existing water quality” resulting in certain specified surface-water impacts as described below. In the absence of such information, Barr recommends a method for the NorthMet Project (Project) Antidegradation Evaluation that is based on US Environmental Protection Agency (USEPA)-approved laboratory testing methods and on the language of the Revised Rule.

The term “degradation” is defined in the Revised Rule as a “measurable change to existing water quality made or induced by human activity resulting in diminished chemical, physical, biological, or radiological qualities of surface water” (Minnesota Rules, part 7050.0255, subpart 11). In turn, “measurable change” is defined as “the practical ability to detect a variation in water quality, taking into account limitations in analytical technique and sampling variability” (Minnesota Rules, part 7050.0255, subpart 24). The challenge is to translate this narrative definition into a numerical value.

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1 MPCA revised its antidegradation rules, effective November 2016 (Minnesota Rules, part 7050.0250 to 7050.0335, collectively, the “Revised Rule”)
2 The “Antidegradation Evaluation” is Poly Met Mining, Inc.’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052.
Barr considered a number of possible methods of quantifying whether a small estimated change would represent a measurable change. Of these options, Barr recommends using the practical quantification limit (PQL) to define measurable change where existing concentrations are so low that they are most commonly reported as “non-detect.” For circumstances where existing concentrations are usually detectable, Barr recommends using the laboratory control sample (LCS) acceptance range. Overall, the LCS acceptance limits aligns with the regulatory definition and provides a practical method for quantifying measurable change in the Antidegradation Evaluation.

2.0 Description of Potential Methods to Define Measurable Change

Barr considered a number of possible methods of quantifying whether a small estimated change would represent a measurable change:

- Method Detection Limit (MDL)
- Practical Quantification Limit (PQL)
- Laboratory Control Sample (LCS) acceptance limit
- LCS average, based on Project data
- Field duplicate relative percent difference (RPD) acceptance limit
- Field duplicate RPD average, based on Project data
- Upper and lower confidence limit (UCL and LCL), based on Project data

Table 1 summarizes these methods, and additional information is presented in the following paragraphs.
Table 1 Summary of Potential Methods for Defining Measurable Change

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method Detection Limit (MDL)</td>
<td>Lowest concentration that can be detected by an instrument with 99% confidence that the concentration is greater than zero.</td>
<td>Calculated and updated after a defined period, typically annually, based on laboratory sample data. Threshold that applies to very low concentrations. Doesn't apply to variability in detectable concentrations.</td>
</tr>
<tr>
<td>Practical Quantification Limit (PQL)</td>
<td>Lowest concentration that can be reliably measured within the specified limits of precision and accuracy during routine laboratory operating conditions.</td>
<td>Fixed for each analytical method. Threshold that applies to very low concentrations. Doesn't apply to variability in detectable concentrations.</td>
</tr>
<tr>
<td>Laboratory Control Sample (LCS) acceptance limit</td>
<td>The acceptable variability inherent in a USEPA-approved method.</td>
<td>Fixed for each analytical method. Applies to variability in detectable concentrations due to laboratory procedures.</td>
</tr>
<tr>
<td>LCS average, based on Project data</td>
<td>The actual variability in laboratory results, based on control samples processed in the same batch as the project samples over a defined time period.</td>
<td>Calculated for each parameter with each batch of samples. Backward-looking and laboratory specific.</td>
</tr>
<tr>
<td>Relative Percent Difference (RPD) acceptance limit</td>
<td>The acceptable variability between duplicate samples.</td>
<td>Fixed value. Applies to variability in detectable concentrations due to sampling and laboratory procedures.</td>
</tr>
<tr>
<td>RPD average, based on Project data</td>
<td>The actual variability between duplicate samples.</td>
<td>Calculated for each pair of duplicates. Backward-looking, sampling event and laboratory specific.</td>
</tr>
<tr>
<td>Upper and lower confidence limits (UCL and LCL), based on Project data</td>
<td>The amount of variability that is statistically significant.</td>
<td>Calculated for each parameter at each monitoring station, based on all available monitoring data.</td>
</tr>
</tbody>
</table>

The MDL is the minimum concentration of a substance that can be measured with a high level of confidence (typically 99%) that the concentration is greater than zero. Laboratories are capable of reporting to the MDL but any data reported between the MDL and PQL do not meet the laboratory standards for accuracy and precision with 100% confidence. The MDL is a threshold that applies only to very low concentrations, not to variations around a measurable concentration.

The PQL (also referred to as the reporting limit (RL)) is the lowest concentration that can be reliably measured within an USEPA method’s specified limits of precision and accuracy. Like the MDL, the PQL is a threshold that applies only to very low concentrations, not to variations around a measurable concentration. While models can calculate very small values, in reality, a modeled concentration that falls below the PQL for a parameter would be expected to be reported as “non-detect.”
The LCS acceptance range defines the acceptable variability inherent in a USEPA-approved method, expressed as a percentage (Reference (1)). Applied to average values for existing conditions, the LCS acceptance range essentially signifies the "error bars" in any measurement of existing conditions. A laboratory must demonstrate that it can meet the USEPA method-specific variability requirements in order to be considered for accreditation for that method. The quality control sample that represents the laboratory variability is the LCS. The typical LCS consists of clean soil or liquid spiked with a known amount of a parameter. This sample is created in the laboratory and run through the entire analytical process (digestion, extraction, analysis, etc.). Each analytical batch includes an LCS to demonstrate that the laboratory system is operating correctly. If the LCS result is within the LCS acceptance range, results for other samples are considered acceptable. Say, for example, an LCS was created of clean water containing precisely 1 ng/L of total mercury. The LCS acceptance range for total mercury is ±23%, so an acceptable laboratory result is anywhere between 0.77 ng/L and 1.23 ng/L. In other words, the precision of the laboratory method is such that if the "true" concentration is 1.0 ng/L, the reported value may be anywhere between 0.77 ng/L and 1.23 ng/L. Barr proposes that a modeled concentration that differs from the mean existing concentration by less than the LCS acceptance range should not be considered a measurable change. In other words, if the average future concentration falls within the error bars of the existing concentration, there is no practical way to tell them apart, and therefore, there is no practical ability to detect a change in concentration attributable to the Project.

The LCS averages from analyses of Project data are also a potential method for defining measurable change. As described in the previous paragraph, these are the control samples run alongside the Project samples to demonstrate that the laboratory is operating with acceptable precision and accuracy. Project-specific LCS results can be lower than the LCS acceptance range when laboratory conditions are favorable, but they do not reflect future conditions within that laboratory or conditions at other laboratories. A limitation of using the LCS averages from Project data as a method to define measurable change would be that it is backward-looking and laboratory specific. Future laboratory performance could be anywhere up to the LCS acceptance limits.

The field duplicate RPD acceptance limit is another potential method for defining measurable change that aligns well with the regulatory definition, because it takes into account the effects of variability in both sample collection and laboratory analysis. During sample collection, duplicate samples usually are collected at a percentage of monitoring stations (typically one set per sampling event). Both samples are analyzed, and the results are compared using the RPD calculation. The RPDs are then compared to a reference limit. For field duplicate evaluation of water samples, this limit is typically around 30-35% (Reference (1)), meaning that duplicate samples with laboratory results differing by 30-35% or less are acceptable. For example, total mercury concentrations in duplicate samples reported as 1.2 ng/L and 1.6 ng/L would be considered to be within acceptable limits of analytical technique and sampling variability.

The RPD averages from field duplicate samples analyses can be lower than the RPD acceptance range when laboratory conditions are favorable, but again they do not reflect future conditions at the subject laboratory or conditions at other laboratories. Similar to the LCS, a limitation of using the RPD averages from Project data as a method to define measurable change would be that this approach is backward-
looking as well as sampling event and laboratory specific. Future sampling and laboratory performance could be anywhere up to the RPD acceptance limits.

Finally, Barr considered using statistical analyses of the existing conditions data to define the variation from the mean that would be statistically significant. Specifically, the approach would be to use a one-sided t-test to determine the 95% UCL and LCL. There are several limitations of using the approach of statistical significance to define measurable change. First, the confidence intervals can be quite large if there are a limited number of samples in the existing conditions dataset (Table 2). Second, the confidence intervals must be calculated for each parameter at each monitoring station.

### Table 2  Confidence Intervals for Total Mercury

<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>n</th>
<th>mean</th>
<th>sd</th>
<th>se</th>
<th>95% LCL</th>
<th>95% UCL</th>
<th>interval/mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-11</td>
<td>38</td>
<td>1.73</td>
<td>1.18</td>
<td>0.19</td>
<td>1.34</td>
<td>2.12</td>
<td>23%</td>
</tr>
<tr>
<td>PM-13</td>
<td>43</td>
<td>3.43</td>
<td>2.90</td>
<td>0.44</td>
<td>2.54</td>
<td>4.32</td>
<td>26%</td>
</tr>
<tr>
<td>EP2</td>
<td>4</td>
<td>4.60</td>
<td>3.72</td>
<td>1.86</td>
<td>-1.32</td>
<td>10.52</td>
<td>129%</td>
</tr>
</tbody>
</table>

### 3.0  Assessment of Potential Methods to Define Measurable Change

Ideally, the method to define measurable change would have the following characteristics:

- Reflect variability due to analytical accuracy and precision
- Reflect variability due to sampling
- Be reproducible and reliable
- Be as simple as possible to use

Table 3 summarizes the likely performance of the potential methods to define measurable change relative to these characteristics.
To further compare the potential methods to define measurable change, Barr applied each method to Project data, using example parameters of arsenic, cobalt, copper, mercury, and nickel at monitoring station PM-13 on the Embarrass River. Table 4 shows the results, and Figure 1 illustrates the outcomes of the various methods, applied to the baseline monitoring results for mercury at PM-13. Figure 1 shows that all the potential methods for defining a measurable change between an existing average concentration and a future estimated (average) concentration would identify a range around the average that is much smaller than observed natural variability.

Table 3  Suitability of Various Potential Methods to Define Measurable Change

<table>
<thead>
<tr>
<th>Potential methods for defining measurable change</th>
<th>Reflects Analytical Variability</th>
<th>Reflects Sampling Variability</th>
<th>Reproducibility and reliability</th>
<th>Simplicity of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method Detection Limit (MDL)</td>
<td>Not suitable because does not apply to variability between detectable concentrations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical Quantification Limit (PQL)</td>
<td>Not suitable because does not apply to variability between detectable concentrations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Control Sample (LCS) acceptance limit</td>
<td>Yes</td>
<td>No</td>
<td>High</td>
<td>High – USEPA promulgated values</td>
</tr>
<tr>
<td>LCS average, based on Project data</td>
<td>Yes</td>
<td>No</td>
<td>Medium – backward-looking and laboratory specific.</td>
<td>Medium – must be calculated for each for each parameter</td>
</tr>
<tr>
<td>Relative Percent Difference (RPD) acceptance limit</td>
<td>Yes</td>
<td>Yes</td>
<td>High</td>
<td>High – USEPA-approved values</td>
</tr>
<tr>
<td>RPD average, based on Project data</td>
<td>Yes</td>
<td>Yes</td>
<td>Medium – backward-looking and laboratory specific.</td>
<td>Medium – must be calculated for each for each parameter</td>
</tr>
<tr>
<td>Upper and lower confidence limits (UCL and LCL), based on Project data</td>
<td>Yes</td>
<td>Yes</td>
<td>Low – highly dependent on the number of samples</td>
<td>Low – must be calculated for each parameter at each monitoring station</td>
</tr>
</tbody>
</table>

= Undesirable characteristic
= Desirable characteristic
= Neutral characteristic
Table 4  Comparison of Potential Methods to Define Measurable Change

<table>
<thead>
<tr>
<th>Parameter</th>
<th>USEPA Method</th>
<th>LCS Acceptance Range</th>
<th>n</th>
<th>Project-specific LCS Average</th>
<th>Field Duplicate Relative Percent Difference (RPD)</th>
<th>Project-Specific RPD Average</th>
<th>n</th>
<th>95% Confidence Interval of the Mean (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>200.7</td>
<td>15%</td>
<td>649</td>
<td>11%</td>
<td>35%</td>
<td>9.5%</td>
<td>47</td>
<td>18%</td>
</tr>
<tr>
<td>Cobalt</td>
<td>200.7</td>
<td>15%</td>
<td>716</td>
<td>13%</td>
<td>35%</td>
<td>3.4%</td>
<td>68</td>
<td>10%</td>
</tr>
<tr>
<td>Copper</td>
<td>200.7</td>
<td>15%</td>
<td>736</td>
<td>14%</td>
<td>35%</td>
<td>5.8%</td>
<td>70</td>
<td>9%</td>
</tr>
<tr>
<td>Mercury (total)</td>
<td>1631E</td>
<td>23%</td>
<td>276</td>
<td>15%</td>
<td>35%</td>
<td>17%</td>
<td>43</td>
<td>26%</td>
</tr>
<tr>
<td>Nickel</td>
<td>200.7</td>
<td>15%</td>
<td>732</td>
<td>12%</td>
<td>35%</td>
<td>3.6%</td>
<td>70</td>
<td>12%</td>
</tr>
</tbody>
</table>

(1) Results for monitoring station PM-13 on the Embarrass River. Calculated using the method from the USEPA Unified Guide (nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10055GQ.TXT), with statistics for mercury calculated using the Kaplan Meier method, and statistics for the other parameters calculated assuming non-detect values are one half of the reporting limit.

Note: Box and Whiskers plot of baseline monitoring results does not include non-detect values.

Figure 1  Potential Methods to Define Measurable Change Applied to Existing Conditions Mercury Baseline Monitoring Results at PM-13 on the Embarrass River
4.0 Conclusions and Recommendations

Two methods are necessary for defining measurable change: one for situations where both the existing and the estimated concentration values are so low that they are at or below the analytical reporting limit, and a second for situations where the existing and/or the estimated concentration values are above the analytical reporting limit.

For the first situation, where both the existing and the estimated concentration values are at or below the analytical reporting limit, two methods were considered the most appropriate, the MDL and the PQL. Use of the MDL for the purpose of the Antidegradation Evaluation is not recommended, because it varies from laboratory to laboratory, and because values falling between the MDL and the PQL are not accurate or precise enough to be relied upon for a regulatory determination. Instead, Barr recommends using the PQL: if both the existing average and the estimated concentration values are below the PQL, the Project effect would not be considered a measurable change.

For the second situation, where the existing and/or the estimated concentration values are above the analytical reporting limit, LCS methods, RPD methods, and statistical methods were considered. Applied to select Project monitoring data, the various proposed methods result in similar outcomes (Table 4 and Figure 1). The various potential methods for defining measurable change were also assessed to determine how well they align with the narrative regulatory definition (reflecting variability in sampling and analysis), their reproducibility and reliability, and their ease of use. Evaluated according to these criteria, the RPD acceptance limit is the most suitable method, because it reflects variability in analysis and sampling, is reliable, reproducible, and easy to use. The LCS acceptance limit is also a suitable method, lacking only in that it does not represent sampling variability. Project-specific LCS and RPD methods are not recommended because they are less reproducible and reliable (they are backward-looking and laboratory specific), and more complex to use (they must be calculated for each parameter). Determination of statistical significance is not recommended as a method to define measurable change because it is less reliable and reproducible (highly dependent on sample size) and more complex to use (must be calculated for or each parameter at each monitoring station).

The assessment shows that the Project-specific LCS and RPD methods and statistical methods have more downsides than the methods that rely on standard USEPA-approved methods. Therefore, Barr recommends use of either the RPD acceptance limits or the LCS acceptance limits to define measurable change. The LCS acceptance limits would be the more protective of the two options, as they would define smaller changes as measurable. Overall, none of the options are perfect, but the LCS acceptance limits aligns with the regulatory definition and provides a practical method for quantifying measurable change in the Antidegradation Evaluation.

References

Attachment D

Probability of Exceedance Plots for Hardness Dependent Parameters

From Appendix J of the Water Modeling Data Package - Plant
**Concentration Statistics at the Surface Water Evaluation Locations**

Estimated surface water quality is shown in this attachment using a series of concentration statistic plots. Data for these plots were created as follows:

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the concentration at each surface water evaluation location for each constituent was individually recorded.

- After one realization (i.e., one model run) was completed, the process was repeated until 500 model realizations were completed. The result is 500 estimated concentrations of each constituent at each surface water evaluation location at every time step.

- At every time step, and for every constituent, the 500 estimated concentrations were sorted smallest-to-largest and 3 single values (P10, P50, and P90) were chosen to represent the statistics at that particular time step. This step was performed at each surface water evaluation location.

- From the 500 estimate concentrations, sorted smallest-to-largest, the 50th value was chosen to represent the 10th percentile (P10), the 250th value was chosen to represent the median (P50), and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, 50% are less than or equal to the P50 value, and 90% are less than or equal to the P90 value.

- This process was repeated for all constituents at each surface water evaluation location, resulting in 3 time series lines representing the 10th, 50th, and 90th percentiles of concentrations at every time step (monthly results).

- For plotting the results over the entire 200 years of the simulation, the data was summarized by year to make the plots legible. The monthly model outputs for the 10th, 50th, and 90th percentiles are plotted on an annual basis by either
  
  - Taking the maximum value of each percentile for a given year (i.e., the highest 90th percentile value), or
  
  - Taking the average value of each percentile for a given year (i.e., the average of the twelve 90th percentile values).

On the following plots, "OPS" refers to the operations phase, and "REC" refers to the reclamation and closure phases.
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cd in the Embarrass River at PM-13

Figure J-01-09.2

- % Exceeding in Project Model
- % Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cu in the Embarrass River at PM-13

Figure J-01-13.2

% Exceeding in Project Model

% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Ni in the Embarrass River at PM-13

Figure J-01-20.2
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Pb in the Embarrass River at PM-13

% Exceeding in Project Model

% Exceeding in Project Model when CEC Scenario Model does not exceed

Figure J-01-21.2
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Zn in the Embarrass River at PM-13

Figure J-01-27.2
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cd in Trimble Creek at TC-1

Figure J-03-09.2
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cu in Trimble Creek at TC-1

Figure J-03-13.2

% Exceeding in Project Model
% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Ni in Trimble Creek at TC-1

Figure J-03-20.2
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Pb in Trimble Creek at TC-1

Figure J-03-21.2

% Exceeding in Project Model

% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Zn in Trimble Creek at TC-1

Figure J-03-27.2

Probability of Exceeding

Time (yr)
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cd inUnnamed Creek at PM-11

Figure J-04-09.2

% Exceeding in Project Model
% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Cu in Unnamed Creek at PM-11

Figure J-04-13.2

% Exceeding in Project Model
% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Ni in Unnamed Creek at PM-11

Figure J-04-20.2

% Exceeding in Project Model

% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Pb in Unnamed Creek at PM-11

Figure J-04-21.2

% Exceeding in Project Model
% Exceeding in Project Model when CEC Scenario Model does not exceed
Plant Site Version 6.0 Model
Annual Average of Exceedance Probability
Zn in Unnamed Creek at PM-11

Figure J-04-27.2

% Exceeding in Project Model

% Exceeding in Project Model when CEC Scenario Model does not exceed
Attachment E

Mass Balance Calculations for Parameters Other Than Mercury
Memorandum

To: Jennifer Saran and Christie Kearney, Poly Met Mining, Inc.
From: Peter Hinck and Melisa Pollak
Subject: Mass Balance Calculations for Parameters Other Than Mercury: Estimated Effect of WWTS Discharge and Related Activities on Loading and Concentration in Second Creek, the Lower Partridge River, and the St. Louis River During NorthMet Project Operations
Date: September 25, 2017
Project: 23/69-0862.00

1.0 Introduction

In support of the Antidegradation Evaluation prepared as part of the National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) Permit Application for the Poly Met Mining, Inc. (PolyMet) NorthMet Project (Project), Barr Engineering Co. used mass-balance calculations to analyze the potential effects of the Project Waste Water Treatment System (WWTS) discharge and related activities in certain waters downstream of planned Project discharges. Specifically, this technical memorandum assesses potential effects of the WWTS discharge and related activities on concentrations and loads of parameters of concern for the Antidegradation Evaluation, other than mercury, in Second Creek, the Lower Partridge River, and the St. Louis River (hereinafter referred to as the non-mercury mass balance analysis).

The Antidegradation Evaluation used existing water quality and estimated water quality for Mine Year 10 to assess the potential effects of the WWTS discharge and related activities at nine evaluation locations. Estimated water quality in Mine Year 10 at six of the nine locations was based principally on the GoldSim water modeling conducted for the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) (Reference (1)), as described in Section 5.8 of Appendix A of Volume III. Water quality in Mine Year 10 at downstream evaluation points not included in FEIS GoldSim modeling (three locations) was estimated using mass balance calculations, and the results are presented in this memorandum. There was no change to the FEIS GoldSim models as a result of the Antidegradation Evaluation, including the analysis discussed in this memorandum; data was extracted from the GoldSim models for this analysis. The three evaluation locations where mass balance calculations were performed are:

1 The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052, presented in Appendix A of Volume III.
2 “WWTS discharge and related activities” means the WWTS discharge and related Project activities that may affect the quality and quantity of that discharge, including the Flotation Tailings Basin (FTB) seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake.
This memorandum describes the mass balance calculation methods, the FEIS GoldSim model outputs used to characterize the mass flux associated with the WWTS discharge and related activities, the data used to characterize the existing water quality, and the resulting comparison of Project mass flux relative to existing conditions at the three evaluation locations listed above.

2.0 Mass Balance Calculation Methods

The mass balance calculation used outputs from the FEIS GoldSim water quality modeling as well as existing water quality and flow data to estimate the change in constituent mass flux (i.e., grams per day) due to the WWTS discharge and related activities at each evaluation location.

The net change in constituent mass flux at the downstream extents of the FEIS GoldSim models is described in Section 3.0. The available data on existing water quality and flow are summarized for each of the three evaluation locations in Section 4.0; these data were used to estimate the average annual constituent mass flux under existing conditions. The change in constituent mass flux due to the WWTS discharge and related activities was then converted into an estimated change in water quality (concentration equals mass flux divided by flow), as presented in Section 5.0.

3.0 NorthMet Mass Flux

The FEIS GoldSim water quality modeling provided monthly mass flux outputs at multiple evaluation locations for two GoldSim model scenarios: the Continuation of Existing Conditions (CEC) and Project models. The GoldSim CEC model scenario represents conditions associated with the former LTV Steel Mining Company (LTIVSMC) tailings basin prior to implementation of any of the short term mitigation measures required as part of the Cliffs Erie-Minnesota Pollution Control Agency (MPCA) Consent Decree for the existing tailings basin (Section 3.1.1 of Reference (2)). For evaluation points included within the GoldSim model extents (e.g., Trimble Creek, Unnamed Creek, and the Embarrass River), the relative change in concentration due to the WWTS discharge and related activities was evaluated directly from the GoldSim Project model scenario results. For the three locations that are subject of this non-mercury
mass balance analysis, which are located downstream of the GoldSim model extents, the GoldSim mass flux results from these two model scenarios were combined with other estimates of existing conditions mass flux to determine the relative change in surface water concentrations due to the WWTS discharge and related activities.

The mass flux estimated by the two GoldSim model scenarios for metals in surface water assumed that metal concentrations were represented by total metal concentrations rather than dissolved metal concentrations. For the FEIS, total metal concentrations in the existing watershed were used to calibrate the GoldSim model and to estimate the constituent mass flux from surface runoff from undisturbed areas. Changes in mass flux due to watershed area changes from the Project were, therefore, reflected in changes in the total metal mass flux to surface water bodies. For Project discharge of treated water from the WWTS, it was assumed that total metal concentrations equal dissolved metal concentrations.

In general, for purposes of the non-mercury mass balance analysis, the mass fluxes of each constituent were extracted from the GoldSim CEC and Project model scenarios as described in the model documentation (Reference (2) and Reference (3)). The GoldSim models are probabilistic (Monte Carlo) simulations, and included multiple realizations of the entire model output. For each month of the simulation, an average mass flux was determined for each constituent from the 500 model realizations. For the non-mercury mass balance analysis, the resulting monthly average values from the FEIS GoldSim model scenarios were further summarized into annual average mass fluxes for each constituent. The annual average mass flux for both GoldSim CEC and the Project model scenarios were then used in the non-mercury mass balance analysis to determine the net change in mass flux due to the WWTS discharge and related activities.

The following sections describe the details of the FEIS GoldSim model results used in the non-mercury mass balance analysis.

### 3.1 Embarrass River at PM-13

The full effect of the WWTS discharge and related activities on the Embarrass River during Project operations can be captured by changes in mass flux and flow rates at evaluation location PM-13, which is downstream of Project impacts in the Embarrass River watershed (Large Figure 2 of Appendix A of Volume III). Therefore, for the non-mercury mass balance, the change in the mass flux at PM-13 was also be used to evaluate the overall effects of the WWTS discharge and related activities on downstream locations (e.g., the St. Louis River).

The modeled mass flux for each constituent at PM-13 in the Project model included the effects of the following Project features that were not present in the GoldSim CEC model scenario: the Flotation Tailings Basin (FTB), the FTB Seepage Containment System, watershed area changes, the WWTS, the WWTS...
discharge to Trimble Creek and Unnamed Creek, and the drainage swale to Unnamed (Mud Lake) Creek. The difference in mass flux between the Project and CEC GoldSim model scenarios represented the net effect of the WWTS discharge and related activities on the Embarrass River.

### 3.2 Second Creek at SD026

Seepage from the FTB will be captured by the FTB seepage capture systems. During Project operations, a portion of the seepage will be returned untreated to the FTB Pond and a portion will be treated at the WWTS and discharged to the surface waters that currently receive seepage from the existing LTVSMC tailings basin. This stream augmentation via WWTS discharge will be done to reduce hydrologic impacts to the surface waters associated with operation of the FTB seepage capture systems. Second Creek is located south of the Tailings Basin and is one of the streams where seepage will be captured, treated, and returned. Second Creek eventually drains to the Partridge River.

Although Second Creek was not included in the GoldSim model of the Plant Site, the model included the effects of the WWTS discharge and related activities on the headwater segment of Second Creek at evaluation location SD026 (refer to Large Figure 2 of Appendix A of Volume III). The modeled mass flux for each constituent at SD026 in the Project model included the effects of the following Project features that were not present in the CEC model: the FTB, the FTB South Seepage Management System, the WWTS, and the WWTS discharge to Second Creek. The difference in mass flux between the Project and CEC models represented the net effect of the WWTS discharge and related activities on Second Creek.

Note that the GoldSim CEC model scenario included seepage to SD026 from the existing LTVSMC tailings basin but did not include the seepage capture system at SD026 that was installed in 2011. This representation of existing conditions is consistent with the existing conditions surface water quality data presented in Section 4.0; those data were collected prior to 2011.

### 3.3 Colby Lake Withdrawal

During Project operations, water will be withdrawn from Colby Lake and pumped to the Plant Site as make-up water for processing. The Partridge River flows through Colby Lake, and therefore, any removal of water (and the constituent mass in the water) by the Project from Colby Lake will result in a constituent mass removal from the Partridge River.

The constituent mass flux from Colby Lake to the Plant Site was extracted from the GoldSim Project model scenario. The GoldSim CEC model scenario does not include pumping from Colby Lake, so only the GoldSim Project model scenario results were needed for this evaluation rather than the difference in mass flux between these two GoldSim model scenarios.
3.4 Partridge River Upstream of Colby Lake

The full effect of the Mine Site on the Partridge River upstream of Colby Lake can be captured by modeled changes in constituent mass flux and flow rates at location SW004a and downstream portions of the Partridge River, which are downstream of the expected Project impacts at the Mine Site (see Large Figure 2 of Appendix A of Volume III). The Partridge River flows through Colby Lake, which represented the downstream extent of the GoldSim Project and CEC model scenarios.

The modeled mass flux for each constituent at SW004a in the GoldSim Project model scenario included the following effects of the Project that were not included in the GoldSim CEC model scenario: the removal of watershed area and reduction in groundwater baseflow due to the development of the Mine Site, and changes in groundwater quality due to stockpile liner leakage (although the effects on groundwater quality during mining are minimal). The difference in mass flux between these two GoldSim model scenarios represented the estimated net effect of the WWTS discharge and related activities on the Partridge River upstream of Colby Lake.

3.5 Overall Project Mass Flux

The effect of the WWTS discharge and related activities on the three downstream evaluation points not included in FEIS GoldSim models for the Mine Site and Plant Site was estimated by summing the impacts at the four previously described locations (Embarrass River at PM-13, Second Creek at SD026, Colby Lake, and Partridge River upstream of Colby Lake).

The estimated net changes in mass flux and flow at the evaluation locations due to the WWTS discharge and related activities is shown in Table 1 for constituents included in the GoldSim models. Note that mercury was not included in the GoldSim models and is assessed separately for the purposes of the Antidegradation Evaluation (Attachment F of Appendix A of Volume III). The values presented in Table 1 represent conditions during Mine Year 10. This period was selected for the Antidegradation Evaluation because it is estimated to be the period when the peak discharge of treated water from the WWTS at the Plant Site will occur and when the Project is expected to have the greatest impact on receiving and downstream surface water bodies.
### Table 1: Net Change in Mass Flux and Flow Summary for Mine Year 10 Due to WWTS Discharge and Related Activities

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Embarrass River at PM-13</th>
<th>Second Creek at SD026</th>
<th>Withdrawal from Colby Lake</th>
<th>Partridge River upstream of Colby Lake</th>
<th>Second Creek at MNSW8</th>
<th>Partridge River at MNSW12</th>
<th>St. Louis River at USGS #04024000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (cfs)</td>
<td>-0.22</td>
<td>0.14</td>
<td>-0.58</td>
<td>-1.90</td>
<td>0.14</td>
<td>-2.33</td>
<td>-2.55</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>4.62E-01</td>
<td>6.75E-02</td>
<td>-5.16E-02</td>
<td>-1.33E-01</td>
<td>6.75E-02</td>
<td>-1.18E-01</td>
<td>3.44E-01</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>-4.90E+00</td>
<td>-1.47E+00</td>
<td>-4.85E+01</td>
<td>-1.70E+02</td>
<td>-1.47E+00</td>
<td>-2.28E+02</td>
<td>-2.33E+02</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>3.19E+01</td>
<td>3.93E+00</td>
<td>-5.05E-01</td>
<td>-1.28E+00</td>
<td>3.93E+00</td>
<td>2.14E+00</td>
<td>3.41E+01</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>-9.33E+02</td>
<td>-2.45E+01</td>
<td>-3.15E+01</td>
<td>-1.01E+02</td>
<td>-2.45E+01</td>
<td>-1.57E+02</td>
<td>-1.09E+03</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>3.11E+00</td>
<td>4.04E-01</td>
<td>-5.16E-02</td>
<td>-9.53E-02</td>
<td>4.04E-01</td>
<td>2.57E-01</td>
<td>3.37E+00</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>-1.00E+05</td>
<td>-9.56E+03</td>
<td>-2.08E+03</td>
<td>-8.48E+03</td>
<td>-9.56E+03</td>
<td>-2.01E+04</td>
<td>-1.21E+05</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>1.60E+01</td>
<td>2.35E+00</td>
<td>-1.70E-01</td>
<td>-6.60E-01</td>
<td>2.35E+00</td>
<td>1.52E+00</td>
<td>1.75E+01</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>2.23E+01</td>
<td>2.82E+00</td>
<td>-2.58E-01</td>
<td>-8.69E-01</td>
<td>2.82E+00</td>
<td>1.70E+00</td>
<td>2.40E+01</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>3.25E+01</td>
<td>4.40E-00</td>
<td>-2.11E-00</td>
<td>-1.92E-00</td>
<td>4.40E-00</td>
<td>3.64E-01</td>
<td>3.29E+01</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>2.20E+02</td>
<td>2.81E+01</td>
<td>-1.08E+00</td>
<td>-1.86E+00</td>
<td>2.81E+01</td>
<td>2.51E+01</td>
<td>2.46E+02</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>9.91E+00</td>
<td>1.15E+00</td>
<td>-3.09E-01</td>
<td>-4.03E-01</td>
<td>1.15E+00</td>
<td>4.34E-01</td>
<td>1.03E+01</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>2.83E+01</td>
<td>3.58E+00</td>
<td>-1.29E-01</td>
<td>-3.29E-01</td>
<td>3.58E+00</td>
<td>3.12E+00</td>
<td>3.14E+01</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>5.30E+00</td>
<td>7.16E-01</td>
<td>-3.61E-01</td>
<td>-8.09E-01</td>
<td>7.16E-01</td>
<td>-4.54E-01</td>
<td>4.84E+00</td>
</tr>
<tr>
<td>Sulfate (SO4)</td>
<td>-1.28E+06</td>
<td>-8.43E+04</td>
<td>-1.48E+04</td>
<td>-9.96E+03</td>
<td>-8.43E+04</td>
<td>-1.09E+05</td>
<td>-1.39E+06</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>8.94E-02</td>
<td>1.90E-02</td>
<td>-1.03E-02</td>
<td>-1.54E-02</td>
<td>1.90E-02</td>
<td>-6.70E-03</td>
<td>8.27E-02</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>2.39E+02</td>
<td>2.95E+01</td>
<td>-2.73E+00</td>
<td>-1.19E+01</td>
<td>2.95E+01</td>
<td>1.49E+01</td>
<td>2.53E+02</td>
</tr>
<tr>
<td>Hardness (as CaCO3)</td>
<td>-2.49E+06</td>
<td>-1.16E+05</td>
<td>-4.44E+04</td>
<td>-9.32E+04</td>
<td>-1.16E+05</td>
<td>-2.54E+05</td>
<td>-2.74E+06</td>
</tr>
</tbody>
</table>

Negative values, shown in blue cells, indicate a net decrease in constituent mass flux or flow relative to CEC modeling.
4.0 Existing Water Quality

4.1 Second Creek and Partridge River

The Antidegradation Evaluation relied on water quality and stream flow measurements on Second Creek and the Partridge River downstream of Second Creek performed by Mesabi Nugget in 2008-2009. Mesabi Nugget submitted this publicly-available information to MPCA as part of a chemical balance report for that project (Reference (4)). These measurements were used to show the surface water quality as affected by discharges to Second Creek at that time, including the existing LTVSMC tailings basin prior to installation of seepage capture system at SD026. The average annual flow in Second Creek just upstream of the Partridge River (station MNSW8, refer to Large Figure 2 of Appendix A of Volume III) during this time period (i.e., 2008-2009) was 11.2 cubic feet per second (cfs), and the average annual flow in the Partridge River downstream of the confluence with Second Creek (station MNSW12, see Large Figure 2 of Appendix A of Volume III) was 111 cfs. The available water quality data for these locations are summarized in Table 2 and Table 3. For computing the average concentrations, non-detected values were set to one-half of the detection limit for purposes of the non-mercury mass balance analysis.

Table 2 Existing Water Quality Summary for Second Creek at MNSW8

<table>
<thead>
<tr>
<th>Constituent(1)</th>
<th>Units</th>
<th>Number of samples</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>cfs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.2</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>µg/L</td>
<td>8</td>
<td>0.044</td>
<td>&lt;0.2</td>
<td>0.04</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>µg/L</td>
<td>12</td>
<td>26.4</td>
<td>187</td>
<td>42.6</td>
<td>12.3</td>
<td>59.8</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>µg/L</td>
<td>12</td>
<td>&lt;2</td>
<td>2.9</td>
<td>0.65</td>
<td>0.19</td>
<td>1.5</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>µg/L</td>
<td>12</td>
<td>53.6</td>
<td>113</td>
<td>21.9</td>
<td>7.7</td>
<td>84.8</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>µg/L</td>
<td>8</td>
<td>0.042</td>
<td>&lt;0.2</td>
<td>0.03</td>
<td>0.01</td>
<td>0.09</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>21</td>
<td>7.27</td>
<td>10.6</td>
<td>0.89</td>
<td>0.19</td>
<td>8.47</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>µg/L</td>
<td>8</td>
<td>0.62</td>
<td>1.1</td>
<td>0.17</td>
<td>0.06</td>
<td>0.77</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>µg/L</td>
<td>8</td>
<td>0.33</td>
<td>1.2</td>
<td>0.29</td>
<td>0.10</td>
<td>0.58</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>µg/L</td>
<td>8</td>
<td>0.58</td>
<td>1.4</td>
<td>0.33</td>
<td>0.11</td>
<td>0.69</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>µg/L</td>
<td>8</td>
<td>3.7</td>
<td>8.6</td>
<td>1.6</td>
<td>0.56</td>
<td>5.8</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>µg/L</td>
<td>8</td>
<td>0.079</td>
<td>0.94</td>
<td>0.28</td>
<td>0.10</td>
<td>0.29</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>µg/L</td>
<td>8</td>
<td>0.04</td>
<td>&lt;0.5</td>
<td>0.07</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>µg/L</td>
<td>8</td>
<td>0.43</td>
<td>1.4</td>
<td>0.31</td>
<td>0.11</td>
<td>0.77</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>mg/L</td>
<td>12</td>
<td>269</td>
<td>624</td>
<td>110</td>
<td>31.8</td>
<td>473</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>µg/L</td>
<td>8</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>NA</td>
<td>NA</td>
<td>0.2</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>µg/L</td>
<td>8</td>
<td>0.82</td>
<td>7.8</td>
<td>0.84</td>
<td>4.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>12</td>
<td>491</td>
<td>949</td>
<td>157</td>
<td>45.2</td>
<td>806</td>
</tr>
</tbody>
</table>

Data collected during 2008-2009 (Reference (4)).
(1) Existing conditions water quality data for metals includes total metals concentrations for MNSW8.
Table 3  Exiting Water Quality Summary for the Partridge River at MNSW12

<table>
<thead>
<tr>
<th>Constituent(1)</th>
<th>Units</th>
<th>Number samples</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>cfs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>111</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>µg/L</td>
<td>7</td>
<td>0.0058</td>
<td>&lt;0.2</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>µg/L</td>
<td>9</td>
<td>29.3</td>
<td>194</td>
<td>57.7</td>
<td>19.2</td>
<td>105</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>µg/L</td>
<td>9</td>
<td>0.66</td>
<td>&lt;2</td>
<td>0.3</td>
<td>0.10</td>
<td>1.0</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>µg/L</td>
<td>7</td>
<td>59.4</td>
<td>150</td>
<td>30.8</td>
<td>11.6</td>
<td>106</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>µg/L</td>
<td>7</td>
<td>0.032</td>
<td>&lt;0.2</td>
<td>0.03</td>
<td>0.01</td>
<td>0.09</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>15</td>
<td>2.7</td>
<td>8.24</td>
<td>1.93</td>
<td>0.50</td>
<td>5.36</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>µg/L</td>
<td>7</td>
<td>0.34</td>
<td>0.73</td>
<td>0.12</td>
<td>0.05</td>
<td>0.48</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>µg/L</td>
<td>7</td>
<td>0.38</td>
<td>&lt;1</td>
<td>0.18</td>
<td>0.07</td>
<td>0.57</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>µg/L</td>
<td>7</td>
<td>1.9</td>
<td>4.8</td>
<td>1.1</td>
<td>0.40</td>
<td>3.3</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>µg/L</td>
<td>7</td>
<td>3.3</td>
<td>4.6</td>
<td>0.46</td>
<td>0.17</td>
<td>3.8</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>µg/L</td>
<td>7</td>
<td>0.054</td>
<td>0.51</td>
<td>0.16</td>
<td>0.06</td>
<td>0.29</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>µg/L</td>
<td>7</td>
<td>0.05</td>
<td>&lt;0.5</td>
<td>0.06</td>
<td>0.02</td>
<td>0.11</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>µg/L</td>
<td>7</td>
<td>0.43</td>
<td>&lt;1</td>
<td>0.19</td>
<td>0.07</td>
<td>0.60</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>mg/L</td>
<td>9</td>
<td>58.3</td>
<td>302</td>
<td>99.4</td>
<td>33.1</td>
<td>178</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>µg/L</td>
<td>7</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>NA</td>
<td>NA</td>
<td>0.2</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>µg/L</td>
<td>7</td>
<td>1</td>
<td>6.5</td>
<td>1.6</td>
<td>0.61</td>
<td>3.7</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>9</td>
<td>120</td>
<td>546</td>
<td>159</td>
<td>53.0</td>
<td>314</td>
</tr>
</tbody>
</table>

Data collected during 2008-2009 (Reference (4)).
(1) Existing conditions water quality data for metals includes total metals concentrations for MNSW12.

Subsequent to the monitoring performed by Mesabi Nugget in 2008–2009, several additional flows commenced from Mesabi Nugget and Cliffs Erie that potentially affected Second Creek. These flows included:

- Mesabi Nugget discharge from LTVSMC Pit 1 (Large Figure 2 of Appendix A of Volume III) to Second Creek, beginning in late 2012. Mesabi Nugget reported flow and water quality (including metals) of this seasonal discharge at discharge station SD001 for its NPDES/SDS permit #MN0067687 (Reference (5)).

- Cliffs Erie discharge from LTVSMC Pit 2W (Large Figure 2 of Appendix A of Volume III) to Second Creek, beginning in late 2012. Cliffs Erie reported flow and limited water quality of this seasonal discharge at discharge station SD008 in its NPDES/SDS permit #MN0042536 (Reference (6)). Cliffs Erie submitted additional water quality data concerning LTVSMC Pit 2W, including metals concentrations (monitored from 2006–2011) in Attachment 2 to a permit-related submittal for NPDES/SDS permit #MN0042536 (Reference (7)). The water quality data for this Cliffs Erie discharge did not contain all metals included in this non-mercury mass balance analysis, which
assumed that the water discharged from LTVSMC Pit 2W had the same water quality as the pit water.

- Seepage from LTVSMC Pit 6 (Large Figure 2 of Appendix A of Volume III) to Second Creek, beginning in 2009 or 2010 when the pit approached its steady-state water level. Mesabi Nugget estimated the steady-state seepage from the pit for its proposed project (Reference (4)), and the pit water quality was monitored at multiple depths. For purposes of this non-mercury mass balance analysis, the water currently seeping from LTVSMC Pit 6 to Second Creek was assumed to have the same water quality as the pit surface water; the influence of the pit seepage was assumed to be not represented in the 2008-2009 monitoring data presented in Table 2 and Table 3.

These available water quality data for the additional discharges to Second Creek are summarized in Table 4. For computing the average concentrations in this non-mercury mass balance analysis, non-detected values were set to one-half of the detection limit. The constituent mass flux and flow from the additional discharges was assumed to be additive to the mass flux and flow measured prior to 2010 in Second Creek, the Partridge River, and the St. Louis River. Thus, the non-mercury mass balance analysis included the mass flux from these additional flows in the existing conditions load and concentrations at evaluation points downstream of these additional flows.
Table 4  Existing Water Quality Summary for Pit Discharges

<table>
<thead>
<tr>
<th>Constituent(4)</th>
<th>Units</th>
<th>LTVSMC Pit 1 Discharge(1)</th>
<th>LTVSMC Pit 2W Discharge(2)</th>
<th>LTVSMC Pit 6 Seepage(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>cfs</td>
<td>3.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>µg/L</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;2.3</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>µg/L</td>
<td>3</td>
<td>0.67</td>
<td>1.20</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>µg/L</td>
<td>3</td>
<td>137</td>
<td>149</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.02</td>
<td>&lt;0.20</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>18</td>
<td>5.7</td>
<td>47</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.10</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.16</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>µg/L</td>
<td>3</td>
<td>1.40</td>
<td>2.03</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.03</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.01</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>µg/L</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.11</td>
<td>2.10</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>mg/L</td>
<td>18</td>
<td>445</td>
<td>505</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>µg/L</td>
<td>3</td>
<td>0.22</td>
<td>0.39</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>µg/L</td>
<td>3</td>
<td>&lt;0.38</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Hardness</td>
<td>mg/L</td>
<td>36</td>
<td>714</td>
<td>822</td>
</tr>
</tbody>
</table>

(1) Discharge flow and water quality reported for 2013-2015 (Reference (5)).
(4) Existing conditions water quality data for all metals includes total metals concentrations.
4.2 St. Louis River

Project-impacted water will flow to the St. Louis River, downstream of the confluence with the Partridge River and the Embarrass River. The St. Louis River enters Lake Superior, portions of which are a designated Outstanding Resource Value Water (ORVW) at Duluth-Superior. In order to assess the potential impact of the Project on loading to Lake Superior, PolyMet examined the existing water quality in the St. Louis River and how that quality will change as a result of the WWTS discharge and related activities.

The most-complete set of water quality data for the St. Louis River near Lake Superior is from a USGS monitoring station at Scanlon, Minnesota (USGS 04024000, Large Figure 3 of Appendix A of Volume III). Water quality data are available at this location from 1955, 1958-1994, and 2011-2015, and flow data are available continuously from 1908 to the present (Reference (8)). The watershed area of the St. Louis River at Scanlon is approximately 3,430 square miles, compared to a total watershed area of 4,200 square miles where the river enters Lake Superior at Duluth-Superior. The average annual flow in the St. Louis River at Scanlon is approximately 2,284 cfs (Reference (9)).

Table 5 summarizes the available water quality data for the St. Louis River at Scanlon for the same chemical constituents shown in Table 1. Data for hardness, chloride, and sulfate include measurements through the end of 2015; data for other constituents are available only through 1994. Only data with quantified values are shown in Table 5, samples with a constituent’s presence verified but not quantified, or not detected with a detection limit not documented, were excluded from this non-mercury mass balance analysis. For computing the average concentrations, non-detected values were set to one-half of the detection limit for this analysis.
Table 5  Existing Water Quality Summary for the St. Louis River at Scanlon (USGS #04024000)

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Units</th>
<th>Number samples</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow(2)</td>
<td>cfs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,284</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>µg/L</td>
<td>53</td>
<td>&lt; 1</td>
<td>&lt; 2</td>
<td>0.10</td>
<td>0.01</td>
<td>0.52</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>µg/L</td>
<td>60</td>
<td>&lt; 10</td>
<td>1,000</td>
<td>176</td>
<td>24.9</td>
<td>100.</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>µg/L</td>
<td>67</td>
<td>&lt; 1</td>
<td>20</td>
<td>2.5</td>
<td>0.30</td>
<td>1.5</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>µg/L</td>
<td>91</td>
<td>10</td>
<td>280</td>
<td>70.8</td>
<td>7.4</td>
<td>111</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>µg/L</td>
<td>48</td>
<td>&lt; 1</td>
<td>30</td>
<td>3.1</td>
<td>0.45</td>
<td>1.4</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>386</td>
<td>0.1</td>
<td>32</td>
<td>5.34</td>
<td>0.27</td>
<td>8.15</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>µg/L</td>
<td>52</td>
<td>&lt; 1</td>
<td>5</td>
<td>0.61</td>
<td>0.09</td>
<td>1.5</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>µg/L</td>
<td>50</td>
<td>&lt; 1</td>
<td>20</td>
<td>7.3</td>
<td>1.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>µg/L</td>
<td>34</td>
<td>&lt; 1</td>
<td>110</td>
<td>18.8</td>
<td>3.2</td>
<td>7.5</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>µg/L</td>
<td>39</td>
<td>&lt; 1</td>
<td>&lt; 10</td>
<td>1.1</td>
<td>0.17</td>
<td>1.1</td>
</tr>
<tr>
<td>Lead (Pb)(3)</td>
<td>µg/L</td>
<td>36</td>
<td>&lt; 1</td>
<td>200</td>
<td>1.2</td>
<td>0.20</td>
<td>1.8</td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>µg/L</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>µg/L</td>
<td>73</td>
<td>&lt; 1</td>
<td>20</td>
<td>3.0</td>
<td>0.35</td>
<td>1.0</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>mg/L</td>
<td>265</td>
<td>2.45</td>
<td>39</td>
<td>6.5</td>
<td>0.40</td>
<td>17.6</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>µg/L</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>µg/L</td>
<td>55</td>
<td>&lt; 3</td>
<td>110</td>
<td>19.0</td>
<td>2.6</td>
<td>18.9</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>mg/L</td>
<td>267</td>
<td>8</td>
<td>190</td>
<td>20.8</td>
<td>1.3</td>
<td>76.7</td>
</tr>
</tbody>
</table>

Data collected during 1955-2015 (Reference (8)).

(1) Existing conditions water quality data for metals includes dissolved metals concentrations for USGS #04024000.
(2) Flow value from Reference (9)
(3) Statistics for lead exclude two samples from 1976-1977 at 200 µg/L detection limit, one non-detect and one detection at 200 µg/L.

5.0  Project Mass Flux Relative to Existing Conditions

For the non-mercury mass balance analysis, the average existing constituent mass flux was calculated using the annual average existing flow and the average existing concentrations. The constituent mass flux and flow from the discharges shown in Table 4 were assumed to be additive to the existing conditions mass flux and flow measured in Second Creek, the Partridge River, and the St. Louis River. The Project’s estimated effects on flows in downstream water bodies were included in calculations of Mine Year 10 concentrations.

Table 6 presents the results of the non-mercury mass balance analysis, showing the estimated existing conditions loads and concentrations, and the estimated Mine Year 10 loads and concentrations at each...
evaluation location. Analysis and interpretation of the results of the non-mercury mass balance analysis is presented in Sections 6 and 7 of Appendix A of Volume III.
### Table 6  Estimated Change in Constituent Mass Flux and Concentration at Downstream Locations for Mine Year 10

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Existing Conditions</th>
<th>Project Net Change</th>
<th>Estimated MY10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>µg/L</td>
<td>6.92E+02</td>
<td>-1.47E+00</td>
<td>35.9</td>
</tr>
<tr>
<td>Antimony</td>
<td>µg/L</td>
<td>2.11E+00</td>
<td>3.58E+00</td>
<td>0.11</td>
</tr>
<tr>
<td>Arsenic</td>
<td>µg/L</td>
<td>2.73E+01</td>
<td>3.93E+00</td>
<td>1.42</td>
</tr>
<tr>
<td>Boron</td>
<td>µg/L</td>
<td>2.05E+03</td>
<td>-2.45E+01</td>
<td>106.6</td>
</tr>
<tr>
<td>Cadmium</td>
<td>µg/L</td>
<td>1.60E+00</td>
<td>4.04E+00</td>
<td>0.08</td>
</tr>
<tr>
<td>Chromium</td>
<td>µg/L</td>
<td>1.36E+01</td>
<td>2.82E+00</td>
<td>0.71</td>
</tr>
<tr>
<td>Cobalt</td>
<td>µg/L</td>
<td>1.40E+01</td>
<td>2.35E+00</td>
<td>0.73</td>
</tr>
<tr>
<td>Copper</td>
<td>µg/L</td>
<td>2.27E+01</td>
<td>4.40E+00</td>
<td>1.18</td>
</tr>
<tr>
<td>Lead</td>
<td>µg/L</td>
<td>5.24E+00</td>
<td>1.15E+00</td>
<td>0.27</td>
</tr>
<tr>
<td>Nickel</td>
<td>µg/L</td>
<td>7.93E+01</td>
<td>2.81E+01</td>
<td>4.12</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>1.87E+01</td>
<td>7.16E+01</td>
<td>0.97</td>
</tr>
<tr>
<td>Silver</td>
<td>µg/L</td>
<td>1.39E+01</td>
<td>6.75E+02</td>
<td>0.07</td>
</tr>
<tr>
<td>Thallium</td>
<td>µg/L</td>
<td>3.87E+00</td>
<td>1.90E+02</td>
<td>0.20</td>
</tr>
<tr>
<td>Zinc</td>
<td>µg/L</td>
<td>9.84E+01</td>
<td>2.95E+01</td>
<td>5.11</td>
</tr>
<tr>
<td><strong>General Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>3.18E+05</td>
<td>-9.56E+03</td>
<td>16.5</td>
</tr>
<tr>
<td>Hardness</td>
<td>mg/L</td>
<td>1.55E+07</td>
<td>-1.16E+05</td>
<td>806</td>
</tr>
<tr>
<td>pH(7)</td>
<td>SU</td>
<td>7.99</td>
<td>7.66</td>
<td>7.99</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>µmhos/cm at 25°C</td>
<td>1336</td>
<td>700</td>
<td>189</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>9.08E+06</td>
<td>-8.43E+04</td>
<td>472</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>967</td>
<td>452</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Includes estimated constituent mass flux and flow from average discharge from LTVMSC Pits 1 and 2W and seepage from LTVMSC Pit 6, added to average mass flux and flow from stream monitoring data.
2. Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.
3. Existing conditions water quality data for metals includes total metals concentrations for MNSW8, MNSW12, and pit discharges, and dissolved concentrations for USGS 04024000.
4. For parameters not included in the FEIS GoldSim models, existing concentrations are provided.

MY10 - Mine Year 10
6.0 References


Attachment F

Mass Balance Calculations for Mercury
Memorandum

To: Jennifer Saran and Christie Kearney, Poly Met Mining, Inc.
From: Denise Levitan, Melisa Pollak, and Cliff Twaroski
Subject: Mass Balance Calculations for Mercury: Estimated Effect of WWTS Discharge and Related Activities on Loading and Concentration in Receiving and Downstream Waters During NorthMet Project Operations
Date: September 25, 2017
Project: NorthMet Project

1.0 Executive Summary

In support of the Antidegradation Evaluation\(^1\) prepared as part of the National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) Permit Application for the Poly Met Mining, Inc. (PolyMet) NorthMet Project (Project), Barr Engineering Co. (Barr) used mass balance calculations to analyze the potential effect of the Project Waste Water Treatment System (WWTS) discharge and related activities\(^2\) on mercury loading and concentration in receiving and downstream waters (hereinafter referred to as the “mercury mass balance analysis”). Minnesota's numeric water quality standards for the Lake Superior Basin include a water column mercury standard of 1.3 ng/L, which for purposes of this report is assumed to be the applicable water quality standard.

During operations, the Waste Water Treatment System (WWTS) will discharge to wetlands in the headwater areas of Trimble Creek and Unnamed Creek in the Embarrass River watershed and to the headwater segment of Second Creek in the Partridge River watershed. The WWTS will include reverse osmosis technology or equivalently-performing technology, and the performance level for this technology will result in a discharge concentration for mercury of 1.3 nanograms per liter (ng/L) or less.

The objectives of this technical analysis were (1) to estimate the potential change in annual average mercury loading to receiving waters and downstream waters associated with the WWTS discharge and related activities and (2) to evaluate how potential changes in mercury loading may affect mercury water column concentrations at specified locations.

\(^1\) The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052, presented in Appendix A of Volume III of the NPDES/SDS Permit Application.

\(^2\) “WWTS discharge and related activities” means the WWTS discharge and related Project activities that may affect the quality and quantity of that discharge, including the Flotation Tailings Basin (FTB) seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake.
Minnesota currently receives annual atmospheric deposition of mercury that is estimated at 12.5 micrograms per square meter (µg/m²) (Reference (1)). This atmospheric deposition is apportioned to include approximately 30% from natural sources, 30% from global sources, and 40% from regional sources, with Minnesota representing only 10% of the regional sources (Reference (1)). Background total mercury concentrations in northeast Minnesota that are representative of the Project area average from about 2 to 5 ng/L in lakes (Reference (2)), and in the Project area average about 3 to 4 ng/L in streams (Reference (3)) and about 4 to 5 ng/L in wetlands (Reference (4)). Baseline monitoring data for the Project area are consistent with the regional data; for example, the average total mercury concentration in Sabin and Wynne Lakes is about 3 ng/L and for Colby Lake is about 5 to 6 ng/L. Minnesota’s iron-mining operations produce surface water discharges that are low in mercury, typically less than 1.3 ng/L (Reference (5)). In the St. Louis River, most of the mercury in surface water is contributed from non-mining watersheds (Reference (6)); higher-mercury water from non-mining watersheds overwhelms low-mercury water from mining operations such that existing mercury concentrations in the St. Louis River near Forbes and Cloquet (4.1 ng/L and 4.6 ng/L, respectively) are more reflective of non-mining background concentrations (Reference (6)).

Under existing conditions, four streams near the Project Plant Site receive a portion of their baseflow from seepage from the former LTV Steel Mining Company (LTVSMC) tailings basin. These streams include Unnamed Creek, Trimble Creek, and Unnamed (Mud Lake) Creek, which are tributaries of the Upper Embarrass River on the northern/northwestern sides of the LTVSMC tailings basin, and Second Creek, which is a tributary of the Lower Partridge River, on the southern side of the LTVSMC tailings basin. The effect of this existing seepage on these streams has been a reduction of mercury concentrations to levels below non-mining background concentrations. Existing mercury concentrations in Trimble, Unnamed, and Second creeks average from 0.6 to 2.1 ng/L.

At the Project Mine Site, existing conditions reflect non-mining background mercury concentrations in watershed surface runoff to the Upper Partridge River (approximately 3.9 ng/L in the watershed of SW004a) and in the Upper Partridge River itself (average of 3.8 ng/L at surface water monitoring station SW004a).

This mercury mass balance analysis incorporated the effects of the following Project activities that may affect mercury loading in the St. Louis River watershed:

- The WWTS will discharge to headwater areas of Trimble, Unnamed, and Second creeks. Water modeling results indicate that Mine Year 10 will have the highest discharge rate and mass loading (Reference (4)); thus, Mine Year 10 was used for this mercury mass balance analysis. In other years, when less WWTS discharge is anticipated, there will be less mass loading to the receiving and downstream waters.
The Flotation Tailings Basin (FTB) seepage capture systems will collect seepage from the Tailings Basin. PolyMet will build the FTB on top of the LTVSMC tailings basin. The FTB seepage capture systems are estimated to collect 100% of surface seepage and at least 90% of groundwater seepage, thereby preventing tailings basin seepage from significantly contributing to stream flow (Reference (7)). Collected seepage will be either recycled to the FTB Pond or sent to the WWTS for treatment prior to discharge.

A drainage swale near the proposed East Dam will route off-site stormwater runoff that currently flows into the LTVSMC tailings basin to the headwater area of Unnamed (Mud Lake) Creek.

Mine water (including water from mine pit dewatering) will be treated at the WWTS, then pumped to the FTB for use in mineral processing.

Additional make-up water for mineral processing will be pumped from Colby Lake to the Plant Reservoir, as needed. Colby Lake is in the Partridge River watershed, about 11 miles southwest (downstream) of the Mine Site, and upstream of the Partridge River confluence with Second Creek.

Project activities will change the size of watershed areas that contribute runoff to receiving waters and downstream waters.

This mercury mass balance analysis estimated total mercury annual load (mass per year) and average concentration in the Embarrass River and Partridge River watersheds under existing conditions and during Project operations (i.e., Mine Year 10). Total mercury includes all mercury species, both dissolved and particulate, in the water column. For purposes of this memorandum, “mercury” refers to total mercury unless otherwise specified. Because the Project is located in both the Embarrass and Partridge River watersheds and these rivers are tributaries of the St. Louis River, potential changes in mercury loading to the St. Louis River at Forbes (at the Highway 7 bridge) and at Cloquet (at the Highway 33 bridge) were also estimated.

Receiving waters and waters further downstream of the proposed surface water discharge outfalls (downstream waters) were the focus of this mercury mass balance analysis. Other surface waters were included to provide additional analysis of the potential effect of the WWTS discharge and related activities on mercury loading in the St. Louis River watershed, including Unnamed (Mud Lake) Creek, Colby Lake, and the Partridge River from the Mine Site to the confluence with Second Creek. Receiving waters and evaluation points (EPs) are shown in Large Figure 6 of Appendix A of Reference (8), and are identified as follows:
• Receiving Waters:
  o The Trimble Creek headwater wetlands will receive WWTS discharge. No mercury monitoring has been conducted in these wetlands, so TC-1a was used as the best available proxy for the wetlands near the future outfall locations.
  o The Unnamed Creek headwater wetlands will receive WWTS discharge. No mercury monitoring has been conducted in these wetlands, so PM-11 was used as the best available proxy for the wetlands near the future outfall location.
  o The headwater segment of Second Creek will receive WWTS discharge. Mercury monitoring has been conducted on Second Creek at PM-7/SD026, the approximate location of the proposed Second Creek outfall.

• Near-Project EPs:
  o TC-1a on Trimble Creek is the first surface water monitoring station downstream of the proposed surface water discharge outfall locations in the headwater area of Trimble Creek. TC-1a is located approximately 1.5 miles from the Trimble Creek outfalls.
  o PM-11 on Unnamed Creek is the first surface water monitoring station downstream of the proposed surface water discharge outfall location in the headwater area of Unnamed Creek. PM-11 is located approximately 1 mile from the Unnamed Creek outfall.
  o PM-7/SD026 on Second Creek is located approximately at the proposed Second Creek surface water discharge outfall.
  o MNSW8 on Second Creek is located just upstream of the confluence with the Partridge River, approximately 5 miles downstream of PM-7/SD026, and has been monitored by Mesabi Nugget (these monitoring results are publically available).
  o SW004a on the Upper Partridge River is the first surface water monitoring station downstream of the Mine Site.

• Watershed EPs:
  o PM-13 on the Upper Embarrass River is downstream of projected Plant Site impacts.
  o U.S. Geological Survey (USGS) Gaging Station 04016000 (also referred to as Mesabi Nugget MNSW12) on the Lower Partridge River is downstream of projected Mine Site and Plant Site impacts in the Partridge River watershed.
• St. Louis River EPs:
  
  o USGS Gaging Station 04018750, referred to in Reference (3) as EP1, at the Highway 7 bridge near Forbes is approximately 60 river miles downstream of the Project.
  
  o Highway 33 bridge in Cloquet, referred to in Reference (3) as EP2, just upstream from the Scanlon Dam (USGS Gaging Station 04024000) is approximately 150 river miles downstream of the Project.

This mercury mass balance analysis in support of the Antidegradation Evaluation was based on the St. Louis River mercury mass-balance approach and model that PolyMet developed for the environmental review process (Reference (3)). This analysis was conducted in five steps for each EP:

1. The average annual total existing flow, mercury concentration, and mercury load were determined based on available data.

2. The portions of the existing flows and mercury loads that originate from the Mine Site and Plant Site and their corresponding concentrations were determined.

3. The estimated Mine Year 10 average annual mercury loads resulting from changes in flow, concentrations, and/or sources at the Mine Site and Plant Site from the Project operations were calculated.

4. The estimated average annual total mercury load in Mine Year 10 was calculated by summing existing conditions values and the changes calculated in Step 3.

5. The estimated Mine Year 10 average mercury concentration was calculated by dividing the calculated average annual total mercury load in Mine Year 10 by calculated average annual mean flow in Mine Year 10.

The results of this mercury mass balance analysis indicated that there will be an overall reduction in mercury loading in the Partridge River, Embarrass River, and St. Louis River watersheds with the Project in operation. The WWTS discharge and related activities were estimated to result in potential increases in loading in Second Creek at PM-7/SD026 and MNSW8, but the resulting concentration at the surface water discharge outfall is estimated to be below 1.3 ng/L, the applicable water quality standard. This estimated small increase in mercury loading to Second Creek will be offset in the Partridge River watershed as a whole due to estimated reductions attributed to water capture at the Mine Site and water withdrawal from Colby Lake which are expected to result in a net decrease in mercury loading of about 8.7 g/yr in the Lower Partridge River (at USGS 04016000). Other reductions in mercury loading are estimated to occur in the Embarrass River watershed, in Trimble Creek (at TC-1a), Unnamed Creek (at PM-11), and the Upper
Embarrass River (at PM-13). Given the estimated reductions in mercury loading in the Partridge and Embarrass River watersheds, the Project is estimated to result in reduced mercury loading in the Lower St. Louis River at Forbes (USGS 04018750) and at Cloquet (Highway 33 bridge) of approximately 10.0 g/yr.

Calculated potential changes in surface water mercury concentrations followed the same trends as the estimated potential changes in mercury loading. For example, mass-balance calculations indicated a potential decrease of 0.6 ng/L in Trimble Creek at TC-1a (from 2.1 to 1.6 ng/L) and a potential increase of 0.7 ng/L at PM-7/SD026 (from 0.6 to 1.3 ng/L). For the other EPs, the estimated potential changes in future surface water mercury concentrations were within the measured range of existing conditions concentrations.

In summary, the estimated WWTS discharge will meet the surface water quality standard of 1.3 ng/L at the surface water discharge outfalls, and the overall Project is estimated to result in a net reduction in mercury loading to the Embarrass River watershed, the Partridge River watershed, and the St. Louis River watershed. While the WWTS discharge may result in an estimated increase in mercury loading and concentration in the headwater segment of Second Creek, there is an estimated overall net reduction in mercury loading and concentration in the Partridge River watershed. In receiving waters other than the Second Creek headwater segment, and in downstream waters, the estimated potential changes in mercury concentration for each EP are expected to be within the range of natural variability.

# 2.0 Introduction

Poly Met Mining, Inc. (PolyMet) instructed Barr to conduct an analysis of the potential effect of the NorthMet Project (Project) Waste Water Treatment System (WWTS) discharge and related activities on mercury loading and concentration in receiving and downstream waters (hereinafter referred to as the “mercury mass balance analysis”) to support the Antidegradation Evaluation prepared as part of the Project’s NPDES/SDS Permit Application. Minnesota’s numeric water quality standards for the Lake Superior Basin include a water column mercury standard of 1.3 ng/L, which for purposes of this report is assumed to be the applicable water quality standard.

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3 “WWTS discharge and related activities” means the WWTS discharge and related Project activities that may affect the quality and quantity of that discharge, including the Flotation Tailings Basin (FTB) seepage capture systems, watershed changes at the Mine and Plant Sites, and the withdrawal of water from Colby Lake.

4 The “Antidegradation Evaluation” is PolyMet’s combined antidegradation analysis under Minnesota Rules, chapters 7050 and 7052, presented in Appendix A of Volume III of the NPDES/SDS Permit Application.
PolyMet proposes to manage Project water in several specifically-defined categories; definitions are presented in Table 1-1 of Volume I of the NPDES/SDS Permit Application. In the application, and in this document, these defined terms are italicized in text, for example tailings basin seepage.

For this evaluation, the “FTB” means the newly constructed Project Flotation Tailings Basin, the “LTVSMC tailings basin” means the existing former LTVSMC tailings basin, and the “Tailings Basin” means the combined LTVSMC tailings basin and the FTB.

### 3.0 Assessment Methods

The potential effects of the WWTS discharge and related activities on mercury load and concentration in receiving and downstream waters were estimated using a spreadsheet-based mass-balance model developed for the environmental review process as described in the Final Environmental Impact Statement (FEIS; Reference (9)). The mass-balance estimation method incorporated the primary inputs for mercury, was transparent with regard to data inputs, and allowed for assessing a range of input values with respect to estimated mercury loading and concentrations for existing conditions and for the Project during operations. The mass-balance model calculated mercury load and concentrations in surface water bodies using the mercury contributions from upstream surface water, groundwater recharge, stormwater runoff, and Project features.

### 3.1 Receiving Waters

For purposes of the NPDES/SDS Permit Application, the receiving waters are those waters located at the Project surface water discharge outfalls, and they include:

- The Trimble Creek headwater wetlands will receive WWTS discharge. No mercury monitoring or flow modeling has been conducted in these wetlands; therefore, TC-1a was used as the best available proxy for the wetlands near the future outfall locations.

- The Unnamed Creek headwater wetlands will receive WWTS discharge. No mercury monitoring or flow modeling has been conducted in these wetlands; therefore, PM-11 was used as the best available proxy for the wetlands near the future outfall location.

- The headwater segment of Second Creek will receive WWTS discharge. Mercury monitoring has been conducted on Second Creek at PM-7/SD026, the approximate location of the proposed Second Creek outfall.

### 3.2 Evaluation Points

Evaluation Points (EPs) for this mercury mass balance analysis (Large Figure 6 in Appendix A of Reference (8)) were identified based on locations with previous water quality and quantity sampling data
and modeling information, as found in References (3), (4), (6), (10), (11), and (12). EPs are described as Near-Project EPs (adjacent to either the Plant Site or Mine Site to assess immediate effects of the discharge), Watershed EPs (within the watershed to assess potential downstream effects in either the Upper Embarrass River or the Lower Partridge River), or St. Louis River EPs (further downstream to assess cumulative effects from the WWTS discharge and related activities).

- **Near-Project EPs:**
  
  o TC-1a on Trimble Creek is the first surface water monitoring station downstream of the proposed surface water discharge outfall locations in the headwater area of Trimble Creek. TC-1a is located approximately 1.5 miles from the Trimble Creek outfalls. This EP was selected to assess potential effects from the Project on Trimble Creek.
  
  o PM-11 on Unnamed Creek is the first surface water monitoring station downstream of the proposed surface water discharge outfall location in the headwater area of Unnamed Creek. PM-11 is located approximately 1 mile from the Unnamed Creek outfall. This EP was selected to assess potential impacts from the Project on Unnamed Creek.
  
  o PM-7/SD026 on Second Creek is located approximately at the proposed Second Creek surface water discharge outfall. This EP was selected to assess potential effects from the Project on Second Creek.
  
  o MNSW8 on Second Creek is located just upstream of the confluence with the Partridge River, approximately 5 miles downstream of PM-7/SD026. Mercury concentrations have been monitored at this location for the Mesabi Nugget operations, and sampling results are publicly available. This EP was selected to provide a point of comparison for the Second Creek headwater segment at PM-7/SD026.
  
  o SW004a on the Upper Partridge River is the first surface water monitoring station downstream of the Mine Site. This EP was selected to assess potential effects from the Project on the Upper Partridge River.

- **Watershed EPs:**

  o PM-13 on the Upper Embarrass River is downstream of projected Plant Site impacts. This EP was selected to assess the potential effects from the Project on the Embarrass River watershed, including potential impacts on Unnamed (Mud Lake) Creek, Trimble Creek, and Unnamed Creek.

  o USGS Gaging Station 04016000 (MNSW12) on the Lower Partridge River, is downstream of the Second Creek confluence. This EP was selected to assess the combined potential
effects from the Project on the Partridge River watershed, including potential impacts on the Upper Partridge River (Mine Site) and Second Creek (Plant Site).

- St. Louis River EPs:
  - EP-1, USGS Gaging Station 04018750, referred to in Reference (3) as EP1, at the Highway 7 bridge near Forbes is approximately 60 river miles downstream of the Project. This EP was selected because it is the first surface water monitoring station on the St. Louis River downstream of the Project for which both flow and mercury concentration data are available and because it represents an approximate mid-watershed location (about halfway from the Project to Cloquet). This EP enables estimating the combined potential effects from the Project on the St. Louis River watershed, comprising potential contributions from both the Embarrass River and the Partridge River.
  - EP-2, Highway 33 bridge in Cloquet, referred to in Reference (3) as EP2, is approximately 150 river miles downstream of the Project. This EP was selected because it is a point of reference in several Minnesota Department of Natural Resources assessments of the St. Louis River watershed and it is included in Reference (3). Flow data from the Scanlon Dam (USGS 04024000), located just downstream of the Highway 33 bridge, is applied to EP-2. This EP was also selected to assess the combined potential effects from the Project on the Lower St. Louis River at a location which receives flow from many other tributaries.

Several other locations were included in portions of this mercury mass balance analysis described in this technical memorandum, but were not assessed as EPs:

- MLC-3 on Unnamed (Mud Lake) Creek will not receive a discharge from the WWTS, but there will be changes to its watershed as a result of the Project. Unnamed (Mud Lake) Creek is a tributary of the Embarrass River upstream of Trimble Creek, so impacts at MLC-3 may result in impacts to the Embarrass River at PM-13. It was not included as an EP because it does not receive WWTS discharge, but the calculations for PM-13 included the potential changes at MLC-3.

- Colby Lake is located along the Partridge River, about 11 miles downstream of the Mine Site, and upstream of the Partridge River confluence with Second Creek. Additional make-up water for Project mineral processing will be pumped from Colby Lake to the Plant Reservoir, as needed. Because it is a lake, it was not included as an EP, but potential effects on mercury loading and concentration from pumping Colby Lake water to the Plant Site were included in the calculations for the EPs in the Lower Partridge River and the St. Louis River.

- PM-17 is located on Second Creek approximately 1.5 miles downstream of PM-7/SD026. Mercury concentrations were monitored at this location in 2006 and 2007, but flows at this location were
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not included in Project’s GoldSim modeling, and it is thus not included as an EP in this analysis. However, the average existing condition concentration was calculated from monitoring data for this technical memorandum to provide a point of comparison for the Second Creek headwater segment at PM-7/SD026.

3.3 Input Data

This mercury mass balance analysis incorporates flows and mercury concentrations from the FEIS GoldSim modeling associated with the WWTS discharge and related activities as input data.

For several EPs downstream of the Mesabi Nugget and Cliffs Erie projects (MNSW8, MNSW12, EP1 at Forbes, and EP2 at Cloquet), additional flows and loads associated with Mesabi Nugget and Cliffs Erie mine pits are also included, as described in Section 4.1 of Attachment E of Appendix A of Volume III of the NPDES/SDS Permit Application.

Potential mercury loading from Project air emissions to receiving and downstream waters was assessed in the 2012 Cumulative Impacts Analysis: Local Mercury Deposition (Reference (13)), and the potential cumulative loading from Project air emissions and the WWTS discharge and related activities was assessed in additional studies conducted to respond to MPCA inquiries concerning potential mercury and methylmercury impacts from various air emissions sources associated with the Project (Reference (14)). Therefore, this mercury mass balance analysis focuses exclusively on the potential changes in mercury load and concentration due to the WWTS discharge and related activities.

3.3.1 Flows

The term “flow”, in this technical memorandum, is used to describe a volume of water per unit time. Estimates of average annual mean flows at the EPs were obtained from existing stream gage data, information on additional flows from Mesabi Nugget and Cliffs Erie to Second Creek (Section 4.1 of Attachment E of Appendix A of Volume III of the NPDES/SDS Permit Application), and from FEIS GoldSim modeling (described in Reference (4) and Reference (10)).

3.3.1.1 Existing (Baseline) Conditions

Flow sources modeled to contribute to each EP for existing conditions are listed in Table 1.

Modeled flows at PM-11 and TC-1a included estimated contributions from the Plant Site (seepage from the existing LTVSMC tailings basin, runoff from the LTVSMC tailings basin dam exterior slopes, non-contact stormwater runoff, and groundwater), and background non-contact stormwater runoff and groundwater from the non-Project parts of the respective watersheds. Although TC-1a was used as the Trimble Creek EP (because it is a surface water quality monitoring station), flow modeling was conducted for TC-1, which is less than one mile upstream. For PM-13, contributions from PM-11 and TC-1a were
included in the FEIS GoldSim modeling, as were upstream Project area flows from Unnamed (Mud Lake) Creek. Non-Project flows contributing to PM-13 in the FEIS GoldSim model reflected upstream contributions, including the Babbitt Wastewater Treatment Plant and the Area 5 Pit (SD033), as well as background non-contact stormwater runoff and groundwater from unimpacted areas of the Embarrass River watershed.

At PM-7/SD026, the FEIS GoldSim modeling estimated a seepage discharge of 230 gpm under existing conditions. However, a pumpback system, as required by the May 2010 Consent Decree between Cliffs Erie LLC and the Minnesota Pollution Control Agency (MPCA), was installed in 2011 just upstream of PM-7/SD026. This system pumps seepage from the LTVSMC tailings basin back into the tailings basin. Existing flows used in this mercury mass balance analysis reflected the conditions that existed before the seepage pumpback system was installed.

At SW004a, estimated flows included annual average mean flows for groundwater contributions and surface runoff obtained from the FEIS GoldSim modeling (Reference (9)). Flows to the Partridge River in the FEIS GoldSim modeling included non-contact stormwater and the dewatering of the Peter Mitchell Mine by Northshore Mining (based on publicly-available information). The groundwater and surface runoff contributions were divided into Mine Site (originating from within the Mine Site boundary) and non-Project background (originating outside of the Mine Site boundary).
Table 1  Flow Source Terms Included at Each Evaluation Point During Existing Conditions and Mine Year 10 Operating Conditions

<table>
<thead>
<tr>
<th>Stream</th>
<th>Evaluation Point (EP)</th>
<th>Existing Conditions Sources</th>
<th>Sources under Mine Year 10 Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Creek</td>
<td>PM-11</td>
<td>Background runoff&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;LTVSMC tailings slope runoff&lt;br&gt;LTVSMC tailings basin seepage</td>
<td>Background runoff&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;Uncaptured tailings basin seepage</td>
</tr>
<tr>
<td>Trimble Creek</td>
<td>TC-1a</td>
<td>Background runoff&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;LTVSMC tailings slopes runoff&lt;br&gt;LTVSMC tailings basin seepage</td>
<td>Background runoff&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;Uncaptured tailings basin seepage</td>
</tr>
<tr>
<td>Second Creek</td>
<td>PM-7/ SD026</td>
<td>LTVSMC tailings basin seepage</td>
<td>Approximately 11% of total WWTS discharge</td>
</tr>
<tr>
<td>Second Creek</td>
<td>MNSW8</td>
<td>Background runoff and groundwater&lt;br&gt;LTVSMC tailings basin seepage Mesabi Nugget and Cliffs Erie mine pit flows to Second Creek</td>
<td>Background runoff and groundwater&lt;br&gt;Approximately 11% of total WWTS discharge Mesabi Nugget and Cliffs Erie mine pit flows to Second Creek</td>
</tr>
<tr>
<td>Embarrass River</td>
<td>PM-13</td>
<td>Background runoff[1]&lt;br&gt;Background groundwater&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;Plant Site groundwater&lt;br&gt;LTVSMC tailings slopes runoff&lt;br&gt;LTVSMC tailings basin seepage</td>
<td>Background runoff[1]&lt;br&gt;Background groundwater&lt;br&gt;Plant Site non-contact stormwater runoff&lt;br&gt;Plant Site groundwater&lt;br&gt;Uncaptured tailings basin seepage WWTS discharge</td>
</tr>
<tr>
<td>Upper Partridge River</td>
<td>SW004a</td>
<td>Background runoff&lt;br&gt;Background groundwater&lt;br&gt;Mine Site non-contact stormwater runoff&lt;br&gt;Mine Site groundwater</td>
<td>Background runoff&lt;br&gt;Background groundwater&lt;br&gt;Mine Site non-contact stormwater runoff&lt;br&gt;Mine Site groundwater</td>
</tr>
</tbody>
</table>
Stream | Evaluation Point (EP) | Existing Conditions Sources | Sources under Mine Year 10 Operating Conditions
--- | --- | --- | ---

Italics indicate non-Project background sources. Non-italicized sources are Plant Site and Mine Site sources.

[1] Background runoff in the Embarrass River reflected upstream contributions, including discharges from the Babbitt Wastewater Treatment Plant and Area 5.

[2] At downstream locations that were not included in FEIS GoldSim modeling, background runoff and background groundwater were evaluated as a single source term, as there was not available data to differentiate these background sources.

[3] Upstream Near-Project sources were combined into a single source term (i.e., Plant Site or Mine Site) for the EPs (i.e., Lower Partridge River and St. Louis River).

[4] Colby Lake pumping was a negative source term in the mass-balance calculations, meaning that it reflected a loss of mercury from the EP. Water having a mercury concentration of about 5 ng/L will be pumped from Colby Lake to the Plant Site Reservoir as a source of make-up water for Project mineral processing.

[5] EPs in the St. Louis River: A) Forbes, Highway 7 bridge, USGS 04018750; B) Highway 33 bridge in Cloquet (flow estimates from Scanlon Dam (USGS 04024000) applied to the Highway 33 bridge location).

Average annual flows for existing conditions at downstream USGS Gaging Stations were obtained from the USGS: these EPs were not included in the FEIS GoldSim water modeling. Flow data for each of these EPs, adjusted for additional flows to Second Creek where necessary, are presented in Large Table 1 and Large Table 2.

3.3.1.2 Project Operating Conditions

Estimated operating conditions for the Project were assessed for Mine Year 10, the year when the maximum amount of discharge from the WWTS is estimated to occur.

Total estimated flow at each EP was calculated as the sum of the estimated Plant Site and Mine Site flow, non-Project background flow, and additional flows to Second Creek, where applicable. The mass balance calculations used the FEIS GoldSim model-estimated average annual mean flows from the Plant Site or Mine Site in Mine Year 10 (described in Reference (4) and Reference (10)). Sources of flow during operations are listed in Table 1. At Plant Site EPs, these flows included a small amount of uncaptured seepage from the Tailings Basin, non-contact stormwater runoff, groundwater from within the Plant Site boundary, and WWTS discharge. At the Mine Site, these flows included the groundwater contribution and non-contact stormwater runoff from within the Mine Site boundary. For downstream EPs in the Lower
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Partridge River (USGS 04016000) and in the St. Louis River (Forbes (USGS 04018750) and Cloquet), Plant Site and Mine Site flows were calculated as the sum of the Plant Site and Mine Site flows at upstream EPs (PM-7/SD026 flow + SW004a flow + PM-13 flow (St. Louis River locations only)), with the inclusion of a negative term for the amount of water and associated mercury load pumped to the Plant Reservoir from Colby Lake (Exhibit 1) and an adjustment for additional flows to Second Creek, where relevant.

The non-Project background flows were assumed to be the same during Mine Year 10 as in existing conditions, because they are from areas that are not expected to be modified by the Project. An exception occurs at PM-13, where changes to the Unnamed (Mud Lake) Creek watershed from construction of the drainage swale will redirect a small amount of non-contact stormwater runoff to Unnamed (Mud Lake) Creek and subsequently to the Embarrass River (PM-13). For other EPs, including downstream EPs on the lower Partridge River (USGS 04016000) and the St. Louis River (Forbes (USGS 04018750) and Cloquet), non-Project background flows were also assumed to be the same as during existing conditions.

Though Colby Lake was not used as an EP, withdrawals for Plant Site make-up water (direct loss from the Partridge River watershed) were included in the mass-balance calculations.

3.3.2 Mercury Concentrations
3.3.2.1 Existing Conditions
Existing Conditions mercury concentration data are presented in Table 2 and Table 3. Averages of mercury concentrations measured in samples collected as part of the FEIS water quality monitoring were used for TC-1a, PM-11, PM-7/SD026, PM-13, and SW004a. Averages of mercury concentrations reported in Reference (6), adjusted to account for additional flows to Second Creek, were used for the Lower Partridge River near USGS 04016000 and the St. Louis River at EP-1 and EP-2.
Table 2  Average Total Mercury Concentrations from Monitoring Data in Receiving Waters, at Evaluation Points, in Colby Lake, and in Shallow Groundwater

<table>
<thead>
<tr>
<th>Water Body / Evaluation Point</th>
<th>Sampling Location</th>
<th>Average Mercury Concentration, ng/L</th>
<th>Sample Collection Time Period</th>
<th>Location of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Creek PM-11</td>
<td>PM-11</td>
<td>1.7[1]</td>
<td>2004-2015</td>
<td>Large Table 2 of Reference (12)</td>
</tr>
<tr>
<td>Trimble Creek TC-1a</td>
<td>TC-1a</td>
<td>2.1</td>
<td>2012-2015</td>
<td>Large Table 2 of Reference (12)</td>
</tr>
<tr>
<td>Second Creek PM-7/SD026</td>
<td>PM-7/SD026</td>
<td>0.6[1]</td>
<td>2002-2015</td>
<td>Large Table 2 of Reference (12)</td>
</tr>
<tr>
<td>Second Creek PM-17</td>
<td>PM-17</td>
<td>3.7[1]</td>
<td>2006-2007</td>
<td>Appendix D, Table 2 of Reference (15)</td>
</tr>
<tr>
<td>Second Creek MNSW8</td>
<td>MNSW8</td>
<td>2.4[2]</td>
<td>2008-2009</td>
<td>Table 1 of Reference (16)</td>
</tr>
<tr>
<td>Embarrass River PM-13</td>
<td>PM-13</td>
<td>3.4[1]</td>
<td>2004-2015</td>
<td>Large Table 2 of Reference (12)</td>
</tr>
<tr>
<td>Upper Partridge River SW004a</td>
<td>SW004a</td>
<td>3.8</td>
<td>2010-2015</td>
<td>Large Table 4 of Reference (11)</td>
</tr>
<tr>
<td>Colby Lake</td>
<td>Various</td>
<td>5.3</td>
<td>2008, 2013-2015</td>
<td>Large Table 9 of Reference (10)</td>
</tr>
<tr>
<td>St. Louis River, Cloquet</td>
<td>Hwy 33 bridge in Cloquet</td>
<td>4.6[2]</td>
<td>2007-2008</td>
<td>Reference (6)</td>
</tr>
<tr>
<td>Plant Site Shallow Groundwater</td>
<td>GW002, GW011, GW013, GW015</td>
<td>3.5[1]</td>
<td>2007-2015</td>
<td>Large Table 4 of Reference (12)</td>
</tr>
</tbody>
</table>

[1] Averages were computed using the Kaplan-Meier method (Reference (17)) to account for values below analytical detection limits.
[2] Adjusted to account for Mesabi Nugget and Cliffs Erie mine pit flows to Second Creek
In computing concentration averages, field duplicate samples were averaged to a single value. For monitoring sites with measurements including values below analytical detection limits (i.e., PM-11, PM-13, SD004, PM-7/SD026, and Plant Site and Mine Site groundwater), averages were computed using the Kaplan-Meier method in the statistical software R (Reference (17)). This method was chosen because different detection limits, some greater than the mercury standard of 1.3 ng/L, were provided for samples analyzed at different times and/or by different laboratories. Concentration averages estimated by the Kaplan-Meier method were rounded to three significant figures for use in the detailed calculation spreadsheet, but are rounded in this technical memorandum to one decimal point to facilitate comparison with the surface water quality standard of 1.3 ng/L.

Existing conditions concentrations of mercury in the Lower Partridge River (USGS 04016000) and in the St. Louis River (Forbes (USGS 04018750) and Cloquet) were calculated as the average from samples collected at those locations as reported in Reference (6).

Mercury concentrations in non-contact stormwater runoff to each EP (Table 4) were calculated based on existing conditions annual average mean flow values obtained from the FEIS GoldSim Continuation of Existing Conditions model (References (10) and (4)) and loads from other sources, because these concentration values were not directly measured. Inputs to the mass balance calculations were the values for the total mercury load from the WWTS discharge and related activities, the mercury loads from non-runoff sources, the non-contact stormwater runoff flow from Project, and non-Project sources (see Exhibit 1). The mercury concentration in non-contact stormwater runoff was calculated in the mass balance as the difference between the total load and the non-runoff load, divided by the non-contact stormwater runoff flow. The runoff concentration was assumed to be the same for existing conditions and Project operating conditions because the runoff does not contact Project features.

<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>Seep/Well(s)</th>
<th>Estimated Seepage Mercury Concentration, ng/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Creek (PM-11)</td>
<td>SD004, GW007</td>
<td>1.0</td>
</tr>
<tr>
<td>Trimble Creek (TC-1a)</td>
<td>GW006; GW001, GW012</td>
<td>2.0[1]</td>
</tr>
<tr>
<td>Second Creek (PM-7/SD026)</td>
<td>PM-7/SD026</td>
<td>0.6</td>
</tr>
<tr>
<td>Embarrass River (PM-13)</td>
<td>SD004, PM-7/SD026, GW001, GW006, GW007, GW012</td>
<td>1.5</td>
</tr>
</tbody>
</table>

[1] A flow-weighted average based on relative seepage contribution from LTVSMC tailings Cell 2W (GW006) and Cell 2E (GW001 and GW012) was used.
Non-contact stormwater runoff flow consisted of non-Project background watershed stormwater runoff flow (runoff from outside the Plant Site or Mine Site), Plant Site or Mine Site non-contact stormwater runoff flow, and the runoff from LTVSMC tailings basin dam exterior slopes where applicable. The runoff from the LTVSMC tailings basin slopes was assumed to be similar to non-contact stormwater runoff because the slopes are largely vegetated. The three components of non-contact stormwater runoff were assumed to have the same mercury concentration within the respective watershed for each EP (i.e., the non-Project area, Project area, and tailings slope stormwater runoff contributions to a particular EP are evaluated at the same mercury concentration).

Background atmospheric deposition to the watershed was included in the non-contact stormwater runoff term and was therefore not included as a separate term in this mercury mass balance analysis.

**Table 4** Estimated Stormwater Runoff (background and Project non-contact runoff) Total Mercury Concentrations at Evaluation Points

<table>
<thead>
<tr>
<th>Stream</th>
<th>Evaluation Point</th>
<th>Estimated Runoff Mercury Concentration, ng/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Creek</td>
<td>PM-11</td>
<td>2.1</td>
</tr>
<tr>
<td>Trimble Creek</td>
<td>TC-1a</td>
<td>2.5</td>
</tr>
<tr>
<td>Second Creek</td>
<td>PM-7/SD026</td>
<td>n/a</td>
</tr>
<tr>
<td>Second Creek</td>
<td>MNSW8</td>
<td>4.1&lt;sup&gt;[1]&lt;/sup&gt;</td>
</tr>
<tr>
<td>Embarrass River</td>
<td>PM-13</td>
<td>3.6</td>
</tr>
<tr>
<td>Upper Partridge River</td>
<td>SW004a</td>
<td>3.9</td>
</tr>
<tr>
<td>Lower Partridge River</td>
<td>USGS 04016000</td>
<td>4.7&lt;sup&gt;[1]&lt;/sup&gt;</td>
</tr>
<tr>
<td>St. Louis River near Forbes</td>
<td>USGS 04018750</td>
<td>4.2&lt;sup&gt;[1]&lt;/sup&gt;</td>
</tr>
<tr>
<td>St. Louis River at Cloquet</td>
<td>Highway 33 bridge</td>
<td>4.6&lt;sup&gt;[1]&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>[1]</sup> Non-Project background runoff and groundwater combined concentration.

Mercury concentrations in groundwater were calculated as the average concentration of shallow groundwater monitoring wells from the Plant Site (for PM-13) and Mine Site (for SW004a). Plant Site wells included those not impacted by existing LTVSMC tailings basin seepage (Table 2), and Mine Site wells included monitored groundwater wells in the surficial aquifer (Large Table 3 of Reference (10)). Groundwater concentrations were only included for PM-13 and SW004a. The amount of groundwater contributing to the near-Project EPs has been negligible, and contributions from groundwater and non-contact stormwater runoff were not considered separately in the Lower Partridge River (at USGS 04016000) or at the EPs in the St. Louis River. Groundwater flow included both Plant Site or Mine Site and non-Project background groundwater contributions. Similar to non-contact stormwater runoff,
groundwater contributions from the background and the Plant Site or Mine Site to PM-13 or SW004a are assumed to have the same concentration.

### 3.3.2.2 Operating Conditions

Average mercury concentrations in seepage, runoff, groundwater, additional flows to Second Creek, and Colby Lake were assumed constant between existing conditions and operating conditions. The WWTS discharge concentration used in the mass-balance calculations was 1.3 ng/L, the maximum allowed concentration from a new discharge in the Lake Superior Basin, and is considered to represent a conservative maximum discharge value for this mercury mass balance analysis.

Mercury concentrations in stream water at EPs during operating conditions were calculated based on estimated loads and annual average flows from the FEIS GoldSim modeling, plus the flows and loads associated with the additional flows to Second Creek, where appropriate.

### 3.4 Analysis

Mercury loading was a foundation of the mass-balance analysis. The estimated effect of the WWTS discharge and related activities on loading was calculated for each EP by comparing the mercury load under existing conditions with the estimated mercury load under Project operating conditions (Mine Year 10). The estimated effect of the WWTS discharge and related activities on mercury concentrations at each EP was then calculated by dividing the operating conditions annual mercury load by the operating conditions annual average mean flow, and comparing the operating conditions mercury concentration to the existing conditions concentration. Formulas for the calculations described in this section can be found in Exhibit 1.

#### 3.4.1 Project Mercury Load

Loads (mass/time) were calculated by multiplying concentrations (mass/volume) by flows (volume/time). The mercury loads in each flow source contributing to an EP were calculated separately, then summed.

##### 3.4.1.1 Existing Conditions

For each EP, the flow and mercury load for the individual sources contributing to that EP were estimated in existing conditions to allow for adjustments in the individual components for operating conditions (Exhibit 1). Existing conditions mercury load as grams of mercury per year (g/yr) was calculated by multiplying the estimated annual average mean flow (converted from gpm to liters per year, L/yr) by the existing mercury concentration (in nanograms per liter, ng/L, divided by $10^9$ to convert to g/L) at each EP. It was assumed that by using average annual mean flow values and an average of mercury concentrations measured during a variety of sampling events, a representative annual total load representing existing conditions was obtained for each contributing source and each EP.
3.4.1.2 Operating Conditions

For operating conditions, the annual load from each source to each EP was calculated for Mine Year 10 by multiplying the estimated annual average mean flow by the estimated concentration. Because the contributing flow sources and the available data for these sources varied among EPs, further load calculation specifics are discussed in the succeeding paragraphs. The Project operating conditions loads described below represent total loads at the EPs during Project operating conditions, including from sources outside of the Project area (i.e., background and additional flows to Second Creek).

Mercury loads in Unnamed Creek at PM-11, Trimble Creek at TC-1a, and Second Creek at PM-7/SD026 were calculated as a mixture of WWTS discharge load, Plant Site non-contact stormwater runoff load, and non-Project background watershed stormwater runoff load (Exhibit 1). The potential load of mercury from the WWTS was determined as follows: WWTS discharge rate obtained from FEIS GoldSim modeling was multiplied by the maximum discharge mercury concentration of 1.3 ng/L. The loads from the WWTS discharge and the watershed runoff contribution were summed for each EP to provide an estimated total annual mercury load in g/yr. The load in the Upper Embarrass River at PM-13 was calculated similarly but with the addition of the uncaptured seepage load that is expected to travel to the Embarrass River via groundwater or other pathways that will not contribute to flow and load at EPs PM-11 and TC-1a.

There are no planned direct discharges to the Upper Partridge River (upstream of Colby Lake) from the Mine Site during operations, but changes to the amount of non-contact stormwater runoff and groundwater flow from the Mine Site to the river are expected due to the planned capture and recycling of mine water from the Mine Site, including from the dewatering of mine pits (Reference (18)). The mass-balance calculations account for the expected change (overall reduction) in flow and load from the Mine Site during operations (Exhibit 1).

In the Lower Partridge River at USGS 04016000, load was calculated as the sum of the Mine Site load from SW004a, the Plant Site load from PM-7/SD026, the load pumped from Colby Lake to the Plant Site (a loss from the watershed), load from additional flows to Second Creek, and the non-Project background load (calculated by subtracting the existing loads from PM-7/SD026 and the Mine Site from the estimated existing conditions total load at USGS 04016000).

For the St. Louis River at Forbes (USGS 04018750) and Cloquet (Highway 33 bridge), the load was calculated as the sum of the Mine Site load from the Partridge River (as estimated for USGS 04016000), the Plant Site load from the Upper Embarrass River (PM-13), load from additional flows to Second Creek, and the non-Project background load, using the same subtraction method as for the background load estimated for the lower Partridge River (USGS 04016000).
A very important assumption to note for the Lower Partridge River (USGS 04016000) and the St. Louis River (Forbes (USGS 04018750) and Cloquet) is that the mercury loads from the WWTS discharge and related activities are assumed to be the same at these downstream EPs as at upstream EPs closer to the Plant Site or Mine Site (i.e., PM-13, SW004a, and PM-7/SD026). In other words, the net effect of the WWTS discharge and related activities on mercury loading near the Project is assumed to be transferred downstream unchanged. Another way to envision this assumption is as if the discharges from the Plant Site and Mine Site occurred immediately upstream of the St. Louis River EPs at Forbes and Cloquet. This assumption obviously is a conservative approach that results in overestimation of the potential changes in these downstream waters because it does not account for upstream losses due to physical or biogeochemical processes that remove mercury from the water column, such as loss to sediments through burial or adsorption or to the atmosphere through evasion (Reference (3)).

3.4.2 Estimated Operating Conditions Concentration

Mercury concentrations in receiving waters at the surface water discharge outfalls were estimated to be 1.3 ng/L, the maximum potential concentration of the WWTS discharge, because the discharge is to the headwater area for all three streams. No mixing was assumed.

Mercury concentrations at the EPs were calculated by dividing the total operating conditions annual load by the total operating conditions annual average mean flow (Exhibit 1).
4.0 Results

4.1 Estimated Potential Changes Between Existing Conditions and Mine Year 10 Operating Conditions

The potential change in mercury load between existing conditions and Mine Year 10 operating conditions was estimated for the EPs. These EPs encompassed the potential changes due to the WWTS discharge and related activities. Results can be found in Table 5, Large Table 1, and Large Table 2.

4.1.1 Embarrass River Watershed

The mass-balance calculations indicated potential decreases in mercury loading as a result of the Project in Trimble Creek at TC-1a and in Unnamed Creek at PM-11 in the Embarrass River watershed (Table 5 and Large Table 2). These estimated reductions in loading occurred because the total mercury load expected to be discharged by the WWTS to the Embarrass River watershed was estimated to be offset by reductions from the FTB Seepage Containment System which will collect tailings basin seepage and runoff from the Tailings Basin dam exterior slopes.

The mass-balance calculations indicated a potential overall decrease in average mercury loading in the Embarrass River at PM-13 during Mine Year 10 as compared to existing conditions (Large Table 1). The estimated potential change in mercury loading at PM-13 was not simply the sum of the changes in loading to Trimble and Unnamed Creeks. Mercury loading at PM-13 during operations included the effects of changes to the watershed area due to construction of the Unnamed (Mud Lake) Creek drainage swale.

4.1.2 Partridge River Watershed

At PM-7/SD026 on Second Creek, the mercury load and concentration were estimated to increase due to WWTS discharge to the headwater segment of Second Creek. This effect is not expected to persist downstream. Historical sampling data indicates that the low mercury concentration water discharged at PM-7/SD026 is quickly overwhelmed with background water from other parts of the watershed such that by the time Second Creek reaches downstream monitoring site PM-17 (about 1.5 miles downstream), existing mercury concentrations reflect background conditions (an average of 3.7 ng/L (Reference (15))). Further downstream, near the Second Creek confluence with the Partridge River at MNSW8 (about 5 miles downstream of PM-7/SD026), existing mercury concentrations average 2.4 ng/L (Table 5).

At SW004a, there was an estimated decrease in mercury loading to the Upper Partridge River due to water capture associated with Project mining activities. Despite this estimated reduction in loading, because of a decrease in flow at SW004a the mass-balance calculations estimated a potential small increase (<0.1 ng/L) in mercury concentration during Project operations.
The mass-balance calculations estimated an overall decrease in average mercury loading in the Lower Partridge River at USGS 04016000 during Mine Year 10 (Large Table 1). Discharge from the WWTS to Second Creek was estimated to add to the load in the Lower Partridge River, but overall the WWTS discharge and related activities were estimated to decrease loading in the Lower Partridge River, due to reduced loading from runoff and groundwater at the Mine Site, compared to existing conditions, and due to the load estimated to be removed from the Partridge River via pumping water from Colby Lake to the Plant Site for use as make-up water. The mercury in the make-up water pumped from Colby Lake will be sequestered in the tailings within the Tailings Basin, not transferred to another surface water body (Section 9.3.1 of Appendix A of Volume III of the NPDES/SDS Permit Application). The estimated mercury concentration in the Lower Partridge River at USGS 04016000 was calculated to decrease during operations.

4.1.3 St. Louis River

In the St. Louis River, the overall effect of the WWTS discharge and related activities was estimated to slightly decrease the mercury load as compared to existing conditions (Table 5 and Large Table 1). The same mercury load reduction was calculated at Forbes (USGS 04018750) and Cloquet (Highway 33 bridge) because the calculations conservatively assumed no loss from burial, evasion, or other physical or biogeochemical processes as the mercury load travels down river from the Project to the downstream EPs.
Table 5  Summary of Potential Changes in Estimated Total Mercury Load and Concentration in Mine Year 10 Compared to Existing Conditions

<table>
<thead>
<tr>
<th>Location</th>
<th>Total Mercury Load</th>
<th></th>
<th>Total Mercury Concentration</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Condition</td>
<td>Operating Condition Estimate</td>
<td>Potential Change</td>
<td>Existing Condition</td>
</tr>
<tr>
<td></td>
<td>g/yr</td>
<td>g/yr</td>
<td>ng/L</td>
<td>ng/L</td>
</tr>
<tr>
<td>Trimble Creek, TC-1a</td>
<td>9.3</td>
<td>7.7</td>
<td>- 1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Unnamed Creek, PM-11</td>
<td>5.3</td>
<td>5.0</td>
<td>- 0.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Second Creek, PM-7/SD026</td>
<td>0.3</td>
<td>0.8</td>
<td>+ 0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Second Creek, MNSW8</td>
<td>46.6</td>
<td>47.1</td>
<td>+ 0.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Partridge River, SW004a</td>
<td>168.0</td>
<td>161.6</td>
<td>- 6.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Upper Embarrass River, PM-13</td>
<td>265.9</td>
<td>264.6</td>
<td>- 1.3</td>
<td>3.4</td>
</tr>
<tr>
<td>Lower Partridge River, USGS 04016000[1]</td>
<td>469.3</td>
<td>460.6</td>
<td>- 8.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Forbes USGS 04018750[1]</td>
<td>2,070.0</td>
<td>2,060.0</td>
<td>- 10.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Cloquet, Highway 33 bridge[1]</td>
<td>9,389.0</td>
<td>9,379.0</td>
<td>- 10.0</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Values from detailed calculation spreadsheet and rounded. Values may not sum due to independent rounding.

[1] Mass-balance calculations for the Lower Partridge River (USGS 04016000) and the St. Louis River (Forbes (USGS 04018750) and Cloquet (Highway 33 bridge)) included the loss from pumping of water from Colby Lake in the Partridge River watershed to the Plant Site in the Embarrass River watershed.

4.2 Natural Variability and Protectiveness in the Analysis

4.2.1 Natural Variability

The mercury loading analysis was conducted as a mass balance using averaged mercury concentrations and annual average mean flows for Mine Year 10 (from monitoring data and FEIS GoldSim modeling). However, there is natural variability in both flow and mercury concentrations, and, therefore, any estimated change from existing conditions due to Project operations may be within the range of natural variability.

Annual average mercury loads for existing conditions were calculated using averaged values of measured mercury concentrations and annual average mean flows. In reality, these parameters are related to a number of biogeochemical and hydrological processes, and can vary as a result of fluctuations in those processes (Reference (19)). A simple investigation of the potential natural variability in mercury loads and concentrations was undertaken by identifying the lowest and highest measured mercury concentrations at
each EP, and multiplying this concentration range by the annual average mean flow to estimate the natural variability in mercury load (Table 6).

Estimated Mine Year 10 concentrations and loads were also evaluated in comparison to the range of existing natural variability (Table 6). This comparison showed that estimated concentrations and loads during Project operating conditions were within the range of the natural variability in existing conditions.

### Table 6 Natural Variability in Existing Conditions Total Mercury Concentration and Load and Comparison with Average Estimated Operating Conditions

<table>
<thead>
<tr>
<th>Evaluation Point</th>
<th>Mercury Concentration (ng/L)</th>
<th>Mercury Load (g/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC-1a</td>
<td>0.8</td>
<td>4.9</td>
</tr>
<tr>
<td>PM-11</td>
<td>&lt;0.5</td>
<td>6.0</td>
</tr>
<tr>
<td>PM-7/SD026</td>
<td>&lt;0.1</td>
<td>2.1</td>
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<tr>
<td>MNSW8</td>
<td>1.4</td>
<td>7.5</td>
</tr>
<tr>
<td>PM-13</td>
<td>&lt;2.0</td>
<td>12.4</td>
</tr>
<tr>
<td>SW004a</td>
<td>0.8</td>
<td>12.5</td>
</tr>
</tbody>
</table>

|                  |                              |                     |     |                            |                               |                             |
| Forth: USGS 04018750 | 1.5                        | 8.9                 | 4.1 | 762.6                      | 4,525.0                       | 2,060.0                     |
| Cloquet: Highway 33 bridge | 1.1                      | 9.4                 | 4.6 | 2,253.7                    | 19,259.2                      | 9,379.0                     |

<sup>[1]</sup> Maximum detected concentration from samples collected during monitoring

<sup>[2]</sup> Estimated concentrations are rounded values from the mass-balance calculation spreadsheet

<sup>[3]</sup> Load calculated from existing conditions annual average mean flow and maximum measured concentration in [1]

#### 4.2.2 Protectiveness in the Analysis

A critical simplifying assumption for the estimation of potential future mercury concentrations was that the Project mercury load from the near-Project and Watershed EPs will be released directly to the next EP downstream (e.g., the entire mercury load from PM-7/SD026 and SW004a is included at USGS 04016000 on the lower Partridge River). This assumption, also included in Reference (3), resulted in an overestimation of the potential contribution from the Plant Site and Mine Site to downstream locations, because it disregards the effects of biogeochemical and hydrological loss factors (e.g., burial and volatilization) that act as water flows downstream from the Project to the EPs. Because the intent is to
provide a conservative screening analysis, these loss factors and potential effects on mercury loading and concentration were not included in this mercury mass balance analysis.

The analysis is also conservative in that it assumes the concentration of mercury in the WWTS discharge will be equal to the water quality standard of 1.3 ng/L. However, the discharge concentration of mercury from the WWTS may be lower than 1.3 ng/L for two reasons. First, it is expected that the discharge concentration of mercury will be no greater than the influent concentration. The influent to the WWTS will be primarily tailings basin seepage, and the concentration of mercury in the future tailings basin seepage is expected to be similar to the concentration in the seepage from the existing LTVSMC tailings basin, which is approximately 1.0 ng/L (Section 6.9 of Reference (4)). Second, treatment technology employed at the WWTS, which includes greensand filtration and reverse osmosis (RO) membrane separation technology or equivalently performing technology, is expected to remove mercury. If the mercury concentration in the WWTS discharge is lower than 1.3 ng/L, the Project could then result in a larger decrease in net mercury loading to the St. Louis River watershed than estimated in this mercury mass balance analysis.

5.0 Comparison with FEIS Mercury Mass Balances

Section 5.2.2.3.4 of the FEIS (Reference (9)) presents the results from several mercury mass-balance analyses. Those analyses described potential future mercury concentrations in the West Pit lake and its discharge and potential effects from the Project on mercury loading in the St. Louis River during postclosure maintenance. Those FEIS analyses differed from this mercury mass balance analysis because they assessed mercury loading during a different time period. The FEIS analyses assessed the postclosure maintenance phase (Mine Year 55 and thereafter), whereas this mercury mass balance analysis assessed MY10 of the operations phase. The methods, assumptions, and conclusions of the FEIS analyses and this mercury mass balance analysis are consistent, but the numerical results differ slightly because the two analyses assess different Project phases. The two analyses show that the Project is expected to decrease mercury loading to the St. Louis River in both the operations phase (decrease of 10 g/yr) and the postclosure maintenance phase (decrease of 1 g/yr).

6.0 Conclusion

This mercury mass balance analysis for Mine Year 10 (maximum WWTS discharge and loading) indicated an overall decrease in mercury loading in the Embarrass River watershed, the Partridge River Watershed and the St. Louis River watershed as compared to existing conditions. Mercury concentrations at the surface water discharge outfalls will be at or below the applicable standard of 1.3 ng/L. While there is a potential increase in mercury loading to the headwater segment of Second Creek, the estimated net effect of the Project at the EPs in other receiving and downstream waters is an estimated reduction in mercury loading in the environment, and particularly in the St. Louis River, as compared to existing conditions. The
estimated Mine Year 10 mercury concentrations and loads at all EPs were within the respective ranges for existing natural variability. Analysis and interpretation of the results of this mercury mass balance analysis is presented in Sections 8 and 9 of Appendix A of Volume III of the NPDES/SDS Permit Application.
7.0 References


Large Tables
<table>
<thead>
<tr>
<th>Watershed</th>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow (gpm)</th>
<th>(cfs)</th>
<th>(liters/yr)</th>
<th>HgT Conc ng/L</th>
<th>HgT Load ng/yr</th>
<th>HgT Load g/yr</th>
<th>CHANGE IN LOAD g/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embarrass River</strong></td>
<td><strong>Existing Conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contribution to PM-13 from outside Plant Site boundary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Background runoff</td>
<td>33794</td>
<td>75.4</td>
<td>6.73E+10</td>
<td>3.6</td>
<td>2.40E+11</td>
<td>240.1</td>
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<tr>
<td></td>
<td>Concentration calculated by subtracting non-runoff loads from total load and dividing by runoff flow modeled by GoldSim</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>Includes flow from upstream Babbitt WWTP and Area S</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>Background groundwater</td>
<td>2113</td>
<td>4.7</td>
<td>4.21E+09</td>
<td>3.5</td>
<td>1.48E+10</td>
<td>14.8</td>
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<td>-0.01</td>
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### Large Table 1  Mercury Loading to Embarrass, Partridge, and St. Louis Rivers in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow (gpm)</th>
<th>HgT Conc (ng/L)</th>
<th>HgT Load (ng/yr)</th>
<th>CHANGE IN LOAD (g/yr)</th>
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<td>Partridge River</td>
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<td>Upper (SW004a)</td>
<td>Contribution to SW004a from outside Mine Site boundary</td>
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<tr>
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<td>Background runoff</td>
<td>19323</td>
<td>43.1</td>
<td>3.85E+10</td>
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<td>988</td>
<td>2.2</td>
<td>1.97E+09</td>
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<td>Water pumped to Plant Site = 0</td>
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<td>Project (Mine Year 10):</td>
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<td>Upper (SW004a)</td>
<td>Contribution to SW004a from outside Mine Site boundary</td>
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<td>19323</td>
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<td>988</td>
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<td>Contribution to SW004a from within Mine Site boundary</td>
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<td>Non-contact runoff</td>
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<td>Lower (USGS 04016000)</td>
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<td>Addition from Mesabi Nugget dewatering</td>
<td>4641</td>
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<td>Loss from Colby Lake pumping</td>
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<td>Water pumped to Plant Site = 259 gpm</td>
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(1) WWTS effluent is major source of water,
## Large Table 1  Mercury Loading to Embarrass, Partridge, and St Louis Rivers in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow (gpm)</th>
<th>Flow (cfs)</th>
<th>Flow (liters/yr)</th>
<th>HgT Conc (ng/L)</th>
<th>HgT Load (ng/yr)</th>
<th>HgT Load (g/yr)</th>
<th>CHANGE IN LOAD (g/yr)</th>
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<td><strong>PROJECT BALANCE</strong></td>
<td>Overall change due to tailings basin seepage capture, WWTS discharge, Mine Site water capture and transfer of St. Louis River at Forbes</td>
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<td><strong>-10.0</strong></td>
<td><strong>-0.1%</strong></td>
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(1) Based on annual average flow, 1943-1981, from USGS Station 0401600K
(2) Based on annual average flow, 1965-1989, from USGS Station 04018750
(3) Existing conditions flow from USGS Station 04024000 from Reference (14)
### Large Table 2: Mercury Loading to Unnamed, Timble, and Second Creeks in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
<thead>
<tr>
<th>Assessment Condition / Source of Hg Load</th>
<th>Unnamed Creek (PM-11)</th>
<th>Flow</th>
<th>HgT Conc</th>
<th>HgT Load</th>
<th>CHANGE IN LOAD</th>
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<td></td>
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<td>(gpm)</td>
<td>(cfs)</td>
<td>(liters/yr)</td>
<td>ng/L</td>
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<td>Background (outside Plant Site boundary)</td>
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<tr>
<td>Background runoff</td>
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<td>1.8</td>
<td>1.59E+09</td>
<td>2.1</td>
<td>3.33E+09</td>
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<td>Background (outside Plant Site boundary)</td>
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<tr>
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<td>1.59E+09</td>
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<td>n/a</td>
<td>n/a</td>
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<td>Tailings basin seepage</td>
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## Large Table 2: Mercury Loading to Unnamed, Trimble, and Second Creeks in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
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<tr>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow (gpm)</th>
<th>HgT Conc (cfs)</th>
<th>HgT Conc (liters/yr)</th>
<th>HgT Load (ng/L)</th>
<th>HgT Load (ng/yr)</th>
<th>HgT Load (g/yr)</th>
<th>HgT Load (g/yr)</th>
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<td>Background (outside Plant Site boundary)</td>
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<tr>
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<td>2.60E+09</td>
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<td>525</td>
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<td>1.05E+09</td>
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<td>2.60E+09</td>
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### Large Table 2: Mercury Loading to Unnamed, Timble, and Second Creeks in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
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<tr>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow (gpm)</th>
<th>Flow (cfs)</th>
<th>Flow (liters/yr)</th>
<th>HgT Conc (ng/L)</th>
<th>HgT Conc (ng/yr)</th>
<th>HgT Conc (g/yr)</th>
<th>HgT Load CHANGE IN LOAD (g/yr)</th>
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<td>Background (outside Plant Site boundary)</td>
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<td>n/a</td>
<td>n/a</td>
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<td>n/a</td>
<td>n/a</td>
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</tr>
<tr>
<td>WWTS discharge</td>
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<td>5.87E+08</td>
<td>1.3</td>
<td>7.64E+08</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Sum for Project Conditions</strong></td>
<td>295</td>
<td>0.7</td>
<td>5.87E+08</td>
<td>1.3</td>
<td>7.64E+08</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>NET CHANGE</strong></td>
<td>65</td>
<td>0.14</td>
<td>1.29E+08</td>
<td>+0.69</td>
<td></td>
<td></td>
<td>+0.5</td>
</tr>
<tr>
<td>Percentage Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Large Table 2: Mercury Loading to Unnamed, Trimble, and Second Creeks in Mine Year 10 (Maximum Modeled WWTS Discharge) Scenario

<table>
<thead>
<tr>
<th>Assessment Condition / Source of Hg Load</th>
<th>Flow</th>
<th>HgT Conc</th>
<th>HgT Load</th>
<th>CHANGE IN LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(gpm)</td>
<td>(cfs)</td>
<td>liters/yr</td>
<td>ng/L</td>
</tr>
<tr>
<td><strong>Existing Conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background (outside Plant Site boundary)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background runoff and groundwater</td>
<td>4792</td>
<td>10.7</td>
<td>9.54E+09</td>
<td>4.1</td>
</tr>
<tr>
<td>Mesabi Nugget Dewatering</td>
<td>4641</td>
<td>10.4</td>
<td>9.24E+09</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Plant Site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-contact runoff</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Runoff from LTVSMC tailings dam banks</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Tailings basin seepage</td>
<td>230</td>
<td>0.5</td>
<td>4.58E+08</td>
<td>0.6</td>
</tr>
<tr>
<td>Plant Site groundwater</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0.7</td>
</tr>
<tr>
<td>WWTS discharge: 0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Sum for Existing Conditions</strong></td>
<td>9664</td>
<td>22</td>
<td>1.92E+10</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Project (Mine Year 10):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background (outside Plant Site boundary)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background runoff and groundwater</td>
<td>4792</td>
<td>10.7</td>
<td>9.54E+09</td>
<td>4.1</td>
</tr>
<tr>
<td>Mesabi Nugget Dewatering</td>
<td>4641</td>
<td>10.4</td>
<td>9.24E+09</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Plant Site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-contact runoff (includes runoff redirected to MLC-3 by drain)</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Runoff from LTVSMC tailings dam banks</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Tailings basin seepage</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Plant Site groundwater</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>WWTS discharge: 0</td>
<td>295</td>
<td>0.7</td>
<td>5.87E+08</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Sum for Project Conditions</strong></td>
<td>9729</td>
<td>21.7</td>
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<td>2.4</td>
</tr>
<tr>
<td><strong>NET CHANGE</strong></td>
<td>65</td>
<td>0.14</td>
<td>1.29E+08</td>
<td>+0.01</td>
</tr>
<tr>
<td>Percentage Change</td>
<td>1%</td>
<td>0%</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>
Exhibit 1

Calculation Formulas for Spreadsheets
### Exhibit 1 Calculation Formulas for Spreadsheets

Conversion factors used in this analysis:

<table>
<thead>
<tr>
<th>Conversion Factor</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallons per minute (gpm) to cubic feet per second (cfs)</td>
<td>0.00223</td>
</tr>
<tr>
<td>Cubic feet per second (cfs) to gallons per minute (gpm)</td>
<td>$=\frac{1}{0.00223}$</td>
</tr>
<tr>
<td>Liters (L) per cubic foot</td>
<td>28.31685</td>
</tr>
<tr>
<td>Seconds (s) per year (yr)</td>
<td>31536000</td>
</tr>
<tr>
<td>Gallons per minute (gpm) to liters per year (L/yr)</td>
<td>$=0.00223 \times 28.31685 \times 31536000$</td>
</tr>
<tr>
<td>Liters per year (L/yr) to gallons per minute (gpm)</td>
<td>$=\frac{1}{0.00223 \times 28.31685 \times 31536000}$</td>
</tr>
<tr>
<td>Cubic feet per second (cfs) to liters per year (L/yr)</td>
<td>$=28.31685 \times 31536000$</td>
</tr>
<tr>
<td>Liters per year (L/yr) to cubic feet per second (cfs)</td>
<td>$=\frac{1}{28.31685 \times 31536000}$</td>
</tr>
<tr>
<td>Grams (g) to nanograms (ng)</td>
<td>$=10^9$</td>
</tr>
<tr>
<td>Nanograms (ng) to grams (g)</td>
<td>$=10^{-9}$</td>
</tr>
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</table>

Abbreviations used in calculation formulas:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Total mercury concentration (ng/L)</td>
</tr>
<tr>
<td>Q</td>
<td>Flow (L/yr)</td>
</tr>
<tr>
<td>L</td>
<td>Load (g/yr)</td>
</tr>
<tr>
<td>BG</td>
<td>Background</td>
</tr>
<tr>
<td>EC</td>
<td>Existing conditions</td>
</tr>
<tr>
<td>OC</td>
<td>Operating conditions</td>
</tr>
<tr>
<td>RO</td>
<td>Runoff</td>
</tr>
<tr>
<td>NCRO</td>
<td>non-contact stormwater runoff</td>
</tr>
<tr>
<td>BGRO</td>
<td>background stormwater runoff</td>
</tr>
<tr>
<td>GW</td>
<td>Groundwater</td>
</tr>
<tr>
<td>WWTS</td>
<td>Waste Water Treatment System</td>
</tr>
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</table>
Calculation formulas:

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load ((g/yr))</td>
<td>(L = Q \times C \times 10^{-9}) &lt;br&gt;10(^{-9}) is the conversion factor between nanograms and grams</td>
</tr>
<tr>
<td>Runoff Mercury Concentration ((ng/L))</td>
<td>(C_{RO} = (L_{EC} - L_{seepage} - L_{GW}) \div Q_{RO})</td>
</tr>
<tr>
<td>Operating Conditions Load at TC-1a and PM-11 ((g/yr))</td>
<td>(L_{OC} = L_{WWTS} + L_{NCRO} + L_{BGRO})</td>
</tr>
<tr>
<td>Operating Conditions Load at SW004a ((g/yr))</td>
<td>(L_{SW004a} = L_{Mine Site GW} + L_{BG GW} + L_{NCRO} + L_{BGRO})</td>
</tr>
<tr>
<td>Operating Conditions Load at Station 04016000 ((g/yr))</td>
<td>(L_{04016000} = L_{Mine Site} + L_{BG} + L_{SD026} - L_{Colby Lake Pumping})</td>
</tr>
<tr>
<td>Operating Conditions Load at Stations EP-1 and EP-2 ((g/yr))</td>
<td>(L_{EP1, EP2} = L_{Project-PM-13} + L_{Project-04016000} + L_{BG})</td>
</tr>
<tr>
<td>Change in Load due to Project Operations ((g/yr))</td>
<td>(L_{change} = L_{OC} - L_{EC})</td>
</tr>
<tr>
<td>Mercury Concentration ((ng/L))</td>
<td>(C = L \div Q \times 10^9) &lt;br&gt;10(^9) is the conversion factor between grams and nanograms</td>
</tr>
</tbody>
</table>
Appendix B

Zero-Discharge Demonstration
Technical Memorandum

To: Christie Kearney and Jennifer Saran, Poly Met Mining, Inc.
From: Cory Anderson and Melisa Pollak, Barr Engineering Co.
Subject: Application of the New Source Performance Standards “Zero Discharge” Standard (40 CFR § 440.104) to the NorthMet Project
Date: August 25, 2017
Project: 23/69-0862.00

1.0 Introduction

This memorandum evaluates whether the proposed NorthMet Project (Project) as currently planned can comply with the discharge requirements of the Clean Water Act (CWA) New Source Performance Standard (NSPS) for the ore mining and dressing point source category applicable to new copper processing facilities (40 C.F.R. 440.104(b)(1))—referred to as the "zero discharge" standard. Specifically, this memorandum considers whether or not the volume of water to be discharged from the proposed Waste Water Treatment System (WWTS) is expected to exceed the volume allowed under the NSPS. Barr concludes that the WWTS discharge will not exceed this volume limitation.

This memorandum summarizes the relevant law and facts, then presents the technical analysis supporting Barr’s conclusion that the Project can comply with the NSPS. The memorandum employs terms for various types of water associated with the Project that are specifically defined in Poly Met Mining, Inc.’s (PolyMet) application for a National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) permit for the Project. Italicized terms are defined in Table 1-1 of Volume I of the NorthMet NPDES/SDS Permit Application. Additionally, the term “Flotation Tailings Basin” (FTB) refers to the proposed NorthMet Flotation Tailings Basin, which will be newly constructed atop the existing former LTV Steel Mining Company (LTVSMC) tailings basin. The term “Tailings Basin” refers more generally to the combined LTVSMC tailings basin and the FTB.

Barr understands that PolyMet plans to obtain NPDES/SDS permit coverage starting approximately 2 years before mine operations begin, to allow for the construction of the Project, which is expected to take 18-24 months. In this case, Mine Year 1 will be the third year of NPDES/SDS permit coverage.
2.0 Legal Basis

The proposed NorthMet discharge will be subject to the CWA’s NSPS for the new copper mills and set forth in 40 CFR § 440. The applicable regulations and guidelines of the U. S. Environmental Protection Agency (USEPA) set forth a general prohibition against discharging process wastewater to waters of the United States from new mills that use the froth-flotation process for the beneficiation of copper, lead, zinc, gold, silver, and molybdenum ores (40 CFR § 440.104(b)(1)). While this general prohibition is referred to as the "zero discharge" standard, the applicable law includes exceptions that allow a certain volume of discharge to account for specific conditions and does not prohibit discharge of mine drainage. This zero-discharge standard is based upon the USEPA assessment that total recycling of process wastewater at froth-flotation plants is a demonstrated and feasible technology.

The terms "process wastewater" and "mine drainage" are specifically defined for the NSPS, and associated USEPA guidance provides additional insight on these terms. Table 1 provides these definitions and shows the corresponding NorthMet flows using the water terminology definitions for the NPDES/SDS Permit Application.

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1 See 40 CFR § 440.104(b)(1) (prohibiting the discharge of process wastewater to “navigable waters”) and 40 CFR § 401.11(l) (defining “navigable waters” as “waters of the United States, including the territorial seas”). Section 401.11(l) also provides the lengthy definition of “waters of the United States.” This memorandum assumes that the Project receiving waters are “waters of the United States.”

2 "Mill" is defined as “a preparation facility within which the metal ore is cleaned, concentrated, or otherwise processed before it is shipped to the customer, refiner, smelter, or manufacturer. A mill includes all ancillary operations and structures necessary to clean, concentrate, or otherwise process metal ore, such as ore and gangue storage areas and loading facilities.” (40 CFR § 440.132(f)) The Beneficiation Plant falls within this definition.

3 40 CFR §§ 440.100 to 440.105. The standards for new sources in this category are set forth in 40 CFR § 440.104. In the relevant part, the NSPS applies to: (a) mines that produce copper, lead, zinc, gold, silver, or molybdenum bearing ores, or any combination of these ores from open-pit or underground operations other than placer deposits; and (b) mills that use the froth-flotation process alone or in conjunction with other processes, for the beneficiation of copper, lead, zinc, gold, silver, or molybdenum ores, or any combination of these ores. 40 CFR § 440.100(a).

4 USEPA, Proposed Ore Mining and Dressing Point Source Category Rule, 47 Fed. Reg. 25682, 25716 (Monday, June 14, 1982). In this preamble and in the zero-discharge standard itself, USEPA notes the agency’s understanding that the zero-discharge standard could result in an increase of discharges to other media. See 40 CFR § 440.104(b)(1).
Table 1 Correlation of Water Terminology Between NSPS and NorthMet NPDES/SDS Application

<table>
<thead>
<tr>
<th>NSPS term</th>
<th>NSPS definition</th>
<th>Corresponding NorthMet flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process wastewater</td>
<td>“Any water which, during manufacturing or processing, comes into direct contact</td>
<td>Process water</td>
</tr>
<tr>
<td></td>
<td>with or results from the production or use of any raw material, intermediate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>product, finished product, by-product, or waste product.” 40 CFR § 401.11(q)</td>
<td></td>
</tr>
<tr>
<td>Mine drainage</td>
<td>“Any water drained, pumped, or siphoned from a mine.” 40 CFR § 440.132(h)</td>
<td>Mine water</td>
</tr>
</tbody>
</table>

As noted, the zero-discharge standard for process wastewater from new copper mills is subject to certain exceptions, two of which are relevant to the Project:

1. **Net precipitation can be discharged.** A volume of water may be discharged equal to the annual net precipitation (precipitation minus evaporation) falling on the treatment facility and on the area contributing runoff to the treatment facility.\(^5\)

2. **Combined waste streams that include process wastewater can be discharged, subject to limitations.** Process wastewater can be discharged when it has been combined with other waste streams, such as mine drainage, that are not subject to the zero discharge standard. The volume and concentration of the combined discharge, however, may not exceed the volume and concentration of the allowable discharge of the other waste streams, and the combined discharge is subject to the NSPS effluent limitations for mine drainage.\(^6\)

\(^5\) 40 CFR § 440.104(b)(2). “Treatment facility” is not defined, but USEPA’s preamble to the regulations make clear that USEPA views a tailings basin as a treatment facility.

\(^6\) 40 CFR § 440.131(a). This provision provides: “In the event that waste streams from various subparts or segments of subparts in part 440 are combined for treatment and discharge, the quantity and concentration of each pollutant or pollutant property in the combined discharge that is subject to effluent limitations shall not exceed the quantity and concentration of each pollutant or pollutant property that could have been discharged had each waste stream been treated separately. In addition, the discharge flow from the combined discharge shall not exceed the volume that could have been discharged had each waste stream been treated separately.”

Notably, USEPA’s preamble and Development Document for the Ore Dressing NSPS addressed the Combined Waste Stream Provision in response to a commenter’s question involving a situation almost identical to PolyMet’s: whether mine drainage commingled with the process wastewater from a new froth flotation mill is subject to the zero-discharge requirements for new froth flotation mills. USEPA concluded that the mine drainage would not be subject to the zero discharge standard, even though the discharge would technically contain some process wastewater. In addition, USEPA noted that (a) the combined waste stream discharge would be subject to the effluent limitations for the mine drainage, and (b) the volume of the discharge could not exceed the volume of mine drainage that would have been discharged had the mine drainage and the mill discharge been treated separately. USEPA also clarified that it was immaterial “whether the mine drainage is introduced to the treatment system simultaneously with the discharge from the mill, e.g., two separate pipes leading to the tailings pond, or whether the mine drainage is introduced as part of the feed water and intake to the mill itself.” See USEPA, Office of Water, Development Document for Final Effluent Limitations, Guidelines and New Source Performance Standards for the ore Mining and Dressing Category 507 (Development Document) (Reference (5)); 47 Fed. Reg. 5498, 54604 (Dec. 3, 1982) (Reference (4)).
The NSPS set forth in 40 CFR § 440 does not establish timeframes for calculating either allowable discharge or actual discharge for purposes of the zero discharge standard. PolyMet proposes that the NPDES/SDS permit adopt a multi-year approach for calculating these volumes so as to take into account timing considerations relative to variability in weather conditions and timeframes for water treatment.

3.0 Overview of NorthMet Flows Relevant to the “Zero Discharge” Standard

The Project will generate process wastewater in the Beneficiation Plant, but the discharge to the environment will occur later as treated effluent from the WWTS. In between these steps, the process wastewater will be managed within the Tailings Basin. The link between process wastewater and discharge, illustrated in Figure 1, involves the following processes:

- The overall Project water management strategy will involve pumping treated mine drainage to the FTB to serve as process water for the Beneficiation Plant. Process wastewater from the Plant will be recycled back to the FTB Pond, where it will mix with mine drainage and other waste streams. Tailings basin water will be a “combined waste stream” (40 CFR § 440.131(a)).
- Some tailings basin water will infiltrate and migrate to the toes of the Tailings Basin dams as tailings basin seepage. PolyMet will install FTB seepage capture systems around the Tailings Basin that are designed to capture the tailings basin seepage.
- There will be a delay between the time water enters the FTB and the time that resulting seepage reports to the FTB seepage capture systems. GoldSim modeling for the Final Environmental Impact Statement (FEIS) indicates the time delay will be at least seven years.
- Tailings basin seepage captured by the FTB seepage capture systems will either be recycled to the FTB Pond or pumped to the WWTS for treatment. PolyMet will determine how much seepage to recycle back to the FTB Pond, and how much to send to the WWTS for treatment and discharge, based on factors such as weather, operational needs, FTB size, and regulatory and augmentation requirements (such as the zero discharge standard and the need to avoid hydrologic impacts to Second Creek, Trimble Creek, and Unnamed Creek).
- WWTS discharge, which will consist primarily of treated tailings basin seepage, will be conveyed to the headwater areas of Trimble Creek, Unnamed Creek, and Second Creek.
Figure 1  Overview of NorthMet Project Flows Relevant to NSPS Zero-Discharge Standard

4.0  Technical Analysis

The Plant Site GoldSim model developed for the FEIS (Reference (1)) was used as the starting point for analysis of the Project’s ability to comply with the zero-discharge standard.

4.1  Calculating the “Allowable Discharge Volume”

Based on the Project-specific flows and applicable exceptions to the “zero discharge” standard described in Section 2.0, the volume that the Project may discharge can be calculated as the sum of 1) net precipitation and runoff over the Tailings Basin, and 2) the volume of other waste streams combined with process wastewater.

4.1.1  Net Precipitation

Net precipitation includes precipitation minus evaporation over the area of the Tailings Basin plus runoff into the Tailings Basin, runoff from the exterior slopes of the dams, and runoff from the small watershed area between the toes of the dams and the FTB seepage capture system. Net precipitation over other portions of the Plant Site is not included. Net precipitation will change as the FTB is expanded during operations. Areas included in net precipitation for the zero-discharge analysis are illustrated for Mine Year 11 in Figure 2 and described in the following paragraphs. Further details on the numeric values for each area are provided in Attachment B of Reference (1).

For the zero-discharge analysis, the areas used to calculate the precipitation inflow volume are the areas of exposed tailings in Cell 2W, Cell 2E, and Cell 1E, the areas of the north, east, and south beaches, the areas of the north, south, and east dams, the areas of the north and south buttresses, the area of the FTB Pond, and the area of the pond in Cell 1E (for Mine Years 1 through 7; after Mine Year 7, the FTB Pond...
combines with the Cell 1E Pond). The rate of precipitation times the total sum of the areas is the total precipitation inflow rate. Run-on flows are from watershed areas contributing to Cell 1E and to Cell 2E, and the small watershed areas between the toes of the dams and the FTB Seepage Containment System.

Evaporation losses were calculated in a manner consistent with the FEIS GoldSim model for the Project (Reference (1)). Because the evaporation rate (depth over time) from each area is unique, the volumetric evaporation rates were summed from each of the same areas listed in the preceding paragraph.

Figure 2   Areas Used to Calculate Net Precipitation for the Zero Discharge Analysis
4.1.2 Combined Waste Streams

Waste streams combined with process wastewater in the FTB Pond will originate from six sources, but of these waste streams, PolyMet proposes to count only mine drainage toward the allowable discharge. Because of the extensive water recycling that is planned, recirculated flows are excluded to avoid "double counting" in a way that would increase the calculated allowable discharge volume. Also for simplicity, PolyMet is excluding from its calculation certain de minimis additions to the FTB that are exempt from the zero discharge standard. The waste streams that will be combined with process wastewater in the FTB Pond, and their approximate flow in Mine Year 10, are presented in Table 2. The table also identifies whether PolyMet will count these flows toward the allowable discharge. Additional detail on the flows included in treated mine drainage is presented in Section 6.1 of the NorthMet Project Water Modeling Data Package Volume 1 – Mine Site (Reference (2)).

Table 2 Waste Streams Combined with Process Wastewater in the FTB Pond

<table>
<thead>
<tr>
<th>Waste stream combined with process wastewater</th>
<th>Approximate annual P50 flow Mine Year 10(1)</th>
<th>Count toward allowable discharge?</th>
</tr>
</thead>
<tbody>
<tr>
<td>treated mine drainage (i.e., mine water) which includes treated reject concentrate from WWTS</td>
<td>1,750 gpm</td>
<td>Yes. Less the volume of treated reject concentrate</td>
</tr>
<tr>
<td>mine drainage from Construction Mine Water Basin (i.e., construction mine water and OSLA runoff)</td>
<td>30 gpm</td>
<td>Yes.</td>
</tr>
<tr>
<td>treated reject concentrate</td>
<td>118 gpm</td>
<td>No. Not included to avoid double counting.</td>
</tr>
<tr>
<td>tailings basin seepage</td>
<td>1,170 gpm</td>
<td>No. Not included to avoid double counting.</td>
</tr>
<tr>
<td>backwash waste from the WWTS</td>
<td>150 gpm</td>
<td>No. Not included to avoid double counting.</td>
</tr>
<tr>
<td>treated sewage</td>
<td>20 gpm</td>
<td>No. Not included for simplicity in reporting</td>
</tr>
</tbody>
</table>

(1) Flows are based on the 50th percentile (P50) flows from the FEIS GoldSim model (Section 6.1 of Reference (1))

4.1.3 Allowable Discharge Equation for Zero-Discharge Analysis

Based on the analysis above, for reporting and modeling with respect to the zero-discharge standard, the allowable discharge is calculated as follows:

\[
\text{Allowable Discharge} = \text{net precipitation} + \text{mine drainage}^7 - \text{WWTS reject concentrate}
\]

---

7 The sum of the flow from the Construction Mine Water Basin to the FTB and the treated mine water from the WWTS to the FTB.
Figure 3 illustrates the Project flows relevant to calculation of the maximum allowable discharge permitted under the zero-discharge standard, and also indicates which flows are included in PolyMet’s allowable discharge equation for purposes of the Project.

**Figure 3  NorthMet Flows for Calculation of Allowable Discharge**

### 4.2 Evaluating Compliance with Zero Discharge Requirements

Because the allowable discharge equation includes the volume of net precipitation, the calculation for the amount of allowable discharge is weather-dependent. Specifically, the allowable discharge value will be smaller in dry years than in wet years.

The actual discharge from the WWTS is also weather-dependent. The actual amount the Project will discharge is determined by the amount of tailings basin seepage captured by the F TB seepage capture systems, minus the amount of captured seepage that is recycled to the F TB rather than sent to the WWTS.
for treatment. Precipitation in a given year will affect actual discharge in subsequent years in two ways. First, an extended period of wet weather will result in additional infiltration, resulting in additional *tailings basin seepage* captured at the toe of the basin later. Second, when the water level in the FTB Pond is at the top of the design range, there will be less capacity to return captured *tailings basin seepage* to the FTB Pond.

The following analysis was conducted to determine how a range of weather conditions will affect both the allowable discharge and the actual discharge.

### 4.2.1 Zero-Discharge Modeling Method

The Plant Site GoldSim model developed for the FEIS was adapted for permitting to simulate the scenario in which the Mine Site and Plant Site experience a range of climatic conditions simultaneously. In the FEIS Project model, precipitation and evaporation were input into each model (Plant Site and Mine Site) as independent probabilistic variables, using a probability distribution based on the most recent climate normal period (1981-2010). The FEIS Mine Site model results defined a probabilistic range of flows from the Mine Site to the Plant Site, as an input for the Plant Site model.

For the zero-discharge modeling described in this memorandum, the Plant Site model was adapted to link net precipitation between the Plant Site and Mine Site. The Plant Site model was modified to correlate the amount of treated mine drainage received at the Plant Site (from the Mine Site) to the precipitation at the Plant Site. Specifically, the flow from the Mine Site to the Plant Site was perfectly correlated (value of 1.0) to the randomly generated precipitation in the Plant Site model. Therefore, for a year with a high rainfall amount, an equally high flow amount from the Mine Site was delivered to the Plant Site in the model, and vice-a-versa for low rainfall amounts.

Zero-discharge modeling for permitting was conducted using the adapted Plant Site model as follows:

- 500 model realizations were run of the period from Mine Year 1 through Mine Year 20. For each year, in each realization, the model randomly selected an annual precipitation value from a probability distribution derived from the most recent climate normal period (1980-2010).
- The allowable discharge was calculated within GoldSim using the formula shown in Section 4.1.3 at each monthly time step and for each of the 500 model realizations.
- The WWTS discharge was calculated within GoldSim, using the same conditions used for the FEIS, which set the minimum discharge volume at 1,700 gpm (based on the stream augmentation target) and the maximum discharge volume at 3,600 ppm (based on the maximum capacity of the WWTS). There was no change to the calculation method used for the FEIS; however, the monthly results differed slightly from the FEIS results because of the modeling change to link precipitation at the Mine and Plant Sites.
- For each monthly time step and each realization, the allowable discharge, the actual discharge, and the corresponding precipitation were exported from GoldSim into an Excel spreadsheet.
The exported monthly results of the allowable discharge, the actual discharge, and the precipitation were further condensed into annual averages within Excel. This step created 500 realizations of annual results for each Mine Year.

4.2.2 Results

4.2.2.1 Allowable Discharge

Allowable discharge will increase when precipitation increases and as the sizes of the three mine pits and the FTB increase, as summarized in Table 3 and as shown in Figure 4 (Mine Year 1), Figure 5 (Mine Year 5), and Figure 6 (Mine Year 10).

Table 3 Allowable Discharge as a Function of Precipitation (gpm)

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Mine Year 1</th>
<th>Mine Year 5</th>
<th>Mine Year 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th percentile (22.9 in)</td>
<td>1,780</td>
<td>2,320</td>
<td>2,340</td>
</tr>
<tr>
<td>50th percentile (27.8 in)</td>
<td>2,460</td>
<td>2,980</td>
<td>3,260</td>
</tr>
<tr>
<td>90th percentile (33.5 in)</td>
<td>3,140</td>
<td>3,740</td>
<td>4,180</td>
</tr>
</tbody>
</table>
To: Christie Kearney and Jennifer Saran, Poly Met Mining, Inc.
From: Cory Anderson and Melisa Pollak, Barr Engineering Co.
Subject: Application of the New Source Performance Standards “Zero Discharge” Standard (40 CFR § 440.104) to the NorthMet Project
Date: August 25, 2017
Page: 11

Figure 4  Allowable Discharge as a Function of Annual Precipitation, Mine Year 1
Figure 5  Allowable Discharge as a Function of Annual Precipitation, Mine Year 5
Figure 6  Allowable Discharge as a Function of Annual Precipitation, Mine Year 10
4.2.2.2 Comparison of Allowable Discharge and Actual Discharge

Barr compared the modeled allowable and actual discharge in several ways: 1) annual averages; 2) cumulative totals; 3) probability that actual discharge will exceed the allowable discharge calculated with a one-year carry-over; and 4) probability that actual discharge will exceed the allowable discharge calculated as a five-year rolling average.

On an average annual basis, the actual discharge was estimated to be less than the allowable discharge in Mine Years 1 through 10, as shown in Figure 7.

![Figure 7: Allowable Discharge Compared to Actual Discharge: Estimated Annual Averages](image)

On a cumulative basis, the total actual discharge volume was calculated to be less than the total allowable discharge volume over the life of the Project. Cumulatively, over the first five years of mining operations (approximately the first seven years of NPDES permit coverage), the actual discharge volume averaged 64% of the allowable discharge volume. Over the 20-year operating life of the Project, the estimated actual discharge volume averaged 77% of the allowable discharge volume. Figure 8 shows the relationship between the calculated actual and allowable discharge volumes, cumulatively through Mine Year 5 and through Mine Year 20, based on the results of the Plant Site GoldSim model as adapted for permitting analysis of the zero discharge standard. The results indicated that given the full range of precipitation included in the most recent climate normal period, the Project can comply with zero discharge requirements.
The probability that actual discharge will exceed the allowable discharge also can be assessed over a specified time frame. As previously discussed, the NSPS set forth in 40 CFR § 440 does not establish timeframes for calculating either allowable discharge or actual discharge for purposes of the zero discharge standard. PolyMet proposes that the NPDES/SDS permit adopt a multi-year approach for calculating these volumes so as to take into account timing considerations relative to variability in modeled weather conditions and timeframes for treatment of process water. Results are presented below for two different multi-year approaches: with a one-year carry-over and as a five-year rolling average.

Table 4 shows the probability of the actual discharge WWTS exceeding the allowable discharge, calculated with a one-year carry-over, using two assumptions about stream augmentation:

- Stream augmentation minimum discharge set at 1,700 gpm, based on stream augmentation goals from the Water Appropriation permitting process
- No stream augmentation minimum discharge rate
Table 4  Probability of the Actual WWTS Discharge Exceeding the Allowable Discharge, Calculated With a One-Year Carry-Over

<table>
<thead>
<tr>
<th>NPDES/SDS Permit Year</th>
<th>Probability of exceedance with stream augmentation minimum discharge set at 1,700 gpm</th>
<th>Probability of exceedance with no stream augmentation minimum discharge rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>4</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>5</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>6</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>7</td>
<td>0.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>8</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>9</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>10</td>
<td>0.2%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Calculated as a five-year rolling average, the Project can comply with NSPS zero discharge requirements while providing a minimum of 1,700 gpm for stream augmentation over the range of modeled weather conditions. Figure 9 and Figure 10 show estimated actual versus allowable discharge in Mine Years 5 and 10, calculated as 5-year rolling averages.
To: Christie Kearney and Jennifer Saran, Poly Met Mining, Inc.
From: Cory Anderson and Melisa Pollak, Barr Engineering Co.
Subject: Application of the New Source Performance Standards “Zero Discharge” Standard (40 CFR § 440.104) to the NorthMet Project
Date: August 25, 2017
Page: 17

Figure 9  Estimated Actual Versus Allowable Discharge, Mine Year 5, 5-Year Rolling Average

Figure 10  Estimated Actual Versus Allowable Discharge, Mine Year 10, 5-Year Rolling Average
Barr also qualitatively considered potential effects of climate change on PolyMet’s ability to comply with zero discharge requirements. During the environmental review process, PolyMet conducted sensitivity analysis to determine potential effects of climate change on flows from the Project. The GoldSim Plant Site model was run during environmental review using increased values of mean annual temperature, mean annual precipitation, and mean annual open water evaporation (Section 6.1 of Reference (3)). Results showed that tailings basin seepage at the toes of the Tailings Basin is expected to increase slightly due to the increase in infiltration throughout the Tailings Basin; the total increased tailings basin seepage flow due to climate change as specified for the FEIS sensitivity analysis, would be about 60 gallons per minute (Reference (3)). This would represent an approximately 1.4% increase in seepage flow during Mine Year 10. Because the zero-discharge standard allows discharge of the volume of net precipitation, the projected increase in annual average precipitation is not expected to affect PolyMet’s ability to comply with the “zero discharge” standard.

5.0 Conclusion

The USEPA’s NSPS under the CWA contain a general prohibition against discharging process wastewater to waters of the United States from new mills that use the froth-flotation process for the beneficiation of copper, lead, zinc, gold, silver, and molybdenum ores (40 CFR § 440.104(b)(1)). While this general prohibition is referred to as the zero discharge standard, the applicable law includes certain exceptions that allow a certain volume of discharge to account for specific conditions and does not prohibit discharge of mine drainage. The NorthMet Beneficiation Plant and WWTS discharge, as proposed by PolyMet, can comply with this zero discharge standard.

As outlined above, modeling demonstrated that the Project will discharge less than the allowed amount of process wastewater during the first 5 years of operations (approximately the first 7 years of NPDES/SDS permit coverage) as well as over its 20-year operating life. Further, the modeled results showed that there is a greater than 99% likelihood that the Project will comply with both stream augmentation goals and zero discharge requirements for the full range of modeled weather conditions over the first 10 years of NPDES/SDS Permit coverage, when calculated with a one-year carry-over, and a 100% likelihood of complying with both when calculated as a five-year rolling average. Possible future climate trends toward increased precipitation during the life of the Project are not expected to affect compliance, because the zero discharge standard allows discharge of net precipitation. Therefore, Barr concludes that the Project, as currently planned, can comply with the NSPS zero discharge standard.
6.0 References


Appendix C

Waste Water Treatment System Terminology Changes
Appendix C  Waste Water Treatment System Terminology Changes

Some terminology associated with the Waste Water Treatment System (WWTS) has changed since the environmental review process was completed and the NPDES/SDS Permit Application was submitted in July 2016. Changes are associated with the relocation of the mine water treatment trains that were previously planned for the Mine Site Waste Water Treatment Facility (WWTF), which will now be in the Plant Site WWTS, and the relocation of the Mine Site equalization basins, Central Pumping Station (CPS), and Construction Mine Water Basin south of Dunka Road. There is no change to the level of treatment planned for the Project as a result of these relocations.

To facilitate the review of documents prepared for the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) which are also referenced in this NPDES/SDS Permit Application, the following table explains WWTS terminology changes.

<table>
<thead>
<tr>
<th>Former Name</th>
<th>New Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Water Treatment Plant (WWTP) and Waste Water Treatment Facility (WWTF)</td>
<td>Waste Water Treatment System (WWTS)(1)</td>
</tr>
<tr>
<td>Treated Water Pipeline</td>
<td>As a whole:</td>
</tr>
<tr>
<td></td>
<td>• Mine to Plant Pipelines (MPP)</td>
</tr>
<tr>
<td></td>
<td>Three individual pipes:</td>
</tr>
<tr>
<td></td>
<td>• Construction Mine Water Pipeline</td>
</tr>
<tr>
<td></td>
<td>• Low Concentration Mine Water Pipeline</td>
</tr>
<tr>
<td></td>
<td>• High Concentration Mine Water Pipeline</td>
</tr>
<tr>
<td>Construction Mine Water Basin</td>
<td>Construction Mine Water Basin</td>
</tr>
<tr>
<td>West Equalization Basin</td>
<td>High Concentration Equalization Basin (HCEQ Basin)</td>
</tr>
<tr>
<td>East Equalization Basin 1</td>
<td>Low Concentration Equalization Basin 1 (LCEQ Basin 1)</td>
</tr>
<tr>
<td>East Equalization Basin 2</td>
<td>Low Concentration Equalization Basin 2 (LCEQ Basin 2)</td>
</tr>
<tr>
<td>WWTP effluent (discharged to receiving waters)</td>
<td>WWTS discharge</td>
</tr>
<tr>
<td>WWTF effluent (sent to the FTB via the Central Pumping Station)</td>
<td>Treated mine water(3) (WWTS stream pumped to the FTB)</td>
</tr>
<tr>
<td>Treated mine water(2)</td>
<td>Treated mine water(3)</td>
</tr>
<tr>
<td>Central Pumping Station</td>
<td>Central Pumping Station</td>
</tr>
<tr>
<td>--</td>
<td>Equalization Basin Area(4)</td>
</tr>
<tr>
<td>Splitter Structure</td>
<td>This structure will be integrated into the Central Pumping Station.</td>
</tr>
<tr>
<td>Central Pumping Station (CPS) Pond</td>
<td>This pond no longer exists.</td>
</tr>
</tbody>
</table>

(1) The two sets of treatment trains that were previously at two locations will now be housed under one roof at the Plant Site.
(2) “Treated mine water” formerly included WWTF effluent, OSLA runoff, and construction mine water and was all sent to the FTB.
(3) “Treated mine water” now consists of effluent from the chemical precipitation and membrane filtration portion of the WWTS that are sent to the FTB.
(4) New term describing pond area south of Dunka Road.
Appendix D

Waste Water Treatment System Permit Application Support Drawings
Appendix E

Chemical Additives Safety Data Sheets
Appendix E
Chemical Additives Safety Data Sheets
July 2016

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Carbon Dioxide ........................................................................................................ E-25
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NLR 505 .................................................................................................................... E-77
Hydrochloric Acid ....................................................................................................... E-83
Hydrated Lime ........................................................................................................... E-92
Ferric Sulfate ............................................................................................................ E-101
MetClear MR2405 ................................................................................................... E-107
1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: NALCLEAR® 8173 P
APPLICATION: WATER CLARIFICATION AID
COMPANY IDENTIFICATION: Nalco Company
1601 W. Diehl Road
Naperville, Illinois
60563-1198
EMERGENCY TELEPHONE NUMBER(S): (800) 424-9300 (24 Hours) CHEMTREC

NFPA 704M/HMIS RATING
HEALTH: 0 / 1 FLAMMABILITY: 1 / 1 INSTABILITY: 0 / 0 OTHER:
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme * = Chronic Health Hazard

2. COMPOSITION/INFORMATION ON INGREDIENTS

Based on our hazard evaluation, none of the substances in this product are hazardous.

3. HAZARDS IDENTIFICATION

**EMERGENCY OVERVIEW**

CAUTION
May cause irritation with prolonged contact.
Do not get in eyes, on skin, on clothing. Do not take internally. Do not breathe dust. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of soap and water. Avoid generating dusts.
Wear suitable protective clothing.
May form explosive dust-air mixtures. Handling operations may generate combustible dust in the finely divided and suspended state. To reduce the potential for dust explosions and/or fire, do not permit dust to accumulate. Empty product containers may contain product residue. Do not pressurize, cut, heat, weld, or expose containers to flame or other sources of ignition. May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) under fire conditions.

PRIMARY ROUTES OF EXPOSURE:
Eye, Skin, Inhalation

HUMAN HEALTH HAZARDS - ACUTE:

EYE CONTACT:
May cause irritation with prolonged contact.

SKIN CONTACT:
May cause irritation with prolonged contact.
INGESTION:
Not a likely route of exposure. May be harmful if swallowed.

INHALATION:
If dust is generated, can cause mucous membrane irritation. A single brief inhalation exposure (minutes) is not likely to cause serious effects.

SYMPTOMS OF EXPOSURE:
Acute:
A review of available data does not identify any symptoms from exposure not previously mentioned.
Chronic:
A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS:
A review of available data does not identify any worsening of existing conditions.

HUMAN HEALTH HAZARDS - CHRONIC:
No adverse effects expected other than those mentioned above.

4. FIRST AID MEASURES

EYE CONTACT:
Immediately flush eye with water for at least 15 minutes while holding eyelids open. Get immediate medical attention.

SKIN CONTACT:
Immediately wash with plenty of soap and water. Remove contaminated clothing. Wash off affected area immediately with soap and plenty of water. If skin irritation persists, obtain medical attention.

INGESTION:
Do not induce vomiting without medical advice. If conscious, washout mouth and give water to drink. Get medical attention.

INHALATION:
Remove to fresh air, treat symptomatically. Get medical attention.

NOTE TO PHYSICIAN:
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

5. FIRE FIGHTING MEASURES

FLASH POINT: None
LOWER EXPLOSION LIMIT: Not flammable
UPPER EXPLOSION LIMIT: Not flammable
SAFETY DATA SHEET

PRODUCT
NALCLEAR® 8173 P

EMERGENCY TELEPHONE NUMBER(S)
(800) 424-9300 (24 Hours) CHEMTREC

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS:
Ensure adequate ventilation. Eliminate ignition sources. Remove sources of ignition.

METHODS FOR CLEANING UP:
Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations). Clean up promptly by scoop or vacuum.

ENVIRONMENTAL PRECAUTIONS:
Do not contaminate surface water. If drains, streams, soil or sewers become contaminated, notify local authority.

7. HANDLING AND STORAGE

HANDLING:
Wash thoroughly with soap and water or shower after handling. Do not take internally. Empty product containers may contain product residue. Do not pressurize, cut, heat, weld, or expose containers to flame or other sources of ignition. Do not use, store, spill or pour near heat, sparks or open flame. Avoid generating dusts. Maintain good housekeeping practices.

STORAGE CONDITIONS:
Store separately from oxidizers. Store in suitable labeled containers. Keep in dry place. Store the containers tightly closed. Store away from heat and sources of ignition. Connections must be grounded to avoid electrical charges.

SUITABLE CONSTRUCTION MATERIAL:
Compatibility with Plastic Materials can vary; we therefore recommend that compatibility is tested prior to use.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:
Exposure guidelines have not been established for this product. Available exposure limits for the substance(s) are shown below.
ACGIH/TLV:

<table>
<thead>
<tr>
<th>Substance(s)</th>
<th>Respiration (Total)</th>
<th>TWA: 3 mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration</td>
<td>Inhalable (Total)</td>
<td>TWA: 10 mg/m³</td>
</tr>
<tr>
<td>Particulates</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OSHA/PEL:

<table>
<thead>
<tr>
<th>Substance(s)</th>
<th>Respiration (Total)</th>
<th>TWA: 5 mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ENGINEERING MEASURES:
General ventilation is recommended. Local exhaust ventilation may be necessary when dusts or mists are generated.

RESPIRATORY PROTECTION:
Respiratory protection is not normally needed. If dusts are generated, use an approved air-purifying respirator. A dust respirator may be used.

HAND PROTECTION:
When handling this product, the use of chemical gloves is recommended. The choice of work glove depends on work conditions and what chemicals are handled. Please contact the PPE manufacturer for advice on what type of glove material may be suitable. Gloves should be replaced immediately if signs of degradation are observed.

SKIN PROTECTION:
Wear impervious apron and boots.

EYE PROTECTION:
Wear chemical splash goggles.

HYGIENE RECOMMENDATIONS:
Use good work and personal hygiene practices to avoid exposure. Keep an eye wash fountain available. Keep a safety shower available. If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse. Always wash thoroughly after handling chemicals. When handling this product never eat, drink or smoke.

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Physical State</th>
<th>Powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>White</td>
</tr>
<tr>
<td>Odor</td>
<td>Slight</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>44 lb/ft³</td>
</tr>
<tr>
<td>Solubility in Water</td>
<td>Complete</td>
</tr>
<tr>
<td>pH (0.5 %)</td>
<td>7 - 9</td>
</tr>
</tbody>
</table>
Note: These physical properties are typical values for this product and are subject to change.

10. STABILITY AND REACTIVITY

STABILITY:
Stable under normal conditions.

HAZARDOUS POLYMERIZATION:
Hazardous polymerization will not occur.

CONDITIONS TO AVOID:
Moisture, Heat, and sources of ignition including static discharges. Avoid generating dusts.

MATERIALS TO AVOID:
Contact with strong oxidizers (e.g., chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.

HAZARDOUS DECOMPOSITION PRODUCTS:
Under fire conditions: Oxides of carbon, Oxides of nitrogen, Oxides of sulfur

11. TOXICOLOGICAL INFORMATION

The following results are for the product.

ACUTE ORAL TOXICITY:
Species: Rat
LD50: > 5,000 mg/kg
Test Descriptor: Product

SENSITIZATION:
This product is not expected to be a sensitizer.

CARCINOGENICITY:
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION:
Based on our hazard characterization, the potential human hazard is: Low

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS:
The tests for (products or similar products) were performed in clean water as set forth by USEPA (EPA/600/4-90/027). In order to evaluate the potential toxicity mitigation, the tests for (representative polymers) were performed in
environmentally relevant water with dissolved organic carbon (DOC: 4.5 mg/l). The toxicity of this product is due to an external mode of action, e.g., suffocation or immobilization. In the presence of suspended material, e.g., DOC, the polymers are bound to suspended material and the bioavailability is substantially reduced. As a result, the toxicity is expected to be lower. Under normal use and discharge conditions, the LC50 values of the representative polymers tested in the presence of DOC are expected to apply to this product. However, for large spills, the clean water data is more applicable.

**ACUTE FISH RESULTS:**

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure</th>
<th>LC50</th>
<th>Test Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fathead Minnow</td>
<td>96 hrs</td>
<td>&gt; 1,000 mg/l</td>
<td>Product</td>
</tr>
<tr>
<td>Bluegill Sunfish</td>
<td>96 hrs</td>
<td>&gt; 100 mg/l</td>
<td>Product</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>96 hrs</td>
<td>&gt; 100 mg/l</td>
<td>Product</td>
</tr>
<tr>
<td>Zebra Danio</td>
<td>96 hrs</td>
<td>&gt; 100 mg/l</td>
<td>Representative polymer tested in water with DOC</td>
</tr>
</tbody>
</table>

**ACUTE INVERTEBRATE RESULTS:**

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure</th>
<th>LC50</th>
<th>EC50</th>
<th>Test Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daphnia magna</td>
<td>48 hrs</td>
<td>&gt; 100 mg/l</td>
<td></td>
<td>Representative polymer tested in water with DOC</td>
</tr>
</tbody>
</table>

**AQUATIC PLANT RESULTS:**

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure</th>
<th>EC50/LC50</th>
<th>Test Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Algae (Pseudokirchneriella subcapitata, previously Selenastrum capricornutum)</td>
<td>96 hrs</td>
<td>&gt; 1,000 mg/l</td>
<td>Product</td>
</tr>
</tbody>
</table>

**ADDITIONAL ECOLOGICAL DATA**

NOEC on earthworm: > 1000 mg/l (representative polymer)

**PERSISTENCY AND DEGRADATION:**

Chemical Oxygen Demand (COD): 523,000 mg/l

The organic portion of this preparation is expected to be poorly biodegradable.

**MOBILITY:**

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.

If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages:

<table>
<thead>
<tr>
<th>Air</th>
<th>Water</th>
<th>Soil/Sediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5%</td>
<td>&lt; 5%</td>
<td>&gt; 90%</td>
</tr>
</tbody>
</table>
The portion in water is expected to float on the surface.

BIOACCUMULATION POTENTIAL
The product will not bioaccumulate.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION
Based on our hazard characterization, the potential environmental hazard is: Low

If released into the environment, see CERCLA/SUPERFUND in Section 15.

13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it is not a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

Dispose of wastes in an approved incinerator or waste treatment/disposal site, in accordance with all applicable regulations. Do not dispose of wastes in local sewer or with normal garbage.

Empty drums should be taken for recycling, recovery, or disposal through a suitably qualified or licensed contractor.

14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

LAND TRANSPORT :

   Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

AIR TRANSPORT (ICAO/IATA) :

   Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO) :

   Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION
15. REGULATORY INFORMATION

This section contains additional information that may have relevance to regulatory compliance. The information in this section is for reference only. It is not exhaustive, and should not be relied upon to take the place of an individualized compliance or hazard assessment. Nalco accepts no liability for the use of this information.

NATIONAL REGULATIONS, USA:

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, none of the substances in this product are hazardous.

CERCLA/SUPERFUND, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain substances on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
The substances in this preparation are included on or exempted from the TSCA 8(b) Inventory (40 CFR 710).

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act:
When use situations necessitate compliance with FDA regulations, this product is acceptable under: 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods.

Limitation: For use as an adjuvant in the manufacture of paper and paperboard in an amount not to exceed that necessary to accomplish the technical effect and not to exceed 2 percent (as polymer) by weight of the paper or paperboard.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR 116.4 / formerly Sec. 311:
This product may contain trace levels (<0.1% for carcinogens, <1% all other substances) of the following substance(s) listed under the regulation:

<table>
<thead>
<tr>
<th>Substance(s)</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous Ammonium Sulphate</td>
<td>Sec. 311</td>
</tr>
</tbody>
</table>
CLEAN AIR ACT, Sec. 112 (40 CFR 61, Hazardous Air Pollutants), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances):
This product may contain trace levels (<0.1% for carcinogens, <1% all other substances) of the following substance(s) listed under the regulation:

<table>
<thead>
<tr>
<th>Substance(s)</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Acrylamide</td>
<td>Sec. 112</td>
</tr>
</tbody>
</table>

CALIFORNIA PROPOSITION 65:
Substances known to the State of California to cause cancer are present as an impurity or residue.

MICHIGAN CRITICAL MATERIALS:
None of the substances are specifically listed in the regulation.

STATE RIGHT TO KNOW LAWS:
None of the substances are specifically listed in the regulation.

NATIONAL REGULATIONS, CANADA:

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS):
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS CLASSIFICATION:
Not considered a WHMIS controlled product.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):
The substance(s) in this preparation are included in or exempted from the Domestic Substance List (DSL).

AUSTRALIA
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

CHINA
All substances in this product comply with the Provisions on the Environmental Administration of New Chemical Substances and are listed on the Inventory of Existing Chemical Substances China (IECSC).

EUROPE
The substances in this preparation have been reviewed for compliance with the EINECS or ELINCS inventories.

JAPAN
All substances in this product comply with the Law Regulating the Manufacture and Importation Of Chemical Substances and are listed on the Existing and New Chemical Substances list (ENCS).
KOREA
All substances in this product comply with the Toxic Chemical Control Law (TCCL) and are listed on the Existing Chemicals List (ECL)

PHILIPPINES
All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

16. OTHER INFORMATION
FCHE080696

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: Low

* The environmental risk is: Low

Any use inconsistent with our recommendations may affect the risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.


Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH, (TOMES CPS CD-ROM Version), Micromedx, Inc., Englewood, CO.

Ariel Insight (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS CD-ROM Version), Micromedx, Inc., Englewood, CO.

Prepared By: Product Safety Department
Date issued: 07/04/2009
Version Number: 1.5
NALCLEAR™ 8173 PULV
Dry Anionic Flocculant

PRODUCT DESCRIPTION AND APPLICATION

NALCLEAR 8173 PULV is a dry anionic flocculant designed to enhance suspended solids removal in industrial and municipal applications. This product can be used as a coagulant aid in coagulation and precipitation softening processes. It can also be used in raw water and wastewater clarification, sludge thickening and dewatering. NALCLEAR anionic flocculants are intended for use in a pH range of 6.0-9.0.

PHYSICAL & CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Powder</td>
</tr>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Odor</td>
<td>Slight</td>
</tr>
<tr>
<td>Bulk Density:</td>
<td>45 lb/ft³ (0.70 gm/cc)</td>
</tr>
<tr>
<td>Solubility in Water:</td>
<td>Complete</td>
</tr>
</tbody>
</table>

ACTIVE CONSTITUENTS

Anionic copolymer of polyacrylamide

REGULATORY APPROVALS

NALCLEAR 8173 PULV conforms to the requirements of ANSI/NSF Standard 60-Drinking Water Treatment Chemicals-Health Effects. NALCLEAR 8173 PULV is certified by NSF International as a coagulant and flocculant drinking water chemical to a maximum use level of 1.0 mg/l.

Please refer to the Regulatory Certifications (RCR) document for the most recent approval information.
MATERIALS OF COMPATIBILITY

<table>
<thead>
<tr>
<th>Compatible</th>
<th>Not Compatible</th>
<th>Not Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless Steel 304 &amp; 316</td>
<td>Mild Steel</td>
<td>Galvanized</td>
</tr>
<tr>
<td>Plasite 6000</td>
<td>Aluminum</td>
<td></td>
</tr>
<tr>
<td>Plasite 4005</td>
<td>Brass</td>
<td></td>
</tr>
<tr>
<td>Plasite 7122</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Polyethylene (HDCL)</td>
<td>Neoprene</td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td>Vinyl</td>
<td></td>
</tr>
<tr>
<td>Viton® synthetic rubber</td>
<td>Polyurethane</td>
<td></td>
</tr>
<tr>
<td>Fluoropolymer</td>
<td>Synthetic Rubber</td>
<td></td>
</tr>
<tr>
<td>Buna-N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypalon® elastomer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polypropylene</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Testing conducted on 1.0% solution concentration)

DOSAGE AND FEEDING

The proper make-up of dry polymer products requires a four-step process that includes: feeding, wetting, mixing and aging. All steps are required to provide a homogeneous solution of maximum activity. Dry polymer is fed into a high energy wetting device that provides maximum dispersion. Following this process, the solution is fed into a tank and receives a gentle mix cycle to achieve maximum activity. The mixed solution is then fed to a holding tank for a period of aging, generally 30 minutes or greater. This product should not be made up at concentrations greater than 0.3%. Polymer solutions that have been properly made up and aged can be fed using either gear or diaphragm pumps. As with all pumps, and especially with high viscosity products, flooded suction is strongly recommended. The quality of water used to make up the polymer is important. Avoid using plant recycle water or other sources high in suspended solids, mineral salts and iron with a pH below 6.5 or above 7.8. A dilution aging tank is recommended.

ENVIRONMENTAL AND TOXICITY DATA

Refer to the Safety Data Sheet (SDS) for the most current data.

SAFETY AND HANDLING

As with any chemical, NALCLEAR 8173 PULV should be handled with responsible care. When considering the use of NALCLEAR 8173 PULV in a particular application, the Safety Data Sheet must be reviewed to assure that the intended use can be accomplished safely. All precautions described in the SDS should be strictly followed when handling NALCLEAR 8173 PULV.

STORAGE

Store separately from oxidizers. Keep in dry place. Store at temperatures below 120°F (35°C).
REMARKS
If you need assistance or more information on this product, please call your nearest Nalco Representative.
For more news about Nalco Company, visit our website www.nalco.com

For Medical and Transportation Emergencies involving Nalco products, please see the Material Safety Data Sheet for the phone number.

ADDITIONAL INFORMATION

Solution Concentration vs Viscosity

<table>
<thead>
<tr>
<th>Product Concentration (%)</th>
<th>Brookfield Viscosity (cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>400</td>
</tr>
<tr>
<td>0.50</td>
<td>1,500</td>
</tr>
<tr>
<td>0.75</td>
<td>2,200</td>
</tr>
<tr>
<td>1.00</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Readings taken at 70°F (21°C)

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NALCLEAR 8173 PULV

Do not handle until all safety precautions have been read and understood. Store separately from oxidizers. Keep in dry place. Store at temperatures below 120F (35C).

Nalco Company

Please refer to the original SDS for more information
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: Sodium permanganate solution
Product Number: 519073
Brand: Aldrich

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Oxidizing liquids (Category 2), H272
Acute toxicity, Oral (Category 4), H302
Skin corrosion (Category 1B), H314
Serious eye damage (Category 1), H318
Acute aquatic toxicity (Category 1), H400
Chronic aquatic toxicity (Category 1), H410

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)
H272 May intensify fire; oxidiser.
H302 Harmful if swallowed.
H314 Causes severe skin burns and eye damage.
H410 Very toxic to aquatic life with long lasting effects.

Precautionary statement(s)
P210 Keep away from heat.
P220 Keep/Store away from clothing/ combustible materials.
P221 Take any precaution to avoid mixing with combustibles.
P264 Wash skin thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
Avoid release to the environment.
Wear protective gloves/ protective clothing/ eye protection/ face protection.

**P301 + P312**
IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell.

**P301 + P330 + P331**
IF SWALLOWED: rinse mouth. Do NOT induce vomiting.

**P303 + P361 + P353**
IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.

**P304 + P340**
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

**P305 + P351 + P338**
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

**P310**
Immediately call a POISON CENTER or doctor/ physician.

**P321**
Specific treatment (see supplemental first aid instructions on this label).

**P363**
Wash contaminated clothing before reuse.

**P370 + P378**
In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.

**P391**
Collect spillage.

**P405**
Store locked up.

**P501**
Dispose of contents/ container to an approved waste disposal plant.

### 2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

### 3. COMPOSITION/INFORMATION ON INGREDIENTS

#### 3.2 Mixtures

**Formula**: MnNaO₄

**Molecular Weight**: 141.93 g/mol

<table>
<thead>
<tr>
<th>Component</th>
<th>Classification</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium permanganate</td>
<td>Ox. Sol. 2; Acute Tox. 4; Skin Corr. 1B; Eye Dam. 1; Aquatic Acute 1; Aquatic Chronic 1; H272, H302, H314, H410</td>
<td>30 - 50 %</td>
</tr>
</tbody>
</table>

CAS-No.: 10101-50-5  
EC-No.: 233-251-1

For the full text of the H-Statements mentioned in this Section, see Section 16.

### 4. FIRST AID MEASURES

#### 4.1 Description of first aid measures

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

#### 4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11.

#### 4.3 Indication of any immediate medical attention and special treatment needed
No data available
5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Sodium oxides, Manganese/manganese oxides

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections

For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Keep away from sources of ignition - No smoking. Keep away from heat and sources of ignition.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium permanganate</td>
<td>10101-50-5</td>
<td>C</td>
<td>5 mg/m3</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
</tbody>
</table>

Remarks
Ceiling limit is to be determined from breathing-zone air samples.

TWA 0.2 mg/m3
USA. ACGIH Threshold Limit Values (TLV)

Central Nervous System impairment
Adopted values or notations enclosed are those for which changes are proposed in the NIC
See Notice of Intended Changes (NIC) varies
8.2 Exposure controls

**Appropriate engineering controls**
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

**Personal protective equipment**

**Eye/face protection**
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

**Body Protection**
Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

| a) Appearance | Form: liquid |
| b) Odour | no data available |
| c) Odour Threshold | no data available |
| d) pH | no data available |
| e) Melting point/freezing point | no data available |
| f) Initial boiling point and boiling range | 100 °C (212 °F) |
| g) Flash point | no data available |
| h) Evaporation rate | no data available |
| i) Flammability (solid, gas) | no data available |
| j) Upper/lower flammability or explosive limits | no data available |
| k) Vapour pressure | no data available |
| l) Vapour density | no data available |
| m) Relative density | 1.391 g/cm³ |
n) Water solubility no data available
o) Partition coefficient: n-octanol/water no data available
p) Auto-ignition temperature no data available
q) Decomposition temperature no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

9.2 Other safety information no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity no data available

10.2 Chemical stability Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions no data available

10.4 Conditions to avoid no data available

10.5 Incompatible materials Powdered metals, Strong oxidizing agents, Strong acids, Organic materials, Strong reducing agents

10.6 Hazardous decomposition products Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity no data available
Inhalation: no data available
Dermal: no data available
no data available

Skin corrosion/irritation no data available

Serious eye damage/eye irritation no data available

Respiratory or skin sensitisation no data available

Germ cell mutagenicity no data available

Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

**Reproductive toxicity**
no data available
no data available

**Specific target organ toxicity - single exposure**
no data available

**Specific target organ toxicity - repeated exposure**
no data available

**Aspiration hazard**
no data available

**Additional Information**

**RTECS:** Not available

Men exposed to manganese dusts showed a decrease in fertility. Chronic manganese poisoning primarily involves the central nervous system. Early symptoms include languor, sleepiness and weakness in the legs. A stolid mask-like appearance of the face, emotional disturbances such as uncontrollable laughter and a spastic gait with tendency to fall in walking are findings in more advanced cases. High incidence of pneumonia has been found in workers exposed to the dust or fume of some manganese compounds. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin, spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache

Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence (Sodium permanganate)

---

**12. ECOLOGICAL INFORMATION**

**12.1 Toxicity**
no data available

**12.2 Persistence and degradability**
no data available

**12.3 Bioaccumulative potential**
no data available

**12.4 Mobility in soil**
no data available

**12.5 Results of PBT and vPvB assessment**
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

**12.6 Other adverse effects**
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal. Very toxic to aquatic life with long lasting effects.

---

**13. DISPOSAL CONSIDERATIONS**

**13.1 Waste treatment methods**

**Product**
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 3214  Class: 5.1  Packing group: II
Proper shipping name: Permanganates, inorganic, aqueous solution, n.o.s. (Sodium permanganate)
Reportable Quantity (RQ):
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 3214  Class: 5.1  Packing group: II  EMS-No: F-H, S-Q
Proper shipping name: PERMANGANATES, INORGANIC, AQUEOUS SOLUTION, N.O.S. (Sodium permanganate)
Marine pollutant: No

IATA
UN number: 3214  Class: 5.1  Packing group: II
Proper shipping name: Permanganates, inorganic, aqueous solution, n.o.s. (Sodium permanganate)

15. REGULATORY INFORMATION

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>10101-50-5</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

SARA 311/312 Hazards
Reactivity Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7732-18-5</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7732-18-5</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

<table>
<thead>
<tr>
<th>Acute Tox.</th>
<th>Acute toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic Acute</td>
<td>Acute aquatic toxicity</td>
</tr>
<tr>
<td>Aquatic Chronic</td>
<td>Chronic aquatic toxicity</td>
</tr>
<tr>
<td>Eye Dam.</td>
<td>Serious eye damage</td>
</tr>
<tr>
<td>H272</td>
<td>May intensify fire; oxidiser.</td>
</tr>
<tr>
<td>H302</td>
<td>Harmful if swallowed.</td>
</tr>
<tr>
<td>H314</td>
<td>Causes severe skin burns and eye damage.</td>
</tr>
<tr>
<td>H318</td>
<td>Causes serious eye damage.</td>
</tr>
</tbody>
</table>
H400 Very toxic to aquatic life.
H410 Very toxic to aquatic life with long lasting effects.
Ox. Sol. Oxidizing solids
Skin Corr. Skin corrosion

**HMIS Rating**
- Health hazard: 3
- Chronic Health Hazard: *
- Flammability: 0
- Physical Hazard: 2

**NFPA Rating**
- Health hazard: 3
- Fire Hazard: 0
- Reactivity Hazard: 2
- Special hazard.I: OX

**Further information**
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a
guide. The information in this document is based on the present state of our knowledge and is applicable to the
product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the
product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling
or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing
slip for additional terms and conditions of sale.

**Preparation Information**
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 3.6  Revision Date: 07/03/2014  Print Date: 08/14/2014
Sodium permanganate solution

May intensify fire; oxidizer - Causes severe skin burns and eye damage - Very toxic to aquatic life with long lasting effects - Harmful if swallowed

Keep away from heat/sparks/open flames/hot surfaces. - No smoking. - Keep/Store away from clothing/combustible materials. - Take any precaution to avoid mixing with combustibles. - Wash skin thoroughly after handling.

Please refer to the original SDS for more information
Section 1 - PRODUCT AND COMPANY IDENTIFICATION

Material Name
CARBON DIOXIDE, GAS

Synonyms
MTG SDS 17; CARBONIC ACID GAS; CARBONIC ANHYDRIDE; CARBON DIOXIDE; CARBON OXIDE; UN 1013; CO2

Chemical Family
inorganic, Gas

Product Use
Industrial and Specialty Gas Applications.

Restrictions on Use
None known.

Details of the supplier of the safety data sheet
MATHESON TRI-GAS, INC.
150 Allen Road, Suite 302
Basking Ridge, NJ 07920
General Information: 1-800-416-2505
Emergency #: 1-800-424-9300 (CHEMTREC)
Outside the US: 703-527-3887 (Call collect)

Section 2 - HAZARDS IDENTIFICATION

Classification in accordance with paragraph (d) of 29 CFR 1910.1200.
Gases Under Pressure - Compressed gas
Specific target organ toxicity - Single exposure - Category 3

GHS Label Elements

Symbol(s)

Signal Word
Warning

Hazard Statement(s)
Contains gas under pressure; may explode if heated. May cause drowsiness and dizziness. May displace oxygen and cause rapid suffocation.

Precautionary Statement(s)

Prevention
Avoid breathing gas. Use only outdoors or in a well-ventilated area.

Response
IF INHALED. Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or doctor/physician if you feel unwell.

Storage
Protect from sunlight. Store in a well-ventilated place. Keep container tightly closed. Store locked up.

Disposal
Dispose in accordance with all applicable regulations.

Other Hazards
Rapid release of compressed gas may cause frostbite.

---

### Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>CAS</th>
<th>Component Name</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>124-38-9</td>
<td>Carbon dioxide</td>
<td>100</td>
</tr>
</tbody>
</table>

---

### Section 4 - FIRST AID MEASURES

Inhalation
If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

Skin
If frostbite or freezing occur, immediately flush with plenty of lukewarm water (105-115 F; 41-46 C). DO NOT USE HOT WATER. If warm water is not available, gently wrap affected parts in blankets. Get immediate medical attention.

Eyes
Flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Then get immediate medical attention.

**Ingestion**
If swallowed, get medical attention.

**Most Important Symptoms/Effects**

**Acute**
suffocation, frostbite, central nervous system depression

**Delayed**
no information on significant adverse effects.

**Note to Physicians**
For inhalation, consider oxygen.

---

**Section 5 - FIRE FIGHTING MEASURES**

**Extinguishing Media**

**Suitable Extinguishing Media**
carbon dioxide, regular dry chemical, water spray, foam

**Unsuitable Extinguishing Media**
Do not direct water at source of leak or safety devices; icing may occur.

**Special Hazards Arising from the Chemical**
Negligible fire hazard. Containers may rupture or explode if exposed to heat.

**Hazardous Combustion Products**
Oxides of carbon

**Fire Fighting Measures**
Use extinguishing agents appropriate for surrounding fire. Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For tank, rail car or tank truck, evacuation radius: 800 meters (1/2 mile). Do not get water directly on material. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas.

**Special Protective Equipment and Precautions for Firefighters**
Wear full protective fire fighting gear including self contained breathing apparatus (SCBA) for protection against possible exposure.

---

**Section 6 - ACCIDENTAL RELEASE MEASURES**

**Personal Precautions, Protective Equipment and Emergency Procedures**
Wear personal protective clothing and equipment, see Section 8.

**Methods and Materials for Containment and Cleaning Up**
Stop leak if possible without personal risk. Do not touch or walk through spilled material. Use water spray to reduce vapors or divert vapor cloud drift. Do not direct water at spill or source of leak. If possible, turn leaking containers so that gas escapes rather than liquid. Allow substance to evaporate. Ventilate closed spaces before entering. Stay upwind and keep out of low areas.

Section 7 - HANDLING AND STORAGE

Precautions for Safe Handling
Avoid breathing dust/fume/gas/mist/vapors/spray. Use only outdoors or in a well-ventilated area. Wash hands thoroughly after handling.

Conditions for Safe Storage, Including any Incompatibilities
Protect from sunlight. Store in a well-ventilated place.
Keep container tightly closed.
Store locked up.

Incompatible Materials
combustible materials, oxidizing materials, metal salts, reducing agents, metal carbide, metals, bases

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Component Exposure Limits

<table>
<thead>
<tr>
<th>Component</th>
<th>Exposure Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
</tr>
<tr>
<td>ACGIH:</td>
<td>5000 ppm TWA</td>
</tr>
<tr>
<td></td>
<td>30000 ppm STEL</td>
</tr>
<tr>
<td>NIOSH:</td>
<td>5000 ppm TWA; 9000 mg/m3 TWA</td>
</tr>
<tr>
<td></td>
<td>30000 ppm STEL; 54000 mg/m3 STEL</td>
</tr>
<tr>
<td></td>
<td>40000 ppm IDLH</td>
</tr>
<tr>
<td>Europe:</td>
<td>5000 ppm TWA; 9000 mg/m3 TWA</td>
</tr>
<tr>
<td>OSHA (US):</td>
<td>5000 ppm TWA; 9000 mg/m3 TWA</td>
</tr>
<tr>
<td>Mexico:</td>
<td>5000 ppm TWA LMPE-PPT; 9000 mg/m3 TWA LMPE-PPT</td>
</tr>
<tr>
<td></td>
<td>15000 ppm STEL [LMPE-CT]; 27000 mg/m3 STEL [LMPE-CT]</td>
</tr>
</tbody>
</table>
EU - Occupational Exposure (98/24/EC) - Binding Biological Limit Values and Health Surveillance Measures
There are no biological limit values for any of this product's components.

ACGIH - Threshold Limit Values - Biological Exposure Indices (BEI)
There are no biological limit values for any of this product's components.

Engineering Controls
Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

Individual Protection Measures, such as Personal Protective Equipment
Eye/face protection
For the gas: Eye protection not required, but recommended. For the liquid: Wear splash resistant safety goggles. Contact lenses should not be worn. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

Skin Protection
For the gas: Protective clothing is not required. For the liquid: Wear appropriate protective, cold insulating clothing.

Respiratory Protection
The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA. 40,000 ppm. Any supplied-air respirator. Any self-contained breathing apparatus with a full facepiece. Emergency or planned entry into unknown concentrations or IDLH conditions -. Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode. Escape -. Any appropriate escape-type, self-contained breathing apparatus.

Glove Recommendations
Wear insulated gloves.

---

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>colorless gas</td>
</tr>
<tr>
<td>Odor</td>
<td>odorless</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>Not available</td>
</tr>
<tr>
<td>Melting Point</td>
<td>-57 °C at 4000 mmHg (-71 °F)</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>-78.5 °C (-109 °F Sublimation)</td>
</tr>
<tr>
<td>Freezing point</td>
<td>Not available</td>
</tr>
<tr>
<td>Boiling Point Range</td>
<td>Not available</td>
</tr>
<tr>
<td>Physical State</td>
<td>gas</td>
</tr>
<tr>
<td>Color</td>
<td>colorless</td>
</tr>
<tr>
<td>pH</td>
<td>(Acidic in solution)</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>Not available</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>Not flammable</td>
</tr>
<tr>
<td>Property</td>
<td>Value</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Autoignition</td>
<td>Not available</td>
</tr>
<tr>
<td>Flash Point</td>
<td>(Not flammable)</td>
</tr>
<tr>
<td>Lower Explosive Limit</td>
<td>Not available</td>
</tr>
<tr>
<td>Decomposition</td>
<td>Not available</td>
</tr>
<tr>
<td>Upper Explosive Limit</td>
<td>Not available</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>43700 mmHg at 21 °C</td>
</tr>
<tr>
<td>Vapor Density (air=1)</td>
<td>1.5</td>
</tr>
<tr>
<td>Specific Gravity (water=1)</td>
<td>1.527 at 21 °C</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>(Soluble)</td>
</tr>
<tr>
<td>Partition coefficient: n-octanol/water</td>
<td>Not available</td>
</tr>
<tr>
<td>Viscosity</td>
<td>14.9 uPa-sec</td>
</tr>
<tr>
<td>Solubility (Other)</td>
<td>Not available</td>
</tr>
<tr>
<td>Density</td>
<td>Not available</td>
</tr>
<tr>
<td>Physical Form</td>
<td>compressed gas</td>
</tr>
<tr>
<td>Sublimation</td>
<td>-78.5 °C (-109 °F)</td>
</tr>
<tr>
<td>Taste</td>
<td>acid taste</td>
</tr>
<tr>
<td>Volatility by Volume</td>
<td>100 %</td>
</tr>
<tr>
<td>Molecular Formula</td>
<td>C-O2</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>44.01</td>
</tr>
<tr>
<td>triple point</td>
<td>-56.6 °C</td>
</tr>
</tbody>
</table>

**Solvent Solubility**

**Soluble**

alcohol, acetone, Hydrocarbons, organic solvents

---

**Section 10 - STABILITY AND REACTIVITY**

**Reactivity**

No reactivity hazard is expected.

**Chemical Stability**

Stable at normal temperatures and pressure.

**Possibility of Hazardous Reactions**

Will not polymerize.

**Conditions to Avoid**

Protect from physical damage and heat. Containers may rupture or explode if exposed to heat. Avoid contact with water or moisture.

**Incompatible Materials**

combustible materials, oxidizing materials, metal salts, reducing agents, metal carbide, metals, bases

**Hazardous decomposition products**
Information on Likely Routes of Exposure

Inhalation
sensitivity to light, changes in blood pressure, nausea, irregular heartbeat, headache, drowsiness, dizziness, Disorientation, sleep disturbances, emotional disturbances, tingling sensation, tremors, muscle cramps, visual disturbances, suffocation, convulsions, Unconsciousness, coma, difficulty breathing, blood disorders

Skin Contact
blisters, frostbite

Eye Contact
irritation, blurred vision, frostbite

Ingestion
ingestion of a gas is unlikely

Acute and Chronic Toxicity

Component Analysis - LD50/LC50
The components of this material have been reviewed in various sources and no selected endpoints have been identified

Immediate Effects
suffocation, frostbite, central nervous system depression

Delayed Effects
no information on significant adverse effects.

Irritation/Corrosivity Data
No data available.

Respiratory Sensitization
No data available.

Dermal Sensitization
No data available.

Component Carcinogenicity
None of this product’s components are listed by ACGIH, IARC, NTP, DFG or OSHA

Germ Cell Mutagenicity
No data available.

Tumorigenic Data
No data available

Reproductive Toxicity
Specific Target Organ Toxicity - Single Exposure
central nervous system

Specific Target Organ Toxicity - Repeated Exposure
No target organs identified.

Aspiration hazard
Not applicable.

Medical Conditions Aggravated by Exposure
heart or cardiovascular disorders, respiratory disorders

Section 12 - ECOLOGICAL INFORMATION

Component Analysis - Aquatic Toxicity
No LOI ecotoxicity data are available for this product's components

Persistence and Degradability
No data available.

Bioaccumulative Potential
No data available.

Mobility
No data available.

Section 13 - DISPOSAL CONSIDERATIONS

Disposal Methods
Dispose in accordance with all applicable regulations.

Component Waste Numbers
The U.S. EPA has not published waste numbers for this product's components

Section 14 - TRANSPORT INFORMATION

US DOT Information:
Shipping Name: Carbon dioxide
Hazard Class: 2.2
UN/NA #: UN1013
Required Label(s): 2.2

IMDG Information:
Shipping Name: Carbon dioxide
Hazard Class: 2.2  
UN#: UN1013  
Required Label(s): 2.2

**Section 15 - REGULATORY INFORMATION**

**U.S. Federal Regulations**  
None of this product's components are listed under SARA Sections 302/304 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), CERCLA (40 CFR 302.4), TSCA 12(b), or require an OSHA process safety plan.

**SARA Section 311/312 (40 CFR 370 Subparts B and C)**  
Acute Health: Yes Chronic Health: No Fire: No Pressure: Yes Reactivity: No

**U.S. State Regulations**  
The following components appear on one or more of the following state hazardous substances lists:

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS</th>
<th>CA</th>
<th>MA</th>
<th>MN</th>
<th>NJ</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Not listed under California Proposition 65

**Canadian WHMIS Ingredient Disclosure List (IDL)**  
Components of this material have been checked against the Canadian WHMIS Ingredients Disclosure List. The List is composed of chemicals which must be identified on MSDSs if they are included in products which meet WHMIS criteria specified in the Controlled Products Regulations and are present above the threshold limits listed on the IDL.

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
</tr>
<tr>
<td></td>
<td>1 %</td>
</tr>
</tbody>
</table>

**WHMIS Classification**  
A.

**Component Analysis - Inventory**  
Carbon dioxide (124-38-9)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>DSL</td>
<td>EIN</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section 16 - OTHER INFORMATION**

**NFPA Ratings**
Health: 3  Fire: 0  Reactivity: 0
Hazard Scale: 0 = Minimal  1 = Slight  2 = Moderate  3 = Serious  4 = Severe

Summary of Change
Updated: 05/01/2015

Key / Legend
ACGIH - American Conference of Governmental Industrial Hygienists; ADR - European Road Transport;
AU - Australia; BOD - Biochemical Oxygen Demand; C - Celsius; CA - Canada; CAS - Chemical
Abstracts Service; CERCLA - Comprehensive Environmental Response, Compensation, and Liability
Act; CLP - Classification, Labelling, and Packaging; CN - China; CPR - Controlled Products
Regulations; DFG - Deutsche Forschungsgemeinschaft; DOT - Department of Transportation; DSD -
Dangerous Substance Directive; DSL - Domestic Substances List; EEC - European Economic
Community; EINECS - European Inventory of Existing Commercial Chemical Substances; EPA -
Environmental Protection Agency; EU - European Union; F - Fahrenheit; IARC - International Agency
for Research on Cancer; IATA - International Air Transport Association; ICAO - International Civil
Aviation Organization; IDL - Ingredient Disclosure List; IDLH - Immediately Dangerous to Life and
Health; IMDG - International Maritime Dangerous Goods; JP - Japan; Kow - Octanol/water partition
coefficient; KR - Korea; LEL - Lower Explosive Limit; LLV - Level Limit Value; LOLI - List Of LIsts™
- ChemADVISOR’s Regulatory Database; MAK - Maximum Concentration Value in the Workplace;
MEL - Maximum Exposure Limits; NFPA - National Fire Protection Agency; NIOSH - National Institute
for Occupational Safety and Health; NJTSR - New Jersey Trade Secret Registry; NTP - National
Toxicology Program; NZ - New Zealand; OSHA - Occupational Safety and Health Administration; PH -
Philippines; RCRA - Resource Conservation and Recovery Act; REACH- Registration, Evaluation,
Authorisation, and restriction of Chemicals; RID - European Rail Transport; SARA - Superfund
Amendments and Reauthorization Act; STEL - Short-term Exposure Limit; TDG - Transportation of
Dangerous Goods; TSCA - Toxic Substances Control Act; TWA - Time Weighted Average; UEL - Upper
Explosive Limit; US - United States.

Other Information
Disclaimer:
Matheson Tri-Gas, Inc. makes no express or implied warranties, guarantees or representations regarding
the product or the information herein, including but not limited to any implied warranty or
merchantability or fitness for use. Matheson Tri-Gas, Inc. shall not be liable for any personal injury,
property or other damages of any nature, whether compensatory, consequential, exemplary, or otherwise,
resulting from any publication, use or reliance upon the information herein.
CARBON DIOXIDE, GAS

Contains gas under pressure; may explode if heated - May cause respiratory irritation; or; May cause drowsiness or dizziness - May displace oxygen and cause rapid suffocation

Keep container tightly closed. - Avoid breathing dust/fume/gas/mist/vapours/spray. - Use only outdoors or in a well-ventilated area. - IF INHALED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - Store locked up. - Protect from sunlight. Store in a well-ventilated place.

Please refer to the original SDS for more information
Section 1. Product Information

Chemical Name: Calcium Carbonate
Product Name: Limestone, Calcium Carbonate, Calcite, Aragonite, Fluxstone
Formula: CaCO₃
CAS No.: 1317-65-3

Distributed by Pestell Minerals & Ingredients, New Hamburg, ON Canada

24 Hour Emergency Telephone (Canutec): 613-996-6666

Section 2. Hazards Identification

**Calcium Carbonate (Limestone):** 60 to 100% by weight

CAS Number: 471-34-1 (1317-65-3)
OSHA PEL: 15 (tot dust) 5 (resp. dust)
ACGIH TLV: 10 (tot dust)
MSHA PEL: 15 (tot dust) 5 (resp dust)
NIOSH REL: 10 (tot dust) 5 resp dust)

**Crystalline Silica, Quartz:** 0.1 to 1% Approx concentration % by weight:

CAS Number: 14808-60-7
OSHA PEL: 10/(%SiO₂)+2 respirable silica dust
ACGIH TLV: 0.025 respirable silica dust
MSHA PEL: 10/(%SiO₂)+2 respirable silica dust
NIOSH REL: 0.05 respirable free silica

Section 3. Physical Data

<table>
<thead>
<tr>
<th>Odour/Appearance: Odourless, grey to brown lumps, granules or powder</th>
<th>pH: (saturated solution):</th>
<th>sat. sln CaCO₃ 9.4 @ 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical State: Solid</td>
<td>Boiling Point: N/A</td>
<td></td>
</tr>
<tr>
<td>Specific Gravity: 2.65 - 2.75</td>
<td>Coef. Water/Oil Dist: &gt;1</td>
<td></td>
</tr>
<tr>
<td>Melting Point: N/A</td>
<td>Relative Density: N/A</td>
<td></td>
</tr>
<tr>
<td>Vapour Pressure: N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 4. Fire and Explosion Hazard

Flash Point: Non flammable
Auto-Ignition Temperature: Not applicable
Upper/Lower Flammable Limits: None
Explosion Risk: Not applicable
Hazardous Combustion Products: None
Extinguishing Media: Limestone does not burn. Use extinguishing media appropriate to surrounding fire conditions.

Fire Fighting Instructions:
Limestone is generally non flammable, but ignites on contact with fluorine. Wear adequate personal protection to prevent contact with material or its combustion products. Firefighters should use self contained NIOSH approved breathing apparatus with full face piece to protect against the products of combustion.

Section 5. Reactivity

Stability: Stable products, not very soluble

Hazardous Decomposition Products: Decomposition at 870°C will produce calcium oxide and carbon dioxide.

Reactivity: Limestone is a very stable chemical substance. Decomposition does not occur at normal temperatures (inferior to 600 degrees C). Reacts chemically with strong acids to form calcium based compounds and to liberate carbon dioxide.

Incompatible Materials: Fluorine, magnesium, aluminum, silicon, hydrogen, mercury, aluminum sulfate, ammonium salts, acids (violent reaction with generating heat and possible explosion in confined area).

Hazardous Decomposition Products: Calcium oxide

Section 6. Toxicological Properties

Routes of Entry: Skin, Eye, Acute Inhalation, Ingestion

Effects of Acute Exposure to Product

Skin: May cause dryness and irritation.

Eyes: May cause eye irritation with discomfort or pain, local redness and swelling of the conjunctiva.

   Irritation: Eye-Rabbit - 750 ug/24 h - severe

Inhalation: If inhaled in form of dust, may cause respiratory tract, irritation/inflammation. Exposure may cause coughing and sneezing. Large amounts may cause chemical pneumonitis.

Ingestion: Cause gastro-intestinal irritation. If ingested in large quantities may cause nausea, constipation and hypercalcaemia, hemorrhage

Effects of Chronic Exposure to Product

No signs or symptoms of chronic exposure have been reported. This product may contain trace amounts of crystalline silica. Excessive inhalation or respirable crystalline silica dust may result in respiratory disease, including silicosis, pneumoconiosis and pulmonary fibrosis.

Carcinogenicity

Limestone is not listed as a carcinogen by ACGIH, MSHA, OSHA, NTP or IARC. It may, however, contain trace amounts of Crystalline Silica listed carcinogens by these organizations.

Crystalline Silica, which inhaled in the form of quartz or crystobalite from occupational sources, is classified by IARC as (Group 1) carcinogenic to humans.

Silica, crystalline (Airborne particles of respirable size) is regulated under California’s Safe Drinking Water and Toxic
Section 7. Preventive Measures

Personal Protective Equipment: Wear clean, dry gloves, full length pants over boots, long sleeved shirt buttoned at the neck, head protection and approved eye protection selected for the working conditions.

Gloves: Gauntlets cuff style
Respiratory: NIOSH approved (N/R/P95) dust respirator
Eyes: ANSI, CSA or ASTM approved safety glasses with side shields. Tight fitting goggles should be worn when excessive (visible) dust conditions are present.
Clothing: Fully covering skin
Other: Evaluate degree of exposure and use PPE if necessary

Engineering Controls
Enclose dust sources, use exhaust ventilation (dust collector) or other engineering controls at handling points to keep airborne levels below recommended exposure limits.

Leak and Spill Procedures
Limit access to trained personnel. Sweep up and place in container. Use industrial vacuums for large spills. Avoid raising dust. Ventilate area.

Waste Disposal
Transport to disposal area or bury. Review Federal, Provincial and local Environmental regulations

Handling Procedures and Equipment
Avoid skin and eye contact. Minimize dust generation. Wear protective goggles and in cases of insufficient ventilation, use anti dust mask. An eye wash station should be readily available where this is used.

Storage
Keep tightly closed containers in cool, dry and well ventilated area, away from acids.

Special Shipment Information
Limestone is neither regulated by the Transportation of Dangerous Goods (TDG) Regulations (Canada) nor by the Hazardous Materials Regulation (USA).

Section 8. First Aid Measures

Skin: Carefully and gently brush the contaminated body surfaces in order to remove all traces of Limestone. Use a brush, cloth or gloves. Remove all Limestone contaminated clothing. Rinse contaminated area with lukewarm water for 15 to 20 minutes. If irritation occurs or persists seek medical attention:

Eyes: Immediately rinse contaminated eye(s) with gently running lukewarm water (saline solution is preferred) for 15 to 20 minutes. In the case of an embedded particle in the eye, or if irritation occurs or persists, consult a physician.

Inhalation: Move source of dust or move victim to fresh air. Obtain medical attention immediately. If victim does not breathe, give artificial respiration. Contact a physician immediately.

Ingestion: If victim is conscious, wash mouth out with water. Have conscious person drink several glasses of water to dilute. Induce vomiting. Contact a physician immediately. Never give anything by mouth to an unconscious or
convulsing person.

**General Advice**

Consult a physician for all exposures except minor instances of inhalation.

**Disclaimer**

This information contained herein is accurate to the best of our knowledge. We do not suggest or guarantee that any hazards listed herein are the only ones which exist. Pestell Minerals & Ingredients makes no warranty of any kind, expressed or implied, concerning the safe use of this material in your process or combination with any other substances. Effects can be aggravated by other materials and/or this material may aggravate or add to the effects of other materials. This material may be released from gas, liquid or solid materials made directly or indirectly from it. User has the sole responsibility to determine the suitability of the materials for any use and the manner of use contemplated. User must meet all applicable safety and health standards.
Causes severe skin burns and eye damage - May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause hazard) - Harmful if swallowed

Obtain special instructions before use. - Do not handle until all safety precautions have been read and understood. - Wash thoroughly after handling. - Do not eat, drink or smoke when using this product. - Wear protective gloves/protective clothing/eye protection/face protection.

Please refer to the original SDS for more information
SAFETY DATA SHEET
HYPERSPERSE* MDC150

1. Identification

Product identifier
HYPERSPERSE MDC150

Other means of identification
Not available.

Recommended use
Reverse Osmosis Antiscalant

Recommended restrictions
None known.

Company/undertaking identification
GE Betz, Inc.
4636 Somerton Road
Trevose, PA 19053
T 215 355 3300, F 215 953 5524

Emergency telephone
(800) 877 1940

2. Hazard(s) Identification

Physical hazards
Not classified.

Health hazards
Skin corrosion/irritation
Category 2

Serious eye damage/eye irritation
Category 2

Specific target organ toxicity; single exposure
Category 3 respiratory tract irritation

OSHA defined hazards
Not classified.

Label elements

Signal word
Warning

Hazard statement
Causes skin irritation. Causes serious eye irritation. May cause respiratory irritation.

Precautionary statement

Prevention
Avoid breathing mist or vapor. Wash thoroughly after handling. Use only outdoors or in a well-ventilated area. Wear protective gloves. Wear eye/face protection.

Response
If on skin: Wash with plenty of water. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a poison center/doctor if you feel unwell. Specific treatment (see on this label). If skin irritation occurs: Get medical advice/attention. If eye irritation persists: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Storage
Store in a well-ventilated place. Keep container tightly closed. Store locked up.

Disposal
Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HONC)
None known.

Supplemental information
None.
3. Composition/information on ingredients

MIXTURES

<table>
<thead>
<tr>
<th>Chemical name</th>
<th>Common name and synonyms</th>
<th>CAS number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium diethylene triamine penta(methylene phosphonate)</td>
<td></td>
<td>22042-96-2</td>
<td>10 - 20</td>
</tr>
</tbody>
</table>

* Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

Composition comments
Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this SDS for our assessment of the potential hazards of this formulation.

4. First-aid measures

Inhalation
Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/physician if you feel unwell.

Skin contact
Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Eye contact
Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation develops and persists.

Ingestion
Rinse mouth. If ingestion of a large amount does occur, call a poison control center immediately.

Most important symptoms/effects, acute and delayed
Symptoms may include stinging, tearing, redness, swelling, and blurred vision. May cause respiratory irritation. May cause redness and pain.

Indication of immediate medical attention and special treatment needed
Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

5. Fire-fighting measures

Suitable extinguishing media
Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media
Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical
During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters
Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire-fighting equipment/instructions
Move containers from fire area if you can do so without risk.

Specific methods
Use standard firefighting procedures and consider the hazards of other involved materials.

General fire hazards
No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures
Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Avoid inhalation of vapors or mists. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up
Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Environmental precautions
Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling
Avoid breathing mist or vapor. Avoid contact with skin. Avoid contact with eyes. Avoid prolonged exposure. Avoid contact with clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices. Use care in handling/storage.
Conditions for safe storage, including any incompatibilities
Store locked up. Do not freeze. If frozen, thaw completely and mix thoroughly prior to use. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Protect from freezing.

8. Exposure controls/personal protection
Occupational exposure limits
No exposure limits noted for ingredient(s).

Biological limit values
No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls
Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment
Eye/face protection
Splash proof chemical goggles.

Skin protection
Chemical resistant gloves. The choice of an appropriate glove does not only depend on its material but also on other quality features and is different from one producer to the other. Glove selection must take into account any solvents and other hazards present.

Hand protection

Other
Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended.

Respiratory protection

Thermal hazards
Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations
Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties
Appearance

Color
Amber to dark brown

Physical state
Liquid

Odor
Slight

Odor threshold
Not available.

pH (concentrated product)
2.5

pH in aqueous solution
2.8 (5% SOL.)

Melting point/freezing point
5 °F (-15 °C)

Initial boiling point and boiling range
220 °F (104 °C)

Flash point
> 212 °F (> 100 °C) Pensky-Martens Closed Cup

Evaporation rate
< 1 (Ether = 1)

Flammability (solid, gas)
Not available.

Upper/lower flammability or explosive limits
Flammability limit - lower (%)
Not available.

Flammability limit - upper (%)
Not available.

Explosive limit - lower (%)
Not available.

Explosive limit - upper (%)
Not available.

Vapor pressure
18 mm Hg

Vapor pressure temp.
70 °F (21 °C)

Vapor density
< 1 (Air = 1)

Relative density
1.16

Relative density temperature
70 °F (21 °C)

Solubility(ies)
Solubility (water) 100 %

Material name: HYPERSPERSE* MDC150
Version number: 1.0
Partition coefficient  
(n-octanol/water)  
Auto-ignition temperature  
Decomposition temperature  
Viscosity  
Viscosity temperature  
Other information  
  Percent volatile  
  Pour point  
  Specific gravity  

10. Stability and reactivity  
Reactivity  
Chemical stability  
Possibility of hazardous reactions  
Conditions to avoid  
Incompatible materials  
Hazardous decomposition products

11. Toxicological information  
Information on likely routes of exposure  
  Ingestion  
  Inhalation  
  Skin contact  
  Eye contact  
Symptoms related to the physical, chemical and toxicological characteristics  
Information on toxicological effects  
Acute toxicity  

<table>
<thead>
<tr>
<th>Product</th>
<th>Species</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPERSONE MDC150 (CAS Mixture)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dermal</td>
<td>Rabbit</td>
<td>&gt; 5000 mg/kg, (Calculated according to GHS additivity formula)</td>
</tr>
<tr>
<td>LD50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>Rat</td>
<td>&gt; 5000 mg/kg, (Calculated according to GHS additivity formula)</td>
</tr>
<tr>
<td>LD50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation  
Serious eye damage/eye irritation  
Respiratory or skin sensitization  
Respiratory sensitization  
Skin sensitization  
Germ cell mutagenicity  
Carcinogenicity  
OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)  
Reproductive toxicity

Material name: HYPERSONE* MDC150  
Version number: 1.0
Specific target organ toxicity - single exposure  May cause respiratory irritation.
Specific target organ toxicity - repeated exposure  Not available.
Aspiration hazard  Not classified.
Chronic effects  Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity  The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

<table>
<thead>
<tr>
<th>Product</th>
<th>Species</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPERSONSE MDC150 (CAS Mixture)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC50</td>
<td>Fathead Minnow</td>
<td>13139 mg/L, Static Renewal Bioassay, 96 hour</td>
</tr>
<tr>
<td>NOEL</td>
<td>Fathead Minnow</td>
<td>7500 mg/L, Static Renewal Bioassay, 96 hour</td>
</tr>
<tr>
<td>Crustacea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC50</td>
<td>Daphnia magna</td>
<td>3634 mg/L, Static Renewal Bioassay, 48 hour</td>
</tr>
<tr>
<td>NOEL</td>
<td>Daphnia magna</td>
<td>2500 mg/L, Static Renewal Bioassay, 48 hour</td>
</tr>
</tbody>
</table>

* Estimates for product may be based on additional component data not shown.

Bioaccumulative potential  No data available.
Mobility in soil  No data available.
Other adverse effects  No other adverse environmental effects (e.g., ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.
Environmental fate  The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Persistence and degradability  No data is available on the degradability of this product.

- COD (mgO2/g)  180 (calculated data)
- BOD 5 (mgO2/g)  2 (calculated data)
- BOD 28 (mgO2/g)  3 (calculated data)
- Closed Bottle Test (% Degradation in 28 days)  3
- Zahn-Wellens Test (% Degradation in 28 days)  0
- TOC (mg C/g)  40 (calculated data)

13. Disposal considerations

Disposal instructions  Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.
Local disposal regulations  Dispose in accordance with all applicable regulations.
Hazardous waste code  The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products  Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging  Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT  Not regulated as dangerous goods.
Some containers may be DOT exempt, please check BOL for exact container classification.
IATA  Not regulated as dangerous goods.

Material name: HYPERSONSE* MDC150
Version number: 1.0

Page: 5 / 7
IMDG
Not regulated as dangerous goods.

15. Regulatory information

US federal regulations
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

- TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)
  Not regulated.
- CERCLA Hazardous Substance List (40 CFR 302.4)
  Not listed.
- SARA 304 Emergency release notification
  Not regulated.
  Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

<table>
<thead>
<tr>
<th>Hazard categories</th>
<th>Immediate Hazard - Yes</th>
<th>Delayed Hazard - No</th>
<th>Fire Hazard - No</th>
<th>Pressure Hazard - No</th>
<th>Reactivity Hazard - No</th>
</tr>
</thead>
</table>

- SARA 302 Extremely hazardous substance
  Not listed.
- SARA 311/312 Hazardous chemical
  No
- SARA 313 (TRI reporting)
  Not regulated.

Other federal regulations
- Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List
  Not regulated.
- Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)
  Not regulated.
- Safe Drinking Water Act (SDWA)
  Not regulated.

Inventory status

<table>
<thead>
<tr>
<th>Country(s) or region</th>
<th>Inventory name</th>
<th>On inventory [yes/no]*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Domestic Substances List (DSL)</td>
<td>Yes</td>
</tr>
<tr>
<td>Canada</td>
<td>Non-Domestic Substances List (NDSSL)</td>
<td>No</td>
</tr>
<tr>
<td>United States &amp; Puerto Rico</td>
<td>Toxic Substances Control Act (TSCA) Inventory</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*A 'Yes' indicates that all components of this product comply with the inventory requirements administered by the governing country(s).
A 'No' indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

US state regulations
- US - Massachusetts RTK - Substance List
  Not regulated.
- US - Pennsylvania RTK - Hazardous Substances
  Not regulated.
- US - Rhode Island RTK
  Not regulated.
- US, California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100)
  Not listed.
- US, New Jersey Worker and Community Right-to-Know Act
  Not regulated.

Material name: HYPERSONSE* MDC150
Version number: 1.0

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US. California Proposition 65
California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance
No ingredient listed.

US - California Proposition 65 - CRT: Listed date/Developmental toxin
No ingredient listed.

US - California Proposition 65 - CRT: Listed date/Female reproductive toxin
No ingredient listed.

US - California Proposition 65 - CRT: Listed date/Male reproductive toxin
No ingredient listed.

16. Other information, including date of preparation or last revision

Issue date: Oct-25-2014
Revision date: Oct-25-2014
Version #: 1.0

List of abbreviations
- CAS: Chemical Abstract Service Registration Number
- TWA: Time Weighted Average
- STEL: Short Term Exposure Limit
- LD50: Lethal Dose, 50%
- LC50: Lethal Concentration, 50%
- NOEL: No Observed Effect Level
- COD: Chemical Oxygen Demand
- BOD: Biochemical Oxygen Demand
- TOC: Total Organic Carbon
- TLV: Threshold Limit Value
- IATA: International Air Transport Association
- IMDG: International Maritime Dangerous Goods Code
- NFPA: National Fire Protection Association
- ACGIH: American Conference of Governmental Industrial Hygienists
TSRN indicates a Trade Secret Registry Number is used in place of the CAS number.

References: No data available

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Revision Information
- Product and Company Identification: Commercial Names
- Composition / Information on Ingredients: Disclosure Overrides
- Physical & Chemical Properties: Multiple Properties
- Transport Information: Material Transportation Information
- GHS: Classification

Prepared by
This SDS has been prepared by GE Water & Process Technologies Regulatory Department (1-215-355-3300).

* Trademark of General Electric Company. May be registered in one or more countries.
HYPERSPERSE MDC150

Causes skin irritation

Avoid breathing dust/fume/gas/mist/vapours/spray. - Use only outdoors or in a well-ventilated area. - Wear protective gloves/protective clothing/eye protection/face protection. - IF ON SKIN: Wash with plenty of soap and water. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. - Store in a well-ventilated place. Keep container tightly closed. - Dispose of contents/container in accordance with local/regional/national/international regulations.

Please refer to the original SDS for more information
I. Product and Supplier Information

Product Name: NLR759  
MSDS Number: NLR759  
Product Number: NA  
Publication Date: 6-Jul-11  
Product Synonyms: Liquid Anti-scale

Supplier: New Logic Research, Inc.  
Phone: 510-655-7305  
Fax: 510-655-7307  
Web page: www.vsep.com

II. Composition and Information on Ingredients

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Material or Component</th>
<th>Material or Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>2809-21-4</td>
<td>Phosphorous and related phosphor %</td>
<td>Phosphorous and related phosphor %</td>
</tr>
</tbody>
</table>

This product is a proprietary formulation of generally available chemical ingredients. Complying with 29 CFR 1910.1200 (d), each ingredient in this formulation has been reviewed with the "Guide to Occupational Exposure Values - 2005" published by ACGIH. None of the ingredients have listed occupational exposure values, and can be considered generally safe if handled with due care.

III. Hazards Identification

Eye contact: May cause irritation
Skin Contact: Prolonged may cause irritation
Ingestion: No harmful effect reported
Inhalation: No hazard in normal use.

Sign & Symptoms of Exposure: Minor irritations

IV. First Aid

Eyes and skin - flush eyes with excess water. Wash from skin with soap and water.
Inhaled- Remove subject to fresh air.
Ingestion- rinse mouth and throat. Drink water or milk.
In all cases, call or see a physician.

V. Fire Fighting Measures

Flammability Summary (OSHA):
Non-flammable aqueous solution.

Flammable Properties
Flash Point: None
Autoignition Temperature: Not applicable

Fire/Explosion Hazards: Material will not ignite or burn.
Extinguishing Media:  
No Restrictions

Fire Fighting Instructions:  
Person exposed to products of combustions should wear  
self-contained breathing apparatus and full protective equipment.

Hazardous Combustion Products:  
If involved in a fire, oxides of carbon, nitrogen and phosphorous may be generated. Phosphines  
may also be generated under some conditions.

**VI. Accidental Release Measures**

**Personal Protection for Emergency Situations:**  
Wear protective equipment. Keep unprotected persons away.  
Ensure adequate ventilation

**In Case of Spill:**  
Stop spill/release if possible with minimal risk. Recover by pumping or with suitable absorbent. Notify  
appropriate agencies. Immediate clean up recommended.

**VII. Handling and Storage**

**Precautions to Be Taken in Handling and Storing**  
Store in closed containers in cool location away from sunlight.

**Other Precautions**  
Avoid contact. Wear protective equipment if possible.

**VIII. Exposure Controls and Personal Protection**

**Respiratory Protection (Specific Type)**  
Use NIOSH approved respirator if conditions warrant.

**Ventilation**  
Use in ventilated area.

**Protective Gloves**  
Water impenetrable gloves that can be washed

**Eye Protection**  
Chemical safety goggles recommendable

**Other Protective Clothing or Equipment**  
Work overalls would prevent contamination of street clothes.

**Work/Hygienic Practices**  
Wash gloves and hands before touching anything else.

**IX. Physical Data**

<table>
<thead>
<tr>
<th>Physical State:</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color:</td>
<td>Colorless, Clear</td>
</tr>
<tr>
<td>Odor:</td>
<td>None</td>
</tr>
<tr>
<td>Specific Gravity:</td>
<td>1.06</td>
</tr>
<tr>
<td>Solubility in Water:</td>
<td>Completely soluble</td>
</tr>
<tr>
<td>Vapor Density (Air = 1):</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapor Pressure: (@ 25°C)</td>
<td>As Water</td>
</tr>
</tbody>
</table>

| Boiling Point: | 214°F (100°C) |
Freezing Point: 32°F (0°C)

X. Stability and Reactivity
Stability: The product is stable.

Conditions of Instability:
Avoid acids and strong oxidants.

XI. Toxicological Information
This product is non-hazardous and non-toxic

XII. Ecological Information
This product is non-hazardous and non-toxic

XIII. Disposal Considerations
This material when discarded is not a hazardous waste as defined by RCRA (40CFR261)
Flush residual spill with water into sewer.

XIV. Transportation Information
DOT Hazardous Classification - Not considered hazardous by the U.S. Department of Transportation (DOT)
TDG Canadian Transportation - Not considered hazardous under Transportation of Dangerous Goods (TDG)
International Transportation - Products has no UN number, and is not regulated under international rail, road, water or air transport regulations.

XV. Regulatory Information
This ingredients that make up this product are certified under ANSI-NSF Standard 60 for the production of drinking water with reverse osmosis membranes. Ratings under Hazardous Materials Identification Systems (HMIS): Health=1; F=0; R=0; P=0

XVI. Additional Information
MSDS REVISION STATUS: THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS MSDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall New Logic be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if New Logic has been advised of the possibility of such damages.

New Logic Research, Inc.  Publication Date: July, 7, 2011
Warning

May be harmful in contact with skin - Causes eye irritation

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

New Logic Research

Please refer to the original SDS for more information
Material Safety Data Sheet
Sodium bisulfite

MSDS# 21001

Section 1 - Chemical Product and Company Identification

MSDS Name: Sodium bisulfite
Catalog Numbers: AC223070000, AC223070010, AC419440000, AC419440010, AC419440025, AC419440050
Synonyms: Sodium hydrogen sulfite.

Company Identification: Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
For information in the US, call: 201-796-7100
Emergency Number US: 201-796-7100
CHEMTREC Phone Number, US: 800-424-9300

Section 2 - Composition, Information on Ingredients

<table>
<thead>
<tr>
<th>CAS#:</th>
<th>7631-90-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Name:</td>
<td>Sodium bisulfite</td>
</tr>
<tr>
<td>%:</td>
<td>99+</td>
</tr>
<tr>
<td>EINECS#:</td>
<td>231-548-0</td>
</tr>
</tbody>
</table>

Hazard Symbols: XN
Risk Phrases: 22 31

Section 3 - Hazards Identification

EMERGENCY OVERVIEW
Warning! Harmful if swallowed. Contact with acids liberates toxic gas. Target Organs: Respiratory system.

Potential Health Effects
Eye: May cause eye irritation.
Skin: May cause skin irritation. May be harmful if absorbed through the skin. May cause sensitization by skin contact.
Ingestion: Harmful if swallowed. May cause irritation of the digestive tract.
Inhalation: May cause respiratory tract irritation. May be harmful if inhaled. May cause respiratory sensitization.
Chronic: Repeated or prolonged exposure may cause allergic reactions in sensitive individuals.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. If irritation develops, get medical aid.
Skin: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
Ingestion: Do not induce vomiting. Get medical aid immediately. Call a poison control center.
Inhalation: Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.
Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.

Extinguishing Media: Substance is noncombustible; use agent most appropriate to extinguish surrounding fire.

- Autoignition Temperature: Not applicable.
- Flash Point: Not applicable.
- Explosion Limits: Not available
  - Lower: Not available
  - Upper: Not available

NFPA Rating: health: 2; flammability: 0; instability: 2;

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions. Provide ventilation. Do not let this chemical enter the environment.

Section 7 - Handling and Storage

Handling: Use with adequate ventilation. Minimize dust generation and accumulation. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale.

Storage: Store in a cool, dry place. Store in a tightly closed container. Keep away from strong acids. Do not store in aluminum containers.

Section 8 - Exposure Controls, Personal Protection

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>ACGIH</th>
<th>NIOSH</th>
<th>OSHA - Final PELs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium bisulfite</td>
<td>5 mg/m3</td>
<td>5 mg/m3 TWA</td>
<td>none listed</td>
</tr>
</tbody>
</table>

OSHA Vacated PELs: Sodium bisulfite: 5 mg/m3 TWA

Engineering Controls:

Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Personal Protective Equipment

- Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
- Skin: Wear appropriate protective gloves to prevent skin exposure.
- Clothing: Wear appropriate protective clothing to prevent skin exposure.

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a Respirators: NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

- Physical State: Crystalline powder
- Color: white
- Odor: sulfurous odor
- pH: 4 - 5 (25% aq. sol.)
- Vapor Pressure: Not applicable.
- Vapor Density: Not available
- Evaporation Rate: Not applicable.
Viscosity: Not applicable.
Boiling Point: Not applicable.
Freezing/Melting Point: 150 deg C (decom)
Decomposition Temperature: Not available
Solubility in water: 300 g/L
Specific Gravity/Density: 1.480
Molecular Formula: HNaO3S
Molecular Weight: 104.06

Section 10 - Stability and Reactivity

Chemical Stability: Oxidizes when exposed to air. Contact with acid liberates gas. Moisture sensitive.
Conditions to Avoid: Incompatible materials, dust generation, exposure to air, temperatures above 150°C, exposure to moist air or water.
Incompatibilities with Other Materials: Oxidizing agents, acids, aluminum.
Hazardous Decomposition Products: Oxides of sulfur, toxic fumes of sodium oxide.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#: CAS# 7631-90-5: VZ2000000
LD50/LC50:
- Oral, rat: LD50 = 2 gm/kg;

Carcinogenicity: Sodium bisulfite - IARC: Group 3 (not classifiable)
Other: See actual entry in RTECS for complete information.

Section 12 - Ecological Information

Other: Do not empty into drains.

Section 13 - Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.

Section 14 - Transport Information

US DOT
Shipping Name: CORROSIVE SOLID, ACIDIC, INORGANIC, N.O.S.
Hazard Class: 8
UN Number: UN3260
Packing Group: III
Canada TDG
Shipping Name: CORROSIVE SOLID, ACIDIC, INORGANIC, N.O. (SODIUM BISULFITE)
Hazard Class: 8
UN Number: UN3260
Packing Group: III

USA RQ: CAS# 7631-90-5: 5000 lb final RQ; 2270 kg final RQ

Section 15 - Regulatory Information

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols: XN
Risk Phrases:
- R 22 Harmful if swallowed.
- R 31 Contact with acids liberates toxic gas.
Safety Phrases:
S 25 Avoid contact with eyes.
S 46 If swallowed, seek medical advice immediately and show this container or label.

WGK (Water Danger/Protection)

CAS# 7631-90-5: 1

Canada

CAS# 7631-90-5 is listed on Canada's DSL List
Canadian WHMIS Classifications: D1B
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
CAS# 7631-90-5 is listed on Canada's Ingredient Disclosure List

US Federal

TSCA

CAS# 7631-90-5 is listed on the TSCA
Inventory.

Section 16 - Other Information

MSDS Creation Date: 9/02/1997
Revision #10 Date 7/20/2009

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantibility or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential, or exemplary damages howsoever arising, even if the company has been advised of the possibility of such damages.

--------------------------------------------------------------------------------
Warning

Sodium bisulfite

May cause respiratory irritation; or; May cause drowsiness or dizziness - Harmful if swallowed

Avoid breathing dust/fume/gas/mist/vapours/spray. - Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. - Do not eat, drink or smoke when using this product. - Use only outdoors or in a well-ventilated area. - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF INHALED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - Store in a well-ventilated place. Keep container tightly closed. - Store in a cool, dry place. Store in a tightly closed container. Keep away from strong acids. Do not store in aluminum containers.

Please refer to the original SDS for more information
1 Identification

Identification of substance or preparation
MC-1

Product Application Area
Membrane cleaner

Company/Undertaking Identification
GE Water & Process Technologies Canada
3239 Dundas Street West
Oakville, Ontario, L6M 4B2
T 905-465-3030

Emergency Telephone
(800) 877-1940

Prepared on: 02-SEP-2011

2 Hazard(s) identification

********************************************************************************
EMERGENCY OVERVIEW
********************************************************************************

May cause slight irritation to the skin. Corrosive to the eyes.
Dusts may cause irritation to the upper respiratory tract.

Odor: None; Appearance: White, Granules

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media:
dry chemical, carbon dioxide, foam or water

********************************************************************************
POTENTIAL HEALTH EFFECTS
********************************************************************************

ACUTE SKIN EFFECTS:
May cause slight irritation to the skin.

ACUTE EYE EFFECTS:
Corrosive to the eyes.

ACUTE RESPIRATORY EFFECTS:
Primary route of exposure; Dusts may cause irritation to the upper
respiratory tract.

INGESTION EFFECTS:
May cause slight gastrointestinal irritation with possible nausea, vomiting, abdominal discomfort and diarrhea.

**TARGET ORGANS:**
No evidence of potential chronic effects.

**MEDICAL CONDITIONS AGGRAVATED:**
Not known.

**SYMPTOMS OF EXPOSURE:**
Inhalation of dust and/or vapors may cause eye, nose, throat and respiratory tract irritation.

### 3 Composition / information on ingredients

Information for specific product ingredients as required by the WHMIS Regulations is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

**HAZARDOUS INGREDIENTS:**

<table>
<thead>
<tr>
<th>Cas#</th>
<th>Chemical Name</th>
<th>Range (w/w%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>77-92-9</td>
<td>CITRIC ACID</td>
<td>60-100</td>
</tr>
<tr>
<td></td>
<td>Irritant (eyes)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ORAL LD50-RAT: 5,040 MG/KG</td>
<td></td>
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<td>DERMAL LD50: NO DATA.</td>
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</tr>
<tr>
<td></td>
<td>INHL. LC50: NO DATA.</td>
<td></td>
</tr>
</tbody>
</table>

### 4 First-aid measures

**SKIN CONTACT:**
Wash thoroughly with soap and water. Remove contaminated clothing. Thoroughly wash clothing before reuse. Get medical attention if irritation develops or persists.

**EYE CONTACT:**
URGENT! Immediately flush eyes with plenty of low-pressure water for at least 20 minutes while removing contact lenses. Hold eyelids apart. Get immediate medical attention.

**INHALATION:**
Remove to fresh air. Get medical attention if irritation persists.

**INGESTION:**
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 2-8 fluid ounces (60-240 mL) of milk or water.

**NOTES TO PHYSICIANS:**
No special instructions

### 5 Fire-fighting measures
FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).

EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water

HAZARDOUS DECOMPOSITION PRODUCTS:
oxides of carbon

FLASH POINT:
> 213°F > 101°C P-M(CC)

6 Accidental release measures

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Spill residue may be neutralized with soda ash.

DISPOSAL INSTRUCTIONS:
The waste characteristics of the absorbed material, or any contaminated soil, should be determined in accordance with provincial regulations. Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement or discharged under provincial regulations. Incinerate or land dispose in an approved landfill.

7 Handling and storage

HANDLING:
Corrosive to eyes.

STORAGE:
Keep containers closed when not in use. Keep dry.

8 Exposure controls / personal protection

EXPOSURE LIMITS
Consult local authorities for acceptable provincial values.

CHEMICAL NAME

CITRIC ACID

PEL (OSHA): LIMITS HAVE NOT BEEN ESTABLISHED BY US OSHA.
TLV (ACGIH): LIMITS HAVE NOT BEEN ESTABLISHED BY ACGIH.

ENGINEERING CONTROLS:
adequate ventilation

RESPIRATORY PROTECTION:
If air-purifying respirator use is appropriate, use any of the following particulate respirators: N95, N99, N100, R95, R99, R100, P95, P99 or P100.

SKIN PROTECTION:
neoprene gloves—Wash off after each use. Replace as necessary.

EYE PROTECTION:
airtight chemical goggles

9 Physical and chemical properties
Density NO DATA Vapor Pressure (mmHG) < 1.0
Freeze Point (F) NA Vapor Density (air=1) < 1.00
Freeze Point (C) NA
Viscosity(cps 70F,21C) NA % Solubility (water) > 50.0
Odor None
Appearance White
Physical State Granules
Flash Point P-M(CC) > 213F > 101C
pH 0.1n Sol. (approx.) 2.2
Evaporation Rate (Ether=1) < 1.00
Percent VOC: 0.0

NA = not applicable ND = not determined

10 Stability and reactivity

CHEMICAL STABILITY:
Stable under normal storage conditions.

POSSIBILITY OF HAZARDOUS REACTIONS:
Contact with strong bases may cause a violent reaction releasing heat.

INCOMPATIBILITIES:
May react with strong oxidizers.

DECOMPOSITION PRODUCTS:
oxides of carbon

11 Toxicological information

Oral LD50 RAT: >5000 mg/kg
NOTE - Calculated value according to GHS additivity formula

12 Ecological information

AQUATIC TOXICOLOGY
No Data Available.

BIODEGRADATION
No Data Available.

13 Disposal considerations

Incinerate or bury in approved landfill. Please be advised that there may be additional local or provincial requirements relating to the disposal of waste. Consult provincial and local regulations regarding the proper disposal of this material.

14 Transport information
Transportation of Dangerous Goods:
Not Regulated

DOT EMERGENCY RESPONSE GUIDE #: Not applicable

15 Regulatory information

This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

CEPA:
All components of this product comply with substance notification requirements under CEPA.

WHMIS CLASSIFICATION:
D2B

16 Other information

<table>
<thead>
<tr>
<th>HMIS vII</th>
<th>CODE TRANSLATION</th>
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</thead>
<tbody>
<tr>
<td>Health</td>
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<tr>
<td>Fire</td>
<td>1</td>
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<tr>
<td>Reactivity</td>
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<tr>
<td>Special</td>
<td>NONE</td>
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<tr>
<td>(1) Protective Equipment</td>
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(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

<table>
<thead>
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<th>EFFECTIVE DATE</th>
<th>REVISIONS TO SECTION:</th>
<th>SUPERCEDES</th>
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<td>28-NOV-2006</td>
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<td>11</td>
<td>01-SEP-2009</td>
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</table>

Substance or Preparation: MC-1
MC-1

Danger

Causes mild skin irritation - Causes serious eye damage - May be harmful if inhaled

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. - IF ON SKIN: Wash with plenty of soap and water. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Please refer to the original SDS for more information
1 Identification

Identification of substance or preparation
MC-4

Product Application Area
Membrane cleaner

Company/Undertaking Identification
GE Water & Process Technologies Canada
3239 Dundas Street West
Oakville, Ontario, L6M 4B2
T 905-465-3030

Emergency Telephone
(800) 877-1940


2 Hazard(s) identification

********************************************************************************
EMERGENCY OVERVIEW
********************************************************************************

Corrosive to skin. Corrosive to the eyes. Dusts, vapors, mists or aerosols cause respiratory tract irritation.

Odor: Mild; Appearance: White, Powder

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water

********************************************************************************

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; Corrosive to skin.

ACUTE EYE EFFECTS:
Corrosive to the eyes.

ACUTE RESPIRATORY EFFECTS:
Primary route of exposure; Dusts, vapors, mists or aerosols cause respiratory tract irritation.

INGESTION EFFECTS:
May cause severe irritation or burning of mouth, throat, and gastrointestinal tract with severe chest and abdominal pain, nausea, vomiting, diarrhea, lethargy and collapse. Possible death when ingested in very large doses.

**TARGET ORGANS:**
Prolonged or repeated exposures may cause respiratory sensitization, primary irritant dermatitis and/or tissue necrosis.

**MEDICAL CONDITIONS AGGRAVATED:**
Pre-existing skin disorders and chronic respiratory disease.

**SYMPTOMS OF EXPOSURE:**
Causes severe irritation, burns or tissue ulceration with subsequent scarring.

## 3 Composition / information on ingredients

Information for specific product ingredients as required by the WHMIS Regulations is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

### HAZARDOUS INGREDIENTS:

<table>
<thead>
<tr>
<th>Cas#</th>
<th>Chemical Name</th>
<th>Range (w/w%)</th>
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<tbody>
<tr>
<td>497-19-8</td>
<td>SODIUM CARBONATE</td>
<td>30-60</td>
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<td>Irritant (eyes)</td>
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<td>INHL. LC50-RAT: 2,300 MG/M3/2HR</td>
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<td>68081-98-1</td>
<td>SULFURIC ACID, MONO-C14-18-ALKYL ESTERS, SODIUM</td>
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<td>SALTS</td>
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<td>Eye irritant</td>
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<td>ORAL LD50: NO DATA</td>
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<td></td>
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<td>PROPRIETARY ALKYL SULFATE, SODIUM SALT</td>
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<td></td>
<td>DERMAL LD50: NO DATA</td>
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<td></td>
<td>INHL. LC50: NO DATA</td>
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<tr>
<td>1310-73-2</td>
<td>SODIUM HYDROXIDE</td>
<td>7-13</td>
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<td>Corrosive; toxic (by ingestion)</td>
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<td>INHL. LC50: NO DATA</td>
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</tbody>
</table>

## 4 First-aid measures

**SKIN CONTACT:**
URGENT! Wash thoroughly with soap and water. Remove contaminated clothing. Get immediate medical attention. Thoroughly wash clothing before reuse.
EYE CONTACT:
URGENT! Immediately flush eyes with plenty of low-pressure water for at least 20 minutes while removing contact lenses. Hold eyelids apart. Get immediate medical attention.

INHALATION:
Remove to fresh air. If breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. Get immediate medical attention.

INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 2-8 fluid ounces (60-240 mL) of milk or water.

NOTES TO PHYSICIANS:
Material is corrosive. It may not be advisable to induce vomiting. Possible mucosal damage may contraindicate the use of gastric lavage.

5 Fire-fighting measures

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).

EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water

HAZARDOUS DECOMPOSITION PRODUCTS:
oxides of carbon and sulfur

FLASH POINT:
> 213F   > 101C P-M(CC)

6 Accidental release measures

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.

DISPOSAL INSTRUCTIONS:
The waste characteristics of the absorbed material, or any contaminated soil, should be determined in accordance with provincial regulations. Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement or discharged under provincial regulations. Incinerate or land dispose in an approved landfill.

7 Handling and storage

HANDLING:
Corrosive to skin. Corrosive to eyes.

STORAGE:

8 Exposure controls / personal protection
EXPOSURE LIMITS
Consult local authorities for acceptable provincial values.

CHEMICAL NAME

SODIUM CARBONATE
PEL (OSHA): LIMITS HAVE NOT BEEN ESTABLISHED BY US OSHA.
TLV (ACGIH): LIMITS HAVE NOT BEEN ESTABLISHED BY ACGIH.

SULFURIC ACID, MONO-C14-18-ALKYL ESTERS, SODIUM SALTS
PEL (OSHA): LIMITS HAVE NOT BEEN ESTABLISHED BY US OSHA.
TLV (ACGIH): LIMITS HAVE NOT BEEN ESTABLISHED BY ACGIH.

PROPRIETARY ALKYL SULFATE, SODIUM SALT
PEL (OSHA): LIMITS HAVE NOT BEEN ESTABLISHED BY US OSHA.
TLV (ACGIH): LIMITS HAVE NOT BEEN ESTABLISHED BY ACGIH.

SODIUM HYDROXIDE
PEL (OSHA): 2 MG/M3
TLV (ACGIH): TWA (Ceiling) = 2 MG/M3

ENGINEERING CONTROLS:
Adequate ventilation to maintain air contaminants below exposure limits.

RESPIRATORY PROTECTION:
If air-purifying respirator use is appropriate, use any of the following particulate respirators: N95, N99, N100, R95, R99, R100, P95, P99 or P100.

SKIN PROTECTION:
Gauntlet-type neoprene gloves, chemical resistant apron—Wash off after each use. Replace as necessary.

EYE PROTECTION:
Airtight chemical goggles

9 Physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Density</td>
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<tr>
<td>Freeze Point (F)</td>
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<tr>
<td>Freeze Point (C)</td>
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<tr>
<td>Viscosity(cps 70F,21C)</td>
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<tr>
<td>Odor</td>
<td>Mild</td>
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<tr>
<td>Appearance</td>
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<td>Physical State</td>
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<td>Flash Point P-M(CC)</td>
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<td>Evaporation Rate (Ether=1)</td>
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<tr>
<td>Percent VOC</td>
<td>0.0</td>
</tr>
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</table>

NA = not applicable  ND = not determined

10 Stability and reactivity
CHEMICAL STABILITY:
Stable under normal storage conditions.

POSSIBILITY OF HAZARDOUS REACTIONS:
No known hazardous reactions.

INCOMPATIBILITIES:
May react with acids.

DECOMPOSITION PRODUCTS:
oxides of carbon and sulfur

11 Toxicological information

Oral LD50 RAT: 860 mg/kg
NOTE - Calculated value according to GHS additivity formula
Dermal LD50 RABBIT: >5000 mg/kg
NOTE - Calculated value according to GHS additivity formula

12 Ecological information

AQUATIC TOXICOLOGY
No Data Available.

BIODEGRADATION
No Data Available.

13 Disposal considerations

Incinerate or bury in approved landfill. Please be advised that there may be additional local or provincial requirements relating to the disposal of waste. Consult provincial and local regulations regarding the proper disposal of this material.

14 Transport information

Transportation of Dangerous Goods:
CORROSIVE SOLID, BASIC, INORGANIC, N.O.S.(SODIUM HYDROXIDE MIXTURE)
CLASS 8, UN 3262, PG II
DOT EMERGENCY RESPONSE GUIDE #: 154

15 Regulatory information

This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

CEPA:
All components of this product comply with substance notification requirements under CEPA.

WHMIS CLASSIFICATION:
D2A    D2B    E

16 Other information
HMIS vii

CODE TRANSLATION

Health 3 Serious Hazard
Fire 0 Minimal Hazard
Reactivity 1 Slight Hazard
Special CORR DOT corrosive
(1) Protective Equipment C Goggles, Gloves, Apron

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

<table>
<thead>
<tr>
<th>EFFECTIVE DATE</th>
<th>REVISIONS TO SECTION:</th>
<th>SUPERCEDES</th>
</tr>
</thead>
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<tr>
<td>MSDS status: 17-APR-2007</td>
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<td>** NEW **</td>
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<td>01-SEP-2009</td>
<td>4,8,10</td>
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<tr>
<td>02-SEP-2011</td>
<td>11</td>
<td>01-SEP-2009</td>
</tr>
</tbody>
</table>
Danger

MC-4

Causes severe skin burns and eye damage - Harmful if inhaled

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. - IF ON SKIN: Wash with plenty of soap and water. - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Please refer to the original SDS for more information
1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NLR 404
Product Number: NA
Product Synonyms: Membrane Cleaner
Chemical Family: Acidic cleaner with detergents

1295 67th Street
Emeryville, CA 94608 USA
Phone: 510-655-7305
Fax: 510-655-7307

2. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS

Routes of Entry: Inhalation, skin, eyes, ingestion
Chemical Interactions: Reacts with alkaline materials to form salts, and corrodes many metals.
Medical Conditions Aggravated: None known.
Human Threshold Response Data
Odor Threshold: Not established
Irritation Threshold: Not established

Hazard Category Classifications and Ratings

Immediate Yes Fire No Pressure No Reactivity No Reference 49 CFR 171.8.
Delayed No Fire No Pressure No Reactivity No SARA 302/311/312/313.
HMIS Hazard Ratings: Health 2 Fire 0 Instability 0 Other B (Glasses, gloves)
NFPA 704 Hazard Rating: Health 2 Flammability 0 Reactivity 0 Special NA
Hazard Ratings: Least 0 Slight 1 Moderate 2 High 3 Extreme 4

Immediate (Acute) Health Effects

Inhalation Toxicity: Not expected to be toxic by inhalation.
Inhalation Irritation: Moderately irritating to the eyes, nose, throat, and lungs.
Skin Contact: Skin contact may cause minor irritation consisting of transient redness and/or swelling.
Skin Absorption: No significant adverse effects to health would be expected to occur from incidental dermal contact.
Eye Contact: Contact may cause moderate irritation consisting of transient redness, swelling, and mucous membrane discharge to the conjunctiva.
Ingestion Irritation: Irritation may result.
Ingestion Toxicity: See Sec. 11 for animal toxicological results.
Acute Target Organ Toxicity: Eyes, skin, mucous membranes, respiratory tract

Prolonged (Chronic) Health Effects

Carcinogenicity: This product is not known or reported to be carcinogenic by any reference source including IARC, OSHA, NTP or EPA.
Reproductive and Developmental Toxicity: No reproductive or developmental risk to humans is expected from exposure to this product. See Sec. 11 for animal study results.
Sensitization: No sensitizing effects known.
Inhalation: No information.
Skin Contact: Repeated or prolonged dermal contact may cause defatting of skin and/or dermatitis.
Skin Absorption: No information.
Ingestion: Chronic ingestion will chelate calcium in teeth and bones, weakening them.
Material Safety Data Sheet

Chronic Target Organ Toxicity: No data.
Supplemental Health Hazard Information: No additional health information available.

3. COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>CAS #</th>
<th>SARA</th>
<th>Material or Component</th>
<th>Exposure Limits</th>
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<td>313</td>
<td></td>
<td>Organic Acid</td>
<td>%</td>
</tr>
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<td>RQ#</td>
</tr>
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<td></td>
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</table>

No component is listed in "Threshold and Biological Exposure Indices for 2004" from ACGIH except as noted above. Components listed in Title III Sec. 313 (EPCRA) are indicated by "Yes" above. *TWA= Time Weighted Average; STEL= Short Term Exposure Limit; WEEL= Workplace Employee Exposure Level. NE= Not Established

4. FIRST AID MEASURES

**Inhalation:** IF INHALED: Remove individual to fresh air. Seek medical attention.
**Skin Contact:** IF ON SKIN: Flush skin with water, rinse thoroughly.
**Eyes:** IF IN EYES: Immediately flush eyes with plenty of water for at least 15 minutes while holding eyelids apart. Call a physician immediately.
**Ingestion:** IF SWALLOWED: Immediately drink water to dilute. Consult a physician if symptoms develop. Never give anything by mouth to an unconscious person.

5. FIRE FIGHTING MEASURES

**Flammability Summary (OSHA):** Non flammable water solution.

**Flammable Properties**
**Flash Point:** None
**Auto Ignition Temperature:** Not applicable
**Upper Flammable/Explosive Limit, % in air:** Not applicable
**Lower Flammable/Explosive Limit, % in air:** Not applicable
**Fire/Explosion Hazards:** Material will not ignite or burn.
**Extinguishing Media:** Not Applicable. Choose extinguishing media suitable for surrounding materials.
**Fire Fighting Instructions:** In case of fire, use fire fighting equipment appropriate to the cause of the fire.
**Hazardous Combustion Products:** Will produce oxides of carbon if evaporated and burned.

6. ACCIDENTAL RELEASE MEASURES

**Personal Protection for Emergency Situations:**
Wear protective equipment. Keep unprotected persons away. Ensure adequate ventilation

**Spill Mitigation Procedures:**
**Air Release:** Not a likely scenario, nor source of personnel hazard.
**Water Release:** This material is soluble in water. Contain all liquid for treatment and/or disposal. Notify all downstream users of possible contamination.
**Land Release:** Create a dike or trench to contain materials. Absorb spill with inert material (e.g., dry sand, earth or commercial absorbent), then place in a chemical waste container. Decontaminate all clothing and the spill area using a detergent and flush with large amounts of water. Contain all contaminated water for disposal and/or treatment.

**Additional Spill Information:** Stop source of spill as soon as possible and notify appropriate personnel. Utilize emergency response personal protection equipment prior to the start of any response. Evacuate all non-essential personnel. Dispose of spill residues per guidelines under Section XIII, Disposal Considerations.
7. HANDLING AND STORAGE

Handling: Do not take internally. Avoid contact with skin, eyes and clothing. Upon contact with skin or eyes, wash with water. Avoid breathing mist.

Storage: Do not store in metal container.

Shelf Life Limitations: See label or certificate of analysis for shelf life if applicable.

Incompatible Materials for Storage: Storage in original containers is preferred.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Protective Equipment for Routine Use of Product Respiratory Protection:
Respiratory protection not normally needed since volatility and toxicity are low. If vapors, mists or aerosols are generated, wear a NIOSH approved respirator.

General protective and hygienic measures: The usual precautionary measures for handling chemicals should be followed. Keep away from foodstuffs, beverages and feed. Remove all soiled and contaminated clothing immediately. Wash hands before breaks and at the end of work. Avoid contact with the eyes and skin.

Eyes: Use chemical goggles.

Protective Clothing Type: Impervious

Exposure Limit Data: See Section II

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Liquid
Odor: None
pH (@ 25 Deg. C): Acid
Bulk Density: Not applicable
Phosphorous %: 1.16
Vapor Pressure: (@ 25 Deg. C): No data
Volatile % by vol.: Approx. 50% water
Freezing Point: Below 0°C

Color: Water white
Molecular Weight: Not Applicable for a solution.
Solubility in Water: Completely miscible
Specific Gravity: Approx. 1.2
Vapor Density (Air = 1): Not applicable
Evaporation Rate: (Water = 1 ) Not applicable
Boiling Point: About 105°C

10. STABILITY AND REACTIVITY

Stability and Reactivity Summary: Stable under normal conditions.

Reactive Properties:
Sensitivity to mechanical shock: None
Hazardous Polymerization: Will not occur
Conditions to Avoid: None known.
Chemical Incompatibility: Reacts with alkaline and caustic materials.
Hazardous Decomposition Products: Oxides of carbon, nitrogen and sulfur if burned.
Decomposition Temperature: No data
Product May Be Unstable At Temperatures Above: No data

11. TOXICOLOGICAL INFORMATION

Component Animal Toxicology Data are for 100% organic acid from Alfa Aesar MSDS dated 3/11/02.

Irritation of skin: Moderate: 500 mg/24 hr (rbt)
Irritation of eyes: Severe: 750 ug/24 hr (rbt)
Inhalation LC50 value: No information.
LD 50mg/kg: 5040 (mus); 6730 (rat)
Skin Irritation: This material is expected to be moderately irritating.
Eye Irritation: This material is expected to be severely irritating.
Reproductive and Developmental Toxicity: No reproductive or developmental risk to humans is expected from exposure to this product.
Sub acute to chronic toxicity: To the best of our knowledge the acute and chronic toxicity of this material is not fully known.
Carcinogenicity: This chemical is not known or reported to be carcinogenic by any reference source including IARC, OSHA, NTP, or EPA.

12. ECOLOGICAL INFORMATION

Ecological Toxicity Values: No data.

Do not allow material to be released to the environment without proper governmental permits.

13. DISPOSAL CONSIDERATIONS

Care must be taken to prevent environmental contamination from the use of this material. The user of this material has the responsibility to dispose of unused material, residues and containers in compliance with all local, state and federal laws.

Waste Disposal Summary: Product as made has the characteristic of corrosivity, like " Unlisted Hazardous Waste D002", RQ 100#.
Potential US EPA Waste Codes: Not applicable
Disposal Methods: As a corrosive hazardous liquid waste, it should be disposed of in accordance with local, state and federal regulations.
Components subject to land ban restrictions: No components subject to land ban restrictions.

14. TRANSPORTATION INFORMATION

Proper Shipping Name: Corrosive liquid, acidic, organic, nos, 8, UN 3265, PG III
Emergency Response Guide Number ERG 153
Labels required per 49 CFR 172.101: Corrosive
Size for "Limited quantity" per 49 CFR 173.150-.155: 1 gal. max. in 66# max. container
Reportable Quantity ("RQ") per 49 CFR 172.101: None or not possible in one non-bulk package
Aircraft - Passenger: 5 L
Aircraft – Cargo: 60 L
Vessel stowage- Location: A
Vessel stowage- Other (49 CFR 176.184): 40

15. REGULATORY INFORMATION

FEDERAL REGULATORY STATUS

UNITED STATES:
Toxic Substances Control Act (TSCA): The components of this product are listed on the TSCA Inventory of Existing Chemical Substances.
Pesticide acceptance indication: US EPA Registration Number: Not applicable
Superfund Amendments and Reauthorization Act (SARA) Title III: See Section III of this MSDS.

Hazard Categories Sections 311/312 (40 CFR 370.2):
Health: Acute
Chronic Physical: None
Extremely Hazardous Substance Section 302 - Threshold Planning Quantity: Not applicable
State Right-to-Know Regulations Status of Ingredients: No data.
INTERNATIONAL REGULATIONS:

**Canadian Environmental Protection Act:** All of the components of this product are included on the Canadian Domestic Substances List (DSL)

**Canadian Workplace Hazardous Materials Information System (WHMIS):**
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

**WHMIS Classification:** Not Available

**European Inventory of Existing Chemical (EINECS):** All of the components of this product are included on EINECS, DSCL (EEC) R-36/38 Irritating to eyes and skin. S-24/25 Avoid contact with skin and eyes. S-26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S-28 After contact with skin, wash immediately with plenty of water. S-37/39 Wear suitable gloves and eye/face protection.

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16. OTHER INFORMATION

**LABEL REQUIREMENTS:** WARNING! NUISANCE DUST COULD CAUSE COMBUSTIBLE DUST EXPLOSION.

<table>
<thead>
<tr>
<th>Hazardous Material Information System (HMIS):</th>
<th>Health</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Protection</td>
<td></td>
<td>B</td>
</tr>
</tbody>
</table>

**NFPA/HMIS Definitions:**
0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme

**Protective Equipment:** GLASSES, GLOVES

Prepared By: **Paul Eigbrett** (MSDS Authoring Services)  
Product Number: NLR 404  
Approval Date: April 04, 2009  
Supersedes Date: April 14, 2004

**ADDITIONAL INFORMATION:**

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS MSDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

END OF MSDS
Warning

Causes skin irritation - Causes serious eye irritation

IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF ON SKIN: Gently wash with plenty of soap and water. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Dunwell New Logic (Asia Pacific) Ltd.

Please refer to the original SDS for more information
1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NLR 505  
Product Number: NA  
Product Synonyms: Membrane Cleaner  
Chemical Family: Water solution of alkaline salts and detergents

1295 67th Street  
Emeryville, CA 94608 USA  
Phone: 510-655-7305  
Fax: 510-655-7307  
Web Site: www.vsep.com

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
WARNING! EYE IRRITANT, SKIN IRRITANT

POTENTIAL HEALTH EFFECTS

Routes of Entry: Inhalation, skin, eyes, ingestion  
Chemical Interactions: Contains chelator for many polyvalent metal ions.  
Medical Conditions Aggravated: None known. Ingestion will chelator calcium in teeth and bones, weakening them.  
Human Threshold Response Data: Odor Threshold: Not established, Irritation Threshold: Not established

Hazard Category Classifications and Ratings

<table>
<thead>
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<tr>
<td>Immediate</td>
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<td>No</td>
<td>No</td>
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<td>No</td>
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<td>Instability 0</td>
<td>Other B (Glasses, gloves)</td>
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<td>Reactivity 0</td>
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<td>Moderate 2</td>
<td>High 3</td>
<td>Extreme 4</td>
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Immediate (Acute) Health Effects

Inhalation Toxicity: Not expected to be toxic by inhalation.  
Inhalation Irritation: Moderately irritating to the eyes, nose, throat, and lungs.  
Skin Contact: Skin contact may cause minor irritation consisting of transient redness and/or swelling.  
Skin Absorption: No significant adverse effects to health would be expected to occur from incidental dermal contact.  
Eye Contact: Contact may cause moderate irritation consisting of transient redness, swelling, and mucus membrane discharge to the conjunctiva.  
Ingestion Irritation: Irritation may result. Ingestion will chelate calcium in teeth and bones, weakening them.  
Ingestion Toxicity: See Sec. 11 for animal toxicological results.  
Acute Target Organ Toxicity: Eyes, skin, mucous membranes, respiratory tract

Prolonged (Chronic) Health Effects

Carcinogenicity: This product is not known or reported to be carcinogenic by any reference source including IARC, OSHA, NTP or EPA.  
Reproductive and Developmental Toxicity: No reproductive or developmental risk to humans is expected from exposure to this product. See Sec. 11 for animal study results.  
Sensitization: No sensitizing effects known.  
Inhalation: No information.  
Skin Contact: Repeated or prolonged dermal contact may cause defatting of skin and/or dermatitis.  
Skin Absorption: No information.  
Ingestion: Chronic ingestion will chelate calcium in teeth and bones, weakening them.
Chronic Target Organ Toxicity: No data.
Supplemental Health Hazard Information: No additional health information available.

### 3. COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Material or Component</th>
<th>Exposure Limits</th>
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<td>313 %</td>
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<td>RQ# TWA* STEL* WEEL*</td>
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<td>Sodium dodecylbenzene sulfonate</td>
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Product also contains alkaline salts and non regulated detergents which may contribute to eye and skin irritation. No component is listed in “Threshold and Biological Exposure Indices for 2004” from ACGIH except as noted above. Components listed in Title III Sec. 313 (EPCRA) are indicated by “Yes” above. *TWA= Time Weighted Average; STEL= Short Term Exposure Limit; WEEL= Workplace Employee Exposure Level. NE= Not Established

### 4. FIRST AID MEASURES

**Inhalation:** IF INHALED: Remove individual to fresh air. Seek medical attention.
**Skin Contact:** IF ON SKIN: Flush skin with water, rinse thoroughly.
**Eyes:** IF IN EYES: Immediately flush eyes with plenty of water for at least 15 minutes while holding eyelids apart. Call a physician immediately.
**Ingestion:** IF SWALLOWED: Immediately drink water to dilute. Consult a physician if symptoms develop. Never give anything by mouth to an unconscious person.

### 5. FIRE FIGHTING MEASURES

**Flammability Summary (OSHA):** Non flammable water solution.

**Flammable Properties**
- **Flash Point:** None
- **Auto Ignition Temperature:** Not applicable
- **Upper Flammable/Explosive Limit, % in air:** Not applicable
- **Lower Flammable/Explosive Limit, % in air:** Not applicable

**Fire/Explosion Hazards:** Material will not ignite or burn.

**Extinguishing Media:** Not Applicable. Choose extinguishing media suitable for surrounding materials.

**Fire Fighting Instructions:** In case of fire, use fire fighting equipment appropriate to the cause of the fire.

**Hazardous Combustion Products:** Will produce oxides of carbon, nitrogen and sulfur if evaporated and burned.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Protection for Emergency Situations:**
Wear protective equipment. Keep unprotected persons away. Ensure adequate ventilation

**Spill Mitigation Procedures:**
- **Air Release:** Not a likely scenario, nor source of personnel hazard.
- **Water Release:** This material is soluble in water. Contain all liquid for treatment and/or disposal. Notify all downstream users of possible contamination.
- **Land Release:** Create a dike or trench to contain materials. Absorb spill with inert material (e.g., dry sand, earth or commercial absorbent), then place in a chemical waste container. Decontaminate all clothing and the spill area using a detergent and flush with large amounts of water. Contain all contaminated water for disposal and/or treatment.

**Additional Spill Information:** Stop source of spill as soon as possible and notify appropriate personnel. Utilize emergency response personal protection equipment prior to the start of any response. Evacuate all non-essential personnel. Dispose of spill residues per guidelines under Section XIII, Disposal Considerations.
7. HANDLING AND STORAGE

**Handling:** Do not take internally. Avoid contact with skin, eyes and clothing. Upon contact with skin or eyes, wash with water. Avoid breathing mist.

**Storage:** No safety restrictions.

**Shelf Life Limitations:** See label or certificate of analysis for shelf life if applicable.

**Incompatible Materials for Storage:** Storage in original containers is preferred.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**Ventilation:** General exhaust ventilation is likely to be sufficient for general worker safety and comfort.

**Protective Equipment for Routine Use of Product Respiratory Protection:**
Respiratory protection not normally needed since volatility and toxicity are low. If vapors, mists or aerosols are generated, wear a NIOSH approved respirator.

**General protective and hygienic measures:** The usual precautionary measures for handling chemicals should be followed.
Keep away from foodstuffs, beverages and feed. Remove all soiled and contaminated clothing immediately. Wash hands before breaks and at the end of work. Avoid contact with the eyes and skin.

**Eyes:** Use chemical goggles.

**Protective Clothing Type:** Impervious

**Exposure Limit Data:** See Section II

9. PHYSICAL AND CHEMICAL PROPERTIES

**Physical State:** Liquid

**Odor:** None

**pH:** (@ 25 Deg. C): Alkaline

**Bulk Density:** Not applicable

**Phosphorous %:** 1.94

**Vapor Pressure:** (@ 25 Deg. C): No data

**Volatiles % by vol.:** Approx. 84% water

**Freezing Point:** Close to 0°C

**Color:** Water white

**Molecular Weight:** Not Applicable for a solution.

**Solubility in Water:** Completely miscible

**Specific Gravity:** >1

**Vapor Density (Air = 1):** Not applicable

**Evaporation Rate (Water = 1):** Not applicable

**Boiling Point:** Close to 100°C

10. STABILITY AND REACTIVITY

**Stability and Reactivity Summary:** Stable under normal conditions.

**Reactive Properties:**

**Sensitivity to mechanical shock:** None

**Hazardous Polymerization:** Will not occur

**Conditions to Avoid:** None known.

**Chemical Incompatibility:** None known.

**Hazardous Decomposition Products:** Oxides of carbon, nitrogen and sulfur if burned.

**Decomposition Temperature:** No data

**Product May Be Unstable At Temperatures Above:** No data

11. TOXICOLOGICAL INFORMATION

**Component Animal Toxicology Data:**
No information found for such a dilute solution of these materials.

**Irritation of skin:** No information.

**Irritation of eyes:** No information.

**Inhalation LC50 value:** No information.

**LD 50mg/kg:** No information.
Skin Irritation: This material is expected to be slightly irritating.
Eye Irritation: This material is expected to be moderately to severely irritating.
Reproductive and Developmental Toxicity: No reproductive or developmental risk to humans is expected from exposure to this product.
Sub acute to chronic toxicity: Animal studies with EDTA salts such as herein contained have reported convulsions, weight loss, liver, kidney, urethra and bladder changes. Fetotoxicity and developmental abnormalities have also been reported from studies on animals. To the best of our knowledge the acute and chronic toxicity of this material is not fully known.
Carcinogenicity: This chemical is not known or reported to be carcinogenic by any reference source including IARC, OSHA, NTP, or EPA.

12. ECOLOGICAL INFORMATION

Ecological Toxicity Values: No data.
Do not allow material to be released to the environment without proper governmental permits.

13. DISPOSAL CONSIDERATIONS

Care must be taken to prevent environmental contamination from the use of this material. The user of this material has the responsibility to dispose of unused material, residues and containers in compliance with all local, state and federal laws.

Waste Disposal Summary: If this product becomes waste, it DOES NOT meet the criteria of a hazardous waste as defined under 40 CFR 261, in that it does not exhibit the characteristics of a hazardous waste of subpart C, nor is it listed as a hazardous waste under Subpart D.
Potential US EPA Waste Codes: Not applicable
Disposal Methods: As a non-hazardous liquid waste, it should be disposed of in accordance with local, state and federal regulations.
Components subject to land ban restrictions: No components subject to land ban restrictions.

14. TRANSPORTATION INFORMATION

Proper Shipping Name: Not Regulated
Emergency Response Guide Number: Not Applicable
Labels required per 49 CFR 172.101: None
Size for "Limited quantity" per 49 CFR 173.150-.155: Not Applicable
Reportable Quantity ("RQ") per 49 CFR 172.101: None or not possible in one non-bulk package
Aircraft - Passenger: NA
Aircraft – Cargo: NA
Vessel stowage- Location: NA
Vessel stowage- Other (49 CFR 176.84): NA

15. REGULATORY INFORMATION

FEDERAL REGULATORY STATUS

UNITED STATES:
Toxic Substances Control Act (TSCA): The components of this product are listed on the TSCA Inventory of Existing Chemical Substances.
Pesticide acceptance indication: US EPA Registration Number: Not applicable
Superfund Amendments and Reauthorization Act (SARA) Title III: See Section III of this MSDS.

Hazard Categories Sections 311/312 (40 CFR 370.2):
Health: Acute
Chronic Physical: None
Extremely Hazardous Substance Section 302 - Threshold Planning Quantity: Not applicable
State Right-to-Know Regulations Status of Ingredients: No data.
INTERNATIONAL REGULATIONS:

**Canadian Environmental Protection Act:** All of the components of this product are included on the Canadian Domestic Substances List (DSL).

**Canadian Workplace hazardous Materials Information System (WHMIS):** This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR. WHMIS Classification: Class D-2B: Material causing other toxic effects (TOXIC).

**European Inventory of Existing Chemical (EINECS):** All of the components of this product are included on EINECS, DSCL (EEC). R-22 Harmful if swallowed, R-37/38 Irritating to respiratory system and skin, R-41 Risk of serious damage to eyes. S-26 Incase of contact with eyes, rinse immediately with plenty of water and seek medical advice. S-29 Do not empty into drains. S-36/37/39 Wear suitable protective clothing, gloves and eye/face protection.

### 16. OTHER INFORMATION

**LABEL REQUIREMENTS:** WARNING! NUISANCE DUST COULD CAUSE COMBUSTIBLE DUST EXPLOSION.

<table>
<thead>
<tr>
<th>Hazardous Material Information System (HMIS):</th>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Personal Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>B</td>
</tr>
</tbody>
</table>

NFPA/HMIS Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme  
Protective Equipment: GLASSES, GLOVES

Prepared By: Paul Eigbrett (MSDS Authoring Services)  
Product Number: NLR 505  
Approval Date: April 04, 2009  
Supersedes Date: April 15, 2004

ADDITIONAL INFORMATION:

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS MSDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

END OF MSDS
Warning

New Logic Research

NLR 505

Causes skin irritation - Causes serious eye irritation

IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF ON SKIN: Wash with plenty of soap and water. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Please refer to the original SDS for more information
SAFETY DATA SHEET

Creation Date 24-Aug-2009  Revision Date 02-Apr-2014  Revision Number 1

1. Identification

Product Name Hydrochloric acid, Trace Metal Grade
Cat No. : A508-4; A508-212; A508-212LC; A508-500; A508P212; A508P500; A508SK-212
Synonyms Muriatic acid; Hydrogen chloride, HCl
Recommended Use Laboratory chemicals.
Uses advised against No Information available

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive to metals</td>
<td>Category 1</td>
</tr>
<tr>
<td>Skin Corrosion/irritation</td>
<td>Category 1 B</td>
</tr>
<tr>
<td>Serious Eye Damage/Eye Irritation</td>
<td>Category 1</td>
</tr>
<tr>
<td>Specific target organ toxicity (single exposure)</td>
<td>Category 3</td>
</tr>
<tr>
<td>Target Organs - Respiratory system.</td>
<td></td>
</tr>
<tr>
<td>Specific target organ toxicity - (repeated exposure)</td>
<td>Category 2</td>
</tr>
<tr>
<td>Target Organs - Kidney, Liver</td>
<td></td>
</tr>
</tbody>
</table>

Label Elements

Signal Word
Danger

Hazard Statements
May be corrosive to metals
Hydrochloric acid, Trace Metal Grade

Revision Date 02-Apr-2014

Causes severe skin burns and eye damage
May cause respiratory irritation
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep only in original container
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Spills
Absorb spillage to prevent material damage
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition / information on ingredients

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No</th>
<th>Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>7732-18-5</td>
<td>62-65</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>7647-01-0</td>
<td>35-38</td>
</tr>
</tbody>
</table>

4. First-aid measures

Eye Contact
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact
Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation
Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.
Hydrochloric acid, Trace Metal Grade

Ingestion

Do not induce vomiting. Call a physician or Poison Control Center immediately.

Most important symptoms/effects

Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation.

Notes to Physician

Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media

Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.

Unsuitable Extinguishing Media

No information available

Flash Point

No information available

Autoignition Temperature

No information available

Explosion Limits

Upper

No data available

Lower

No data available

Specific Hazards Arising from the Chemical

Corrosive Material. Causes burns by all exposure routes. Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products

Hydrogen chloride gas

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

<table>
<thead>
<tr>
<th>Health</th>
<th>Flammability</th>
<th>Instability</th>
<th>Physical hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
</tbody>
</table>

6. Accidental release measures

Personal Precautions

Use personal protective equipment. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Do not get in eyes, on skin, or on clothing.

Environmental Precautions

Should not be released into the environment. See Section 12 for additional ecological information.

Methods for Containment and Clean Up

Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling

Wear personal protective equipment. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Do not ingest.

Storage

Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines
9. Physical and chemical properties

<table>
<thead>
<tr>
<th>Physical State</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Colorless</td>
</tr>
<tr>
<td>Odor</td>
<td>Pungent</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>No information available</td>
</tr>
<tr>
<td>pH</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Melting Point/Range</td>
<td>-35 °C / -31 °F</td>
</tr>
<tr>
<td>Boiling Point/Range</td>
<td>57 °C / 135 °F @ 760 mmHg</td>
</tr>
<tr>
<td>Flash Point</td>
<td>No information available</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>No information available</td>
</tr>
<tr>
<td>Flammability (solid,gas)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Flammability or explosive limits</td>
<td>No data available</td>
</tr>
</tbody>
</table>

10. Stability and reactivity

Reactive Hazard: None known, based on information available
Stability: Stable under normal conditions.
Conditions to Avoid: Incompatible products. Excess heat.
Incompatible Materials
Metals, Strong oxidizing agents, sodium hypochlorite, Amines, Bases, Fluorine, Cyanides, alkaline

Hazardous Decomposition Products
Hydrogen chloride gas

Hazardous Polymerization
Hazardous polymerization does not occur.

Hazardous Reactions
Contact with metals may evolve flammable hydrogen gas.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50
Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Dermal LD50
Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Vapor LC50
Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

<table>
<thead>
<tr>
<th>Component</th>
<th>LD50 Oral (mg/kg)</th>
<th>LD50 Dermal (mg/kg)</th>
<th>LC50 Inhalation (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>238-277 (Rat)</td>
<td>5010 (Rabbit)</td>
<td>1.68 (Rat) 1 h</td>
</tr>
</tbody>
</table>

Toxicologically Synergistic Products
No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation
Causes burns by all exposure routes

Sensitization
No information available

Carcinogenicity
The table below indicates whether each agency has listed any ingredient as a carcinogen.

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No</th>
<th>IARC</th>
<th>NTP</th>
<th>ACGIH</th>
<th>OSHA</th>
<th>Mexico</th>
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<tbody>
<tr>
<td>Water</td>
<td>7732-18-5</td>
<td>Not listed</td>
<td>Not listed</td>
<td>Not listed</td>
<td>Not listed</td>
<td>Not listed</td>
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<tr>
<td>Hydrochloric acid</td>
<td>7647-01-0</td>
<td>Group 3</td>
<td>Not listed</td>
<td>Not listed</td>
<td>Not listed</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans

Mutagenic Effects
Mutagenic effects have occurred in experimental animals.

Reproductive Effects
Experiments have shown reproductive toxicity effects on laboratory animals.

Developmental Effects
Developmental effects have occurred in experimental animals.

Teratogenicity
Teratogenic effects have occurred in experimental animals.

STOT - single exposure
Respiratory system

STOT - repeated exposure
Kidney Liver

Aspiration hazard
No information available

Symptoms / effects, both acute and delayed
Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Endocrine Disruptor Information
No information available

Other Adverse Effects
See actual entry in RTECS for complete information.

12. Ecological information

Ecotoxicity
13. Disposal considerations

Waste Disposal Methods

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

<table>
<thead>
<tr>
<th>UN-No</th>
<th>Proper Shipping Name</th>
<th>Hazard Class</th>
<th>Packing Group</th>
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</thead>
<tbody>
<tr>
<td>UN1789</td>
<td>HYDROCHLORIC ACID</td>
<td>8</td>
<td>II</td>
</tr>
</tbody>
</table>

TDG

<table>
<thead>
<tr>
<th>UN-No</th>
<th>Proper Shipping Name</th>
<th>Hazard Class</th>
<th>Packing Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN1789</td>
<td>HYDROCHLORIC ACID</td>
<td>8</td>
<td>II</td>
</tr>
</tbody>
</table>

IATA

<table>
<thead>
<tr>
<th>UN-No</th>
<th>Proper Shipping Name</th>
<th>Hazard Class</th>
<th>Packing Group</th>
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</thead>
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<tr>
<td>UN1789</td>
<td>Hydrochloric acid</td>
<td>8</td>
<td>II</td>
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</table>

IMDG/IMO

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<thead>
<tr>
<th>UN-No</th>
<th>Proper Shipping Name</th>
<th>Hazard Class</th>
<th>Packing Group</th>
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</thead>
<tbody>
<tr>
<td>UN1789</td>
<td>Hydrochloric acid</td>
<td>8</td>
<td>II</td>
</tr>
</tbody>
</table>

15. Regulatory information

International Inventories

<table>
<thead>
<tr>
<th>Component</th>
<th>TSCA</th>
<th>DSL</th>
<th>NDSL</th>
<th>EINECS</th>
<th>ELINCS</th>
<th>NLP</th>
<th>PICCS</th>
<th>ENCS</th>
<th>AICS</th>
<th>IECSC</th>
<th>KECL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>231-791-2</td>
<td>-</td>
<td>X</td>
<td>-</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Hydrochloric acid</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>231-595-7</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Legend:

X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations
Hydrochloric acid, Trace Metal Grade

TSCA 12(b) Not applicable

SARA 313

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No</th>
<th>Weight %</th>
<th>SARA 313 - Threshold Values %</th>
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</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>7647-01-0</td>
<td>35-38</td>
<td>1.0</td>
</tr>
</tbody>
</table>

SARA 311/312 Hazardous Categorization

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Health Hazard</td>
<td>Yes</td>
</tr>
<tr>
<td>Chronic Health Hazard</td>
<td>Yes</td>
</tr>
<tr>
<td>Fire Hazard</td>
<td>No</td>
</tr>
<tr>
<td>Sudden Release of Pressure Hazard</td>
<td>No</td>
</tr>
<tr>
<td>Reactive Hazard</td>
<td>No</td>
</tr>
</tbody>
</table>

Clean Water Act

<table>
<thead>
<tr>
<th>Component</th>
<th>CWA - Hazardous Substances</th>
<th>CWA - Reportable Quantities</th>
<th>CWA - Toxic Pollutants</th>
<th>CWA - Priority Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>X</td>
<td>5000 lb</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Clean Air Act

<table>
<thead>
<tr>
<th>Component</th>
<th>HAPS Data</th>
<th>Class 1 Ozone Depleters</th>
<th>Class 2 Ozone Depleters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OSHA Occupational Safety and Health Administration
Not applicable

<table>
<thead>
<tr>
<th>Component</th>
<th>Specifically Regulated Chemicals</th>
<th>Highly Hazardous Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>-</td>
<td>TQ: 5000 lb</td>
</tr>
</tbody>
</table>

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

<table>
<thead>
<tr>
<th>Component</th>
<th>Hazardous Substances RQs</th>
<th>CERCLA EHS RQs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>5000 lb</td>
<td>5000 lb</td>
</tr>
</tbody>
</table>

California Proposition 65
This product does not contain any Proposition 65 chemicals

State Right-to-Know

<table>
<thead>
<tr>
<th>Component</th>
<th>Massachusetts</th>
<th>New Jersey</th>
<th>Pennsylvania</th>
<th>Illinois</th>
<th>Rhode Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security
This product contains the following DHS chemicals:

<table>
<thead>
<tr>
<th>Component</th>
<th>DHS Chemical Facility Anti-Terrorism Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>0 lb STQ (anhydrous); 11250 lb STQ (37% concentration or greater)</td>
</tr>
</tbody>
</table>

Other International Regulations

Mexico - Grade No information available

Canada
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR
### 16. Other information

**Prepared By**  
Regulatory Affairs  
Thermo Fisher Scientific  
Email: EMSDS.RA@thermofisher.com

**Creation Date**  
24-Aug-2009

**Revision Date**  
02-Apr-2014

**Print Date**  
02-Apr-2014

**Revision Summary**  
This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

**Disclaimer**  
The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

**End of SDS**
Hydrochloric acid, Trace Metal Grade

May be corrosive to metals - Causes severe skin burns and eye damage - May cause respiratory irritation; or; May cause drowsiness or dizziness - Causes damage to organs (or state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause hazard)

Keep only in original container. - Do not breathe dust/fume/gas/mist/vapours/spray. - Wash face, hands, and any exposed skin thoroughly after handling. - Use only outdoors or in a well-ventilated area. - Wear protective gloves/protective clothing/eye protection/face protection. - IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. - Immediately call a POISON CENTER or doctor/physician. - Absorb spillage to prevent material damage. - Store in a well-ventilated place. Keep container tightly closed. - Store locked up. - Store in corrosive resistant polypropylene container with a resistant inner liner.

Please refer to the original SDS for more information
SAFETY DATA SHEET

SECTION 1 IDENTIFICATION

Product

Name: Hydrated Lime

Other Names: Hydrate; High-Calcium Hydrated Lime

Recommended Uses: Water Treatment; pH adjustment; FGT; Construction

Company Identification:

3700 Hulen Street
Fort Worth, TX 76107
817-732-8164

Canadian Operations: Lhoist North America of Canada, Inc.
20303-102B Ave.
Langley, BC V1M 3H1
604-888-4333

Emergency Phone Number:

Chemtrec 1-800-424-9300

SECTION 2 HAZARDS(S) IDENTIFICATION

Classification

Eye Damage – Category 1

Carcinogen – Category 1

Skin Irritation – Category 2

Specific Target Organ Toxicity Single Exposure – Category 3
(Respiratory System)

Specific Target Organ Toxicity Repeat Exposure – Category 1
(Respiratory System)

Labeling:

Pictograms:

Signal Word(s): Danger
Hazard Statements: Causes serious eye damage.

Causes skin irritation.

May cause respiratory irritation.

Causes damage to lungs through prolonged or repeated exposure when inhaled.

May cause cancer through inhalation.

Precautionary Statements:

Wear protective gloves and eye protection. Wash exposed skin thoroughly after handling. Do not breathe dust. Use only outdoors or in a well-ventilated area. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not eat, drink or smoke when using this product.

If on skin: wash exposed skin with plenty of water. If skin irritation occurs: Get medical attention. Take off contaminated clothing and wash it before reuse.

If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing. Seek medical attention immediately. If inhaled: Remove person to fresh air and keep comfortable for breathing. Seek medical attention if you feel unwell.

If exposed or concerned: Get medical advice

Dispose of contents or containers in accordance with applicable regulations.

Other Hazards: None.

SECTION 3

COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name: Calcium hydroxide

Common names and synonyms: Hydrate; High-Calcium Hydrated Lime

<table>
<thead>
<tr>
<th>Chemical Identity</th>
<th>CAS #</th>
<th>Concentration, % Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Hydroxide</td>
<td>1305-62-0</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Magnesium Oxide</td>
<td>1309-48-4</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Crystalline Silica</td>
<td>14808-60-7</td>
<td>&lt; 2%</td>
</tr>
</tbody>
</table>
SECTION 4

FIRST AID MEASURES

**Eye Contact:** Contact can cause severe irritation or burning of eyes, including permanent damage. Immediately flush eyes with generous amounts of water for several minutes. Pull back the eyelid to ensure that all lime dust has been washed out. Seek medical attention immediately. Do not rub eyes.

**Inhalation:** This product can cause severe irritation of the respiratory system. Move victim to fresh air. Seek medical attention if necessary. If breathing has stopped, give artificial respiration.

**Skin Contact:** Contact can cause severe irritation or burning of skin, especially in the presence of moisture. Wash exposed area with large amounts of water. Seek medical attention immediately.

**Ingestion:** This product can cause severe irritation or burning of gastrointestinal tract if swallowed. Do not induce vomiting. Seek medical attention immediately. Never give anything by mouth unless instructed to do so by medical personnel.

**Most important symptoms and effects, both acute and delayed:** Irritation of skin, eyes, gastrointestinal tract or respiratory tract. Long-term exposure by inhalation may cause permanent damage. This product contains crystalline silica, which has been classified by IARC as (Group I) carcinogenic to humans when inhaled. Inhalation of silica can also cause a chronic lung disorder, silicosis.

Note to Physician: Provide general supportive measures and treat symptomatically.

SECTION 5

FIREFIGHTING MEASURES

**Extinguishing Media**

**Appropriate Extinguishing Media:** Use dry chemical fire extinguisher

**Inappropriate Extinguishing Media:** Do not use halogenated compounds.

**Firefighting**

**Fire Hazards:** Hydrated Lime is not combustible or flammable. Hydrated Lime is not considered to be an explosive hazard, although reaction with incompatible materials may rupture containers.

**Hazardous Combustion Products:** None
Special Protective Equipment and Fire Fighting Instructions: Keep personnel away from and upwind of fire. Wear full fire-fighting turn-out gear (full Bunker gear), and respiratory protection (SCBA).

SECTION 6  ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use proper protective equipment.

Environmental Precautions: For large spills, as much as possible, avoid the generation of dusts. Prevent release to sewers or waterways.

Methods and Materials for Containment and Cleaning Up:

Small Spills: Use dry methods to collect spilled materials. Avoid generating dust. Do not clean up with compressed air. Store collected materials in dry, sealed plastic or metal containers. Residue on surfaces may be washed with water or dilute vinegar.

Large Spills: Use dry methods to collect spilled materials. Evacuate area downwind of clean-up operations to minimize dust exposure. Store spilled materials in dry, sealed plastic or metal containers.

SECTION 7  HANDLING AND STORAGE

Precautions for Safe Handling: Keep in tightly closed containers. Protect containers from physical damage. Avoid direct skin contact with the material.

Conditions for Safe Storage, Including any Incompatibilities: Store in a cool, dry, and well-ventilated location. Do not store near incompatible materials (see Section 10 below). Keep away from moisture. Do not store or ship in aluminum containers.

SECTION 8  EXPOSURE CONTROLS/ PERSONAL PROTECTION

Control Parameters:

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS #</th>
<th>Exposure Limits</th>
</tr>
</thead>
</table>
| Calcium Hydroxide    | 1305-62-0  | OSHA PEL: 15 mg/m³ (total) 5 mg/m³ (respirable)  
ACGIH TLV: 5 mg/m³     |
| Magnesium Oxide      | 1309-48-4  | OSHA PEL: 15 mg/m³  
ACGIH TLV: 10 mg/m³      |
| Crystalline Silica   | 14808-60-7 | OSHA PEL: 10 mg/m³ divided by (the percentage of silica in the dust plus 2) (respirable)  
ACGIH TLV: 0.025 mg/m³ (respirable) |

Appropriate Engineering Controls: Provide ventilation adequate to maintain PELs.
Personal Protection

Respiratory Protection: Use NIOSH approved respirators if airborne concentration exceeds PEL.

Eye Protection: Use safety glasses with side shields or safety goggles. Contact lenses should not be worn when working with lime products.

Skin Protection: Use appropriate gloves to prevent skin contact. Clothing should fully cover arms and legs.

Other: Eye wash fountain and emergency showers are recommended.

### SECTION 9

<table>
<thead>
<tr>
<th></th>
<th>PHYSICAL AND CHEMICAL PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td></td>
</tr>
<tr>
<td>Physical State:</td>
<td>Solid</td>
</tr>
<tr>
<td>Color:</td>
<td>White</td>
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<tr>
<td>Odor:</td>
<td>Odorless</td>
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<tr>
<td>Odor Threshold:</td>
<td>N/ A</td>
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<tr>
<td>pH:</td>
<td>12.44 @ 25° C</td>
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<tr>
<td>Melting Point:</td>
<td>N/ AF</td>
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<tr>
<td>Initial Boiling Point:</td>
<td>N/ A</td>
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<tr>
<td>Freezing Point:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Flash Point:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Evaporation Rate:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Flammability (solid, gas):</td>
<td>Non-flammable</td>
</tr>
<tr>
<td>Explosion Limits:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Vapor Pressure:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Vapor Density:</td>
<td>N/ A</td>
</tr>
<tr>
<td>Relative Density:</td>
<td>0.4 – 0.7 g/ cm³ (apparent)</td>
</tr>
<tr>
<td>Solubility(ies):</td>
<td>Solubility is 1.6 g/L at 25° C</td>
</tr>
<tr>
<td>Partition coefficient:</td>
<td>Relatively insoluble</td>
</tr>
</tbody>
</table>
Auto-ignition Temperature: N/A
Decomposition Temperature: 580º C / 1076º F
Viscosity: N/A

SECTION 10
STABILITY AND REACTIVITY

Reactivity:

Chemical Stability: Hydrated Lime is chemically stable.

Possibility of Hazardous Reactions: See reactivity above

Conditions to Avoid: Do not allow Hydrated Lime to come into contact with incompatible materials.

Incompatible Materials: Hydrated Lime should not be mixed or stored with the following materials, due to the potential for violent reaction and release of heat:

- Acids (unless in a controlled process)
- Reactive Fluoridated Compounds
- Reactive Brominated Compounds
- Reactive Powdered Metals
- Organic Acid Anhydrides
- Nitro-Organic Compounds
- Reactive Phosphorous Compounds
- Interhalogenated Compounds

Hazardous Decomposition Products: None

SECTION 11
TOXICOLOGICAL INFORMATION

Health Effects: see First Aid discussion in Section 4

Routes of Exposure: see First Aid discussion in Section 4

Symptoms Related to Exposure: see First Aid discussion in Section 4

Carcinogen Listing: Hydrated Lime is not listed by MSHA, OSHA, or IARC as a carcinogen, but this product contains crystalline silica, which has been classified by IARC as (Group I) carcinogenic to humans when inhaled.

SECTION 12
ECOLOGICAL INFORMATION

Ecotoxicity: Because of the high pH of this product, it would be expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems in high concentrations.

Persistence and Degradability: Reacts with atmospheric CO₂ over time to form calcium carbonate
Bioaccumulation Potential: This material shows no bioaccumulation effect or food chain concentration toxicity.

Mobility in Soil: Minimal mobility in soil. Reacts with clay portion of soil to form calcium silicates and calcium aluminates

Other Adverse Effects: This material is alkaline and if released into water or moist soil will cause an increase in pH

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal Recommendations: Dispose of in accordance with all applicable federal, state, and local environmental regulations.

Regulatory Disposal Information: If this product as supplied, and unmixed, becomes a waste, it will not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act.

SECTION 14 TRANSPORT INFORMATION

UN Number: Not Regulated

UN Proper Shipping Name: Not Regulated

Transport Hazard Class(es): Not Regulated

Packing Group: Not Regulated

Marine Pollutant (y/n): This material is alkaline and if released into water or moist soil will cause an increase in pH.

Special Precautions: None

SECTION 15 REGULATORY INFORMATION

National Chemical Inventory Listings:

All chemical ingredients are listed on the USEPA TSCA Inventory List.

US Regulations:
- RCRA Hazardous Waste Number: not listed (40 CFR 261.33)
- RCRA Hazardous Waste Classification (40 CFR 261): not classified
- CERCLA Hazardous Substance (40 CFR 302.4) unlisted specific per RCRA, Sec. 3001; CWA, Sec. 311 (b) (4); CWA, Sec. 307(a), CAA, Sec. 112
- CERCLA Reportable Quantity (RQ) not listed.
- SARA 311/312 Codes: not listed.
- SARA Toxic Chemical (40 CFR 372.65): not listed.

Specific State Regulations: Consult State and Local authorities for guidance. Components found in this product may contain trace amounts of inherent naturally occurring elements (such as, but
not limited to arsenic and cadmium) that may be regulated under California Proposition 65 and other States regulations.

Canada DSL: Listed

Canadian WHMIS Listing:

“E” Corrosive Materials [listed due to corrosive effect on aluminum]

“D2A” Materials causing other toxic effects

<table>
<thead>
<tr>
<th>SECTION 16</th>
<th>OTHER INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepared By: Lhoist North America Technical Services</td>
<td></td>
</tr>
<tr>
<td>Date Prepared: May 1, 2015</td>
<td></td>
</tr>
<tr>
<td>Revision: 2015-1</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations:

N/A Not Available or Not Applicable
IARC International Agency for Research on Cancer
IATA International Air Transport Association
ACGIH American Conference of Governmental Industrial Hygienists
TWA Time Weighted Average
PEL Permissible Exposure Limit
TLV Threshold Limit Value
REL Recommended Exposure Limit

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Hydrated Lime

Causes skin irritation - Causes serious eye damage - May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause hazard) - May cause respiratory irritation; or; May cause drowsiness or dizziness

Obtain special instructions before use. - Do not handle until all safety precautions have been read and understood. - Do not breathe dust/fume/gas/mist/vapours/spray. - Wash exposed skin thoroughly after handling. - Do not eat, drink or smoke when using this product. - Use only outdoors or in a well-ventilated area. - Wear protective gloves/protective clothing/eye protection/face protection. - IF ON SKIN: Wash with plenty of soap and water. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. - IF exposed or concerned: Get medical advice/attention.

Please refer to the original SDS for more information
Material Safety Data Sheet
Ferric sulfate MSDS

Section 1: Chemical Product and Company Identification

<table>
<thead>
<tr>
<th>Product Name:</th>
<th>Ferric sulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Codes:</td>
<td>SLF1315, SLF1828</td>
</tr>
<tr>
<td>CAS#:</td>
<td>10028-22-5</td>
</tr>
<tr>
<td>RTECS:</td>
<td>NO8505000</td>
</tr>
<tr>
<td>TSCA:</td>
<td>TSCA 8(b) inventory: Ferric sulfate</td>
</tr>
<tr>
<td>CI#:</td>
<td>Not available.</td>
</tr>
<tr>
<td>Synonym:</td>
<td></td>
</tr>
<tr>
<td>Chemical Formula:</td>
<td>Fe2(SO4)3.xH2O</td>
</tr>
</tbody>
</table>

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: 1-800-901-7247
International Sales: 1-281-441-4400
Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300
International CHEMTREC, call: 1-703-527-3887
For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

<table>
<thead>
<tr>
<th>Name</th>
<th>CAS #</th>
<th>% by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferric sulfate</td>
<td>10028-22-5</td>
<td>100</td>
</tr>
</tbody>
</table>

Toxicological Data on Ingredients: Ferric sulfate LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact: Check for and remove any contact lenses. Do not use an eye ointment. Seek medical attention.

Skin Contact:
After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention.

**Serious Skin Contact:**
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

**Inhalation:** Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

**Serious Inhalation:** Not available.

**Ingestion:**
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

**Serious Ingestion:** Not available.

### Section 5: Fire and Explosion Data

<table>
<thead>
<tr>
<th>Property</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td><strong>Flammability of the Product:</strong></td>
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<tr>
<td><strong>Auto-Ignition Temperature:</strong></td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Flash Points:</strong></td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Flammable Limits:</strong></td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Products of Combustion:</strong></td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Fire Hazards in Presence of Various Substances:</strong></td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Explosion Hazards in Presence of Various Substances:</strong></td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Risks of explosion of the product in presence of mechanical impact:</strong></td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Risks of explosion of the product in presence of static discharge:</strong></td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Fire Fighting Media and Instructions:</strong></td>
<td>Not applicable</td>
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<tr>
<td><strong>Special Remarks on Fire Hazards:</strong></td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Special Remarks on Explosion Hazards:</strong></td>
<td>Not available</td>
</tr>
</tbody>
</table>

### Section 6: Accidental Release Measures

**Small Spill:**
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

**Large Spill:**
Use a shovel to put the material into a convenient waste disposal container. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

### Section 7: Handling and Storage

**Precautions:**
Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes.

**Storage:**
No specific storage is required. Use shelves or cabinets sturdy enough to bear the weight of the chemicals. Be sure that it is not necessary to strain to reach materials, and that shelves are not overloaded.
Section 8: Exposure Controls/Personal Protection

**Engineering Controls:**
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection:**
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

**Personal Protection in Case of a Large Spill:**
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Exposure Limits:**
TWA: 1 CEIL: 2 (mg/m3) Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

**Physical state and appearance:** Solid.

**Odor:** Not available.

**Taste:** Not available.

**Molecular Weight:** 399.98 g/mole

**Color:** Not available.

**pH (1% soln/water):** Not available.

**Boiling Point:** Not available.

**Melting Point:** Decomposes. (480°C or 896°F)

**Critical Temperature:** Not available.

**Specific Gravity:** 3.097 (Water = 1)

**Vapor Pressure:** Not applicable.

**Vapor Density:** Not available.

**Volutility:** Not available.

**Odor Threshold:** Not available.

**Water/Oil Dist. Coeff.:** Not available.

**Ionicity (in Water):** Not available.

**Dispersion Properties:** Not available.

**Solubility:** Not available.

Section 10: Stability and Reactivity Data

**Stability:** The product is stable.

**Instability Temperature:** Not available.

**Conditions of Instability:** Not available.

**Incompatibility with various substances:** Not available.
Corrosivity: Non-corrosive in presence of glass.
Special Remarks on Reactivity: Not available.
Special Remarks on Corrosivity: Not available.
Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes.

Other Toxic Effects on Humans:
Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.
Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not available. : NA9121 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Pennsylvania RTK: Ferric sulfate Massachusetts RTK: Ferric sulfate TSCA 8(b) inventory: Ferric sulfate CERCLA: Hazardous substances.: Ferric sulfate

Other Classifications:

WHMIS (Canada): CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC): R36/38- Irritating to eyes and skin.

HMIS (U.S.A.):
- Health Hazard: 2
- Fire Hazard: 0
- Reactivity: 0
- Personal Protection: E

National Fire Protection Association (U.S.A.):
- Health: 2
- Flammability: 0
- Reactivity: 0
- Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 05:32 PM

Last Updated: 05/21/2013 12:00 PM

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Ferric Sulfate, Reagent Grade

May be corrosive to metals - Causes skin irritation - Causes serious eye damage - Harmful if swallowed

If medical advice is needed, have product container or label at hand. - Keep out of reach of children. - Read label before use. - Wash the contaminated skin with running water and non-abrasive soap. - Do not eat, drink or smoke when using this product. - Wear protective gloves/protective clothing/eye protection/face protection. - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. - IF ON SKIN: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Please refer to the original SDS for more information
1  Identification

Identification of substance or preparation
METCLEAR MR2405

Product Application Area
Waste treatment additive.

Company/Undertaking Identification
GE Betz, Inc.
4636 Somerton Road
Trevose, PA  19053
T 215 355-3300, F 215 953 5524

Emergency Telephone
(800) 877-1940


2  Hazard(s) identification

********************************************************************************
EMERGENCY OVERVIEW
CAUTION
May cause moderate irritation to the skin. May cause moderate irritation to the eyes. Mists/aerosols may cause irritation to upper respiratory tract.

DOT hazard: Corrosive to aluminum
Odor: Strong; Appearance: Orange, Liquid

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water

********************************************************************************
POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; May cause moderate irritation to the skin.

ACUTE EYE EFFECTS:
May cause moderate irritation to the eyes.

ACUTE RESPIRATORY EFFECTS:
Mists/aerosols may cause irritation to upper respiratory tract.
INGESTION EFFECTS:  
May cause gastrointestinal irritation.

TARGET ORGANS:  
No evidence of potential chronic effects.

MEDICAL CONDITIONS AGGRAVATED:  
Not known.

SYMPTOMS OF EXPOSURE:  
May cause redness or itching of skin.

3 Composition / information on ingredients

Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

This product is not hazardous as defined by OSHA regulations.

No component is considered to be a carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, or the Occupational Safety and Health Administration at OSHA thresholds for carcinogens.

4 First-aid measures

SKIN CONTACT:  
Wash thoroughly with soap and water. Remove contaminated clothing. Thoroughly wash clothing before reuse. Get medical attention if irritation develops or persists.

EYE CONTACT:  
Remove contact lenses. Hold eyelids apart. Immediately flush eyes with plenty of low-pressure water for at least 15 minutes. Get immediate medical attention.

INHALATION:  
Remove to fresh air. If breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. Get immediate medical attention.

INGESTION:  
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 2-8 fluid ounces (60-240 mL) of milk or water.

NOTES TO PHYSICIANS:  
No special instructions

5 Fire-fighting measures
FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).

EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water

HAZARDOUS DECOMPOSITION PRODUCTS:
oxides of carbon, nitrogen and sulfur

FLASH POINT:
> 200F   > 93C P-M(CC)

6 Accidental release measures

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Remove ignition sources. Flush area with water. Spread sand/grit.

DISPOSAL INSTRUCTIONS:
Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement, a permitted waste treatment facility or discharged under a permit. Product as is - Incinerate or land dispose in an approved landfill.

7 Handling and storage

HANDLING:
Alkaline. Do not mix with acidic material. Contact with acids or as the product ages, pH may drop resulting in generation of hydrogen sulfide or carbon disulfide.

STORAGE:
Keep containers closed when not in use. Store away from acids. Keep away from flames or sparks. Store between 40-90F (5-32C). Avoid atmospheric exposure. Avoid exposure to direct sunlight and moisture contamination. Shelf life 270 days.

8 Exposure controls / personal protection

EXPOSURE LIMITS

This product is not hazardous as defined by OSHA regulations.

ENGINEERING CONTROLS:
adequate ventilation

PERSONAL PROTECTIVE EQUIPMENT:
Use protective equipment in accordance with 29CFR 1910 Subpart I

RESPIRATORY PROTECTION:
A RESPIRATORY PROTECTION PROGRAM THAT MEETS OSHA’S 29 CFR 1910.134 AND ANSI Z88.2 REQUIREMENTS MUST BE FOLLOWED WHENEVER WORKPLACE CONDITIONS WARRANT A RESPIRATOR’S USE.

USE AIR PURIFYING RESPIRATORS WITHIN USE LIMITATIONS ASSOCIATED WITH THE EQUIPMENT OR ELSE USE SUPPLIED AIR-RESPIRATORS.

If air-purifying respirator use is appropriate, use any of the following particulate respirators: N95, N99, N100, R95, R99, R100, P95, P99 or P100.

SKIN PROTECTION:
neoprene gloves— Wash off after each use. Replace as
9 Physical and chemical properties

Spec. Grav. (70F,21C) 1.140
Freeze Point (F) 25
Freeze Point (C) -4
Viscosity (cps 70F,21C) 40
Vapor Pressure (mmHg) ~ 18.0
Vapor Density (air=1) < 1.00
% Solubility (water) 100.0

Odor Strong
Appearance Orange
Physical State Liquid
Flash Point P-M(CC) > 200F > 93C
pH As Is (approx.) 12.3
Evaporation Rate (Ether=1) < 1.00
Percent VOC: 0.0

NA = not applicable ND = not determined

10 Stability and reactivity

CHEMICAL STABILITY:
Stable under normal storage conditions.

POSSIBILITY OF HAZARDOUS REACTIONS:
Contact with strong acids may cause a violent reaction releasing heat.

INCOMPATIBILITIES:
May react with strong oxidizers.

DECOMPOSITION PRODUCTS:
oxides of carbon, nitrogen and sulfur

11 Toxicological information

Oral LD50 RAT: >2,000 mg/kg
Dermal LD50 RABBIT: >1,000 mg/kg

Eye Irritation Score RABBIT: 15.33
NOTE - Maximum exposure at 1 hr.; completely reversible by day 3

12 Ecological information

AQUATIC TOXICOLOGY
Ceriodaphnia 48 Hour Static Renewal Bioassay
LC50= 92.5; No Effect Level= 50 mg/L
Ceriodaphnia 7 Day Chronic Bioassay
Reproduction NOEL= 2.5; Reproduction LOEC= 5 mg/L
Daphnia magna 48 Hour Static Acute Bioassay (pH adjusted)
LC50= 240; No Effect Level= 62 mg/L
Fathead Minnow 7 Day Chronic Bioassay
Growth NOEL= 20; Growth LOEL= 40 mg/L
Fathead Minnow 96 Hour Static Acute Bioassay (pH adjusted)
LC50 = 195; No Effect Level = 62.5 mg/L
Rainbow Trout 96 Hour Static Renewal Bioassay
LC50 = 8; 0% Mortality = 3.1 mg/L

BIODEGRADATION
BOD-28 (mg/g): 55
BOD-5 (mg/g): 12
COD (mg/g): 370
TOC (mg/g): 60

13 Disposal considerations

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is:
Not applicable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

14 Transport information

Transportation Hazard: Corrosive to aluminum
DOT: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (SODIUM HYDROXIDE SOLUTION)
8, UN 3266, PG III
DOT EMERGENCY RESPONSE GUIDE #: 154
Note: Some containers may be DOT exempt, please check BOL for exact container classification
IATA: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (SODIUM HYDROXIDE SOLUTION)
8, UN 3266, PG III
IMDG: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (SODIUM HYDROXIDE SOLUTION)
8, UN 3266, PG III

15 Regulatory information

TSCA:
All components of this product are included on or are in compliance with the U.S. TSCA regulations.
CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):
No regulated constituent present at OSHA thresholds
FOOD AND DRUG ADMINISTRATION:
No FDA approval for paper or paperboard having food contact.
NSF Registered and/or meets USDA (according to 1998 Guidelines):
Registration number: Not Registered
SARA SECTION 312 HAZARD CLASS:
Product is non-hazardous under Section 311/312
SARA SECTION 302 CHEMICALS:
No regulated constituent present at OSHA thresholds
SARA SECTION 313 CHEMICALS:
No regulated constituent present at OSHA thresholds

CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC
ENFORCEMENT ACT (PROPOSITION 65):
No regulated constituents present

MICHIGAN REGULATORY INFORMATION
No regulated constituent present at OSHA thresholds

16 Other information

<table>
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<th>HMIS vII</th>
<th>CODE TRANSLATION</th>
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<td>Reactivity</td>
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<td>Special</td>
<td>ALK</td>
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<td>(1) Protective Equipment</td>
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(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

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<th>EFFECTIVE DATE</th>
<th>REVISIONS TO SECTION:</th>
<th>SUPERCEDES</th>
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METCLEAR MR2405

May be corrosive to metals - May be harmful in contact with skin - Causes eye irritation - Harmful if inhaled

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. - IF ON SKIN: Wash with plenty of soap and water. - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Please refer to the original SDS for more information