Permit to Mine Application

NorthMet Project

December 2017

POLYMET
MINING

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Contents

List of Tables

List of Figures

List of Appendices

Glossary of Terms as used by the NorthMet Project

adaptive engineering controls: project elements that control environmental impacts of the Project to water resources and may have their design, operation, and/or maintenance modified before or after installation, if justified, either in scale or type.

adaptive management: a system of management practices, based on clearly defined outcomes and monitoring requirements, that assesses whether planned engineering controls are meeting the desired outcomes, and, if not, the implementation of pre-established processes to improve performance, achieve compliance, and meet the defined outcomes.

background monitoring: monitoring conducted to document surface water quality upstream and groundwater quality upgradient of the Project.

Beneficiation Plant: the buildings and equipment used for ore crushing, grinding, flotation, dewatering, storage and shipping: specifically, the existing Coarse Crusher, Drive House, Fine Crusher, and Concentrator Buildings, and the newly constructed Flotation, Reagent, Concentrate Dewatering, Concentrate Storage, and Concentrate Loadout Buildings.

borrow source: the location of earthen construction material used for the Project. This includes material brought in from off-site and on-site areas. Off-site borrow sources will generally include rock from the Biwabik Iron Formation, rock from the Duluth Complex, and specialty materials that require specific gradations that are not available from on-site sources. Materials from borrow sources, whether sourced from on- or off-site, will be required to meet criteria designed to be protective of water quality.

Category 1 Construction Rock: A subset of Category 1 Waste Rock (see "waste rock") that has a sulfur content of less than or equal to 0.05%. This is also refered to as Duluth Complex construction rock.

Central Pumping Station (CPS): structure in the Equalization Basin Area where mine water is pumped from the equalization basins through pipelines to the WWTS, including the splitter structure.

Colby Lake Pipeline Corridor: follows the Colby Lake Pipeline between Colby Lake and the Plant Site, and includes the Colby Lake Pumphouse.

***compacted soil liner*:** the one-foot thick compacted soil layer of specified gradation and hydraulic conductivity directly underlying the geomembrane component of the liner systems for the Category 2/3 and Category 4 stockpiles and Ore Surge Pile.

***compliance monitoring*:** monitoring conducted at locations downgradient of potential Project impacts where the Project will need to demonstrate compliance.

Construction Mine Water Pumping Station: structure in the Equalization Basin Area for the pumps that convey construction mine water and OSLA runoff (after settling of suspended solids) to the FTB Pond for reuse as process water or to the East Pit to aid in pit flooding in the later years of the operation.

***construction mine water*:** a subset of mine water; runoff from the construction dewatering of saturated mineral overburden, which is collected in the Construction Mine Water Basin. Project water definitions are further described in Table 11-1.

construction stormwater: stormwater associated with construction activities (as defined in Minnesota Rules, part 7090.0080, subpart 4). Project water definitions are further described in Table 11-1.

Contingency Action: the response to unexpected occurrences and potentially hazardous conditions, such as the threat of a dam failure at the FTB or HRF; Contingency Action Plans have been developed for these two facilities.

contingency mitigation: actions that would be undertaken on engineering controls (fixed or adaptive) to address the circumstance that monitoring or modeling estimates show that water quality or quantity at compliance points are projected to exceed applicable standards or limits or if routine adaptive management activities at the Tailings Basin are insufficient to achieve operating constraints.

***dam*:** structure that impounds water and/or waste materials (e.g., tailings, residue), as defined in Minnesota Rules, part 6115.0320, subpart 5.

***dike*:** structure that directs and minimizes the flow of water or separates waters (e.g., perimeter dikes & exclusion dikes).

Equalization Basin Area: the area at the Mine Site (south of Dunka Road and the mainline railroad) that contains the High Concentration Equalization Basin, the Low Concentration Equalization Basins 1 & 2, the Construction Mine Water Basin, the Central Pumping Station, and the Construction Mine Water Pumping Station.

excavated waste rock: the rock material that is removed through blasting from construction and mining activities. See “waste rock stockpile” for the categories of waste rock from the Mine Site.

filtered sludge: the solid material removed in the WWTS chemical precipitation treatment train and filtered (dewatered) prior to disposal in an approved facility. This is also referred to as residual solids or high density sludge (HDS).

fixed engineering controls: project elements that control environmental impacts of the Project to water resources that are not expected to be modified during the life of the Project.

***Flotation Tailings Basin (FTB)*:** the proposed NorthMet Flotation Tailings impoundment to be placed atop the existing LTVSMC tailings basin.

***FTB seepage capture systems*:** the combination of the FTB Seepage Containment System and the FTB South Seepage Management System.

***FTB Seepage Containment System*:** the system consisting of a cutoff wall and collection trench that collects seepage and groundwater along the western, northern, and eastern sides of the Tailings Basin.

FTB South Seepage Management System**:** existing containment dike and sump system that collects surface seepage on southern side of Cell 1E.

high density sludge (HDS): in reference to the WWTS, residual solids are equivalent to filtered sludge or residual solids; see filtered sludge above for definition.

HRF water**:** water collected and stored within the HRF, which includes the following: process water resulting from the hydrometallurgical process and routed to the HRF as part of the residue slurry, and precipitation and runoff from within the HRF dams. Project water definitions are further described in Table 11-1.

Hydrometallurgical Plant: the buildings and equipment used for the further refinement of nickel concentrate to produce a value-added product; specifically, the Hydrometallurgical Plant, the Oxygen Plant, Limestone Preparation Building, and the Hydrometallurgical Reagent Building.

Hydrometallurgical Residue Facility (HRF): lined facility to manage residues generated by the hydrometallurgical process.

indicator monitoring**:** monitoring conducted at locations between the compliance stations and Project features to allow for early detection of potential Project impacts.

industrial stormwater**:** stormwater associated with industrial activities (as defined in Minnesota Rules, part 7090.0080, subpart 6). Project water definitions are further described in Table 11-1.

leakage**:** liquid that leaks through a lined facility.

life of mine: the operations phase.

LTVSMC tailings basin**:** the existing LTV Steel Mining Company taconite tailings basin.

mainline railroad**:** the existing Cliffs Erie private rail line between the Mine Site and Plant Site; this track continues east past the Mine Site to Northshore Mine.

Mine Plan**:** document used during environmental review to present PolyMet's proposed plan for mining. This plan has been replaced by the Mining and Reclamation Plan developed to support this Permit to Mine application.

Mine to Plant Pipelines (MPP)**:** three pipelines that follow the Transportation and Utility Corridor, generally located on the north side of Dunka Road, which consist of the Construction Mine Water Pipeline, the Low Concentration Mine Water Pipeline, and the High Concentration Mine Water Pipeline. These pipelines are used to pump water from the Mine Site to the Plant Site and back.

***mine water*:** water that has contacted surfaces disturbed by mining activities, such as drainage collected on stockpile liners, pit dewatering, and runoff contacting ore, waste rock, and Mine Site haul road surfaces. This water is conveyed by pipe to the equalization basins for further conveyance through the MPP to the Waste Water Treatment System (WWTS). Runoff from construction dewatering of saturated mineral overburden, which is a subset of mine water called construction mine water, is conveyed by pipe to the Construction Mine Water Basin for further conveyance through the MPP to the Flotation Tailings Basin (FTB). Runoff from the Overburden Storage and Laydown Area (OSLA), which is a subset of mine water collected in the OSLA Pond, is conveyed by pipe to the Construction Mine Water Basin for further conveyance through the MPP to the FTB or, in later years, to aid in East and Central Pit flooding. Project water definitions are further described in Table 11-1.

***Mine Year 1*:** the year when production blasting commences within the open pit; production blasting within the pit boundary defines the start of operations.

***Mining and Reclamation Plan*:** Sections 7-11 and 15 along with related appendices of the Permit to Mine application that presents the operating life of the mine; mining activities to be conducted; engineering design, methods, sequence, and schedules of reclamation; and mine waste characterization (as required under Minnesota Rules, part 6132.1100, subpart 6).

Mining Area: the area of land used for the mining and production of metallic minerals, including auxiliary facilities (as defined in Minnesota Rules, part 6132.0100, subparts 19 and 4).

***monitor-only monitoring*:** monitoring required under NPDES/SDS for locations where no limits or standards apply, however, there may be triggers that will initiate further investigation as a result. These locations are not considered compliance locations.

***non-contact stormwater*:** precipitation and runoff that contacts natural, stabilized, or reclaimed surfaces and has not been exposed to mining activities, construction activities (as defined in Minnesota Rules, part 7090.0080, subpart 4), or industrial activities (as defined in Minnesota Rules, part 7090.0080, subpart 6). Project water definitions are further described in Table 11-1.

nonferrous mining rules: Minnesota Rules, chapter 6132.

Observational Method: sequence of data gathering, detailed calculations and performance predictions, additional data gathering and observations, and design modifications as needed to maintain required operating conditions at the Tailings Basin.

Ore Surge Pile: a temporary lined ore storage pile located near the Rail Transfer Hopper, used to help maintain a steady delivery of ore to the Beneficiation Plant.

overburden: includes all unconsolidated earth material that overlies the bedrock; for this Project, there are three general types of overburden to be managed at the Mine Site: peat, saturated mineral overburden, and unsaturated mineral overburden. There are many subsets of each of these types of overburden (e.g., silty sand is a type of mineral overburden and could be either saturated or unsaturated). Minnesota Rules, chapter 6132 uses the term "surface overburden", which in this PTM Application is synomous with the term "overburden" defined here. The term "overburden materials" is also synomous with the term "overburden" defined here. Further definitions associated with overburden include:

- ***mineral overburden:*** all non-peat unconsolidated material above bedrock; includes glacial deposits, alluvial deposits, and topsoil (the top layer of unsaturated mineral overburden, usually the top 2 to 8 inches, with a high concentration of organic matter and microorganisms, which facilitate vegetative growth).
- ***saturated mineral overburden****:* mineral overburden that has remained below the water table and has not been oxidized and can release metals when exposed to air and oxidized.
- ***unsaturated mineral overburden:*** mineral overburden that has been above the water table including all topsoil. At the Project site, this material has been oxidized and has low potential for metal release.
- ***peat:*** organic matter, excluding coal, formed by the partial decomposition of plant material under saturated conditions (as defined in Minnesota Rules, part 6131.0010, subpart 11).

Overburden Storage and Laydown Area (OSLA): storage area for management of overburden material removed during Project activities.

performance monitoring: monitoring conducted to monitor the performance of engineering infrastructure (e.g., liner systems, containment systems).

phases of the Project: there are five separate phases of the Project, as shown on Figure 3-9 and as follows:

- **construction**: the approximately 18-24-month construction phase prior to Mine Year 1.
- **operations:** the approximately 20-year phase of mining and production, from Mine Year 1 through Mine Year 20. This phase includes progressive reclamation activities.
- **reclamation**: the approximately 4-year period of reclamation after operations ends, from approximately Mine Year 21 through Mine Year 24.
- **closure**: the period of time it takes to flood the West Pit, estimated to be from Mine Year 25 through Mine Year 54.
- **postclosure maintenance**: the period after West Pit flooding is completed, estimated to begin in Mine Year 55.

pit rim berm: structure constructed for safety between the pit excavation and the toe of the overburden stripping.

plant reservoir water**:** water collected and stored within the Plant Reservoir, which includes water pumped from Colby Lake and precipitation that falls on the Plant Reservoir. Project water definitions are further described in Table 11-1.

Poly Met Mining, Inc.: the applicant for this Application; a private company incorporated in Minnesota that is the wholly-owned subsidiary of PolyMet Mining Corporation.

PolyMet Mining Corp.: a publicly traded company that is the sole owner of the subsidiary Poly Met Mining, Inc.

Process Plant: consists of the Beneficiation Plant, the Hydrometallurgical Plant, and other auxiliary Plant Site facilities, as shown on Figure 3-6.

process water**:** water that has been used in the beneficiation process or hydrometallurgical process. Project water definitions are further described in Table 11-1.

production blasting: the routine blasting that occurs at the Mine Site performed with the specific intent of accessing ore, and not associated with blasting that may otherwise be required for construction of Mine Site infrastructure and facilities.

progressive reclamation: reclamation activities conducted during the Operations phase of the Project.

PTM Regulations: Minnesota Statutes, chapter 93 and Minnesota Rules, part 6132.1000.

Railroad Spur: new track at the Mine Site off the mainline railroad that connects to the Rail Transfer Hopper and Ore Surge Pile.

refurbish: to repair or make improvements to for continued use.

residual solids: in reference to the WWTS, residual solids are equivalent to filtered sludge or high density sludge (HDS); see filtered sludge above for definition.

Residue: residues generated by the hydrometallurgical process in the Hydrometallurgical Plant and placed in the Hydrometallurgical Residue Facility (HRF).

seepage: water that seeps out of an unlined facility (including water collected by the FTB Seepage Containment System).

sewage**:** water collected from sanitary facilities and sedimentation tank and filter backwash waste collected from the Plant Site Potable Water Treatment System. Project water definitions are further described in Table 11-1.

***stockpile drainage*:** water that flows through a stockpile but is collected (on a liner or in the Category 1 Stockpile Groundwater Containment System).

***surface water discharge monitoring*:** monitoring conducted of the stream augmentation discharge from the Plant Site WWTS where the Project will need to demonstrate compliance with permit limits.

***surface water discharge outfall*:** points where WWTS dischare is released off-site to the wetlands in the headwater area of Unnamed Creek, wetlands in the headwater area of Trimble Creek, and to Second Creek.

***tailings basin seepage*:** tailings basin water that infiltrates through Flotation Tailings, LTVSMC tailings, and/or Tailings Basin dams and migrates through the base or the external dam faces of the Tailings Basin. Project water definitions are further described in Table 11-1.

***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 Flotation Tailings Basin (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; and precipitation and runoff from within the FTB dams. Project water definitions are further described in Table 11-1.

***Tailings Basin*:** the combined LTVSMC tailings basin and FTB.

Transportation and Utility Corridors: areas within the Project outside of the Mine Site and the Plant Site (which includes the HRF and Tailings Basin). They include the following:

> ***Dunka Road and Utility Corridor:*** follows Dunka Road; this corridor includes the MPP and additional utilities (power) that follow the same general alignment.
>
> ***Railroad Corridor:*** follows the railroad track linking the Mine Site and Plant Site, which includes the new Connection Track and the mainline railroad between the Connection Track and the Mine Site and between the Plant Site and the Connection Track.

***treated mine water*:** WWTS effluent from the chemical precipitation and membrane separation portion of the treatment process, which originates from the Mine Site, and is pumped to the FTB after treatment.

***waste rock stockpile*:** lined and unlined above ground waste rock stockpiles for the temporary and/or permanent storage of various categories of waste rock, defined as follows:

- ***Category 1 Waste Rock*:** Duluth Complex waste rock that has a sulfur content of less than or equal to 0.12%.
- ***Category 2 Waste Rock:*** Duluth Complex waste rock that has a sulfur content of greater than 0.12% and less than or equal to 0.31%.

- ***Category 3 Waste Rock:*** Duluth Complex waste rock that has a sulfur content of greater than 0.31% and less than or equal to 0.6%.
- ***Category 4 Waste Rock:*** Duluth Complex waste rock that has a sulfur content of greater than 0.6% and all Virginia formation waste rock.

Waste Water Treatment System (WWTS): the two sets of treatment trains, formerly consisting of the Waste Water Treatment Facility (WWTF) at the Mine Site and the Waste Water Treatment Plant (WWTP) at the Plant Site, that were previously at two locations and would now be housed under one roof at the Plant Site and all associated structures. These treatment trains have been combined to increase efficiency and to allow greater operational flexibility and improvement through the adaptive water management process. While the overall system includes all associated structures, this acronym is specifically used to refer to the building that houses the treatment equipment, which is the primary component of the overall treatment system.

***West Pit discharge*:** discharge from the West Pit after closure to an unnamed tributary to the Partridge River.

Acronyms, Abbreviations and Units

Acronym	Description
<	less than
>	greater than
°	degrees
c'	drained cohesion
C	Cohesion
c_u	undrained cohesion
%	percent
404 Permit	Clean Water Act Section 404 Permit
amsl	above mean sea level
AOCs	Areas of Concern
APE	Area of Potential Effect
Application	Permit to Mine Application
ASTM	American Society for Testing and Materials
BACT	Best Available Control Technology
BGEPA	Bald and Golden Eagle Protection Act
BIF	Biwabik Iron Formation
BMPs	best management practices
BSA	Bank Service Area
CAA	Clean Air Act
CAP	Contingency Action Plan
cfs	cubic feet per second
Cliffs Erie	Cliffs Erie, L.L.C.
cm/sec	centimeters per second
CN	Canadian National
CPS	Central Pumping Station
CPTE	Controlled Potential to Emit
CRE	Contingency Reclamation Estimate
CWA	Clean Water Act
DEIS	Draft EIS
DNR	Minnesota Department of Natural Resources
EIS	Environmental Impact Statement
ELT	Ecological Land Types
ESA	Endangered Species Act
ESSA	effective strength stability analysis
FEC	Fugitive Emission Control
FEIS	Final Environmental Impact Statement
FOS	Factor of Safety
FTB	Flotation Tailings Basin

Fueling Station	Building for fueling mobile equipment
GCL	geosynthetic clay liner
GIS	Geographic Information System
GLO	General Land Office
Golder	Golder Associates
gpm	gallons per minute
HAP	Hazardous Air Pollutants
HRF	Hydrometallurgical Residue Facility
HUC	Hydrologic Unit Code
ICP	inductively coupled plasma
LLDPE	linear low density polyethylene
LLDPE	Linear low density polyethylene
LOM	life of mine
Longyear	Longyear Mesaba Company
LTVSMC	LTV Steel Mining Company
m	meters
MDH	Minnesota Department of Health
MEPA	Minnesota Environmental Policy Act
mg/L	milligrams per liter
MHP	mixed hydroxide product
MIBC	methyl isobutyl carbinol
mil	One thousandth of an inch
MnHPO	Minnesota Historic Preservation Office
MPCA	Minnesota Pollution Control Agency
MPP	Mine to Plant Pipelines
MSFMF	Mine Site Fueling and Maintenance Facility
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NFS	National Forest System
NHIS	Natural Heritage Information System
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standard
OSLA	Overburden Storage and Laydown Area
OSP	Ore Surge Pile
PGE	platinum group elements
PM	particulate matter
PM_{10}	particulate matter in the 10 micron or less size range
$PM_{2.5}$	particulate matter in the size range 2.5 microns or less
PMP	probable maximum precipitation

PolyMet	Poly Met Mining, Inc.
PRI	Partridge River Intrusion
Project	NorthMet Project
PSD	Prevention of Significant Deterioration
PTM	Permit to Mine
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGGS	RGGS Land & Minerals, Ltd. L.P.
RO	reverse osmosis
ROD	Record of Decision
RQD	rock quality designation
RTH	Rail Transfer Hopper
SAG	semi-autogenous grinding
SDEIS	Supplemental Draft Environmental Impact Statement
SDEIS	Supplemental Draft EIS
SDS	State Disposal System
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control, and Countermeasure
SPLS	Synthetic precipitation leaching procedure
SPMP	Special Purpose Monitoring Plan
SRK	SRK Consulting
SWPPP	Stormwater Pollution Prevention Plan
TCLP	Toxicity Characteristic Leaching Procedure
tpy	tons per year
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
USSA	undrained shear strength analysis
$USSA_{liq}$	liquefied shear strength analysis of liquefaction
$USSA_{yield}$	undrained shear strength analysis of yield
VIC	Voluntary Inspection and Cleanup
WCA	Wetland Conservation Act of 1991; Minnesota Rules, chapter 8420
WWTS	Waste Water Treatment System

1.0 Introduction

Poly Met Mining, Inc. (PolyMet) proposes to develop a copper-nickel and platinum-group elements (PGE) ore deposit known as the NorthMet Deposit. Figure 1-1 shows the location of the NorthMet Deposit near Hoyt Lakes, Minnesota, which is on the eastern side of the mining district known as the Mesabi Iron Range. The Mesabi Iron Range hosts extensive mining operations devoted to the extraction and processing of iron ore and taconite.

Ore will be extracted using open pit mining methods. PolyMet will process the ore at the former LTV Steel Mining Company (LTVSMC) plant site, which will be refurbished for the NorthMet Project (Project). Tailings will be disposed of in the existing LTVSMC tailings basin, which will be upgraded to receive nonferrous Flotation Tailings. This Permit to Mine (PTM) Application (Application) refers to the NorthMet Deposit and immediately adjacent land as the "Mine Site," and to the plant processing facilities and nearby Tailings Basin and rail facilities as the "Plant Site." The Plant Site and the Mine Site will be connected by the Transportation and Utility Corridors. An additional pipeline corridor (Colby Lake Pipeline Corridor) will supply water to the Plant Site when needed. Collectively, these facilities and infrastructure comprise the Project. The area of land that encompasses these Project components is the Mining Area, as defined under Minnesota Rules, part 6132.0100, subpart 19. Figure 1-2 depicts the location and extent of the Mining Area. While the extent of the Mining Area is graphically shown on Figure 1-2, the final extent of the boundary will be determined by applicable legal descriptions and surveys.

PolyMet has agreements with Cliffs Erie, L.L.C. (Cliffs Erie) that currently provide PolyMet with access to and other rights to the Plant Site, Mine Site, the Transportation and Utility Corridors, and Colby Lake Pipeline Corridor. PolyMet anticipates that there will be further agreements finalized with Cliffs Erie conveying additional rights to PolyMet, as described in Section 4.0. PolyMet ownership or substantial control, including rights of use or access, will be demonstrated for the lands within the Mining Area before the DNR makes a final decision on whether to issue the permit in response to this Application.

The Mine Site is located on federal land within the Superior National Forest that is administered by the U.S. Forest Service (USFS). The underlying minerals are owned by RGGS Land & Minerals, Ltd. L.P. (RGGS) and the Longyear Mesaba Company (Longyear), and are leased to PolyMet. When discussing the land exchange, areas are described using General Land Office (GLO) acreages. GLO surveys are the official record of the boundaries and contents of public lands and may be different from areas determined using Geographic Information System (GIS) data. In this application, unless noted as GLO acres, all areas provided are calculated in GIS.

As described in its Final Record of Decision (Appendix 16.2.2), the USFS is proposing to convey to PolyMet approximately 6,495 acres (6,650 acres GLO) of Superior National Forest lands encompassing the ore deposit and the adjacent land. In exchange, PolyMet will convey to the USFS approximately 7,075 acres (6,690 acres GLO) of private land within the Superior National Forest. Figure 1-3 and Figure 1-4 show the location of the USFS and PolyMet land holdings that constitute the land exchange. These figures show that the private lands to be conveyed will facilitate the USFS's stated goal of consolidating its land holdings in the region. Figure 1-5 and Figure 1-6 show PolyMet's current and future property interests in surface lands within the Mining Area, respectively. Current interests reflect existing agreements (e.g., contracts for deed and other agreements with Cliffs Erie, agreements with RGGS). Future interests reflect pending or anticipated agreements (e.g., PolyMet having full fee title of lands after the land exchange with the USFS is completed). PolyMet ownership or substantial control, including rights of use or access, will be demonstrated for the lands within the Mining Area before the DNR makes a final decision on whether to issue the permit in response to this Application. Figure 1-7 shows current mineral ownership within the Mining Area. Additional information regarding PolyMet's surface and mineral interests, ownership, and access rights associated with the Project is provided in Section 4.0 and listed in Appendix 1.11 of this Application.

The USFS, together with the U.S. Army Corps of Engineers (USACE) and the Minnesota Department of Natural Resources (DNR) (collectively, the "Co-Lead Agencies") led a joint federal and state environmental review of the Project under the National Environmental Policy Act (NEPA) and the Minnesota Environmental Policy Act (MEPA). This comprehensive process included multiple rounds of agency, tribal, and public review and comment. The Co-Lead Agencies published the Final Environmental Impact Statement (FEIS) in November 2015 (Appendix 16.1). Appendix 16 contains the FEIS and the related environmental studies and analyses.

The FEIS provides governmental decision makers and the public with information about the potential effects of the Project, as well as the mitigation measures that will be taken to eliminate or reduce the effects of the Project on the surrounding environment. As required by NEPA and MEPA, agency decision makers must consider the information in the FEIS before issuing the various permits and approvals needed to build and operate the Project.

The information included in the FEIS and this Application builds on work by Minnesota's state agencies, the copper-nickel mining industry, and members of Minnesota's community (i.e., stakeholders), which have collectively spent decades studying environmental issues relating to the development and production of Minnesota's nonferrous mineral resources. These studies include:

- the Regional Copper-Nickel Study completed in 1979, which concluded that copper-nickel mining can be conducted in an environmentally sound manner (Reference (1))
- the Mining Simulation Study completed in 1990, which focused on the environmental review and permitting processes for metallic minerals mining (Reference (2))
- environmental studies conducted by the DNR on water, rock characterization, and reclamation as they relate to copper-nickel mining (Reference (3))

Given the results of this comprehensive analysis of the potential environmental issues associated with copper-nickel mining, and recognizing the beneficial aspects of nonferrous metallic mineral mining, the issuance of a PTM for the Project will bolster Minnesota's efforts to diversify its mineral economy through long-term support of mineral development, production, and commercialization as set forth in Minnesota Statutes, section 93.001. Additionally, consistent with the policies set forth in Minnesota Rules, part 6132.0200, the Project will promote the orderly development of nonferrous metallic mineral mining by using mining and reclamation best practices to minimize and mitigate adverse environmental effects and to preserve and protect natural resources through each phase of the Project. As further detailed in this Application, PolyMet will implement practices and controls that satisfy each of the provisions in Minnesota Rules, parts 6132.0100 to 6132.5300.

1.1 Overview of Application

This Application contains a comprehensive summary of the Project, including an overview of the Project (Section 3.0), the environmental setting for the Project (Section 5.0 of this Application), the Project mining and reclamation plan (Sections 7.0 through 11.0, and 15.0 and related appendices), environmental and natural resource management and protection (Sections 11.0-14.0), and PolyMet's proposed approach to financial assurance (Section 16.0). It also also describes specific regulatory standards governing various aspects of the Project and the basis of design and/or operational protocols that PolyMet will use to meet these requirements. This information is organized into the following sections:

- Section 1.0 – Introduction
- Section 2.0 – PolyMet Organizational Information and Documents
- Section 3.0 – Overview of the Project's Mining and Reclamation Plan
- Section 4.0 – Land Management
- Section 5.0 – Environmental Setting Information
- Section 6.0 – Related Environmental Review and Permitting
- Section 7.0 – Mine Site and Mining Facilities
- Section 8.0 – Plant Site and Ore Processing Facilities
- Section 9.0 – Transportation and Utility Corridors and Colby Lake Pipeline Corridor
- Section 10.0 – Characterization and Management of Mine Waste
- Section 11.0 – Water Management
- Section 12.0 – Wetland Assessment and Mitigation
- Section 13.0 – Air Quality Management
- Section 14.0 – Project Monitoring Programs
- Section 15.0 – Reclamation, Closure, and Postclosure Maintenance
- Section 16.0 – Financial Assurance
- Section 17.0 – References

This Application also includes supporting appendices. Appendix 1 and Appendix 2 contain more detailed technical information pertinent to the nonferrous mining regulatory requirements including:

- Appendix 1 Regulatory Filings and Compliance Documents
- Appendix 2 Mine Waste Characterization Documentation and Results

Appendix 3 through Appendix 10 contain engineering plans, operational management plans, and reclamation plans. The engineering plans contain permit application support drawings that detail permit level designs. The engineering plans include:

- Appendix 3 Mine Site and Dunka Road Earthwork Permit Application Support Drawings
- Appendix 4 Categories 1, 2/3, and 4 Stockpiles and Ore Surge Pile Design and Category 1 Stockpile Groundwater Containment System Permit Application Support Drawings
- Appendix 5 Mine Site Stormwater Permit Application Support Drawings
- Appendix 6 Flotation Tailings Basin and FTB Seepage Containment and Stream Augmentation Systems Permit Application Support Drawings
- Appendix 7 Hydrometallurgical Residue Facility Permit Application Support Drawings
- Appendix 8 Mechanical Infrastructure Permit Application Support Drawings
- Appendix 9 Sewage Treatment System Permit Application Support Drawings
- Appendix 10 Plant Site Stormwater Permit Application Support Drawings

Management Plans provide information on how the facility will be operated and managed over the Life of Mine (LOM) and include descriptions of the basis of design for various permit level designs. A number of management plans and other reports have been iteratively developed and updated throughout the environmental review process and are included in Appendix 16, as discussed below. These documents, or portions of them, may be further refined to address specific matters in permitting. Six of the management plans were updated following completion of the environmental review process to support this Application and include:

- Appendix 11 Management Plans Updated for Permit to Mine
    - Appendix 11.1 Rock and Overburden Management Plan
    - Appendix 11.2 Water Management Plan – Mine Site
    - Appendix 11.3 Water Management Plan – Plant Site
    - Appendix 11.4 Adaptive Water Management Plan
    - Appendix 11.5 Flotation Tailings Management Plan

- Appendix 11.6 Residue Management Plan

- Appendix 12 contains other plans that have been developed for the Project and includes:
  - Appendix 12.1 Fugitive Emission Control Plan: Mine Site
  - Appendix 12.2 Fugitive Emission Control Plan: Plant Site
  - Appendix 12.3 Blasting Plan

Annual reports will be provided as required by rule (Minnesota Rule, part 6132.1300). They will describe actual mining and reclamation completed during the previous year, the mining and reclamation activities planned for the upcoming year, and a contingency reclamation plan to be implemented if operations cease in the upcoming year. An outline of a typical annual report and the documentation for the first year of operations, as required by Minnesota Rule, part 6132.1100, subpart 8, is provided as follows:

- Appendix 13 Annual Report
  - Appendix 13.1 NorthMet Project Permit to Mine Annual Report Template
  - Appendix 13.2 NorthMet Project Permit to Mine Annual Report First Year of Operations

Reclamation plans and closure cost estimates are detailed in:

- Appendix 14 Reclamation, Closure and Postclosure Maintenance Plan
- Appendix 15 Financial Assurance
  - Appendix 15.1 Legacy Closure Plan
  - Appendix 15.2 Construction Phase Contingency Reclamation Plan and Estimate
  - Appendix 15.3 Mine Year 1 Projected Financial Assurance Estimate
  - Appendix 15.4 NorthMet Project Feature Changes Over Time Memo
  - Appendix 15.5 O&M for Water Treatment During Reclamation and Postclosure Maintenance After Mine Year 1 – 10 mg/L WWTS Sulfate Target Memo

Appendix 16 contains the FEIS, along with related environmental reports. The related environmental reports include the management plans and data packages that were developed to support the environmental review process. In some cases, these reports were updated to support this Application. FEIS supporting documentation that PolyMet updated to support this Application are provided in Appendix 11 and the earlier versions that were developed for the FEIS are included in Appendix 16. Appendix 17 contains work plans for future activities requested by the DNR, and Appendix 18 contains wetland-related reports:

- Appendix 16 Final Environmental Impact Statement and Related Environmental Reports

- Appendix 17 Work Plans
    - Appendix 17.1 2016/2017 Geotechnical Investigation Work Plan (no longer included)
    - Appendix 17.2 Monitoring Wells North of the Mine Site: Installation and Hydrogeologic Monitoring Plan (no longer included)
    - Appendix 17.3 NorthMet Pit: Conceptual Plan for Bedrock Groundwater Flow Mitigation
    - Appendix 17.4 Engineered Wetlands Pilot Scale Testing Work Plan (no longer included)
- Appendix 18 Wetland Related Reports
    - Appendix 18.1 NorthMet Project – Wetland Replacement Plan
    - Appendix 18.2 Biological Opinion

1.2 Regulatory Compliance

The Application was prepared to meet the regulatory requirements set forth in Minnesota Statutes, chapter 93 and Minnesota Rules, chapter 6132. In this Application, these are collectively referred to as the PTM Regulations, while Minnesota Rules, chapter 6132 is referred to as the nonferrous mining rules. For ease of reference, Table 1-1 sets forth the regulatory requirements for a complete application and indicates the specific section of this Application that contains the required information.

Minnesota Rules, chapter 6132 also contains substantive requirements that govern the operation and reclamation of nonferrous mines. This Application describes how the Project will comply with these requirements. With this Application, PolyMet is requesting two variances from the nonferrous mining rules related to closure activities as follows:

- Leaving the Colby Lake Pipeline in-place rather than removing it. Details on this request are provided in Section 1.2.1 of Appendix 14.
- Leaving the existing Utility Tunnels at the Plant Site in-place rather than removing them. Details on this request are provided in Section 1.2.2 of Appendix 14.

In addition to the Application, the Project triggers various other federal, state, county, and city regulatory requirements. A list of the other permits and approvals potentially required for the Project is provided in Table 1-2.

1.3 Permit to Mine Application Process

Minnesota has developed detailed procedures for obtaining a PTM, which are set forth in the PTM Regulations. PolyMet has followed the regulatory procedures required to be completed in advance of filing this Application, and will continue to act in accordance with subsequent procedural requirements. Table 1-3 sets forth the primary procedural requirements for the Application up through the point that the DNR determines that PolyMet has filed the Application. Appendix 1 contains a compilation of materials documenting PolyMet's actions in accordance with applicable procedural requirements.

Table 1-1 Documentation Required in the Application

Required Content	Applicable Regulatory Citation	Location in Application
Documents and Fees		
PTM Application (in duplicate)	Minnesota Rules, part 6132.1100, subpart 2	
Advertisement and affidavit of publication	Minnesota Rules, part 6132.1100, subpart 3, item A	To be filed after publication
Certificate of authority to transact business in Minnesota	Minnesota Rules, part 6132.1100, subpart 3, item B	Appendix 1.7
Certificate of insurance	Minnesota Statutes, section 93.481, subdivision 1(a)(2); Minnesota Rules, part 6132.1100, subpart 3, item C	Appendix 1.8
Financial assurance documents	Minnesota Rules, part 6132.1100, subpart 3, item D; Minnesota Rules, part 6132.1200, subpart 2	Section 16.0 and Appendix 15.2
Application fee of $50,000	Minnesota Statutes, section 93.481, subdivision 1(a)(3)	Previously submitted
Supplemental application fee (if any) for processing application	Minnesota Statutes, section 93.482, subdivision 2	N/A (1)
Organizational Structure		
Post office address	Minnesota Rules, part 6132.1100, subpart 4, item A	Section 2.1
Organizational structure, including parent companies, owners, principal stockholders, partners, and joint venturers	Minnesota Rules, part 6132.1100, subpart 4, item B	Section 2.2
Managing agents or subsidiaries involved in operations	Minnesota Rules, part 6132.1100, subpart 4, item C	N/A
Organizational relationships among joint applicants	Minnesota Rules, part 6132.1100, subpart 4, item D	N/A
Environmental Setting		
Copy of FEIS and all environmental reports	Minnesota Rules, part 6132.1100, subpart 5, item A	Appendix 16
Environmental setting maps	Minnesota Rules, part 6132.1100, subpart 5, item B	Section 5.0

Required Content	Applicable Regulatory Citation	Location in Application
• Bedrock geology	Minnesota Rules, part 6132.1100, subpart 5, item B(1)	Section 5.1 Figure 5-1 through Figure 5-3
• Water basins, water courses, and wetlands that may be affected by mining	Minnesota Rules, part 6132.1100, subpart 5, item B(2)	Sections 5.2 and 5.3 Figure 5-4 through Figure 5-7
• Boundaries of watersheds that may be affected by mining	Minnesota Rules, part 6132.1100, subpart 5, item B(3)	Section 5.2 Figure 5-4 through Figure 5-6
• Hydrogeologic information, including plan view and cross-section maps and description of features on the maps	Minnesota Rules, part 6132.1100, subpart 5, item B(4), including (a) and (b)	Section 5.4 Figure 5-8 through Figure 5-21
• Description of hydrogeological information, including overburden and rock features, well locations, well logs, uses, pumping rates and capacities	Minnesota Rules, part 6132.1100, subpart 5, item B (4) (a) and (b)	Section 5.4 Table 5-3 Appendix 1.12
• Surface water and groundwater compliance monitoring sites and water quality and toxicity standards	Minnesota Rules, part 6132.1100, subpart 5, item B(5)	Section 5.5 Figure 5-22 through Figure 5-29
• Soil inventory	Minnesota Rules, part 6132.1100, subpart 5, item B(6)	Section 5.6 Figure 5-30
• Recorded locations of rare, endangered, and threatened species	Minnesota Rules, part 6132.1100, subpart 5, item B(7)	Section 5.7 Figure 5-31
• Past mining facilities	Minnesota Rules, part 6132.1100, subpart 5, item B(8)	Section 5.8 Figure 5-32
• Recorded archaeological or historic sites	Minnesota Rules, part 6132.1100, subpart 5, item B(9)	Section 5.9 Figure 5-33
• Known surface and subsurface uses	Minnesota Rules, part 6132.1100, subpart 5, item B(10)	Section 5.10 Figure 5-34 through Figure 5-37

Required Content	Applicable Regulatory Citation	Location in Application
• Siting, exclusion, prohibition, and restriction areas	Minnesota Rules, part 6132.1100, subpart 5, item B(11)	Section 5.11 Figure 5-37
• Zoning ordinances and associated land use plans	Minnesota Rules, part 6132.1100, subpart 5, item B(12)	Section 5.12 Figure 5-38
• Surface and mineral rights ownership	Minnesota Rules, part 6132.1100, subpart 5, item B(13)	Section 5.13 Figure 1-5 through Figure 1-7, Figure 4-1 through Figure 4-8
Mining and Reclamation Plan		
Operating life of mine, including mine rate and anticipated changes to mine rate	Minnesota Rules, part 6132.1100, subpart 6, item A	Sections 3.0 and 7.0
Mining activities: types, amounts, sequence, and schedule of mining the ore body and storage piling materials	Minnesota Rules, part 6132.1100, subpart 6, item B(1)	Sections 3.0, 7.0, and 10.0
Mining activities: ore beneficiating process, including type and amount of added chemicals, amounts, sequence, schedule, and means of tailings disposal	Minnesota Rules, part 6132.1100, subpart 6, item B(2)	Sections 3.0, 8.0, and 10.0
Engineering design, methods, sequence, and schedules of reclamation, including closure and postclosure maintenance	Minnesota Rules, part 6132.1100, subpart 6, item C	Sections 3.0 and 15.0; Appendix 3 to Appendix 14
Mine waste characterization	Minnesota Rules, part 6132.1000, subpart 3, item A; Minnesota Rules, part 6132.1100, subpart 6, item D	Sections 10.0; Appendix 2
Wetland replacement plan	Minnesota Statutes, section 103G.222, subdivision 1; Minnesota Rules, part 6132.5300, subpart 2	Appendix 18.1
Mining and Reclamation Maps		
Shape and extent of ore body that will support the operating life of mine	Minnesota Rules, part 6132.1100, subpart 7, item A	Figure 7-5
Lands proposed for use as vegetative reference areas	Minnesota Rules, part 6132.1100, subpart 7, item B	Figure 15-4
Detailed drainage patterns for waters that may contact reactive mine waste	Minnesota Rules, part 6132.1100, subpart 7, item C	Figure 5-4 and Figure 5-6

Required Content	Applicable Regulatory Citation	Location in Application
Status of mining ore body	Minnesota Rules, part 6132.1100, subpart 7, item D	Figure 7-7
Status of watershed and hydrogeologic modification	Minnesota Rules, part 6132.1100, subpart 7, item D	Figure 11-14, through Figure 11-17
Status of construction of storage piles, tailings basin, mine, reservoir, dam, diversion channel, drainage control, settling basin, heap and dump leaching facility, and auxiliary facilities	Minnesota Rules, part 6132.1100, subpart 7, item D	Figure 7-6, Figure 7-7 and Figure 10-15 through Figure 10-18
First Year of Operations		
Detailed plan of activities for first year of operations	Minnesota Rules, part 6132.1100, subpart 8	Appendix 13.2
First Year: Anticipated rate of mining	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item A	Section 3.1 of Appendix 13.2
First Year: Anticipated mining activities	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item B	Section 16.2; Section 3.1 of Appendix 13.2
First Year: Anticipated reclamation	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item C	Section 16.2; Section 3.2 of Appendix 13.2
First Year: Notification of intent to close mining area, if applicable	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item D	Section 3.3 of Appendix 13.2
First Year: Discussion of how anticipated activities differ from approved mining and reclamation plan	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.E	Section 3.4 of Appendix 13.2
First Year: Evidence of liability insurance compliance	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.F	Section 16.0; Section 3.5 of Appendix 13.2
First Year: Anticipated changes in ownership and organizational structure, if applicable	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.G	Section 3.6 of Appendix 13.2
First Year: Approved wetland replacement plan	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.H	Section 3.7 of Appendix 13.2, when approved
Contingency Reclamation Plan: Methods, sequence, and schedule of reclamation	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4, item A	Section 16.2; Appendix 15.2
Contingency Reclamation Plan: Maps and cross-sections depicting construction of each area affected by mining	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4,B	Figures 16-1, 16-2, 16-3

Required Content	Applicable Regulatory Citation	Location in Application
Contingency Reclamation Plan: Cost estimates and financial mechanisms necessary to implement contingency reclamation plan if operations cease in first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4, item C	Section 16.3; Appendix 15.3
Corrective Action: Actual corrective action conducted in previous year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item A	Section 16.3; Section 5 of Appendix 13.2
Corrective Action: Anticipated corrective action for first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item B	Section 16.3; Section 5 of Appendix 13.2
Corrective Action: Corrective action cost estimate for first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item C	Section 16.3; Section 5 of Appendix 13.2
Maps showing status of mining, construction, and reclamation for the first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 6	Figure 16-1, Figure 16-2, and Figure 16-3

Abbreviations:
PTM = Permit to Mine

Notes:
(1) Supplemental fees have been submitted as required and will continue to be submitted for processing the application up until a decision is reached on the Application.

Table 1-2 Potentially Applicable Permits

Regulatory Agency	Permit/Action	Permit Basis
Federal		
USACE	Section 404 Permit	For affected waters within the jurisdiction of the USACE under the CWA, 40 CFR Part 230: Section 404(b)(1)
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
USFWS	Section 7 Endangered Species Act (ESA) Compliance	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 50 CFR 402
USFS	Land Exchange	To resolve any potential conflict between surface and mineral estates
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
State		
DNR	Permit to Mine	Required for all nonferrous metallic mining operations, Minnesota Rules, chapter 6132
	Endangered Species Taking Permit (if required)	If there are state-listed species that may be taken by the Project, Minnesota Rules, parts 6212.1800-6212.2300 and chapter 6134
	Water Appropriation Permits	For withdrawal of water from Colby Lake for plant make-up water; for mine and construction dewatering; for collection of precipitation in lined and concrete basins and ponds; for stream augmentation; Minnesota Rules, chapter 6115
	Dam Safety Permit	For the Tailings Basin and Hydrometallurgical Residue Facility, Minnesota Rules, parts 6115.0300-6115.0520
	Permit for Work in Public Waters	For possible modifications and diversions of a tributary to Wyman Creek in constructing a culvert extension along Dunka Road, and for possible future modifications and diversions of local streams in constructing the West Pit outfall; Minnesota Rules, chapter 6115
	Wetland Replacement Plan approval under WCA and Permit to Mine	For affected wetlands within the scope of the WCA and Minnesota Rules, part 6132.5300
	Burning Permit (if required)	If vegetative material would need to be burned on-site during times with no snow cover

Regulatory Agency	Permit/Action	Permit Basis
MPCA	Section 401 Water Quality Certification/Waiver	Required in conjunction with the Section 404 Permit
	National Pollutant Discharge Elimination System and State Disposal System (NPDES/SDS) Permits	For construction activities that would disturb one acre or more of land, industrial activities, and the management, treatment, and/or discharge of industrial wastewater to surface water or groundwater; this includes both NPDES/SDS general stormwater permits for construction and industrial activities and an individual permit.
	Solid Waste Permit	For construction debris
	Air Emissions Permit (Part 70 Permit)	For emissions of regulated air pollutants
	Waste Tire Storage Permit (if required)	For storage of waste tires generated from NorthMet vehicles
	General Storage Tank Permit	For multiple Project aboveground storage tanks
MDH	Radioactive Material Registration	For measuring instruments
	Permit for Non-Community Public Water Supply System and a Wellhead Protection Plan (if proposed)	Existing Plant Site Potable Water Treatment System to be refurbished
	Permit for Public On-site Sewage Disposal System	For sewage waste generated during construction and operation that would be disposed of on-site
MDPS	Permit for explosives use	For usage of explosives during blasting activities
City of Hoyt Lakes	Zoning Permit	
City of Babbitt	Building Permit	
St. Louis County	Zoning Permit	

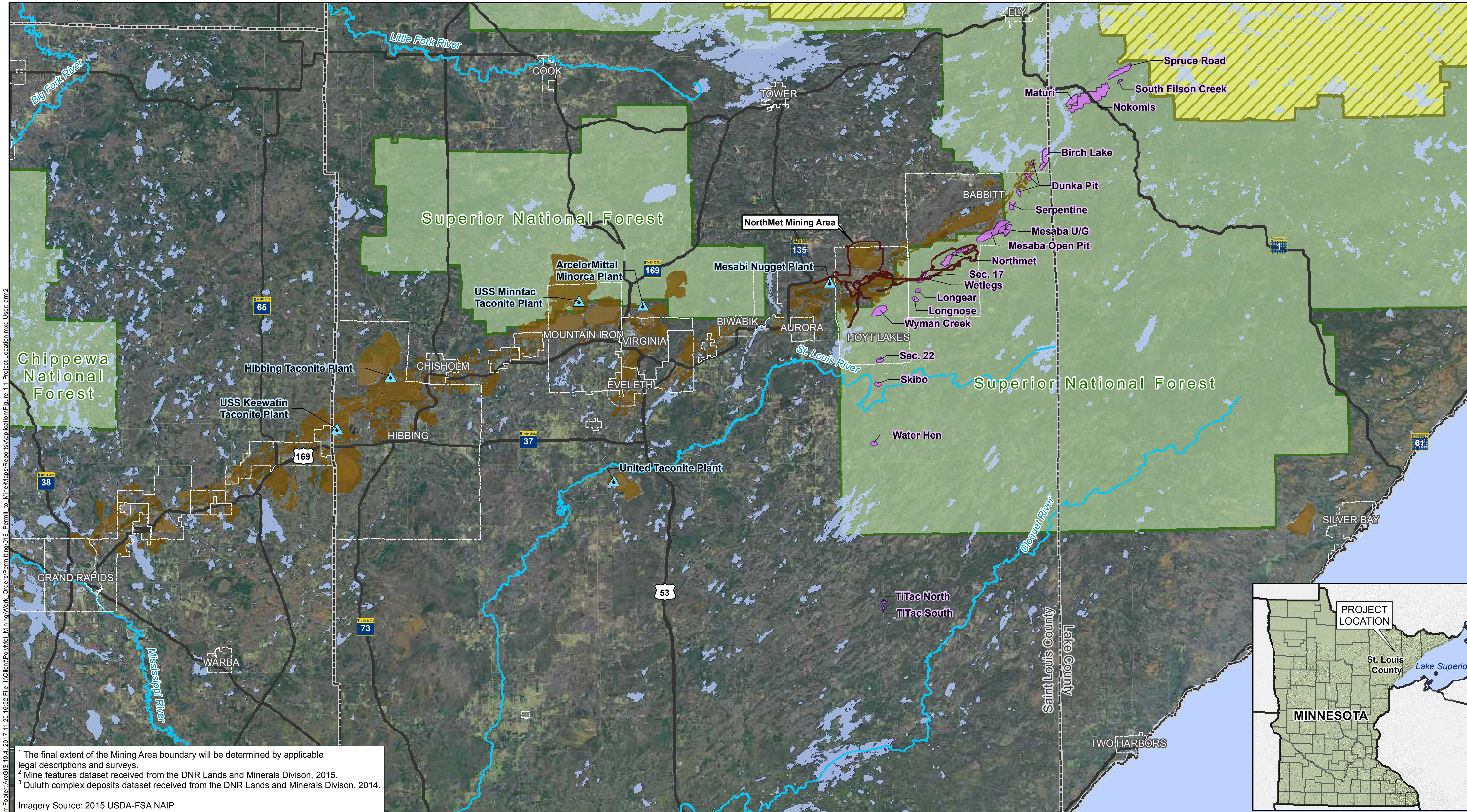
Abbreviations:
CFR = Code of Federal Regulations
CWA = Clean Water Act
DNR = Minnesota Department of Natural Resources
ESA = Endangered Species Act
MDH = Minnesota Department of Health
MPCA = Minnesota Pollution Control Agency
MDPS = Minnesota Department of Public Safety
NHPA = National Historic Preservation Act
NPDES/SDS = National Pollutant Discharge Elimination System and State Disposal System
USACE = U.S. Army Corp of Engineers
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service
WCA = Wetland Conservation Act

Source: Adapted from Appendix 16.1

Table 1-3 Application Procedural Requirements

Procedural Requirement	Statutory/Regulatory Source	Date/Timeframe	Discussion in Application
Mine waste characterization conference with DNR	Minnesota Rules, part 6132.1000, subpart 1	2004/2005	Appendix 2
Preapplication conference with DNR	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	April 19, 2016	Appendix 1.3
Site visit with DNR	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	April 19, 2016	Appendix 1.4
DNR Public Informational Meeting	Minnesota Rules, part 6132.1100, subpart 1	April 19, 2016	Appendix 1.5 and Appendix 1.6
Submission of application in duplicate	Minnesota Rules, part 6132.1100, subpart 2	November 2016, version 1 August 2017, version 2	
DNR completeness determination followed by publication in State Register and EQB by DNR	Minnesota Rules, part 6132.4000, subpart 1	TBD by DNR	
PolyMet's Publication of Advertisement in a qualified newspaper for four weeks once application is determined complete	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	To coincide with DNR publication in State Register and EQB	
Submission of advertisement and affidavit of publication	Minnesota Rules, part 6132.1100, subpart 3; 6132.4000, subpart 1	TBD	
Application deemed filed	Minnesota Rules, part 6132.4000, subpart 1	TBD	

Abbreviations:
DNR = Minnesota Department of Natural Resources
EQB = Environmental Quality Board
TBD = to be determined



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Mine features dataset received from the DNR Lands and Minerals Divison, 2015.
[3] Duluth complex deposits dataset received from the DNR Lands and Minerals Divison, 2014.

Imagery Source: 2015 USDA-FSA NAIP

- Existing Ferrous Plant
- Mining Area[1]
- Mesabi Iron Range Mining Features[2]
- Duluth Complex Deposits[3]
- National Forest Boundary
- Boundary Waters Canoe Area Wilderness
- County Boundaries
- City Boundaries
- Major River
- Lakes

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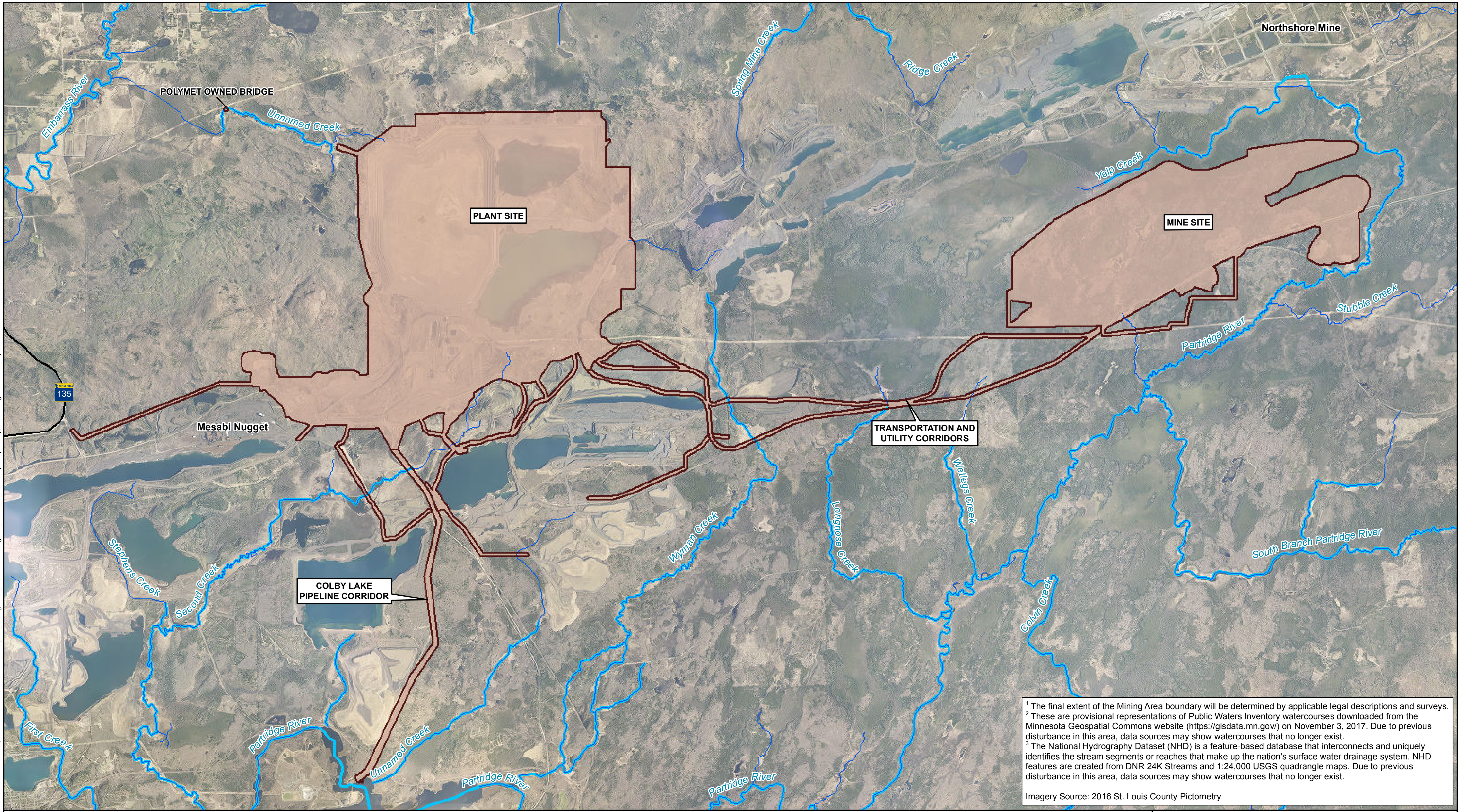
PROJECT LOCATION
NorthMet Project
Poly Met Mining, Inc.

Figure 1-1
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

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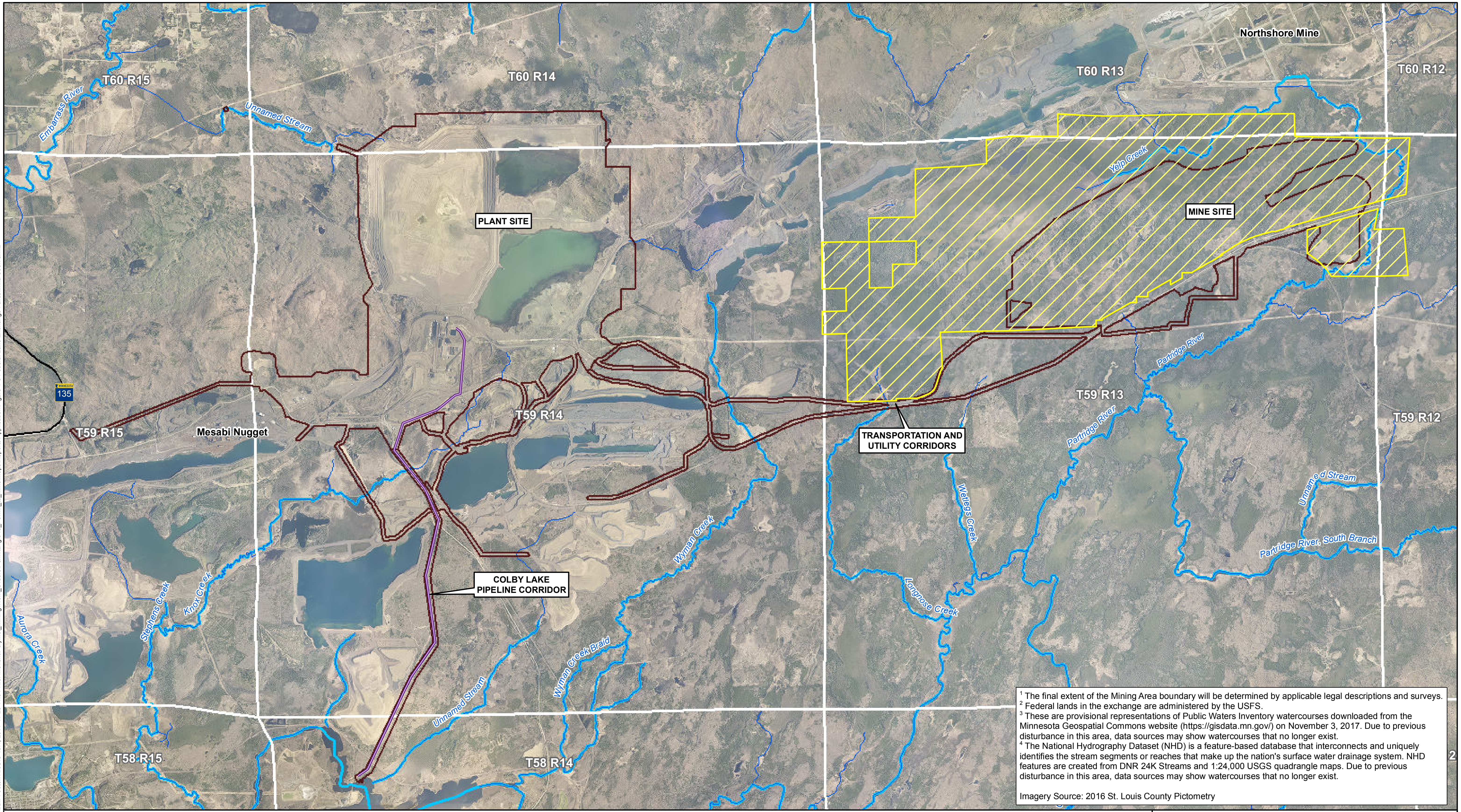
MINING AREA
NorthMet Project
Poly Met Mining, Inc.

Figure 1-2
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Federal lands in the exchange are administered by the USFS.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Federal Land Exchange Parcels[2]
Colby Lake Pipeline
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

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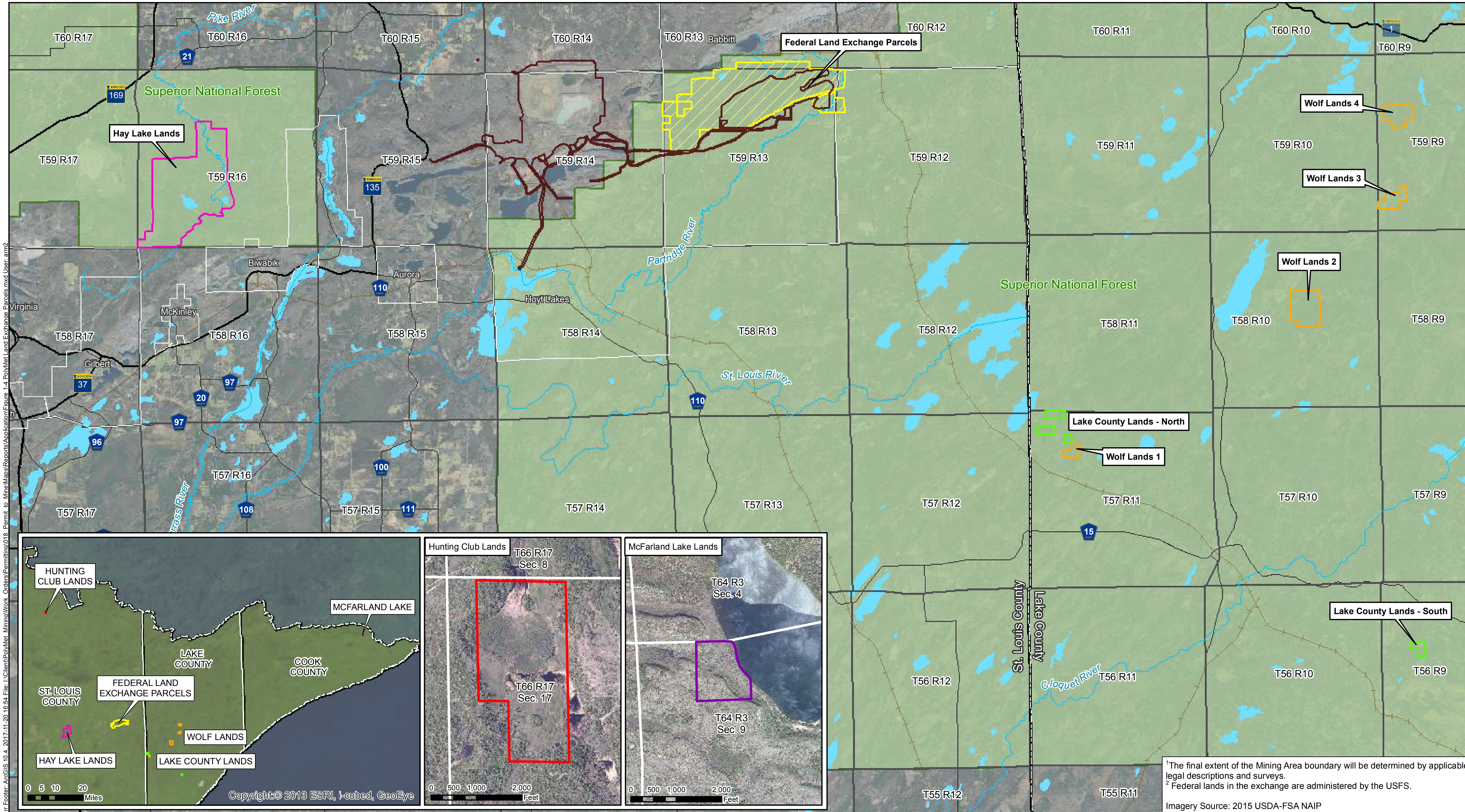
FEDERAL LAND EXCHANGE PARCELS
NorthMet Project
Poly Met Mining, Inc.

Figure 1-3
Permit to Mine Application



[1]The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Federal lands in the exchange are administered by the USFS.

Imagery Source: 2015 USDA-FSA NAIP

Mining Area[1]
Federal Land Exchange Parcels[2]
Hay Lake Lands
Lake County Lands
Wolf Lands
McFarland Lake Lands
Hunting Club Lands
County Boundary
Major River
Lakes

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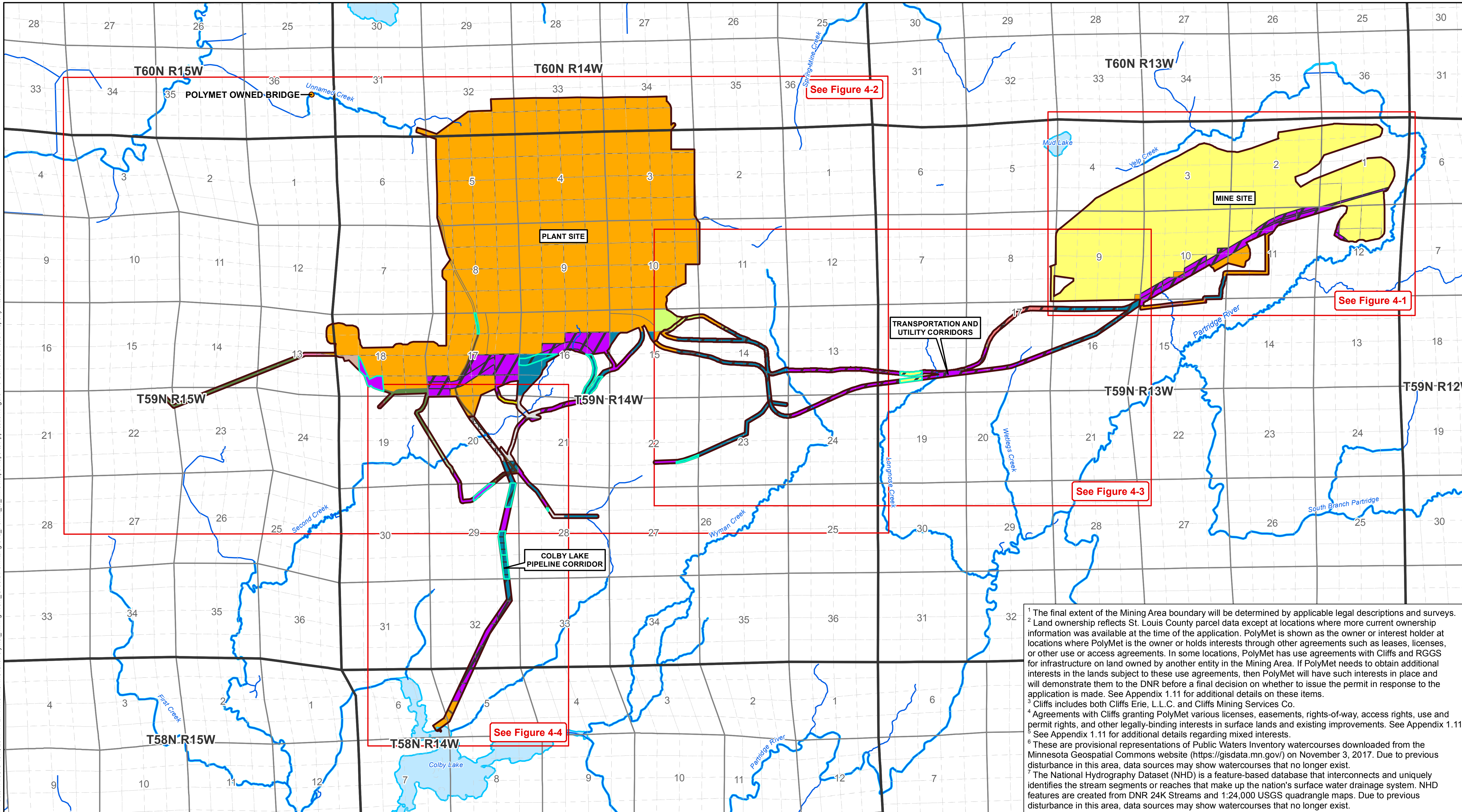
POLYMET LAND EXCHANGE PARCELS
NorthMet Project
Poly Met Mining, Inc.

Figure 1-4
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Land ownership reflects St. Louis County parcel data except at locations where more current ownership information was available at the time of the application. PolyMet is shown as the owner or interest holder at locations where PolyMet is the owner or holds interests through other agreements such as leases, licenses, or other use or access agreements. In some locations, PolyMet has use agreements with Cliffs and RGGS for infrastructure on land owned by another entity in the Mining Area. If PolyMet needs to obtain additional interests in the lands subject to these use agreements, then PolyMet will have such interests in place and will demonstrate them to the DNR before a final decision on whether to issue the permit in response to the application is made. See Appendix 1.11 for additional details on these items.
[3] Cliffs includes both Cliffs Erie, L.L.C. and Cliffs Mining Services Co.
[4] Agreements with Cliffs granting PolyMet various licenses, easements, rights-of-way, access rights, use and permit rights, and other legally-binding interests in surface lands and existing improvements. See Appendix 1.11.
[5] See Appendix 1.11 for additional details regarding mixed interests.
[6] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[7] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]

St. Louis County Parcels by Owner or Interest Holder[2]

- Allete, Inc
- Blandin Paper Company
- Cliffs[3]
- Canadian National
- DuNord Land Company
- Elizabeth P Young Revocable Trust
- Glacier Park Co C/D
- Hughes G S ETAL
- Mesabi Mining, LLC
- Mesabi Nugget Delaware, LLC
- PolyMet - Contract for Deed
- PolyMet - Ancillary Agreements with Cliffs[4]
- PolyMet - Ancillary Agreements with RGGS
- RGGS Land & Minerals LTD LP
- Romberg Carolyn Family Trust
- State of Minnesota
- Tighe Deborah D ETAL
- USA
- Mixed Interests[5]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[6]
- National Hydrography Dataset (NHD) Rivers & Streams[7]

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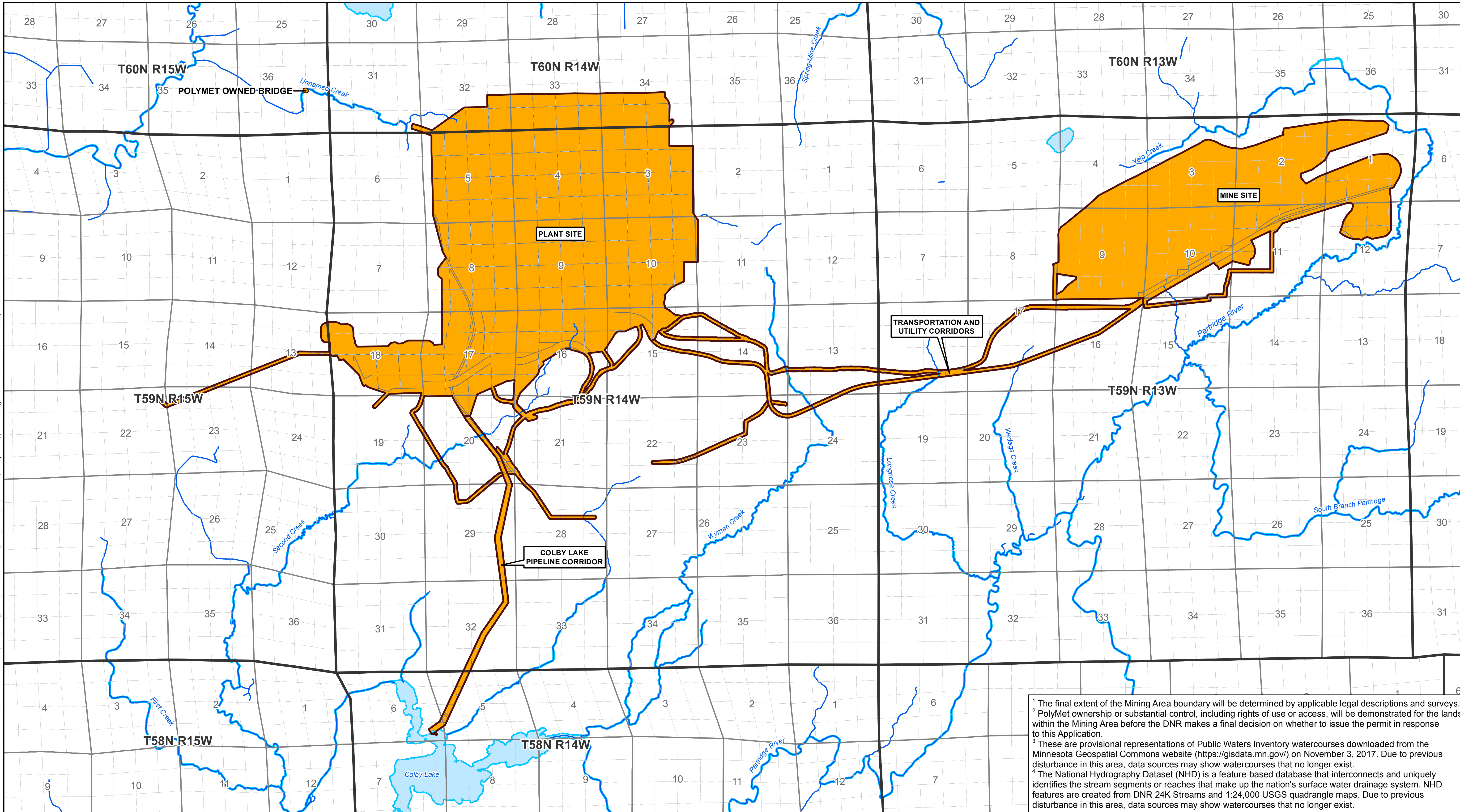
CURRENT SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining, Inc.

Figure 1-5
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-27 14:46 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 1-5 Current Surface Property Interests.mxd User: arm2



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] PolyMet ownership or substantial control, including rights of use or access, will be demonstrated for the lands within the Mining Area before the DNR makes a final decision on whether to issue the permit in response to this Application.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]
St. Louis County Parcels by Owner or Interest Holder[2]
PolyMet
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

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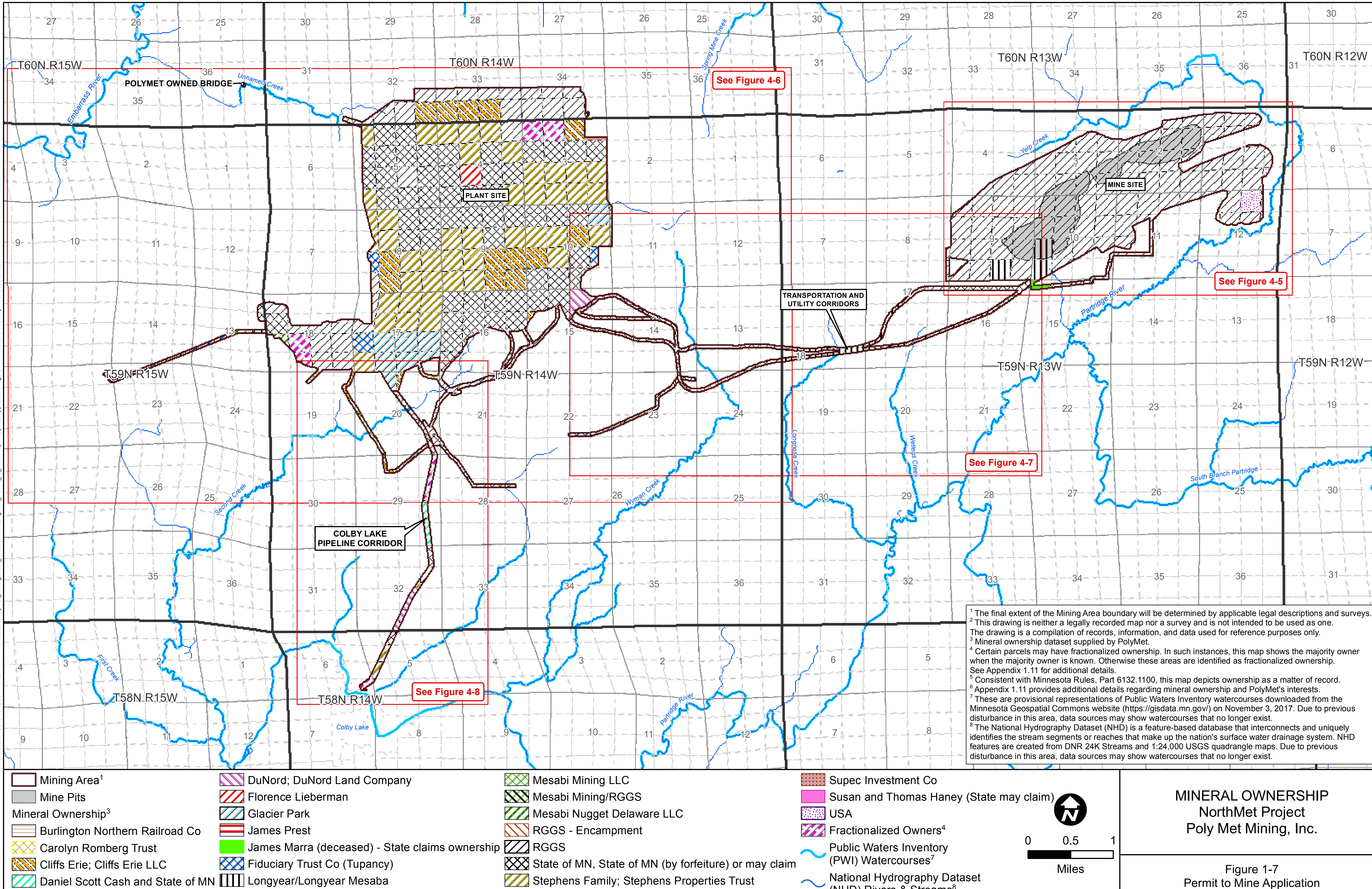
FUTURE SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining Inc.

Figure 1-6
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
[3] Mineral ownership dataset supplied by PolyMet.
[4] Certain parcels may have fractionalized ownership. In such instances, this map shows the majority owner when the majority owner is known. Otherwise these areas are identified as fractionalized ownership. See Appendix 1.11 for additional details.
[5] Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record.
[6] Appendix 1.11 provides additional details regarding mineral ownership and PolyMet's interests.
[7] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[8] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining, Inc.

Figure 1-7
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-27 14:47 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 1-7 Mineral Ownership.mxd User: arm2

2.0 PolyMet Organizational Information and Documents

Consistent with the applicable regulatory requirements, this Section 2.0 provides information about PolyMet's organizational structure, including its post office address; its parent company, owners, principal stockholders, partners, and joint venturers; any managing agents or subsidiaries involved in operations; and any organizational relationships among joint applicants as set forth in Minnesota Rules, part 6132.1100, subpart 4.

2.1 Applicant Name, Address, and Required Certificates

The applicant for this Application is Poly Met Mining, Inc., which is referred to in this Application as PolyMet. The post office address of PolyMet is:

Poly Met Mining, Inc.
444 Cedar Street, Suite 2060
St. Paul, MN 55101

PolyMet is incorporated in Minnesota, and as a domestic corporation is not required to file a certificate of authority to transact business. PolyMet's certificate of good standing and its certificate of public liability insurance are provided in Appendix 1.7 and Appendix 1.8.

2.2 Organizational Structure

PolyMet is a private company that is a wholly-owned subsidiary of PolyMet Mining Corp., which is a publicly traded company listed on the New York Stock Exchange (symbol: PLM) and the Toronto Stock Exchange (symbol: POM). Organizational information is summarized below:

Parent Company:
PolyMet Mining Corp.
First Canadian Place
100 King Street West, Suite 5700
Toronto, ON M5X 1C7
416.915.4149

Subsidiary Company:
Poly Met Mining, Inc.
Executive Office
444 Cedar Street, Suite 2060
St. Paul, MN 55101
651.389.4100

Operational Headquarters
P.O. Box 475, 6500 County Road 666
Hoyt Lakes, MN 55750
218.471.2150

Both Poly Met Mining, Inc. and PolyMet Mining Corp. will be signaories to the Permit to Mine, if granted. None of the following relationships or entities are associated with PolyMet as the applicant for this Application:

- Partners
- Joint venture relationships
- Owners
- Principal stockholders
- Managing agents or subsidiaries involved in mining operations
- Joint applicants

PolyMet Mining Corp.'s Annual Information Form for the fiscal year ending January 31, 2017, filed with the United States Securities and Exchange Commission is included as Appendix 1.9. This report can also be found at:

http://polymetmining.com/investors/financial-reports/

Glencore AG, a wholly owned subsidiary of Glencore plc (together "Glencore"), one of the world's largest global diversified natural resource companies, owns 29.1% of PolyMet Mining Corp.'s issued and outstanding common shares and, pursuant to various financing agreements, would own 35.1% of the common shares if all options and warrants were exercised by Glencore and others.

Glencore's industrial and marketing activities are supported by a global network of more than 90 offices located in over 50 countries. Glencore's diversified operations comprise over 150 mining and metallurgical sites, offshore oil production assets, farms, and agricultural facilities. Glencore currently employs approximately 181,000 people.

Other than Glencore, PolyMet Mining Corp. does not have any partners, joint venture relationships, owners, other principal stockholders (defined for this purpose as holding greater than 5% common shares), managing agents, or subsidiaries involved in mining operations, or joint applicants.

2.3 Qualifications to Hold Permit to Mine

PolyMet is qualified under Minnesota Statutes, chapter 93, and Minnesota Rules, chapter 6132 to apply for and obtain a nonferrous Permit to Mine. A person intending to "engage in or carry out a mining operation for metallic minerals within the state" must apply for and then obtain a Permit to Mine from the DNR before commencing operations (Minnesota Statutes, section 93.481, subdivision 1; Minnesota Rules, part 6132.0300, subpart 1). Under Minnesota Rules, the person intending to "conduct a mining operation for nonferrous metallic minerals . . . must possess capital and provide financial and operational decision making necessary to conduct the mining operation." (Minnesota Rules, part 6132.0300).

First, PolyMet is a "person" (defined to include corporations and other legal entities) intending to conduct mining operations, and has the required decision-making authority and expertise for financial and operations matters. Second, PolyMet Mining Corp.'s audited financial statements reported total assets of $389 million at January 31, 2017 and is financially positioned to conduct the mining operation described in this application. Financial assurance to be provided by PolyMet before issuance of the Permit to Mine will provide a source of funds for the DNR to use in the unlikely event that mining operations cease during construction or in the first year of operations.

3.0 Overview of the Project's Mining and Reclamation Plan

The Project encompassed within the Mining Area consists of the Mine Site, Plant Site, Transportation and Utility Corridors, and the Colby Lake Pipeline Corridor as shown on Figure 1-2. PolyMet has, consistent with Minnesota Rules, part 6132.1000 and part 6132.1100, subparts 6 and 7, prepared a Mining and Reclamation Plan for the Project. This Section 3.0 provides an overview of the Mining and Reclamation Plan, which is discussed in more detail in Sections 7.0 through 11.0 and 15.0, along with related appendices. The Mining and Reclamation Plan is organized as follows:

- Section 3.0 presents a high-level overview of the Project, including the general configuration, construction activities, major materials to be managed, and schedule.
- Section 7.0 describes the Mine Site facilities and operations.
- Section 8.0 describes the Plant Site facilities and operations.
- Section 9.0 describes the Transportation and Utility Corridors and Colby Lake Pipeline Corridor, along with auxiliary facilities.
- Section 10.0 describes PolyMet's waste characterization program, mine waste materials, and the management and progressive reclamation of these materials during Project operations.
- Section 11.0 describes the design and operation of water management facilities during Project operations.
- Section 15.0 provides an overview of the reclamation, closure, and postclosure maintenance phases.

For the analyses and activities set forth in Section 3.0 through 16.0, including the Mining and Reclamation Plan, references to PolyMet include its consultants, contractors, and other technical persons working on its behalf.

The Mining and Reclamation Plan presents PolyMet's current expectations regarding the proposed Project construction and operations, including the information required under Minnesota Rules 6132.1100, subpart 6. Consistent with the nonferrous PTM Regulations and DNR practice, the Mining and Reclamation Plan contemplates that the specific details of the proposed mining operations may vary in a particular year based on operational considerations and market conditions. As part of its Annual Report under the Permit to Mine, PolyMet will submit, among other things, information regarding the anticipated rate of mining, specific mining operations, reclamation for the upcoming year, and discussion of any changes to the Mining and Reclamation Plan set forth in this Application, in accordance with Minnesota Rules, part 6132.1300.

The Mining and Reclamation Plan incorporates an outcome-based approach, as well as PolyMet's business standard for continuous improvement. The PTM Regulations require that mining operations control possible adverse impacts on the environment. Accordingly, each section of the Mining and Reclamation Plan identifies the applicable permitting goals for components of the Project and then describes how the Project will meet the applicable regulatory requirements to achieve these permitting goals. Adaptive management is one of the main tools PolyMet will use to achieve and maintain compliance using the outcome-based approach. Adaptive management is described in more detail in Section 3.6.

3.1 Project Configuration Overview

3.1.1 Mine Site

The layout of the Mine Site during Mine Year 1, Mine Year 11, Mine Year 20 and postclosure maintenance is shown on Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 respectively. When fully operational, the Mine Site will consist of the following features:

- Three mine pits will be referred to as the East Pit, Central Pit, and West Pit.
- The Category 1 Waste Rock Stockpile will contain the waste rock with the lowest sulfur content (≤0.12% S). It will be a permanent, engineered stockpile that includes a groundwater containment system. As part of progressive reclamation, PolyMet will install an engineered cover to minimize precipitation percolating through the stockpile.
- The Category 2/3 Waste Rock Stockpile will contain waste rock with a sulfur content that is higher than Category 1 waste rock and lower than Category 4 waste rock (>0.12% and ≤0.60% S). This stockpile will be a temporary, engineered structure with a liner and drainage collection system at the base to collect precipitation that percolates through the stored waste rock. PolyMet will backfill the Category 2/3 waste rock into the East Pit allowing subaqueous storage after mining in the East Pit is complete.
- The Category 4 Waste Rock Stockpile will contain waste rock with a sulfur content that is greater than Category 2/3 waste rock (>0.60% S). This stockpile will be a temporary, engineered structure with a liner and drainage collection system at the base of the stockpile to collect precipitation that percolates through the stored waste rock. PolyMet will backfill the Category 4 waste rock in the East Pit, allowing subaqueous storage after mining in the East Pit is complete. After the Category 4 Waste Rock Stockpile is removed, the Central Pit will be developed within its former footprint.
- The Ore Surge Pile (OSP) will provide temporary storage of ore at the Mine Site. The OSP will be an engineered stockpile with a liner and drainage collection system.
- The Overburden Storage and Laydown Area (OSLA) will be used to screen, sort, and temporarily stockpile unsaturated mineral overburden and peat.
- The Rail Transfer Hopper (RTH) will be a raised structure used to transfer ore from trucks to rail cars.

- A new, approximately 6,000-foot railroad spur and loadout area will connect the RTH and OSP to an existing private rail line for transport of ore from the Mine Site to the Plant Site (Railroad Spur).

- The Equalization Basin Area will contain the Construction Mine Water Basin and associated Construction Mine Water Pumping Station, and lined mine water equalization basins and associated Central Pumping Station, to convey mine water via the Mine to Plant Pipelines (MPP) to the Plant Site.

- The Mine Site Fueling and Maintenance Facility (MSFMF) will service mobile mine equipment including performing minor maintenance (oil changes, haul truck box welds, etc.) on mine haul trucks.

- Haul Roads will support transport of ore and waste rock.

- Stormwater ponds and associated ditches will be located and sized to manage stormwater. These ponds will collect a mixture of stormwater that, depending on the Mine Year and the pond location, may include construction stormwater, industrial stormwater, and non-contact stormwater from the Mine Site.

- Existing and proposed electric power transmission lines will provide electricity to the Mine Site.

- Perimeter dikes and stormwater ditches will minimize the amount of surface water flowing onto the Mine Site, minimize dewatering of wetlands outside the Mine Site, prevent mine drainage from flowing uncontrolled off the Mine Site, and manage the rate and location of stormwater flowing off the Mine Site.

- Mine water ponds, sumps, pipes, and pumps will collect mine water runoff from mine features and transport the water to the Equalization Basin Area.

Section 7.0 describes the features associated with the Mine Site in more detail, including the planned construction and improvements.

3.1.2 Plant Site

The Plant Site is shown on Figure 3-5, Figure 3-6, and Figure 3-7 and when fully operational will consist of the following features:

- The Beneficiation Plant will combine new and existing LTVSMC buildings and equipment. Ore processing will be accomplished by crushing, grinding, flotation, and concentrate dewatering, followed by product loadout.

- The Flotation Tailing Basin (FTB) will be constructed on top of the existing LTVSMC tailings basin. The FTB will manage Flotation Tailings produced by the Project. The Tailings Basin, in this Application, refers to the combined LTVSMC tailings basin and the FTB.

- FTB seepage capture systems will manage seepage from the Tailings Basin.

- A Hydrometallurgical Plant and a Hydrometallurgical Residue Facility (HRF) are expected to be built several years after mining and ore processing commence, with the timing dependent on customer requirements and overall Project economics. The Hydrometallurgical Plant will further process concentrate to produce a value-added product. The HRF will store Residue from the hydrometallurgical process.

- The Waste Water Treatment System (WWTS) will facilitate compliance with water quality standards through proven control technologies such as reverse osmosis (RO) or similar membrane separation technology and associated systems.

- The Sewage Treatment System will consist of stabilization ponds and associated piping.

- The Potable Water Treatment System will provide potable water for the Plant Site.

- Existing maintenance and repair facilities including the General Shops, the Rebuild Shop, Area 1 Shop facilities, and Area 2 Shop facilities will service Project vehicles and equipment, including performing major maintenance on mine haul trucks.

- Additional auxiliary facilities and supporting infrastructure will include roads, electrical transmission lines and equipment, and rail connections within the boundaries of the Plant Site.

Section 8.0 describes the features associated with the Plant Site in more detail, including the planned construction and improvements. The area containing the Beneficiation Plant, the Hydrometallurgical Plant, and other auxiliary Plant Site facilities, as shown on Figure 3-6, is collectively referred to as the Process Plant. Note that Flotation Tailings and residues generated by the hydrometallurgical process (Residue) are separate materials. As defined in this Application, tailings do not include the Residue generated by the Hydrometallurgical Plant and placed in the HRF.

3.1.3 Transportation and Utility Corridors

The Transportation and Utility Corridors are located between the Mine Site and Plant Site, as shown on Figure 3-8. Features of these corridors include:

- a segment of Dunka Road (a private road)

- new and existing electrical transmission lines and power distribution lines

- the MPP

- a segment of the existing Cliffs Erie private rail line between the Mine Site and Plant Site (mainline railroad)

- a new, approximately 5,575-foot spur track running between the existing track on the north side of Area 2 Pit to the mainline railroad (Connection Track)

Construction of roads and improvements/upgrades of rail lines will include verifying that rail lines will be suitable for ore transport and installing the necessary culverts or culvert extensions and other infrastructure. PolyMet will upgrade the existing Dunka Road to accommodate vehicles associated with mine activity. Section 9.1 describes the components of the Transportation and Utility Corridors in more detail, including the planned construction and improvements.

3.1.4 Colby Lake Pipeline Corridor

The Colby Lake Pipeline Corridor is shown on Figure 3-8 and consists of:

- an existing pipeline that will deliver water from Colby Lake to the Plant Site
- an existing pumphouse located at Colby Lake
- existing electrical transmission lines

Section 9.2 describes the components of the Colby Lake Pipeline Corridor in more detail.

3.2 Project Timeline

The Project timeline, for this Application, is broken into five separate phases: construction, operations, reclamation, closure, and postclosure maintenance. A description of the overall Project timeline during all five phases is presented on Figure 3-9. The Project timeline is the basis for most of the scheduling information in this Application unless otherwise noted. Figure 3-10 presents an overview of the Project timeline through Mine Year 20 (the end of Project operations). The Mine Year, as presented in this Application, is based on the assumption that Project operations start at the beginning of Mine Year 1, which is preceded by the construction phase.

Although construction is anticipated to take 18 to 24 months, for simplicity, construction is accounted for in this Application as beginning in Construction Year 1 extending through Construction Year 2. Section 3.3 describes construction activities.

As part of the second annual report due to the commissioner by March 31 of the first year after permit issuance, Project references will change from Mine Year to calendar year, consistent with reporting requirements, and financial assurance calculations will be adjusted to calendar years. Calendar year will be used in all subsequent annual reports.

The operations phase will commence on the first day of production blasting within the open pit (Mine Year 1) and extend through the end of Mine Year 20. The operations phase is also referred to as the LOM. Section 3.4 presents an overview of the operations phase activities.

The reclamation phase will encompass activities such as demolition of structures, regrading and revegetating footprints of the demolished structures and other mine features, and fencing areas as necessary for site management, security, and monitoring. Project reclamation is planned to begin in Mine Year 21 and extend for four years through Mine Year 24. As described in Section 7.5.6 and Section 8.7 for the Mine Site and Plant Site, respectively, there will also be progressive reclamation of various facilities in advance of Mine Year 21.

Closure, as defined in Minnesota Rules, part 6132.0100, subpart 6 is "the process of terminating and completing final steps in reclaiming any specific portion of a mining operation. Closure begins when, as prescribed in the Permit to Mine, there will be no renewed use or activity by the permittee." PolyMet anticipates commencing closure activities when reclamation activities are complete, which is projected to occur at the end of Mine Year 24. The Project will transition from the closure phase to the postclosure maintenance phase when the West Pit is full of water and PolyMet begins discharging treated water at the Mine Site, in approximately Mine Year 55.

At the end of the closure phase, PolyMet will commence postclosure maintenance activities. As defined in Minnesota Rules, part 6132.0100, subpart 26, postclosure maintenance includes any "activity that may be required to sustain reclamation after cessation of a mining operation." PolyMet anticipates beginning postclosure maintenance activities in Mine Year 55, and will continue those activities until no longer necessary under the applicable statutes and regulations.

The duration of the postclosure maintenance phase will depend upon compliance with applicable water quality standards as enforced through the NorthMet Project National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permit. Further discussion of the reclamation, closure, and postclosure maintenance activities is presented in Section 3.5.

This Application delineates and describes Project phases slightly differently than the FEIS and other PolyMet permit applications, as compared in Table 3-1.

Sections 3.3 through 3.6 present an overview of the Project phases, as defined for this Application.

3.3 Construction Phase

This Section 3.3 describes the construction activities, which would commence upon issuance of a Permit to Mine and take approximately 18 to 24 months. Between now and then, the permitting process and final design may result in refinements to the construction activities, descriptions, and schedules.

Construction activities will be conducted in a manner consistent with applicable permit conditions. Water management during construction will be consistent with the requirements of the state of Minnesota's NPDES/SDS Construction Stormwater General Permit (Permit No. MNR100001 (Construction Stormwater General Permit).

The Permit Application Support Drawings in Appendix 3 through Appendix 10 depict the construction details of various major facilities associated with the Project. Table 3-2 lists the drawing sets and associated structures included in these appendices. Major structures include Mine Site structures and associated water management facilities and Plant Site structures, including the FTB, the HRF, and associated water management facilities. These Permit Application Support Drawings, together with Section 10.0, Appendix 2, and Appendix 11.1, provide information about the materials used for construction based on PolyMet's Mine Waste Characterization. In addition, this Application describes auxiliary facilities, as defined in Minnesota Rules, part 6132.0100, subpart 4, associated with the Project. There will be some auxiliary facilities (e.g., transmission lines, temporary storage areas) that are not yet defined in this Application; the details associated with these additional auxiliary facilities will be identified in final design. PolyMet understands that any auxiliary facilities not shown and/or discussed in this Application may require a PTM amendment and/or other approvals or actions on other permits.

3.3.1 Mine Site Construction Activities

Activities at the Mine Site during the construction phase will include:

- clearing of trees and woody vegetation
- construction of haul roads
- initial overburden stripping of portions of the pit footprints and progressive reclamation of pit rim overburden backslopes once portions reach their final extents
- initial construction of the temporary waste rock stockpiles and OSP liners
- construction of the initial Category 1 Waste Rock Stockpile foundation and Category 1 Waste Rock Stockpile Groundwater Containment System
- construction of the Railroad Spur
- initial grading of the RTH
- construction of the MSFMF
- construction of the Equalization Basin Area, including the CPS and Construction Mine Water Pumping Station
- initial construction of mine water ponds, sumps, pipelines and pumps
- initial construction of perimeter dikes
- initial construction and installation of electrical and mechanical systems
- construction of the OSLA
- initial construction of the stormwater management systems

Section 7.4 describes the construction of Mine Site infrastructure and facilities in more detail.

3.3.2 Plant Site Construction Activities

Activities at the Plant Site during the construction phase will include:

- construction of the WWTS
- installation and refurbishment of the Flotation Tailings discharge system and the return water system

- construction and improvements of the power distribution system
- construction of the first lift of the FTB dams and the associated underdrain and emergency overflow
- construction of initial segment of the FTB buttress
- construction of the drainage swale east of the LTVSMC tailings basin
- construction of the FTB Seepage Containment System
- construction, modification, and refurbishment of the Beneficiation Plant and other Plant Site buildings
- modification and refurbishment of the General Shops, the Rebuild Shop, Area 1 Shop facilities, and Area 2 Shop facilities
- construction and refurbishment of the Sewage Treatment System
- construction and refurbishment of the Potable Water Treatment System
- refurbishment of the Plant Reservoir
- construction and refurbishment of the stormwater management system
- construction and refurbishment of roads and rail connections within the boundaries of the Plant Site
- demolition of select legacy infrastructure
- reclamation of LTVSMC tailings basin Cell 2W borrow areas, after use

Section 8.0 describes the Plant Site facilities in more detail. Section 10.2 describes the construction of the FTB and FTB seepage capture systems, and Section 10.3 describes the construction of the HRF. Section 11.4 describes the construction of the Plant Site stormwater system.

3.3.3 Transportation and Utility Corridors Construction Activities

Activities in the Transportation and Utility Corridors during the construction phase will include:

- upgrades to a section of Dunka Road that will be used for this Project
- construction and upgrades of electrical power distribution system
- construction of the MPP
- refurbishment of select portions of the existing Cliffs Erie private mainline railroad that will be used for this Project

- construction of the Connection Track

Section 9.1 describes the construction of this infrastructure in more detail.

3.3.4 Colby Lake Pipeline Corridor Construction Activities

The existing Colby Lake Pipeline will deliver water from Colby Lake, located approximately four miles south of the Plant Site. The pipeline facilities are already in place as depicted on Figure 3-8. PolyMet will inspect the pumphouse and pipeline and refurbish, as necessary, before use. Construction activities along the Colby Lake Pipeline Corridor will thus include an evaluation and recommissioning of the existing Colby Lake Pipeline and Pumphouse.

3.3.5 Excavation, Earthwork Movement, and Earthwork Balance

Development of the Project will involve excavating, moving, and stockpiling unconsolidated earth materials. General earthwork material movement for the Project is presented on Figure 3-11 for the Mine Site and Figure 3-12 for the Plant Site. Descriptions of these materials are included in Section 3.3.6. Waste rock categorization is included in Section 10.1.3.2. PolyMet has prepared an earthwork material balance for the Project, which is based on current data and will be continually updated and refined as more data are developed during operations. Additional details on the earthwork material balance are included in the Rock and Overburden Management Plan (Appendix 11.1).

3.3.6 Construction Materials

Construction activities will maximize, to the extent practical and permissible, the use of on-site excavated material. Potential on-site construction materials include saturated mineral overburden, unsaturated mineral overburden, and peat.

3.3.6.1 Saturated Mineral Overburden

Saturated mineral overburden encompasses all mineral overburden at the Mine Site located below the water table. The location of the water table will be the primary criterion for classification of this material. Due to geochemical characteristics of saturated mineral overburden, PolyMet proposes to use this material in very limited circumstances, including those that meet the following criteria:

- in a permanently saturated zone
- above temporary membrane liners before ultimate disposal in a permanently saturated zone
- in an area where the water that contacts the saturated mineral overburden will be collected and sent to treatment
- as the compacted stockpile soil liner immediately below the temporary membrane liner before being ultimately disposed in a permanently saturated zone

Saturated mineral overburden not used for construction will be placed on lined stockpiles, or later in the East Pit. Section 10.0 provides further details on management of these materials. Section 15.3 provides details on reclamation at the Mine Site, including long-term management of saturated mineral overburden to be stored below the water table.

PolyMet has currently identified the following potential construction applications for saturated mineral overburden, each of which is described in more detail on Table 10-16 and shown on Figure 10-21:

- stockpile foundation material below the water table (Categories 2/3 and 4 Waste Rock Stockpiles, OSP)
- temporary stockpile drainage layer (Categories 2/3 and 4 Waste Rock Stockpiles, OSP)
- top dressing for ramps and roads in pits
- mine water ponds, sumps, and basins liner cover material
- compacted soil liner below temporary geomembrane liners

3.3.6.2 Unsaturated Mineral Overburden

The mine waste characterization shows that unsaturated mineral overburden has been oxidized and is no longer reactive. PolyMet will use unsaturated mineral overburden as an unrestricted, general construction material at the Mine Site and Plant Site and possibly within the corridors as needed. Temporary storage will take place in the OSLA. To meet construction specifications, PolyMet may screen and/or compact unsaturated mineral overburden. While PolyMet will not crush non-granite cobbles and boulders, it will crush granite boulders and use them for haul road cover and railroad ballast, as described in Section 2.2.3.2 of the Rock and Overburden Management Plan in Appendix 11.1.

3.3.6.3 Peat

Peat includes organic matter that is formed by the partial decomposition of plant material under saturated conditions. PolyMet will excavate peat from construction sites and either use it in the construction activities or stockpile it in the OSLA for later use as a soil amendment when the Category 1 Waste Rock Stockpile and other Mine Site areas are reclaimed. PolyMet will also use the peat for wetland construction within the Mining Area as part of reclamation and closure activities. Due to the timing of this work, credit for construction of on-site wetlands is not currently planned as part of the Wetland Replacement Plan (Appendix 18.1), but may be proposed at a later date. The Wetland Replacement Plan is discussed further in Section 12.1. Peat will be mixed with unsaturated mineral overburden to meet construction specifications for certain materials that are used in construction or reclamation.

3.3.6.4 Additional Construction Material Sources

PolyMet will need additional construction materials beyond what is available on-site. Prior to use, PolyMet will analyze potential borrow sources for geotechnical and geochemical suitability as described in Section 2.3.1 and 2.3.2 of Appendix 11.1.

3.4 Operations Phase

The Project Timeline shown on Figure 3-9 provides an overview of activities that will occur during the operations phase, which will commence at the start of Mine Year 1. Figure 3-10 provides an overview of construction activities in the Construction Years and operation activities through Mine Year 20.

3.4.1 Mine Site Operations

During the operations phase, or LOM, the major Mine Site operations will include:

- overburden stripping within the pit footprints and progressive reclamation of pit rim overburden backslopes once portions reach their final extents
- mining of the open pits
- stockpiling ore and waste rock
- constructing expansions to lined waste rock stockpiles and Category 1 Waste Rock Stockpile
- constructing and operating the RTH and ore handling area to move ore to the Plant Site
- operating the CPS, Construction Mine Water Pumping Station, equalization basins, Construction Mine Water Basin, and mine water systems and expansion of the mine water systems
- operating and constructing expansions to the Category 1 Stockpile Groundwater Containment System
- construction of perimeter dikes
- progressive reclamation of Category 1 Waste Rock Stockpile once portions of the stockpile reaches its final extent
- relocation of Categories 2/3 and 4 waste rock to the East and Central Pits
- removing the liner and reclamation of Category 2/3 Waste Rock Stockpile footprint
- removing the liner and reclaiming the portion of the Category 4 Waste Rock Stockpile footprint that is not within the Central Pit footprint
- stormwater management and expansion of stormwater management systems
- construction of haul roads
- maintaining and operating on the Railroad Spur and haul roads
- backfilling the East and Central Pits with Category 1, 2, 3, and 4 waste rock
- partially flooding the East and Central Pits

- monitoring surface water and groundwater quality in the vicinity of the Mine Site
- maintaining and operating on the Mine Site

Section 7.3 provides additional information regarding the anticipated mining rate, sequence, and schedule.

3.4.2 Plant Site Operations

Plant Site operations will begin in Mine Year 1, with the exception of the Hydrometallurgical Plant and HRF, which are anticipated to begin operation several years after Mine Year 1. The precise timing for construction of the hydrometallurgical facilities will depend on Project economics and other factors.

During the LOM, the major Plant Site operations will include:

- operating the WWTS
- operating the Sewage Treatment System and Potable Water Treatment System
- depositing Flotation Tailings in the FTB
- constructing additional FTB dam lifts and buttress segments at the FTB
- relocating Flotation Tailings transport and discharge pipes and FTB water return pipes
- amending exterior faces of FTB dams with bentonite
- relocating the Coal Ash Landfill
- processing ore at the Beneficiation Plant
- constructing and operating the HRF and Hydrometallurgical Plant
- loading concentrate for shipment
- operating and monitoring the FTB seepage capture systems
- discharging treated water from the WWTS for stream augmentation
- monitoring and maintaining the FTB and the HRF and progressive reclamation of slopes once portions reach their final extents
- maintaining railroads and roads
- progressive reclamation of areas of the Plant Site as soon as practical
- managing stormwater
- monitoring surface water and groundwater quality in the vicinity of the Plant Site

- demolishing select legacy infrastructure

Further discussion of Plant Site operations is presented in Section 8.0.

3.4.3 Transportation and Utility Corridors and Colby Lake Corridor Operations

During operations, ore will be transported by rail from the Mine Site to the Plant Site. Regular inspection and maintenance and periodic upgrades will be performed on the Dunka Road, existing ditches, railways, MPP, and Colby Lake Pipeline. Surface water quality will be monitored in the vicinity of the Transportation and Utility Corridors.

3.5 Reclamation, Closure, and Postclosure Maintenance Phases

The reclamation, closure, and postclosure maintenance schedule of activities is shown on Figure 3-9. The reclamation phase will be completed in accordance with requirements specified in Minnesota Rules, part 6132.2000 through 6132.3200. Timeframes for the reclamation, closure, and postclosure maintenance phases are described in Section 3.2. This Section 3.5 provides an overview of these activities, which are further described in Section 15.0 and Appendix 14, the Reclamation, Closure, and Postclosure Maintenance Plan.

3.5.1 Mine Site Reclamation, Closure, and Postclosure Maintenance Activities

Figure 3-4 displays the Mine Site features that will remain after closure. Section 3.0 describes Mine Site reclamation, closure, and postclosure maintenance phases, which will include the following major activities:

- demolishing structures (e.g., buildings, power lines, substations, culverts) and reclaiming footprints
- constructing the pit barrier system and reclaiming the surrounding areas
- constructing the East Pit and West Pit outlet structures
- completing the shaping and covering of the Category 1 Waste Rock Stockpile
- removing the piping and liner systems and reclaiming the Category 2/3 Waste Rock Stockpile footprint
- removing the piping and liner systems and reclaiming the OSP footprint
- reclaiming the OSLA
- maintaining, removing, and reclaiming the mechanical and electrical systems, as needed
- removing, rerouting, and reclaiming stormwater culverts, dikes, ditches, and ponds
- reclaiming mine water ponds, sumps, and basins

- reclamation of road segments that are not required for access during future phases
- reclaiming the RTH and Railroad Spur
- removing MSFMF infrastructure and reclaiming the footprint
- continuing to operate the CPS
- completing the flooding of the backfilled East Pit and cycling East Pit water through the WWTS to flush constituents from the pit water
- completing East Pit backfilling
- constructing wetlands over the backfilled combined East/Central Pit
- flooding the West Pit, supplemented with water from the Plant Site to accelerate pit flooding
- transitioning to postclosure treatment at the WWTS and discharging to the Partridge River via the unnamed creek (West Pit outlet)
- removing Equalization Basin Area infrastructure and reclaiming the footprint
- general site maintenance
- transitioning to non-mechanical treatment when appropriate and subsequent decommissioning and reclamation of the CPS and MPP
- continued monitoring in the vicinity of the Mine Site through the reclamation and closure phases, and into the postclosure maintenance phase as required under terms of applicable permits (Section 14.0)

Figure 3-13 depicts the water management and treatment plan during the reclamation and the early years of the closure phases. Figure 3-14 depicts the plan for the later years of the closure phase. Figure 3-15 shows postclosure water management using mechanical water treatment, and Figure 3-16 shows postclosure water management after the transition to non-mechanical water treatment. Section 15.8 provides more detail on the transition from mechanical to non-mechanical water treatment.

3.5.2 Plant Site Reclamation, Closure, and Postclosure Maintenance Activities

Section 4.0 describes Plant Site reclamation, closure, and postclosure maintenance phases, and presents a figure showing the Plant Site features that will remain after closure (Figure 15-2). Plant Site reclamation, closure, and postclosure maintenance phases will include the following major activities:

- demolishing structures (e.g., buildings, power lines, substations, culverts) and reclaiming footprints
- fencing, as necessary for site management, security, and monitoring

- reclaiming and/or removing stormwater culverts, dikes, ditches, and ponds
- progressive reclamation of road segments that are not required for access during future phases
- reseeding remaining disturbed areas in the Mining Area
- removing the tailings pipeline and pumping system and reclamation of the footprints
- reclaiming the Tailings Basin, including bentonite amendment of the final beaches and pond bottom
- continuing to operate the FTB seepage capture systems with associated stream augmentation discharge until the Project transitions to non-mechanical treatment
- constructing the FTB Closure Overflow
- dewatering and covering the HRF
- completing the operation of the HRF drainage and leakage collection system
- continuing to operate the WWTS
- removing the liner of the Sewage Treatment System stabilization ponds and pipelines and reclaiming the footprints
- reclaiming the potable and fire water systems
- reclaiming railroad tracks owned by PolyMet
- general site maintenance
- transitioning to non-mechanical treatment when appropriate and subsequent decommissioning and reclamation of the WWTS
- continued monitoring in the vicinity of the Plant Site through the reclamation and closure phases, and into the postclosure maintenance phase as required under terms of applicable permits (Section 14.0)

Figure 3-13 depicts the water management and treatment plan during reclamation and the early years of the closure phase. Figure 3-14 depicts the plan for the later years of the closure phase. Figure 3-15 shows postclosure maintenance water management using mechanical water treatment, and Figure 3-16 shows postclosure maintenance water management after the transition to non-mechanical water treatment. Section 15.8 provides more detail on the transition from mechanical to non-mechanical water treatment.

3.5.3 Transportation and Utility Corridors Reclamation, Closure, and Postclosure Maintenance Activities

Transportation and Utility Corridors infrastructure that is not being utilized for reclamation activities will be reclaimed and vegetated during the reclamation phase. Infrastructure owned by third parties will only be reclaimed as agreed upon under contractual rights of use, including the mainline railroad and Dunka Road, which are owned by Cliffs Erie. Reclamation will include:

- reclamation of Dunka Road passing bays constructed by PolyMet
- removal of rail line components and reclamation of the Connection Track
- progressive removal of powerlines and pipelines that are not required for further use during the next phase of reclamation, closure, and postclosure maintenance
- site grading and revegetation

Maintenance of the portions of Transportation and Utility Corridors that remain in use will continue through the reclamation, closure, and postclosure maintenance phases. Details regarding the Transportation and Utility Corridors that will remain in use during the reclamation, closure, and postclosure maintenance phases is provided in Section 4.0 of Appendix 14.

3.5.4 Colby Lake Pipeline Corridor Reclamation, Closure, and Postclosure Maintenance Activities

The Colby Lake Pipeline and Pumphouse will be decommissioned. These features are legacy regional infrastructure intended for use by third parties after closure. PolyMet requests a variance to allow the Colby Lake Pipeline and Pumphouse to remain in-place rather than being removed after the operations phase. See Section 1.2.3 of Appendix 14 for further explanation of these details and a variance request to leave these infrastructure in place.

3.6 Adaptive Management and Contingency Mitigation

Adaptive management is one of the main tools PolyMet will use to achieve and maintain compliance using the outcome-based approach. Adaptive management is a system of management practices, based on clearly defined outcomes from the monitoring, modeling, and operational results, that assesses whether planned engineering controls are meeting the desired outcomes, and, if they are not, follows pre-established processes to improve performance, achieve compliance, and meet the defined outcomes.

Adaptive management, when required, will be carried out in accordance with the agencies' approval, will continue to achieve compliance, and will include modeling and/or testing (as applicable and necessary) to demonstrate the performance of any modification before it would be implemented. Listed below is a summary of the adaptive management processes that have been developed to date for the Project for water quantity and quality and for FTB stability. Adaptive management measures will continue to be developed and evaluated throughout every phase of the Project.

Contingency mitigation measures are technically feasible options that could be undertaken should engineering controls (fixed or adaptive) be unable to achieve compliance with permit limits. If monitoring, refined modeling, or other operational results were to indicate that contingency mitigation would be needed, these measures would be proposed to the agencies and, upon approval, employed as appropriate.

Adaptive management processes and contingency mitigation measures could change over the LOM. These processes and measures could affect the financial assurance required for the Project and is discussed further in Section 16.0.

Monitoring will be a critical component of the Project to monitor potential impacts, to inform facility operation and maintenance actions, and to select and implement possible adaptive management or contingency mitigation measures. Monitoring is discussed in Section 14.0.

3.6.1 Water Quantity and Quality: Adaptive Management and Contingency Mitigation

Project water management systems will encounter natural variability in water quantity and quality. Adaptive management anticipates uncertainty and natural variability by using flexible (i.e., adaptive) engineering controls that can be adjusted to continue achieving compliance with applicable water quality standards and permit conditions when site-specific conditions vary. Figure 3-13 through Figure 3-16 show both the fixed engineering controls as well as the adaptive engineering controls for water management at the Mine Site and Plant Site. Adaptive water management is further discussed in the Adaptive Water Management Plan (Appendix 11.4).

A proposed work plan which includes additional details on the use of monitoring information, updating models, and discussion of the currently identified adaptive management features that could be implemented had been developed and submitted to the MPCA as part of the NPDES/SDS Permit application (Appendix E of Reference (4)). The cycle of collecting monitoring data and updating models will allow for the comparison of predictive water modeling results to planned objectives. Through this process, the need, if any, to implement an adaptive management feature can be identified prior to reaching a water quality limit or a water quantity threshold. If water quality objectives are not met by the Project water management systems or if an issue is identified with water quantity, adaptive management would include items such as:

- undertaking studies to determine the root cause of the problem
- modifying the design or operation of existing (or planned) Project adaptive engineering controls (i.e., WWTS treatment process, capacity, and duration; Category 1 Waste Rock Stockpile cover; FTB pond bottom cover; non-mechanical treatment design) to remedy the root cause
- if modifying the design or operation of Project adaptive engineering controls is not sufficient, then taking contingency mitigation actions
- monitoring outcomes, and as appropriate, evaluating outcomes with water modeling

- repeating one or more of the preceding activities if the issue persists

Contingency mitigations are available if water quality monitoring or the refined model estimates show that, with adaptive management, water quality objectives are not met. Potential contingency mitigation actions for water management systems are described in the Water Management Plan – Mine, and the Water Management Plan – Plant, which are included in Appendix 11.2 and Appendix 11.3, respectively.

Water quantity and quality are interconnected, and as such, many of the adaptive management and contingency mitigation actions for water quality also can be used for water quantity. For example, an additional treatment train at the WWTS may be required for water quantity as well as water quality. Additional information on adaptive management and contingency mitigation to address water quantity is included in the Water Appropriation Permit Applications (Sections 5.2.3.2 and Section 9.5.3 of Reference (5)). The mitigation includes development of a contingency plan to identify alternatives to appropriating water from Colby Lake during low flow or to protect stream flow or, if necessary, to address changes in hydrologic or in-stream biological conditions if they are identified as a result of stream augmentation.

The difference between adaptive water management and contingency mitigation is in the timing and nature of the work. Adaptive management is the modification of the design, construction, and/or operations in response to findings from routine performance monitoring, modeling, and operations outcomes. Contingency mitigation would involve further modification if routine adaptive management activities are insufficient to achieve the required outcome. An example of an adaptive water management feature is the adaptive nature of the WWTS design, so that the treatment capacity can be adjusted to accommodate varying influent streams for a constant discharge quality and quantity. An example of contingency mitigation for the WWTS would be to add an entirely new treatment process to meet water quality requirements if the proposed treatment process was not able to perform as planned.

3.6.2 Dam Stability: Adaptive Management and Contingency Mitigation

The primary FTB operating constraints as they relate to dam safety include slope stability factor of safety, required beach length, and specified maximum pond elevation, the latter of which defines dam freeboard requirements. The specifics of these requirements are contained within the Dam Safety Permit Application and attachments thereto.

Adaptive management, if warranted, is the modification of the dam design, construction, and/or operations in response to findings from routine performance monitoring, modeling, and operations outcomes (the Observational Method; summarized below and further detailed as part of the DNR Dam Safety Permit application). Contingency mitigation would involve the further modification of the dams if routine adaptive management activities are insufficient to achieve operating constraints. Beyond contingency mitigation for the FTB, a Contingency Action Plan has been established that outlines the planned response to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB (Attachment F of Appendix 11.5.

Significant effort has been made to evaluate potential FTB dam design options, including modifying bench widths and slopes, with the most probable dam design being provided in the Dam Safety Permit application. Material strengths, porewater pressure, and beach width have been established as part of this design and then varied by performing sensitivity analyses or by evaluating different hydraulic loading conditions to confirm resilience of the design. These design parameters will continue to be reviewed as additional data are obtained throughout the development of the FTB and, in accordance with the Observational Method, the engineering models will be refined, and subsequent design, construction, and operation of the FTB adjusted if needed to maintain specified factors of safety.

The Observational Method employs sequences of data gathering, detailed calculations and performance predictions, additional data gathering and observations, and design modifications as needed to maintain required operating conditions at the Tailings Basin. First, the engineer uses available information to prepare an initial concept and design that will predict the behavior of the basin. As the stages of construction progress, the engineer monitors and tests the site to obtain more detailed information. The predicted behavior is then compared with the measured behavior, enabling the engineer to revise the original predictions. Repeating this process leads to successive refinements in FTB dam design and construction. Tailing basin dams are typically built in stages, thus the Observational Method to design is well suited for minimizing risk.

The planned instrumentation for the FTB dams will monitor changes in water levels and pressure head within the dams, as well as for potential deformation of the slopes, based on modeled behavior. The Contingency Action Plan included with the Dam Safety Permit application will guide the initial response to any unexpected conditions, including unanticipated seepage or slope movement.

If updated stability models project that the planned or constructed FTB dams may not meet required factors of safety, adaptive management actions will include some or all of the following:

- Reconfirm the geometry of previously constructed segments of the FTB dams.
- Initiate any field and/or laboratory studies that may be necessary to update material strength parameters and/or phreatic surface data.
- Update stability modeling using as-built dimensions and in-field and/or in the laboratory (as applicable) data gathering.
- Estimate the effects of potential operational changes such as adjusting tailings deposition procedures to modify beach width or modifying the pond elevation to modify phreatic surface conditions within the dam.
- If operational changes (such as change to slurry density, change to dam lift timing, modified pond operations) can achieve the required factors of safety, implement those changes.
- If stability modeling indicates that operational changes or adaptive engineering controls cannot achieve the required factors of safety, implement contingency mitigations to restore required

factors of safety. Contingency mitigations are outlined in Section 6.4 of Appendix 11.5) and summarized below.

- Continue monitoring and/or modeling to estimate dam stability effects with new or adjusted engineering controls.
- If issues reoccur, reinitiate the adaptive management sequence summarized above as appropriate.

FTB dam slope stability contingency mitigations are available if monitoring or the refined model estimates show that, with operational changes, the FTB dams may not meet required factors of safety. In general, stability can be modified by:

- modifying buttressing to modify resisting force at the toe of the FTB
- adjusting the overall slope angle of future lifts to modify driving force at the toe
- adjusting bench widths of future dam lifts
- adjusting future dam lift offsets
- adjusting future dam lift heights and/or rate of construction
- including free-draining underdrain layers or drains to reduce the phreatic surface in the FTB dams

If drain installation were required after the development of the Tailings Basin dams, the drains would typically be installed using horizontal drilling to install drain casing and drainage media. This technique is applied to various drainage projects such as to natural slopes, railroad embankments, and tailings dams.

The contingency mitigation measures listed above can be implemented individually or in combinations as needed to achieve the required mitigation outcomes.

Actions associated with contingency mitigation do not necessarily apply to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB. These conditions are addressed in the FTB Contingency Action Plan, which is Attachment F to the Flotation Tailings Basin Management Plan (Appendix 11.5). The purpose of the FTB Contingency Action Plan is to define responsibilities and provide procedures for identifying and responding to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB.

PolyMet will develop an overall Project-wide Emergency Action Plan, into which the FTB Contingency Action Plan will be incorporated. The Emergency Action Plan will be prepared when Project construction is nearly complete and permanent staffing has been established, at which time content and delegation of responsibilities will be established. The Emergency Action Plan is not a regulatory document. Rather, it is for the use and safety of operations personnel in the event of unexpected emergencies and will be a compilation of plans such as, but not limited to: FTB Contingency Action Plan, Spill Prevention Control and Countermeasures Plan, Severe Weather Response Plan, and Emergency Notification and Evacuation Plan. Environmental insurance will also be obtained for the Project.

Table 3-1 Terminology for Project Phases in Various Project Documents

Mine Year	Construction Year (PTM only)	Project Phase in Permit to Mine	Project Phase in FEIS and supporting documents, and in other environmental permit applications(1)
Not Applicable	1 to 2	Construction	Pre-Operation Construction
1 to 20		Operations	Operation
21 to ~24		Reclamation(2)	Reclamation
24 to ~54		Closure(3)	
55+		Postclosure Maintenance	Long-Term Closure

(1) Water appropriation permit application, NPDES/SDS Permit application, air quality permit application, dam safety permit application

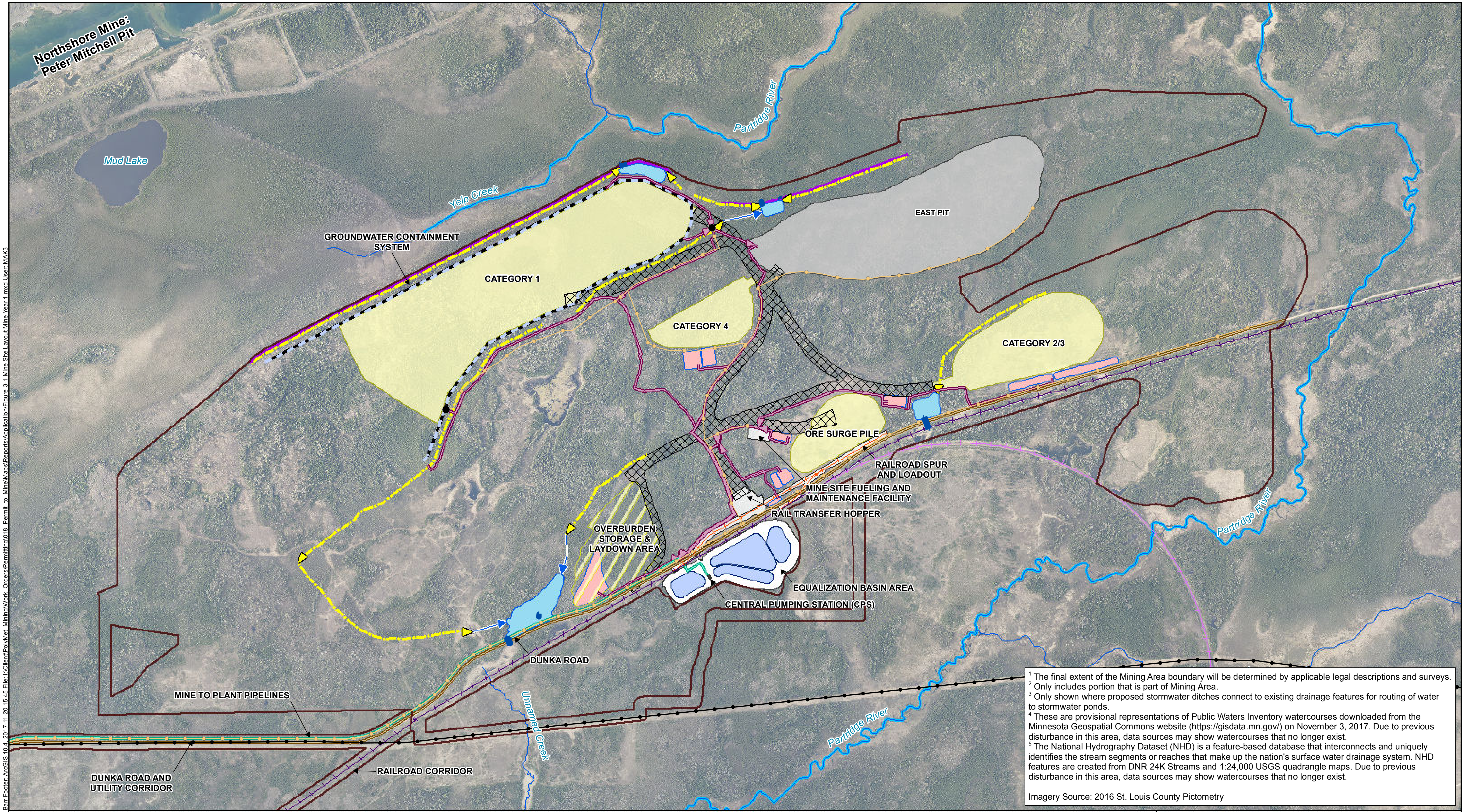
(2) Phase ends when structures are demolished, footprints are revegetated, and perimeters are fenced, as described in Section 3.2

(3) Phase ends when the West Pit is flooded and treated water is discharged at the Mine Site, as described in Section 3.2

Table 3-2 Summary of Permit Application Support Drawings in Appendix 3 through Appendix 10

Drawing Set	Associated Structures	Physical Location	Appendix Number	Drawing Numbers
Mine Site and Dunka Road Earthwork	Dunka Road Earthwork	Mine Site and Transportation and Utility Corridors	Appendix 3	EW-003 through EW-004
	Haul Roads	Mine Site	Appendix 3	EW-005 through EW-007 and EW-010 through EW-011
	Stripping	Mine Site	Appendix 3	EW-008
	Overburden Storage and Laydown Area	Mine Site	Appendix 3	EW-009
	Rail Transfer Hopper	Mine Site	Appendix 3	G-100 through G-101
Stockpiles	Overall	Mine Site	Appendix 4	SKP-001 through SKP-009 and SKP-035
	Category 1 Waste Rock Stockpile	Mine Site	Appendix 4	SKP-010 through SKP-013 and SKP-032 through SKP-034
	Category 2/3 Waste Rock Stockpile	Mine Site	Appendix 4	SKP-014 through SKP-019

Drawing Set	Associated Structures	Physical Location	Appendix Number	Drawing Numbers
	Category 4 Waste Rock Stockpile	Mine Site	Appendix 4	SKP-020 through SKP-025
	Ore Surge Pile	Mine Site	Appendix 4	SKP-026 through SKP-031
Category 1 Stockpile Groundwater Containment System	Category 1 Stockpile Groundwater Containment System	Mine Site	Appendix 4	GCS-001 through GCS-014
Mine Site Stormwater	Mine Site Stormwater	Mine Site	Appendix 5	SW-001 through SW-031
Flotation Tailings Basin	Flotation Tailings Basin	Plant Site	Appendix 6	FTB-001 through FTB-024
Flotation Tailings Basin Seepage Containment and Stream Augmentation System	Flotation Tailings Basin Seepage Containment and Stream Augmentation System	Plant Site	Appendix 6	FTBCA-001 through FTBCA-015
Hydrometallurgical Residue Facility	Hydrometallurgical Residue Facility	Plant Site	Appendix 7	HRF-001 through HRF-024
Mine Site Mechanical Infrastructure	Mine Site Mechanical Infrastructure - General	Mine Site	Appendix 8	ME-001 through ME-004
	Mine to Plant Pipelines	Mine Site, Transportation and Utility Corridors, and Plant Site	Appendix 8	MPP-001 Through MPP-012
	Mine Water	Mine Site	Appendix 8	MW-001 through MW-016
Sewage Treatment System	Sewage Treatment System	Plant Site	Appendix 9	SWGT-001 through SWGT-004
Plant Site Stormwater	Plant Site Stormwater	Plant Site	Appendix 10	PSSW-001 through PSSW-033



Mining Area[1]
Dunka Road[2]
PolyMet Exclusive Track
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
PolyMet Power Distribution Lines
Minnesota Power Transmission Line

Mine Year 1 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Haul Roads
Groundwater Containment System Sumps
Groundwater Containment System

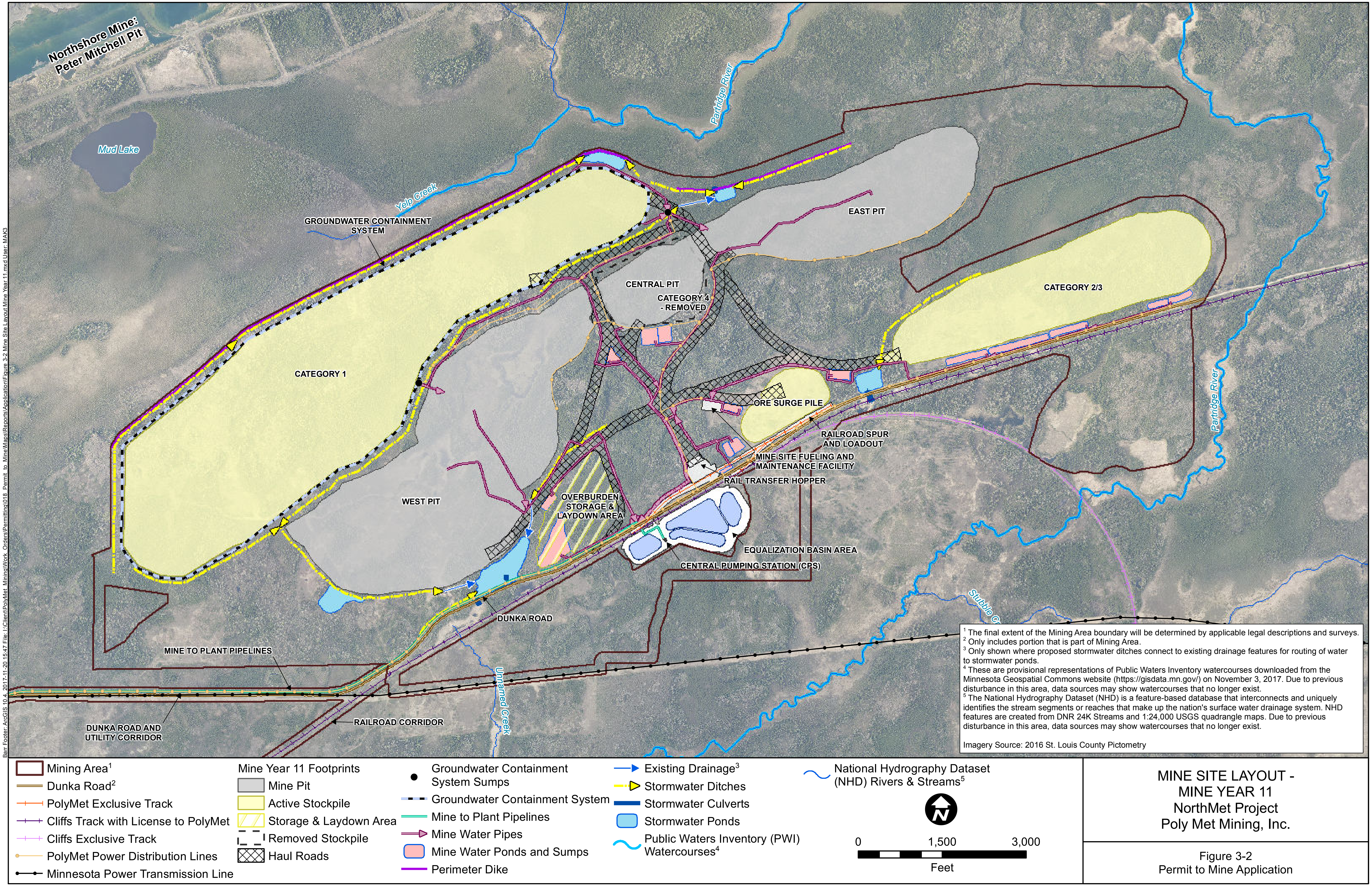
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps
Perimeter Dike
Existing Drainage[3]
Stormwater Ditches
Stormwater Culverts

Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE LAYOUT -
MINE YEAR 1
NorthMet Project
Poly Met Mining, Inc.

Figure 3-1
Permit to Mine Application

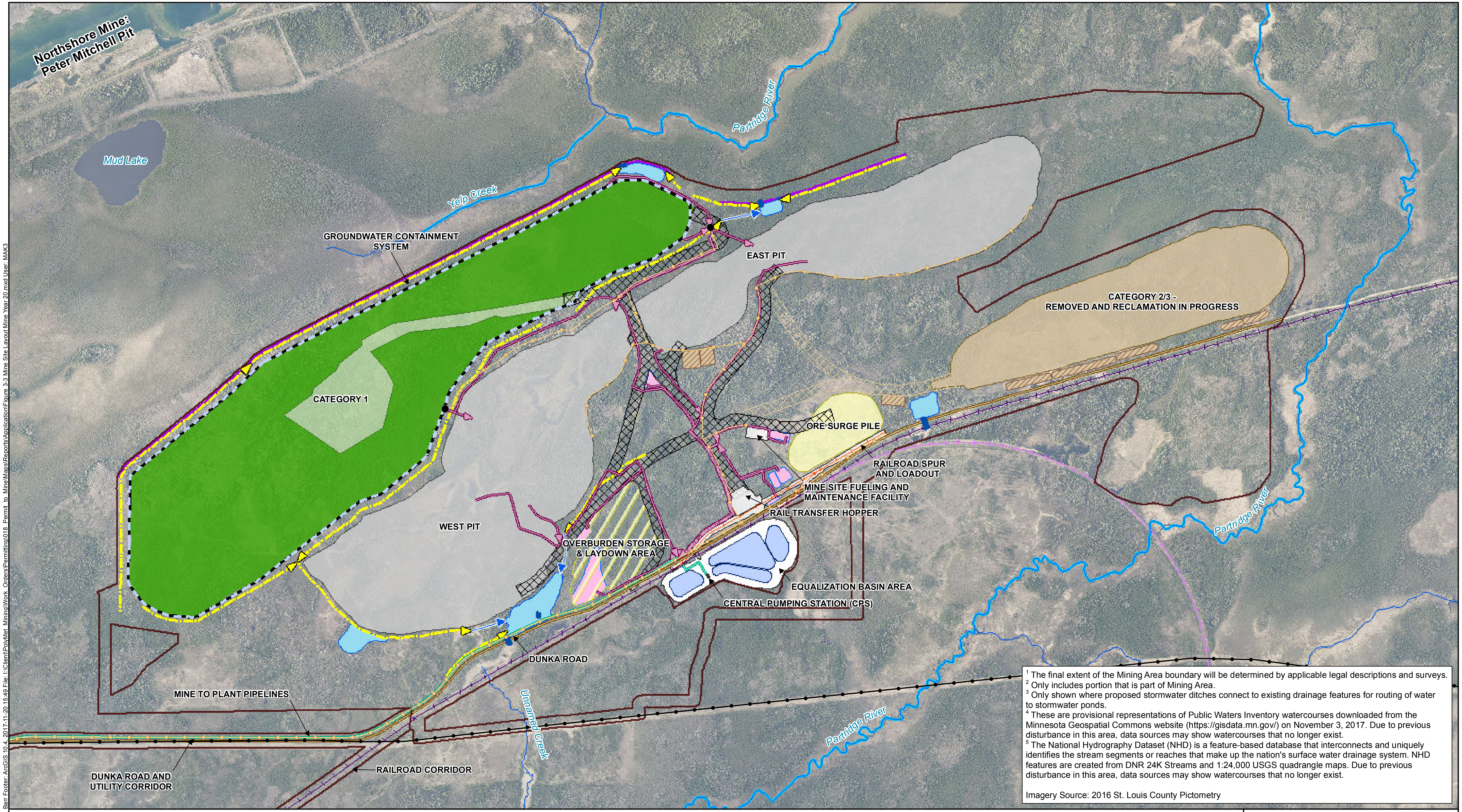


[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

MINE SITE LAYOUT - MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 3-2
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
PolyMet Exclusive Track
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
PolyMet Power Distribution Lines
Minnesota Power Transmission Line

Mine Year 20 Footprints
Mine Pit
Open Stockpile
Covered Stockpile
Active Stockpile
Storage & Laydown Area
Removed and Reclaimed Stockpiles

Haul Roads
Reclaimed Haul Roads
Groundwater Containment System Sumps
Groundwater Containment System
Mine to Plant Pipelines
Mine Water Pipelines

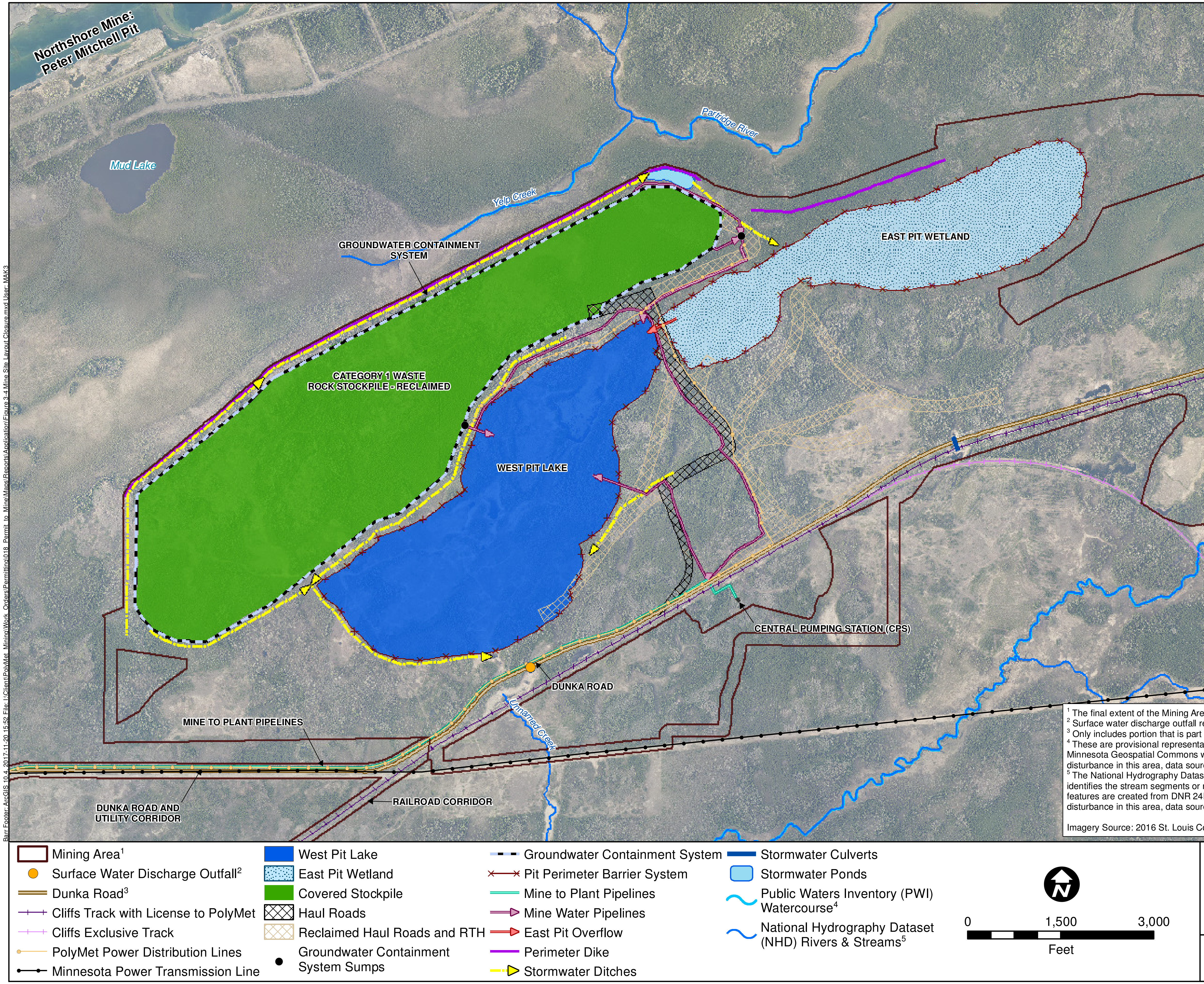
Reclaimed Mine Water Ponds and Sumps
Mine Water Ponds and Sumps
Perimeter Dike
Existing Drainage[3]
Stormwater Ditches
Stormwater Culverts
Stormwater Ponds

Public Waters Inventory (PWI) Watercourses [4]
National Hydrography Dataset (NHD) Rivers & Streams [5]

N
0 750 1,500
Feet

MINE SITE LAYOUT -
MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 3-3
Permit to Mine Application

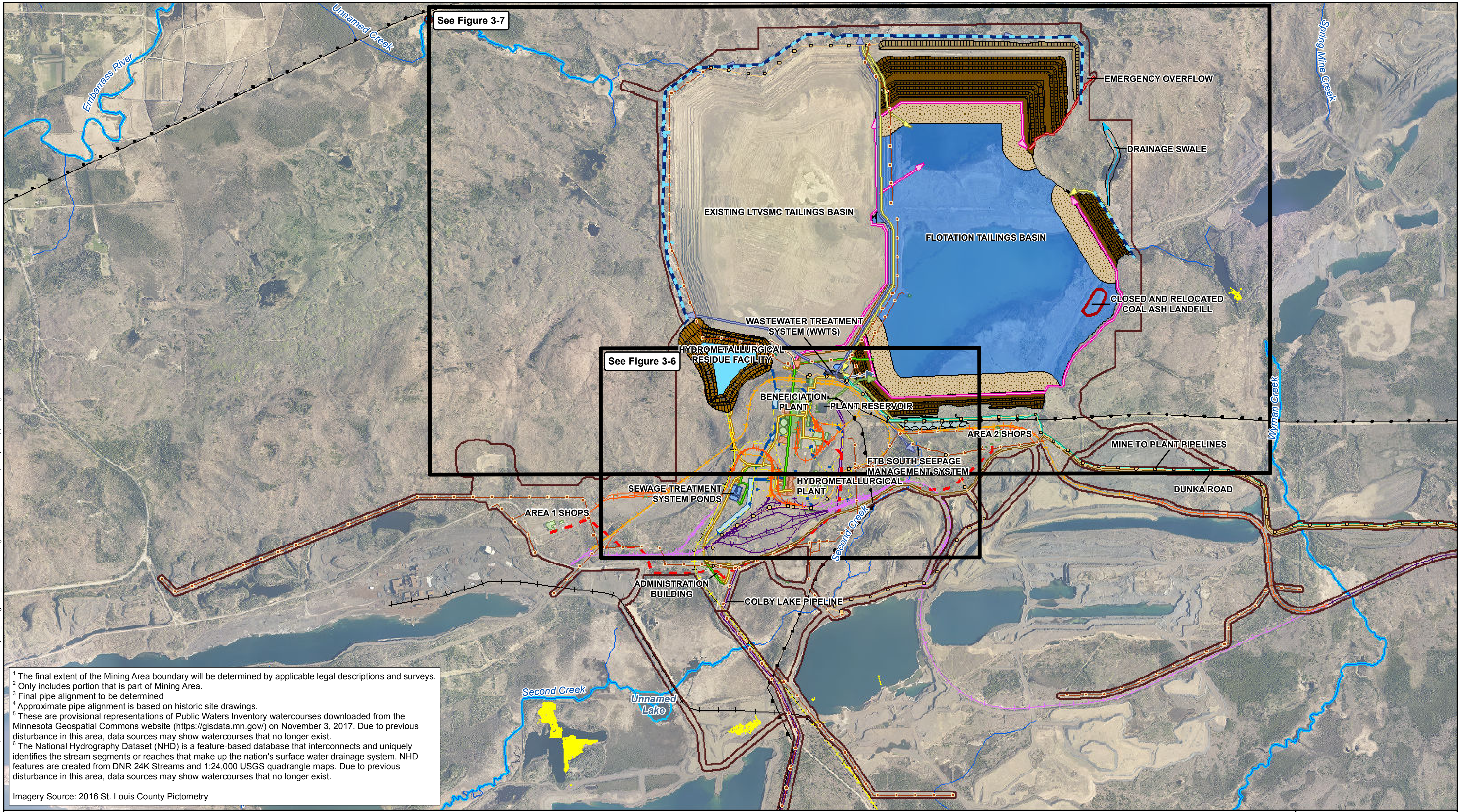


[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Surface water discharge outfall represents mechanical treatment.
[3] Only includes portion that is part of Mining Area.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

MINE SITE LAYOUT - POSTCLOSURE MAINTENANCE
NorthMet Project
Poly Met Mining, Inc.

Figure 3-4
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Final pipe alignment to be determined
[4] Approximate pipe alignment is based on historic site drawings.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

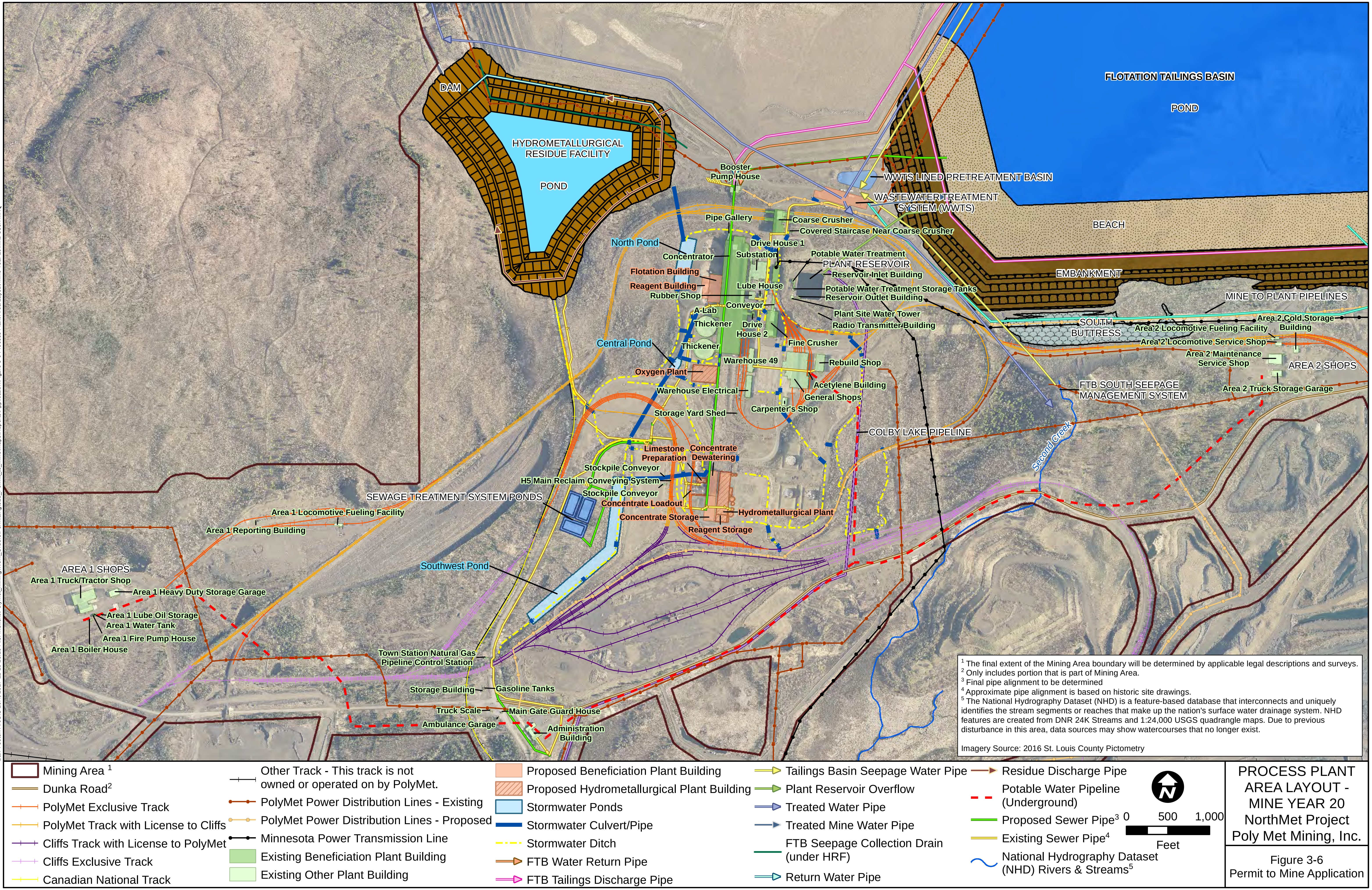
Imagery Source: 2016 St. Louis County Pictometry

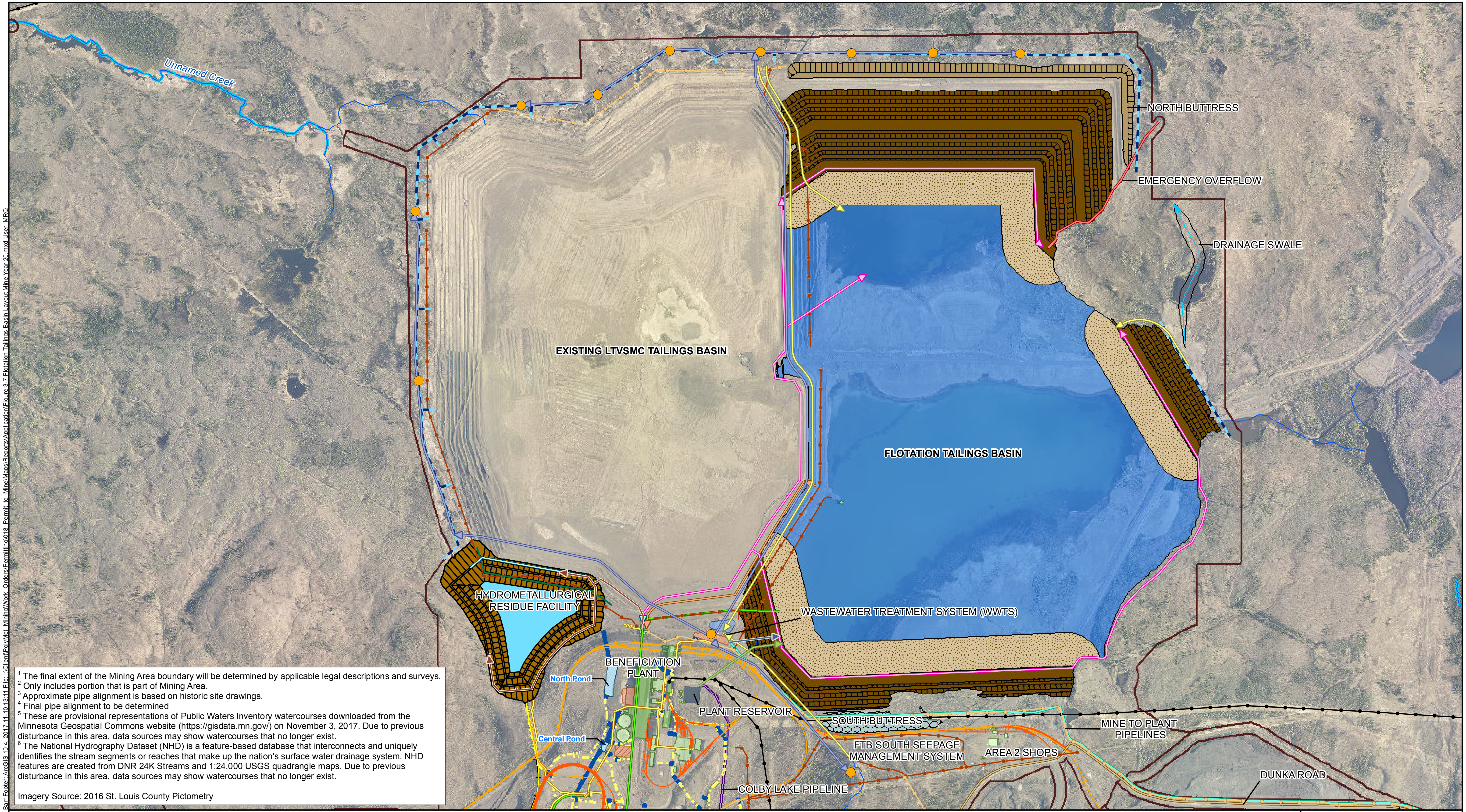
- Mining Area[1]
- Other Track - This track is not owned or operated on by PolyMet.
- PolyMet Exclusive Track
- PolyMet Track with License to Cliffs
- Cliffs Track with License to PolyMet
- Cliffs Exclusive Track
- Canadian National Track
- Dunka Road[2]
- PolyMet Power Distribution Lines - Existing
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Line
- Stormwater Ponds
- FTB Containment System
- Stormwater Culvert
- Stormwater Ditch
- FTB Water Return Pipe
- FTB Tailings Discharge Pipe
- Tailings Basin Seepage Water Pipe
- Plant Reservoir Overflow
- Treated Water Pipe
- Treated Mine Water Pipe
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe
- Proposed Sewer Pipe[3]
- Existing Sewer Pipe[4]
- Potable Water Pipeline (Underground)
- Underground Mine (2011)
- Public Waters Inventory (PWI) Watercourses[5]
- National Hydrography Dataset (NHD) Rivers & Streams[6]

0 1,500 3,000
Feet

PLANT SITE LAYOUT - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 3-5
Permit to Mine Application


FLOTATION TAILINGS BASIN
POND
BEACH
EMBANKMENT
SOUTH BUTTRESS
DAM
HYDROMETALLURGICAL RESIDUE FACILITY
POND
Booster Pump House
WWTS LINED PRETREATMENT BASIN
WASTEWATER TREATMENT SYSTEM (WWTS)
Pipe Gallery
Coarse Crusher
Covered Staircase Near Coarse Crusher
North Pond
Drive House 1
Concentrator
Substation
Potable Water Treatment
PLANT RESERVOIR
Reservoir Inlet Building
Flotation Building
Reagent Building
Rubber Shop
Lube House
Potable Water Treatment Storage Tanks
Reservoir Outlet Building
Conveyor
MINE TO PLANT PIPELINES
A-Lab
Thickener
Drive House 2
Plant Site Water Tower
Radio Transmitter Building
Area 2 Cold Storage Building
Area 2 Locomotive Fueling Facility
Area 2 Locomotive Service Shop
Central Pond
Thickener
Fine Crusher
Area 2 Maintenance Service Shop
AREA 2 SHOPS
Warehouse 49
Rebuild Shop
Oxygen Plant
Acetylene Building
FTB SOUTH SEEPAGE MANAGEMENT SYSTEM
Area 2 Truck Storage Garage
Warehouse Electrical
General Shops
Storage Yard Shed
Carpenter's Shop
COLBY LAKE PIPELINE
Second Creek
Limestone Preparation
Concentrate Dewatering
Stockpile Conveyor
H5 Main Reclaim Conveying System
SEWAGE TREATMENT SYSTEM PONDS
Stockpile Conveyor
Concentrate Loadout
Concentrate Storage
Hydrometallurgical Plant
Reagent Storage
Area 1 Locomotive Fueling Facility
Area 1 Reporting Building
Southwest Pond
AREA 1 SHOPS
Area 1 Truck/Tractor Shop
Area 1 Heavy Duty Storage Garage
Area 1 Lube Oil Storage
Area 1 Water Tank
Area 1 Fire Pump House
Area 1 Boiler House
Town Station Natural Gas Pipeline Control Station
Storage Building
Gasoline Tanks
Truck Scale
Main Gate Guard House
Ambulance Garage
Administration Building
1 The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
2 Only includes portion that is part of Mining Area.
3 Final pipe alignment to be determined
4 Approximate pipe alignment is based on historic site drawings.
5 The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
Imagery Source: 2016 St. Louis County Pictometry
Mining Area 1
Dunka Road2
PolyMet Exclusive Track
PolyMet Track with License to Cliffs
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Canadian National Track
Other Track - This track is not owned or operated on by PolyMet.
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Line
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Stormwater Ponds
Stormwater Culvert/Pipe
Stormwater Ditch
FTB Water Return Pipe
FTB Tailings Discharge Pipe
Tailings Basin Seepage Water Pipe
Plant Reservoir Overflow
Treated Water Pipe
Treated Mine Water Pipe
FTB Seepage Collection Drain (under HRF)
Return Water Pipe
Residue Discharge Pipe
Potable Water Pipeline (Underground)
Proposed Sewer Pipe3
Existing Sewer Pipe4
National Hydrography Dataset (NHD) Rivers & Streams5
N
0 500 1,000
Feet
PROCESS PLANT AREA LAYOUT - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.
Figure 3-6
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Approximate pipe alignment is based on historic site drawings.
[4] Final pipe alignment to be determined
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

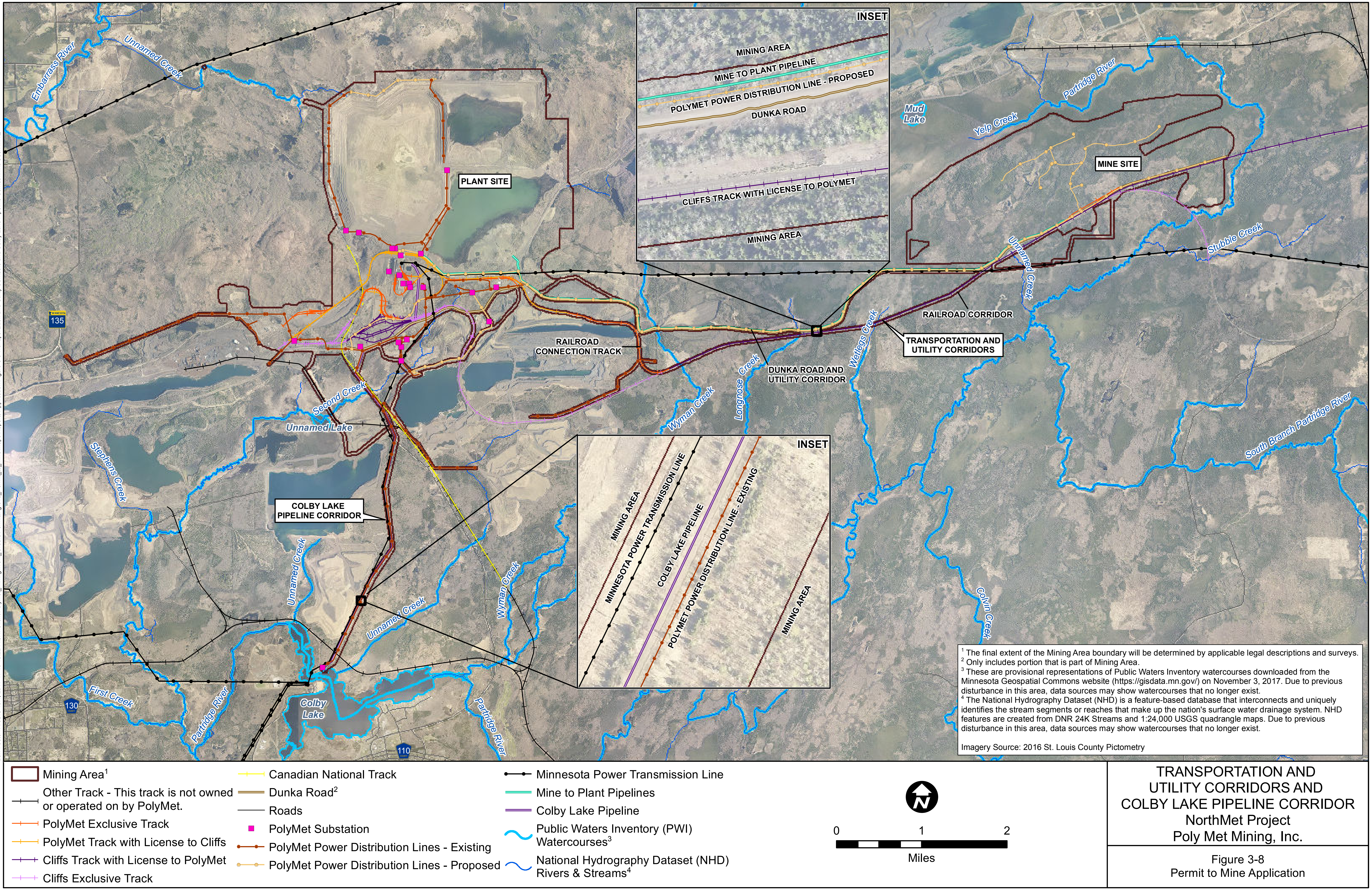
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Dunka Road[2]
- PolyMet Exclusive Track
- PolyMet Track with License to Cliffs
- Canadian National Track
- Other Track - This track is not owned or operated on by PolyMet.
- PolyMet Power Distribution Lines - Existing
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Line
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- FTB Water Return Pipe
- FTB Tailings Discharge Pipe
- Tailings Basin Seepage Water Pipe
- Plant Reservoir Overflow
- Treated Water Pipe
- Treated Mine Water Pipe
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe
- Existing Sewer Pipe[3]
- Proposed Sewer Pipe[4]
- Stormwater Culvert
- Stormwater Ditch
- Stormwater Ponds
- Surface Water Discharge Outfalls
- FTB Containment System
- Emergency Overflow
- Public Waters Inventory (PWI) Watercourses[5]
- National Hydrography Dataset (NHD) Rivers & Streams[6]

0 900 1,800
Feet

FLOTATION TAILINGS BASIN LAYOUT - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

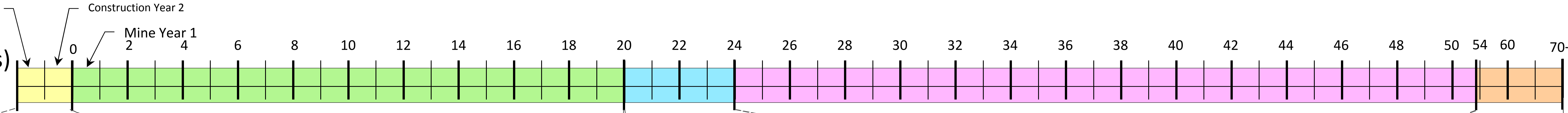
Figure 3-7
Permit to Mine Application



TRANSPORTATION AND UTILITY CORRIDORS AND COLBY LAKE PIPELINE CORRIDOR
NorthMet Project
Poly Met Mining, Inc.

Figure 3-8
Permit to Mine Application

Project Timeline (Years)



Mine Phase

Construction (18-24 months)

Mine Site
- Tree cutting
- Haul road construction
- Stripping of overburden within pit footprints and reclamation of any final pit rim overburden backslopes
- Waste rock and ore stockpile liner construction
- Category 1 Waste Rock Stockpile foundation and Groundwater Containment System construction
- Railroad Spur construction
- RTH grading
- Construction of the MSFMF
- Equalization Basin Area construction
- Construction of mine water ponds, sumps, pipelines and pumps
- Perimeter dikes construction
- Mechanical and electrical systems construction and installation
- OSLA construction
- Construction of storm water management systems

Plant Site
- WWTS construction
- Flotation Tailings discharge system and return water system installation and refurbishment
- Power distribution system improvements and construction
- First lift of FTB dams and associated underdrain and emergency overflow construction
- Initial segment of FTB buttress construction
- Drainage swale construction
- FTB Seepage Containment System construction
- Process plant modifications and construction
- Maintenance and shop building modifications
- Sewage Treatment System construction and refurbishment
- Potable water system construction and refurbishment
- Plant Reservoir refurbishment
- Stormwater management system construction and refurbishment
- Rail line and road construction and refurbishment
- Demolition of select legacy infrastructure
- Reclamation of LTVSMC tailings basin Cell 2W

Transportation and Utility Corridors
- Dunka Road upgrades
- Power distribution system construction and upgrades
- MPP construction
- Cliffs Erie private Mainline Railroad refurbishment
- Rail Connection Track construction

Colby Lake Pipeline Corridor
- Pipeline and pumphouse evaluation and recommissioning

Operations (Life of Mine)

Mine Site
- Stripping of overburden within pit footprints and reclamation of any final pit rim overburden backslopes
- Mining of the open pits
- Stockpiling of waste rock and ore
- Construction of expansions to lined waste rock stockpiles and Category 1 Waste Rock Stockpile
- Construction and operation of RTH
- Operation of Equalization Basin Area and mine water system and expansion of mine water system
- Operation and construction of expansions of Category 1 Stockpile Groundwater Containment System
- Construction of perimeter dikes
- Progressive reclamation of Category 1 Waste Rock Stockpile
- Relocation of Category 2/3 and 4 waste rock to East and Central Pits
- Category 2/3 and 4 Stockpile liner removal and reclamation
- Storm water management and expansion of system
- Haul road construction
- Railroad and haul road operations and maintenance
- Backfill East and Central Pits with Category 1, 2, 3, and 4 waste rock
- Partial flooding of East and Central Pits
- Monitoring per each environmental permit
- General site operations and maintenance

Plant Site
- WWTS operation
- Sewage Treatment System and Potable Water Treatment Plant operations
- Flotation Tailings deposition at FTB
- Construction of additional FTB dams in lifts and buttress segments
- Relocate Flotation tailings transport, discharge pipes and water return pipes
- Amend FTB dams with bentonite
- Coal Ash landfill relocation
- Processing of ore
- Hydrometallurgical Plant and HRF construction and operation
- Loading concentrate for shipment
- FTB seepage capture systems operation and monitoring
- Stream flow augmentation from WWTS
- HRF and FTB monitoring, maintenance, and progressive reclamation of slopes
- Railroad and road maintenance
- Progressive reclamation of Plant Site areas
- Stormwater management
- Monitoring per each environmental permit
- Demolition of select legacy infrastructure

Transportation and Utility Corridors
- Dunka Road operation and maintenance
- Operation and maintenance of MPP
- Rail line operation and maintenance

Colby Lake Pipeline Corridor
- Pipeline operation and maintenance as needed

Reclamation[1] (Mine Years 21-24)

Mine Site
- Structure demolition and footprint reclamation
- Pit perimeter barrier system construction and reclamation
- Construct East Pit outlet structure
- Category 1 Stockpile cover completion
- Category 2/3 Stockpile reclamation
- OSP liner removal and reclamation
- OSLA reclamation
- Mechanical and electrical system maintenance, removal and reclamation
- Remove, reroute, and reclaim stormwater management systems
- Reclaim mine water ponds, sumps, and basins
- Haul road reclamation
- RTH reclamation
- Railroad Spur reclamation
- MSFMF infrastructure removal and reclamation
- CPS operation
- Flooding of backfilled East Pit and cycling water through the WWTS
- Complete East Pit backfilling
- Flooding of West Pit
- Monitoring per each environmental permit
- General site maintenance

Plant Site
- Structure demolition and footprint reclamation
- Fence construction as necessary for site security
- Remove and/or reclaim stormwater management systems
- Progressive road reclamation
- Seeding in the Mining Area
- Tailings pipeline and pumping system removal and reclamation
- Reclaim Tailings Basin
- Bentonite amendment to FTB beach and pond bottom cover
- Continue FTB seepage capture systems operation
- Stream flow augmentation from WWTS
- FTB Closure Overflow construction
- HRF dewatering and temporary cover construction
- Collect and treat HRF drainage at the WWTS
- Continue WWTS treatment
- Removal of the sewage treatment stabilization pond liners, and pipelines, and pond area reclamation
- Potable and fire water system reclamation
- Railroad reclamation of tracks owned by PolyMet
- General site maintenance
- Monitoring per each environmental permit

Transportation and Utility Corridors
- Dunka Road passing bays reclamation
- Reclamation of Connection Track owned by PolyMet
- Power lines progressive reclamation
- Site grading and revegetation

Colby Lake Pipeline Corridor
- Pipeline and pumphouse decommission

Closure[1] (Mine Years 25-54)

Mine Site
- West pit overflow structure construction
- CPS Operation
- Complete flooding of East Pit and cycling water through WWTS
- Flooding of West Pit
- Monitoring per each environmental permit
- General site maintenance

Plant Site
- Continue FTB seepage capture systems and stream augmentation
- Continue WWTS operation
- HRF drainage completion and permanent cover construction
- Complete collection and treatment of HRF drainage at the WWTS
- Monitoring per each environmental permit
- General site maintenance

Postclosure Maintenance (Mine Years 55+)

Mine Site
- Discharge from West Pit to a tributary of the Partridge River
- CPS operation
- Construction of non-mechanical treatment
- CPS decommissioning and reclamation
- Equalization Basin Area decommissioning and reclamation
- Monitoring per each environmental permit
- General site maintenance

Plant Site
- Continue FTB seepage capture systems and stream augmentation
- Continue WWTS operation
- Postclosure WWTS treatment of mine water and Tailings Basin seepage
- Construction of non-mechanical treatment
- WWTS decommissioning and reclamation
- Monitoring per each environmental permit
- General site maintenance

Transportation and Utility Corridors
- MPP removal and reclamation

ABBREVIATIONS
CPS – Central Pumping Station
CRE – Contingency Reclamation Estimate
FTB – Flotation Tailings Basin
HRF – Hydrometallurgical Residue Facility
MPP – Mine to Plant Pipelines
MSFMF – Mine Site Fueling and Maintenance Facility
OSLA – Overburden Storage Laydown Area
OSP – Ore Surge Pile
RTH – Rail Transfer Hopper
WWTS – Waste Water Treatment System

NOTES: 1. The reclamation phase is assumed to begin at the start of Mine Year 21. The closure phase is complete when the West Pit is flooded, and postclosure water treatment is initiated (Mine Year 55).

PROJECT TIMELINE
NorthMet Project
Poly Met Mining, Inc.

Figure 3-9
Permit to Mine Application

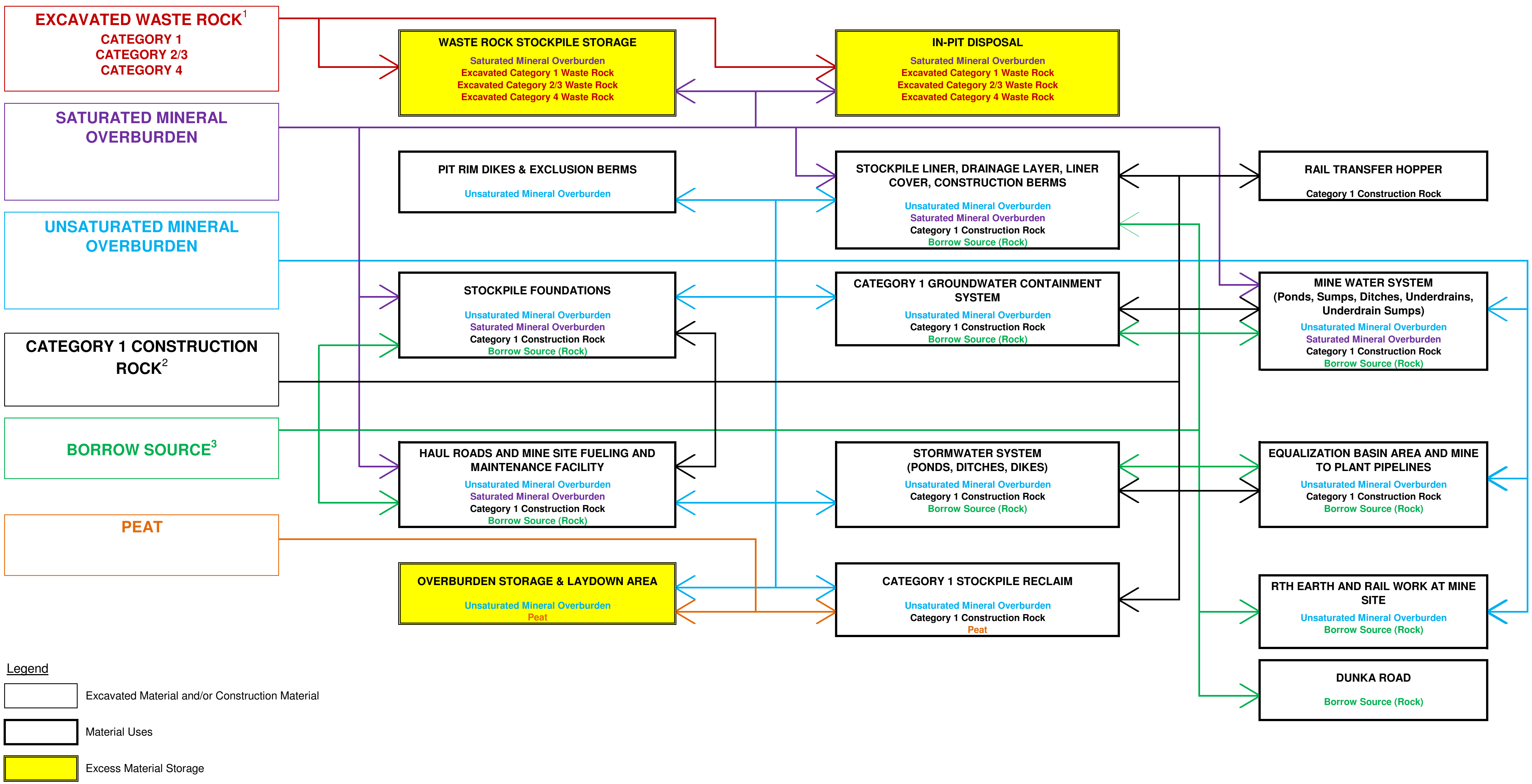
P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-9_PROJECT TIMELINE_v10.pptx

Location	Infrastructure	Construction		Mine Year of Operations											
			Mining Commences (i.e., when production blasting commences within the open pit at the Mine Site)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12-20**
Mine Site	Category 1 Waste Rock Stockpile (with Groundwater Containment System)														
	Category 2/3 Waste Rock Stockpile (with Liner)														
	Category 4 Waste Rock Stockpile (with Liner)														
	Ore Surge Pile (OSP) (with Liner)														
	East Pit														
	West Pit														
	Central Pit														
	Rail Transfer Hopper (RTH)														
	Fueling and Maintenance Facility														
	Mine Water Sumps, Ponds and Pipes														
	Haul Roads														
	Stormwater Ponds, Dikes, and Ditches														
	Overburden Storage and Laydown Area (OSLA)														
	Power Distribution System														
	Equalization Basin Area														
	Central Pumping Station (CPS)														
	Construction Mine Water Pumping Station														
Transportation and Utility Corridors	Dunka Road														
	Railroad Connection Track and Railroad Spurs														
	Power Distribution System														
	Mine to Plant Pipelines (MPP)														
Plant Site	Waste Water Treatment System (WWTS)														
	Surface Water Discharge System (Stream Augmentation System)														
	Sewage Treatment System														
	Potable Water Treatment System														
	Stormwater Infrastructure														
	Railroad														
	Area 1 Shops														
	Area 2 Shops														
	Flotation Tailings Basin (FTB)														
	FTB South Seepage Management System														
	FTB Seepage Containment System														
	Beneficiation Plant														
	Plant Reservoir and Colby Lake Pipeline														
	Hydrometallurgical Plant														
	Hydrometallurgical Residue Facility (HRF)														

Key:	
	No Construction or Operation
	Construction (or Stripping for Mine Pits)
	Operation (or Mining or Backfilling for Mine Pits)
	Both Construction and Operation
	Mine Site
	Waste Water Treatment System
	Plant Site Sewage Treatment, Potable Water Treatment and Stormwater
	Tailings Basin and Beneficiation Plant
	Hydrometallurgical Residue Facility and Hydrometallurgical Plant
	Transportation and Utility Corridors and Colby Lake Corridors

PROJECT TIMELINE OVERVIEW
NorthMet Project
Poly Met Mining, Inc.

Figure 3-10
Permit to Mine Application

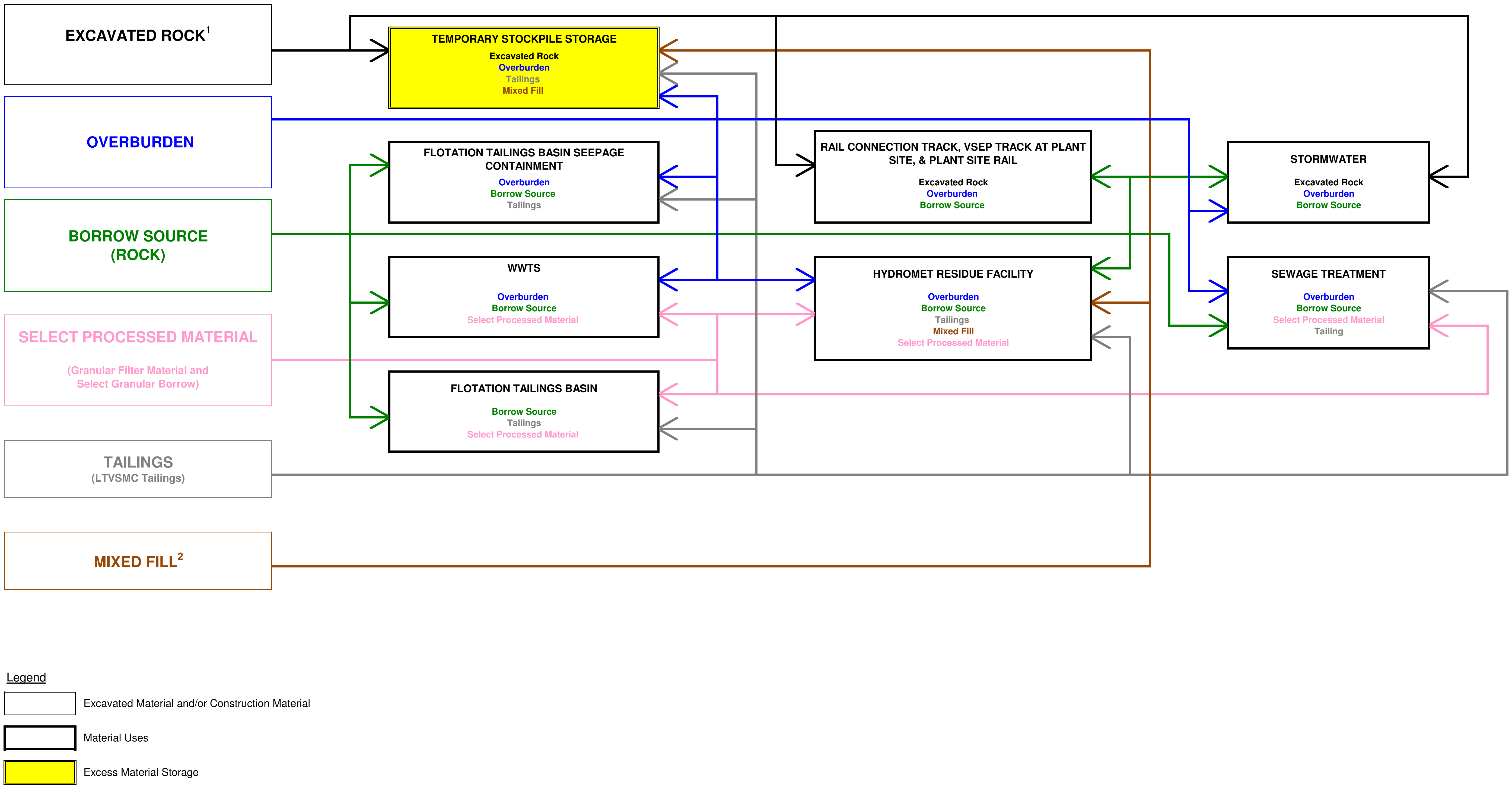


[1] Waste rock excavated during construction activities only (includes all categories of waste rock)
[2] Category 1 Construction Rock is a subset of the Category 1 waste rock with a sulfur content of 0.05% or less
[3] Borrow sources will include taconite waste rock meeting the criteria as specified in the Construction Material SOP

MINE SITE OVERBURDEN AND WASTE ROCK USE AND STORAGE DIAGRAM
NorthMet Project
Poly Met Mining, Inc.

Figure 3-11
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-11_OVERBURDEN AND WASTE ROCK USE AND STORAGE DIAGRAM-v4.xlsx



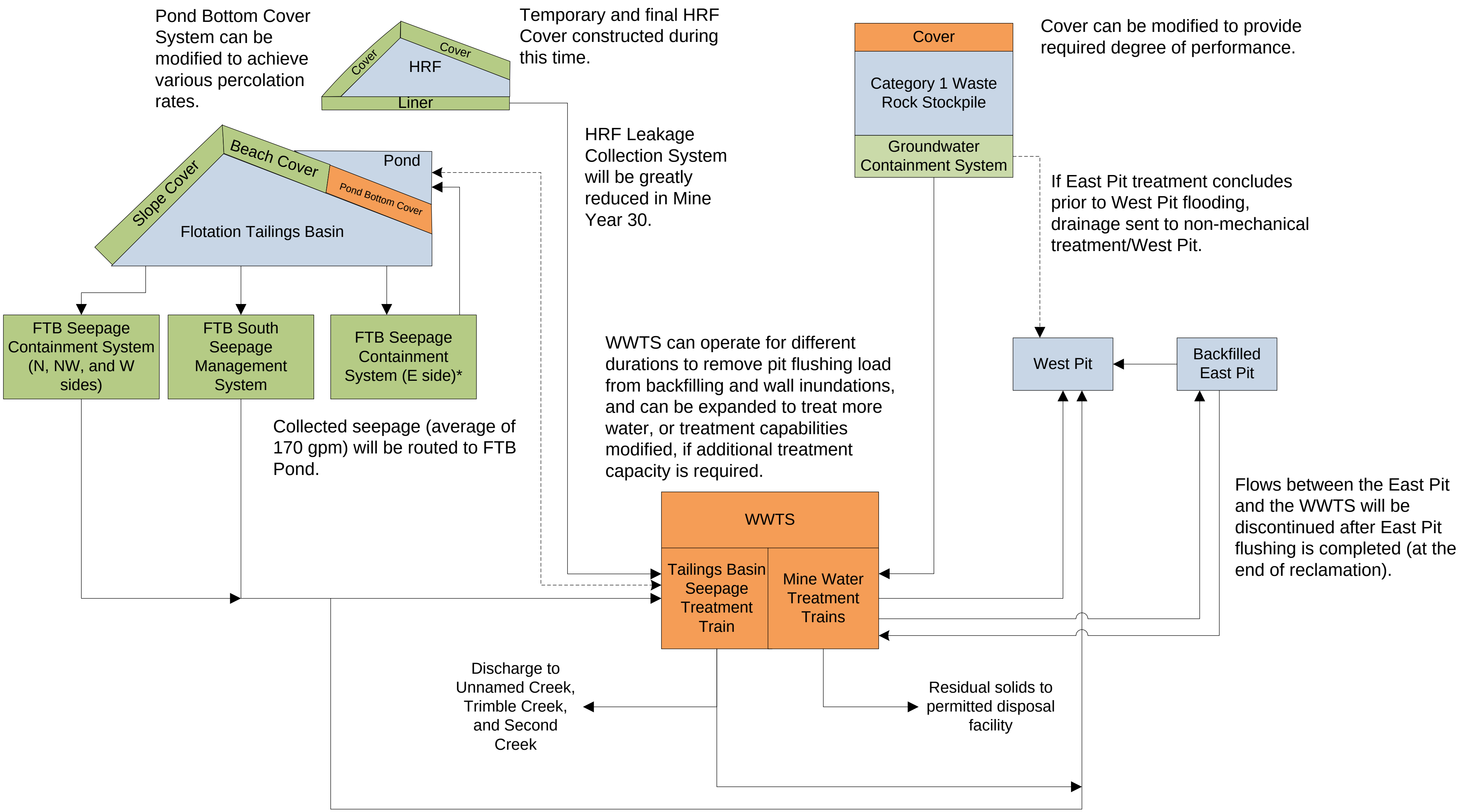
[1] Rock excavated during construction activities only

[2] Mixed Fill includes material excavated from the HRF area and reused in construction.

PLANT SITE EARTHWORK MATERIAL USE AND STORAGE DIAGRAM
NorthMet Project
Poly Met Mining, Inc.

Figure 3-12
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-12_ Material Flow and Storage Diagrams v2.xlsx



Dashed lines represent intermittent or occasional flow

Project Feature

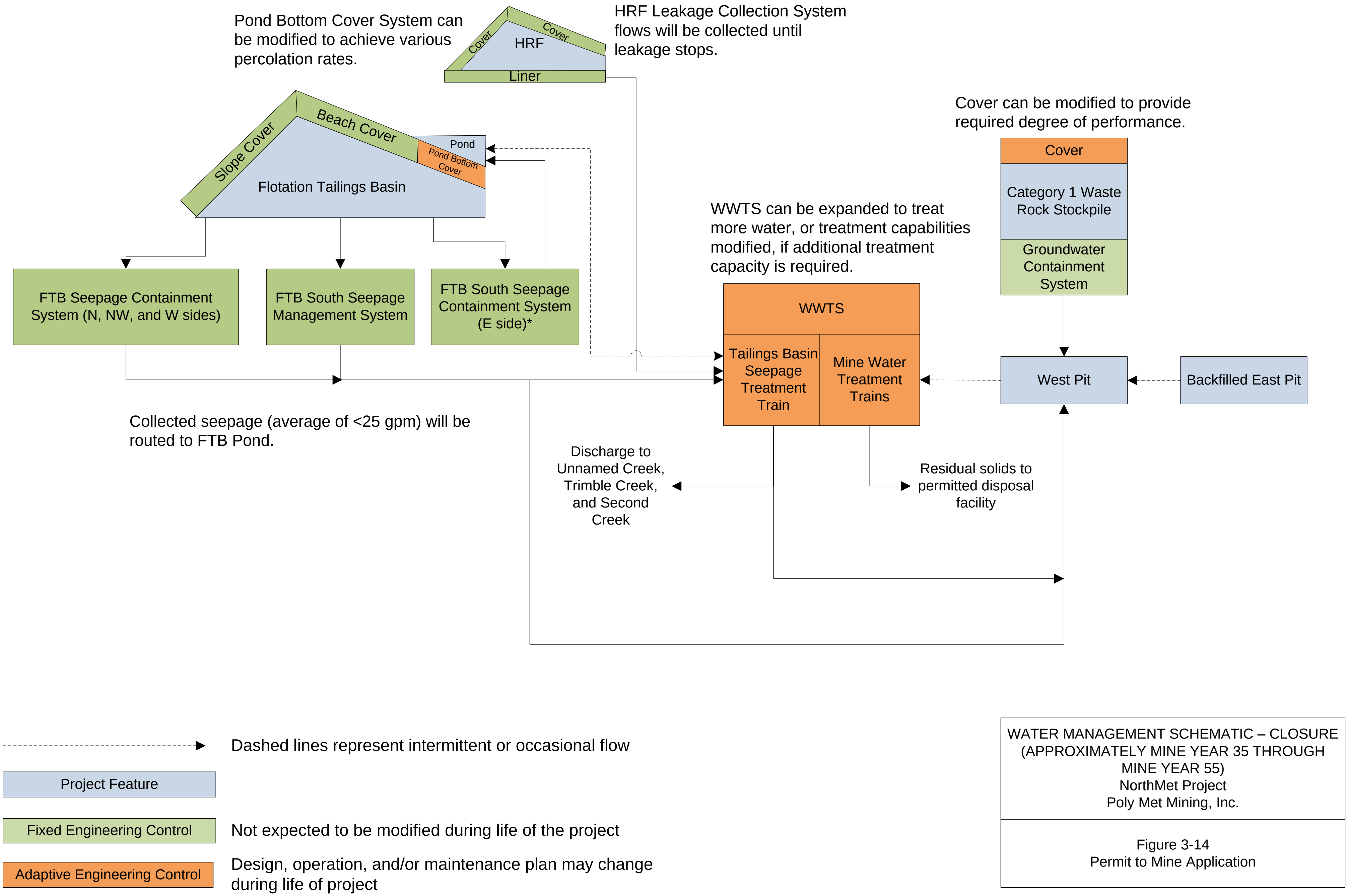
Fixed Engineering Control — Not expected to be modified during life of the project

Adaptive Engineering Control — Design, operation, and/or maintenance plan may change during life of project

WATER MANAGEMENT SCHEMATIC – RECLAMATION AND CLOSURE (APPROXIMATELY MINE YEAR 21 THROUGH MINE YEAR 34)
NorthMet Project
Poly Met Mining, Inc.

Figure 3-13
Permit to Mine Application

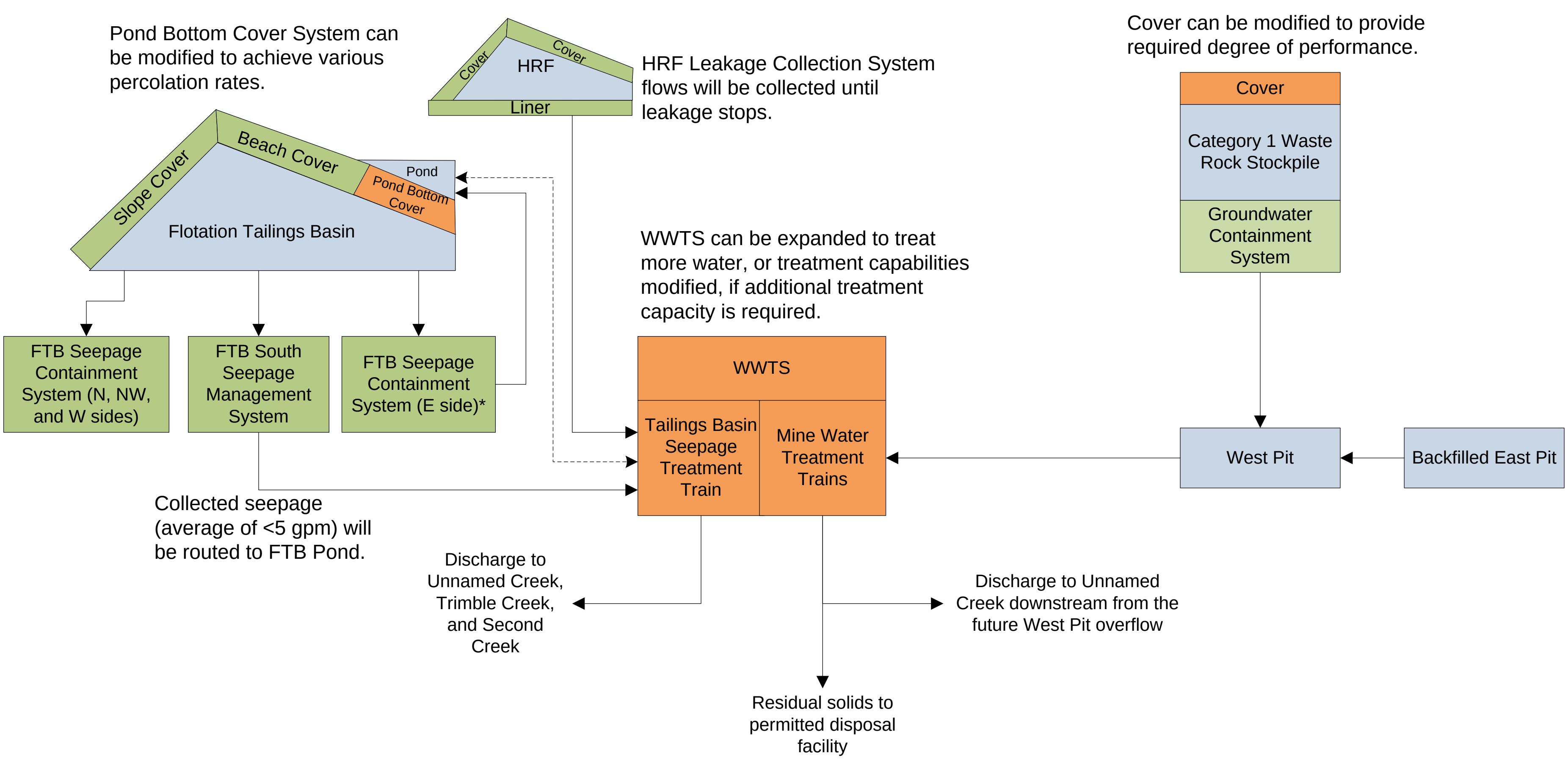
P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-13 WATER MANAGEMENT SCHEMATIC_RECLAMATION AND CLOSURE.vsd



WATER MANAGEMENT SCHEMATIC – CLOSURE (APPROXIMATELY MINE YEAR 35 THROUGH MINE YEAR 55)
NorthMet Project
Poly Met Mining, Inc.

Figure 3-14
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-14 WATER MANAGEMENT SCHEMATIC_CLOSURE.vsd



Dashed lines represent intermittent or occasional flow

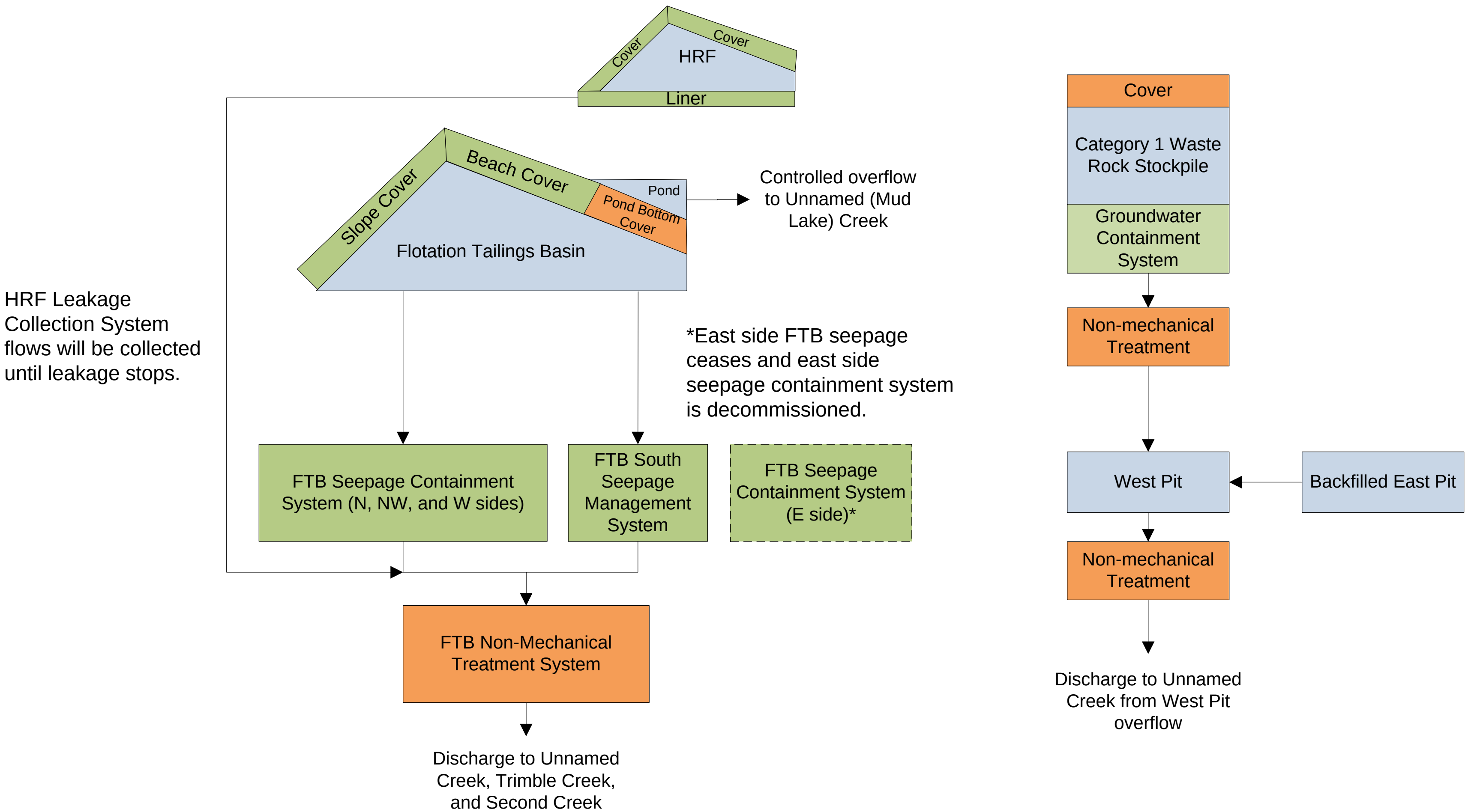
Project Feature

Fixed Engineering Control — Not expected to be modified during life of the project

Adaptive Engineering Control — Design, operation, and/or maintenance plan may change during life of project

WATER MANAGEMENT SCHEMATIC – POSTCLOSURE MAINTENANCE: LONG-TERM MECHANICAL TREATMENT
NorthMet Project
Poly Met Mining, Inc.

Figure 3-15
Permit to Mine Application



Dashed lines represent intermittent or occasional flow

Project Feature

Fixed Engineering Control — Not expected to be modified during life of the project

Adaptive Engineering Control — Design, operation, and/or maintenance plan may change during life of project

WATER MANAGEMENT SCHEMATIC – POSTCLOSURE MAINTENANCE: LONG-TERM NON-MECHANICAL TREATMENT
NorthMet Project
Poly Met Mining, Inc.

Figure 3-16
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\3 Mining and Reclamation\Figures\Figures\FIGURE 3-16 WATER MANAGEMENT SCHEMATIC_POSTCLOSURE NON MECH.vsd

4.0 Land Management

This Section 4.0 provides an overview of PolyMet's interest in the surface lands and minerals within the vicinity of the Mining Area. Figure 1-5 and Figure 1-6 show PolyMet's current and future interest in surface lands within the Mining Area, respectively. Current interests reflect existing agreements (e.g., contracts for deed and other agreements with Cliffs Erie, agreements with RGGS). Future interests reflect pending or anticipated agreements (e.g., PolyMet having full fee title of lands after the land exchange with the USFS is completed). PolyMet ownership or substantial control, including rights of use or access, will be demonstrated for the lands within the Mining Area before the DNR makes a final decision on whether to issue the permit in response to this Application. Figure 1-7 shows current mineral ownership within the Mining Area.

Figure 4-1 thru Figure 4-4 show PolyMet's current property interests in surface lands within the Mining Area for the Mine Site, Plant Site, Transportation and Utility Corridors, and Colby Lake Pipeline Corridor, respectively. These figures also show locations where PolyMet has rights of access and use for roads, railroads, and other uses within the Mining Area. In some locations, PolyMet and Cliffs Erie currently have certain overlapping or concurrent rights of ownership, access and/or use under the agreements between the companies (e.g., licenses concerning use of railroads and roadways, contracts for deeds). Some of the agreements between PolyMet and Cliffs Erie also include contingencies relating to the issuance of permits for this Project, including replacement of Cliffs' existing ferrous reclamation plan as applicable to properties that PolyMet will own as discussed in Section 16.0. PolyMet anticipates the execution of further agreements before permits are issued for the the Project, including execution of the land exchange with the USFS, agreements with Cliffs Erie or its affiliates, and with other parties. These pending or anticipated agreements will provide PolyMet with additional rights of ownership, use, and/or control of lands within the Mining Area, which will be demonstrated before the DNR makes a final decision on whether to issue the PTM and other permits (e.g., the dam safety permit, water appropriation permit) for the Project.

Figure 4-5 thru Figure 4-8 show mineral ownership for the Mine Site, Plant Site, Transportation and Utility Corridors, and Colby Lake Pipeline Corridor, respectively. Appendix 1.11 provides additional details, in table format, regarding ownership and PolyMet's current interests as of the date of this Application for both surface lands and minerals. Appendix 1.11 references existing agreements providing rights of access and use to lands not currently owned in fee by PolyMet.

The tables in Appendix 1.11 organize information by Township, Range, Section, Quarter Section, and Quarter-Quarter Section (or government lot) land survey boundaries. The geographic boundaries, as well as landowner and taxpayer information, are sourced from the October 2016 St. Louis County, Minnesota parcel data. Updates to the St. Louis County data are provided where PolyMet is aware of additional information that is not reflected in the St. Louis County GIS database.

The surface interests tables (Table 1 through Table 4 in Appendix 1.11) identify PolyMet's property interests and other access rights, including the agreements that provide PolyMet with ownership or other control and use rights. The mineral ownership tables (Table 5 through Table 8 of Appendix 1.11) provide additional reference data concerning mineral ownership and other rights. All tables in Appendix 1.11 are organized by Project area (i.e., Mine Site, Plant Site, Transportation and Utility Corridors, or Colby Lake Pipeline Corridor).

Section 4.1 through Section 4.4 provide additional information concerning PolyMet's property, access, and use rights for specific portions of the Project, including:

- the Mine Site (minerals and surface)
- the Plant Site (surface)
- the Transportation and Utility Corridors (surface)
- the Colby Lake Pipeline Corridor (surface)

PolyMet will not disturb land on property that PolyMet does not control. Surveys, based on legal descriptions, will confirm the exterior Mining Area boundaries prior to the commencement of construction on each area.

4.1 Mine Site Mineral and Surface Interests

PolyMet has control of the mineral rights necessary for the Project. Appendix 1.11 lists PolyMet's mineral interests within those portions of the Mine Site that PolyMet proposes to mine during the LOM: the West Pit, the Central Pit, and the East Pit (collectively, the Mine Pits). The Mine Pits include approximately 527 acres of minerals, all of which are privately owned minerals leased by PolyMet.

As shown on Figure 4-5, RGGS owns the majority of the minerals within the Mining Area at the Mine Site. PolyMet currently holds a lease granting it the exclusive right to explore, mine, remove, beneficiate or process, and dispose of all minerals owned by RGGS (RGGS Lease). The remaining minerals within the Mine Pits are owned by Longyear. PolyMet also holds a private lease for these minerals (Longyear Lease), which authorizes the exploration, development, and mining of these minerals.

Collectively, the RGGS Lease and the Longyear Lease provide PolyMet with the necessary rights to conduct the mining operations associated with this Project for the entire LOM. In addition, the proposed operations will comply with the terms and conditions of these leases. These terms and conditions include requirements that PolyMet conduct its operations in a skillful and workmanlike manner in accordance with generally accepted standards and practices for the mining industry. The RGGS Lease and Longyear Lease also both require that PolyMet comply with applicable laws, including environmental statutes and regulations.

Figure 4-5 also shows the location of publicly-owned minerals, identified on the figure as USA, located at the southeast extent of the Mine Site. PolyMet has not acquired any legal rights in these minerals.These areas are not within the Mine Pits, and there is no current plan to mine these minerals.

The Mine Site includes approximately 3,007 acres of surface lands. PolyMet holds various legal interests (including equitable title, leasehold interests, use rights, and other property and legal interests) to certain surface lands within the Mine Site pursuant to several agreements with Cliffs Erie and its affiliates (the Cliffs Agreements) as further described in the discussion of Plant Site surface lands. Pursuant to the Cliffs Agreements, PolyMet currently has the necessary rights to gain access to, utilize, and otherwise possess and operate its present activities on the private surface lands subject to these Cliffs Agreements. Appendix 1.11 provides additional details regarding PolyMet interests.

The majority of surface lands within the Mine Site are owned by the federal government and administered by the USFS. In 2007, PolyMet entered into discussions with the USFS to acquire, through a land exchange, fee title to surface lands overlying PolyMet's private mineral lease. The USFS completed its administrative review process, and on January 9, 2017, issued a Final ROD for the proposed land exchange, which is included as Appendix 16.2.2.

Figure 4-1 shows the current surface interests for Mine Site lands within the Mining Area, including those lands subject to the Cliffs Agreements and the USFS land exchange parcels. Figure 1-6 depicts future Mine Site surface interests within the Mining Area expected by PolyMet after pending or anticipated agreements are finalized, such as acquiring full fee title and other interests to these lands in connection with the USFS land exchange and the Cliffs Agreements. Section 6.2 includes an overview of the regulatory process associated with the land exchange.

4.2 Plant Site Surface Interests

PolyMet has the interests and rights to all surface lands within the Plant Site necessary to conduct the Project. The Plant Site includes approximately 5,978 acres of surface lands, and Figure 4-2 shows the current interests to these lands. Most of these lands are subject to the Cliffs Agreements, including option agreements (which have been exercised), contracts for deed, and other agreements. There also are certain additional lands within the Plant Site for which PolyMet has agreements in place with parties other than Cliffs Erie (e.g., the DuNord lease).

The Cliffs Agreements variously provide PolyMet with title interests, licenses, easements, rights-of-way, access rights, use and permit rights, and other legally-binding interests. The Cliffs Agreements cover not only surface lands, but also buildings, fixtures, and other improvements; infrastructure and equipment such as roadways, railroad lines, electrical power lines, gas pipeline, and water facilities; and intangibles such as permits and licenses, which are necessary to enable production at the Plant Site. The Cliffs Agreements collectively provide PolyMet with the necessary rights to access, utilize, and otherwise possess, control, and operate its present activities on the private surface lands within the Plant Site. Figure 1-6 depicts the expected future surface interests of the lands within the Mining Area at the Plant Site after pending or anticipated agreements are finalized, including the USFS land exchange and final closing on the Cliffs Agreements.

4.3 Transportation and Utility Corridors Surface Interests

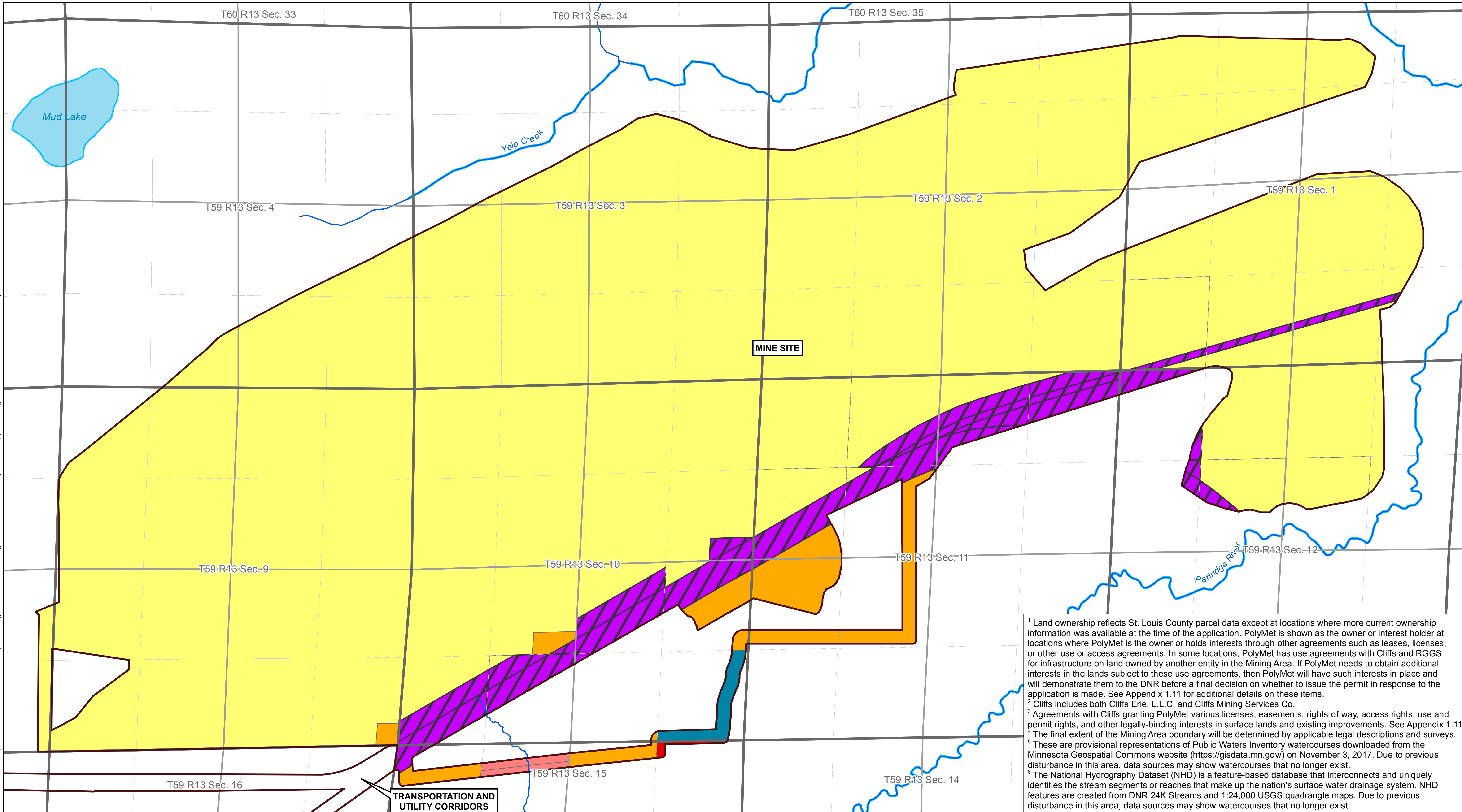
The Transportation and Utility Corridors connect the Plant Site and the Mine Site, and these corridors include approximately 333 acres of surface lands. Figure 4-3 shows current surface interests for these corridors.

PolyMet has acquired the necessary property interests and rights (including, among other things, title interests, easements, rights-of-way, licenses, access rights, use rights, and other rights) in land and infrastructure in the Transportation and Utility Corridors. The primary existing infrastructure within the Transportation and Utility Corridors are the Dunka Road and the mainline railroad. The Dunka Road and mainline railroad diverge at some points as shown on Figure 4-3. PolyMet will also construct water pipelines, transmission lines and equipment, and other utilities within the corridors as shown on Figure 9-3.

Most of the land and infrastructure within the Transportation and Utility Corridors are subject to the Cliffs Agreements described in Section 4.2. Other surface owners within the corridors are Minnesota Power/ALLETE, DuNord Land Company, the state of Minnesota, and the United States (administered by USFS). Figure 1-6 depicts the expected future surface interests for lands within the Transportation and Utility Corridors after all agreements relating to the USFS land exchange, Cliffs Erie, and the other entities referenced in this paragraph have been completed.

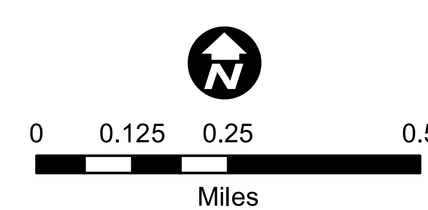
4.4 Colby Lake Pipeline Corridor Surface Interests

The Cliffs and RGGS Agreements provide PolyMet with various legal interests (including title, licenses and permits, use rights, rights-of-way and other rights) in the majority of the Colby Lake Pipeline Corridor, including the existing pumphouse. The properties include land, infrastructure (pipeline and power line), utilities and equipment, and buildings, among other things. Figure 4-4 depicts current surface interests within the Colby Lake Pipeline Corridor. This corridor includes approximately 152 acres of surface lands. Figure 1-6 depicts expected future surface interests for lands within the Colby Lake Corridor after all relevant agreements have been completed.



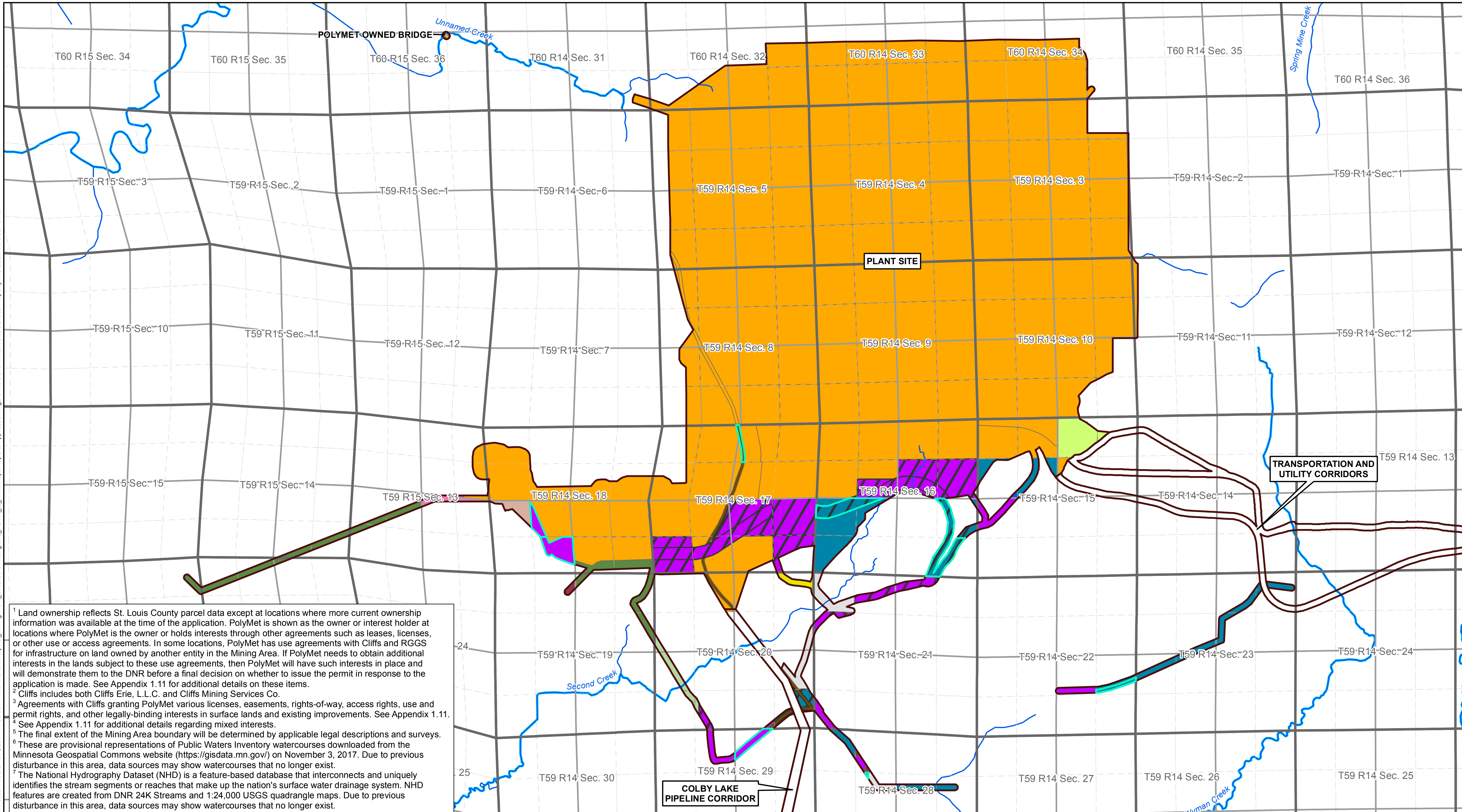
[1] Land ownership reflects St. Louis County parcel data except at locations where more current ownership information was available at the time of the application. PolyMet is shown as the owner or interest holder at locations where PolyMet is the owner or holds interests through other agreements such as leases, licenses, or other use or access agreements. In some locations, PolyMet has use agreements with Cliffs and RGGS for infrastructure on land owned by another entity in the Mining Area. If PolyMet needs to obtain additional interests in the lands subject to these use agreements, then PolyMet will have such interests in place and will demonstrate them to the DNR before a final decision on whether to issue the permit in response to the application is made. See Appendix 1.11 for additional details on these items.
[2] Cliffs includes both Cliffs Erie, L.L.C. and Cliffs Mining Services Co.
[3] Agreements with Cliffs granting PolyMet various licenses, easements, rights-of-way, access rights, use and permit rights, and other legally-binding interests in surface lands and existing improvements. See Appendix 1.11.
[4] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

St. Louis County Parcels by Owner or Interest Holder[1]
- Allete Inc
- Blandin Paper Company
- Cliffs[2]
- PolyMet - Contract for Deed
- PolyMet - Ancillary Agreements with Cliffs[3]
- State of Minnesota
- USA
- Mining Area[4]
- Public Waters Inventory (PWI) Basin
- Public Waters Inventory (PWI) Watercourses[5]
- National Hydrography Dataset (NHD) Rivers & Streams[6]



CURRENT MINE SITE SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining, Inc.

Figure 4-1
Permit to Mine Application



[1] Land ownership reflects St. Louis County parcel data except at locations where more current ownership information was available at the time of the application. PolyMet is shown as the owner or interest holder at locations where PolyMet is the owner or holds interests through other agreements such as leases, licenses, or other use or access agreements. In some locations, PolyMet has use agreements with Cliffs and RGGS for infrastructure on land owned by another entity in the Mining Area. If PolyMet needs to obtain additional interests in the lands subject to these use agreements, then PolyMet will have such interests in place and will demonstrate them to the DNR before a final decision on whether to issue the permit in response to the application is made. See Appendix 1.11 for additional details on these items.

[2] Cliffs includes both Cliffs Erie, L.L.C. and Cliffs Mining Services Co.

[3] Agreements with Cliffs granting PolyMet various licenses, easements, rights-of-way, access rights, use and permit rights, and other legally-binding interests in surface lands and existing improvements. See Appendix 1.11.

[4] See Appendix 1.11 for additional details regarding mixed interests.

[5] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.

[6] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

[7] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

St. Louis County Parcels by Owner or Interest Holder[1]

- Cliffs[2]
- Canadian National
- DuNord Land Company
- Elizabeth P Young Revocable Trust
- Glacier Park Co C/D
- Hughes G S ETAL
- Mesabi Mining, LLC
- Mesabi Nugget Delaware, LLC
- PolyMet - Contract for Deed
- PolyMet - Ancillary Agreements with Cliffs[3]
- PolyMet - Ancillary Agreements with RGGS
- RGGS Land & Minerals LTD LP
- Romberg Carolyn Family Trust
- State of Minnesota
- Tighe Deborah D ETAL
- USA
- Mixed Interests[4]
- Mining Area[5]
- Public Waters Inventory (PWI) Watercourses[6]
- National Hydrography Dataset (NHD) Rivers & Streams[7]

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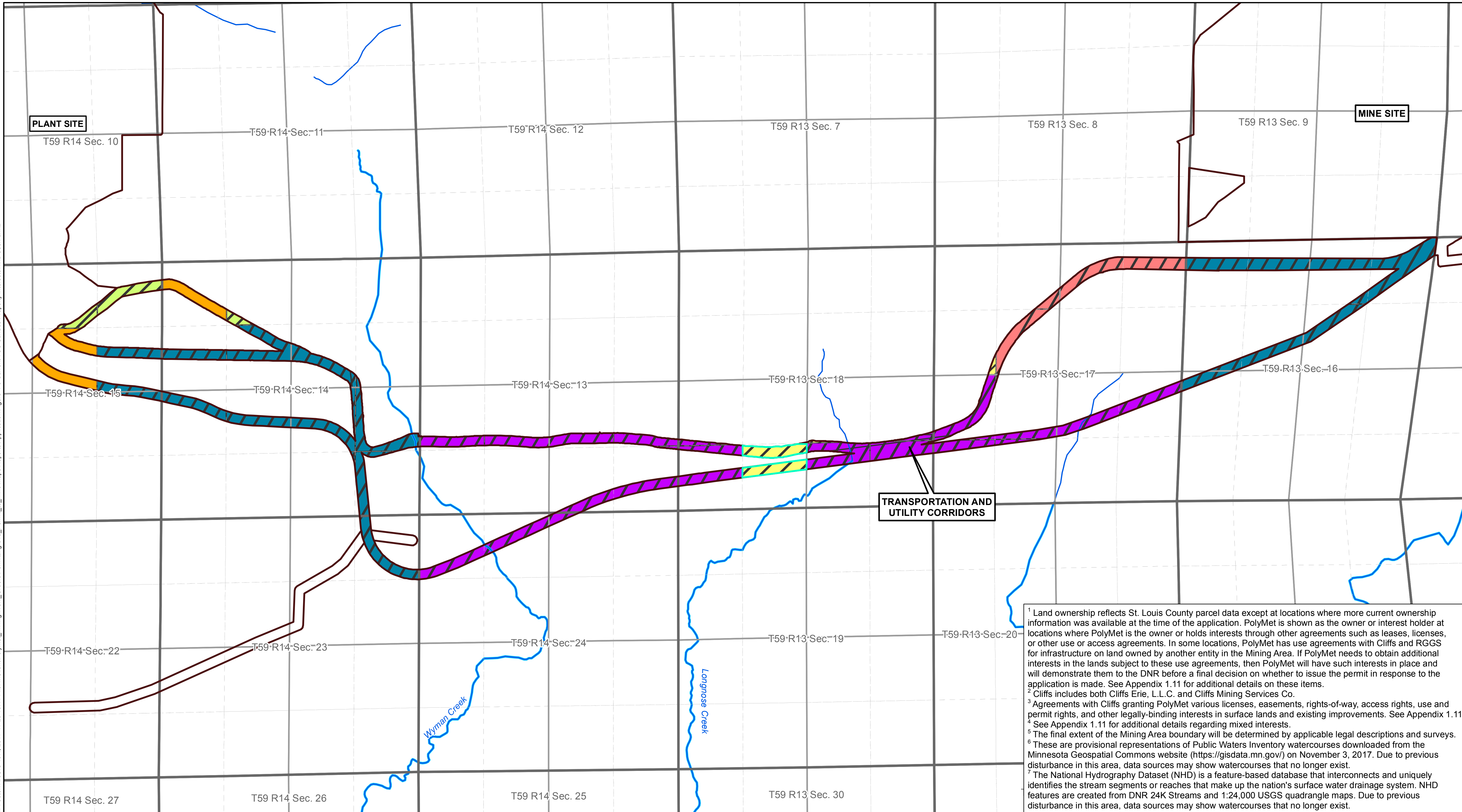
Miles

CURRENT PLANT SITE SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining, Inc.

Figure 4-2
Permit to Mine Application



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[4] See Appendix 1.11 for additional details regarding mixed interests.
[5] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[6] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[7] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

St. Louis County Parcels by Owner or Interest Holder[1]
- Allete, Inc.
- Cliffs[2]
- DuNord Land Company
- PolyMet - Contract for Deed
- PolyMet - Ancillary Agreements with Cliffs[3]
- State of Minnesota
- USA
- Mixed Interests[4]
- Mining Area[5]
- Public Waters Inventory (PWI) Watercourses[6]
- National Hydrography Dataset (NHD) Rivers & Streams[7]

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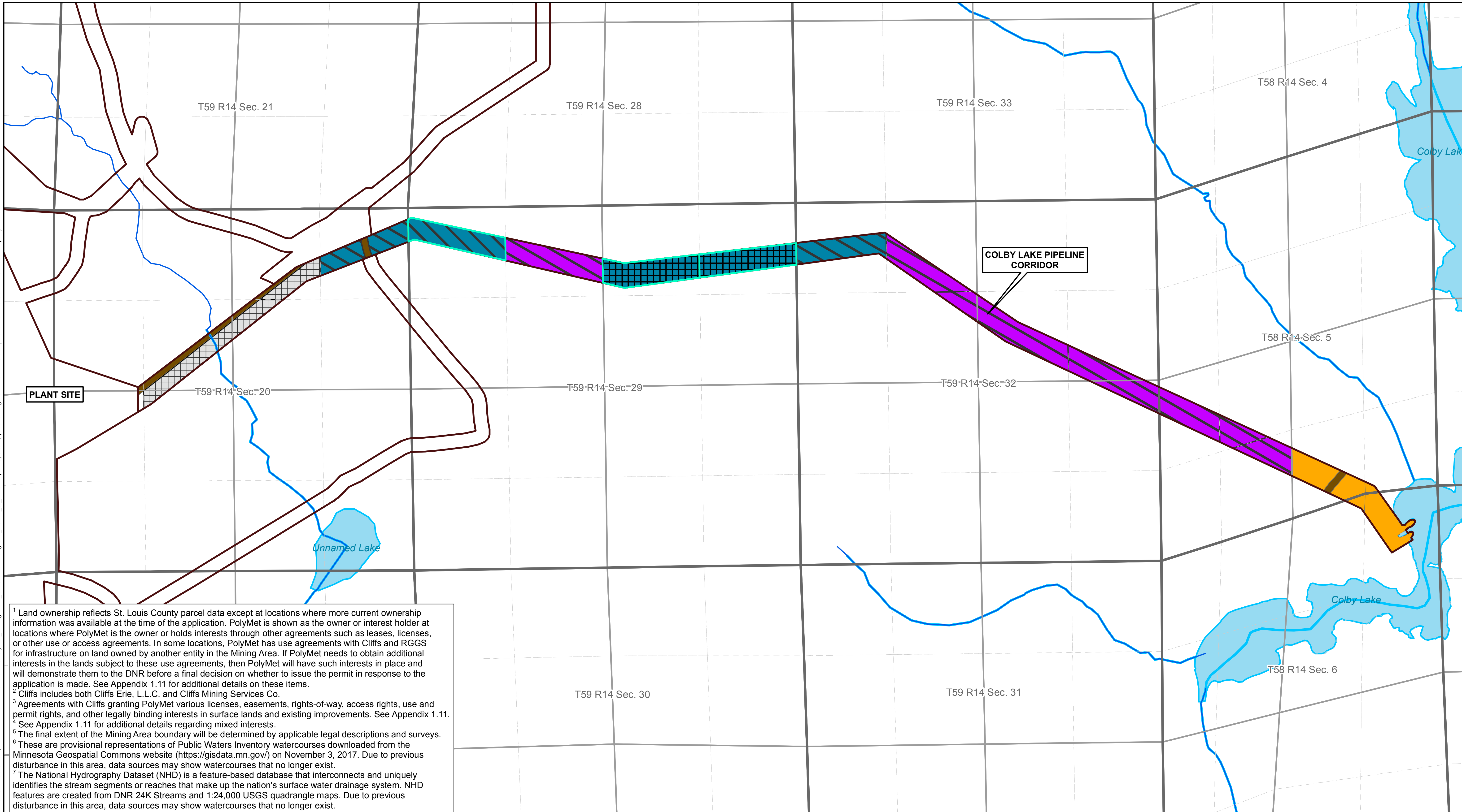
CURRENT TRANSPORTATION AND UTILITY CORRIDORS SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining, Inc.

Figure 4-3
Permit to Mine Application



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St. Louis County Parcels by Owner or Interest Holder[1]
- Cliffs[2]
- Canadian National
- PolyMet - Contract for Deed
- PolyMet - Ancillary Agreements with Cliffs[3]
- PolyMet - Ancillary Agreements with RGGS
- RGGS Land & Minerals LTD LP
- State of Minnesota
- Mixed Interests[4]
- Mining Area[5]
- Public Waters Inventory (PWI) Basin
- Public Waters Inventory (PWI) Watercourses[6]
- National Hydrography Dataset (NHD) Rivers & Streams[7]

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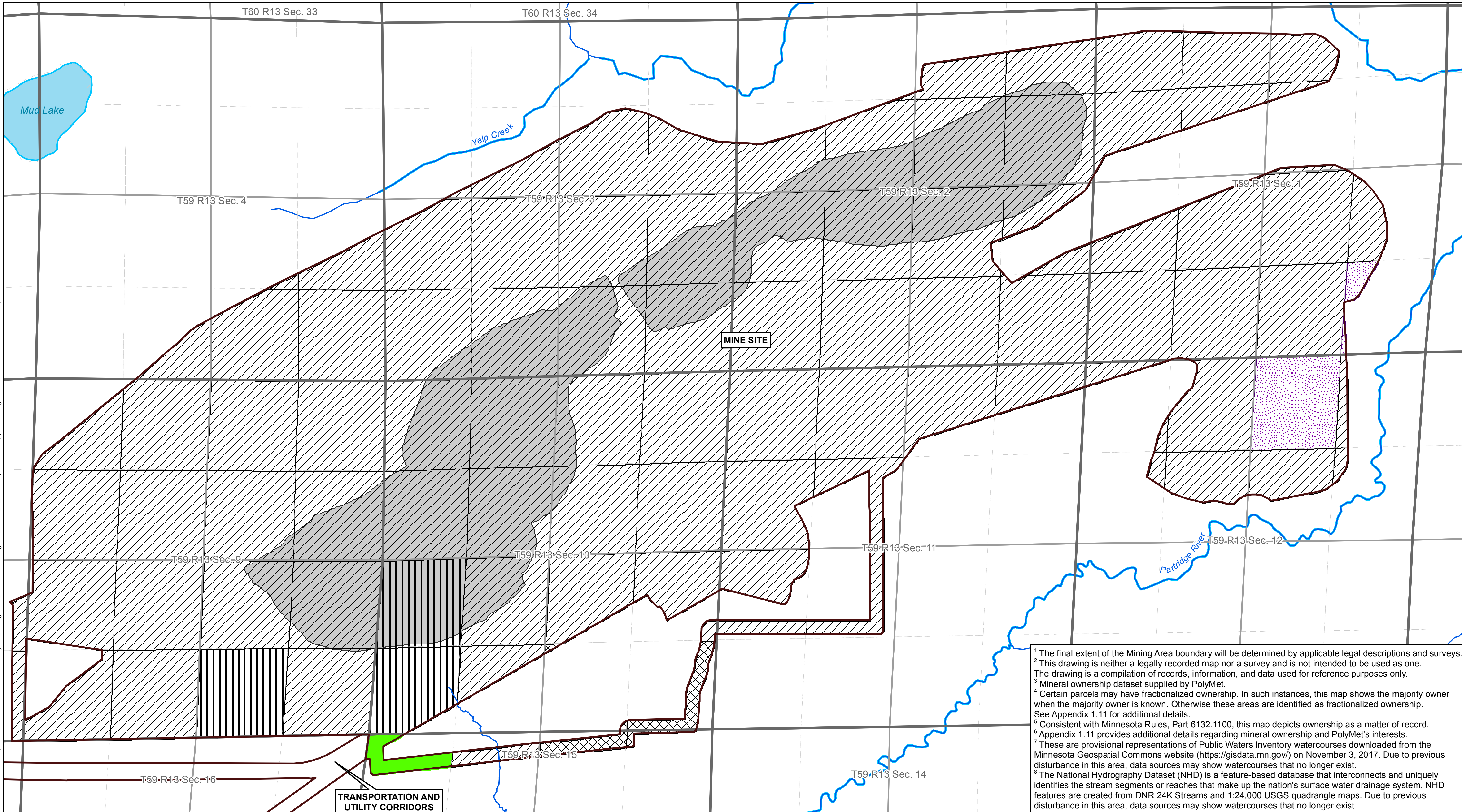
CURRENT COLBY LAKE PIPELINE CORRIDOR SURFACE PROPERTY INTERESTS
NorthMet Project
Poly Met Mining, Inc.

Figure 4-4
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
[3] Mineral ownership dataset supplied by PolyMet.
[4] Certain parcels may have fractionalized ownership. In such instances, this map shows the majority owner when the majority owner is known. Otherwise these areas are identified as fractionalized ownership. See Appendix 1.11 for additional details.
[5] Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record.
[6] Appendix 1.11 provides additional details regarding mineral ownership and PolyMet's interests.
[7] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[8] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]
Mine Pits
Mineral Ownership[3]
James Marra (deceased) - State claims ownership
Longyear/Longyear Mesaba
RGGS
State of MN, State of MN (by forfeiture) or may claim
USA
Public Waters Inventory (PWI) Basin
Public Waters Inventory (PWI) Watercourses[7]
National Hydrography Dataset (NHD) Rivers & Streams[8]

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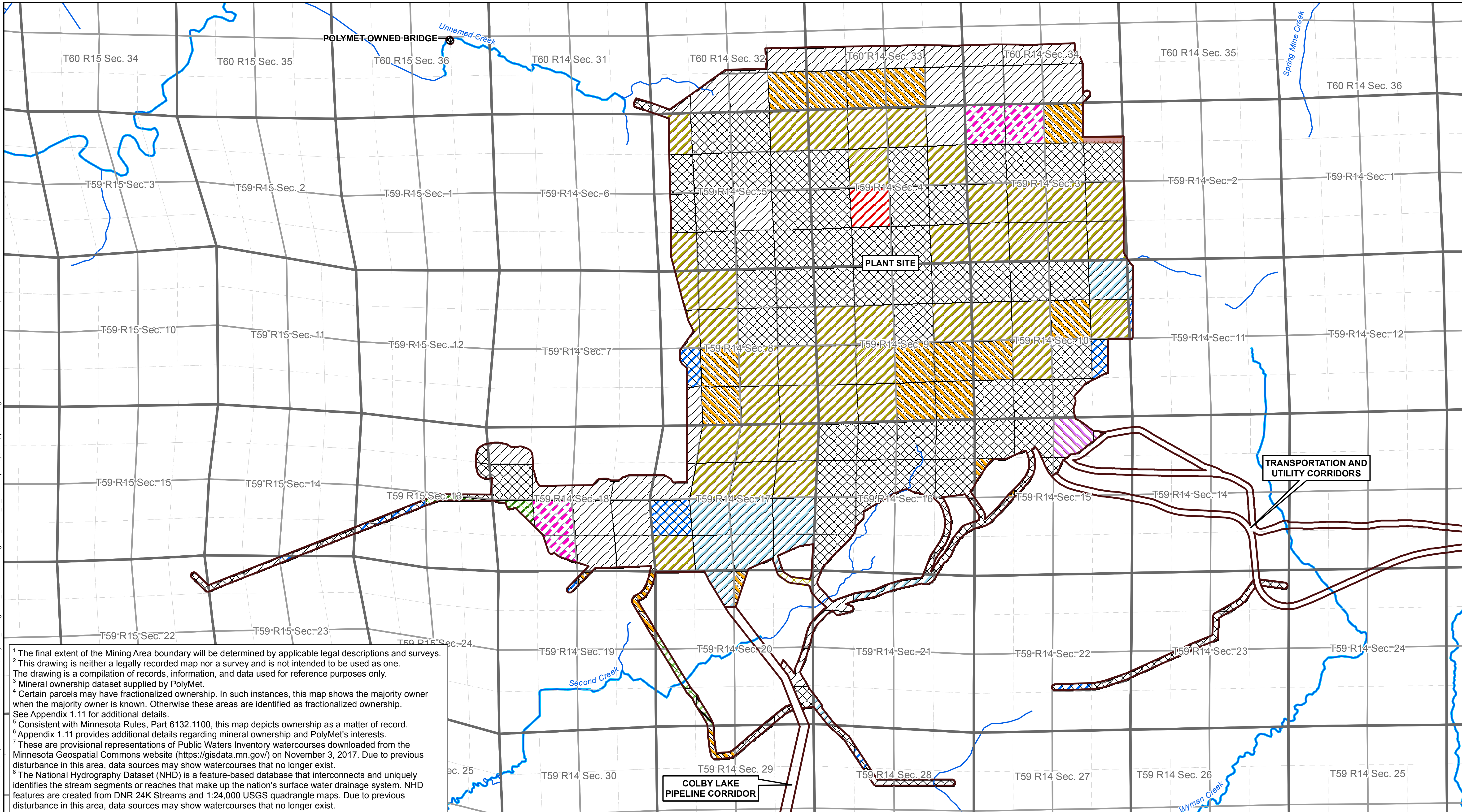
MINE SITE
MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining, Inc.

Figure 4-5
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-27 13:39 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 4-5 Mine Site Mineral Ownership.mxd User: arm2



Barr Footer: ArcGIS 10.4, 2017-11-27 13:39 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 4-6 Plant Site Mineral Ownership.mxd User: amr2

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[3] Mineral ownership dataset supplied by PolyMet.
[4] Certain parcels may have fractionalized ownership. In such instances, this map shows the majority owner when the majority owner is known. Otherwise these areas are identified as fractionalized ownership. See Appendix 1.11 for additional details.
[5] Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record.
[6] Appendix 1.11 provides additional details regarding mineral ownership and PolyMet's interests.
[7] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[8] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]

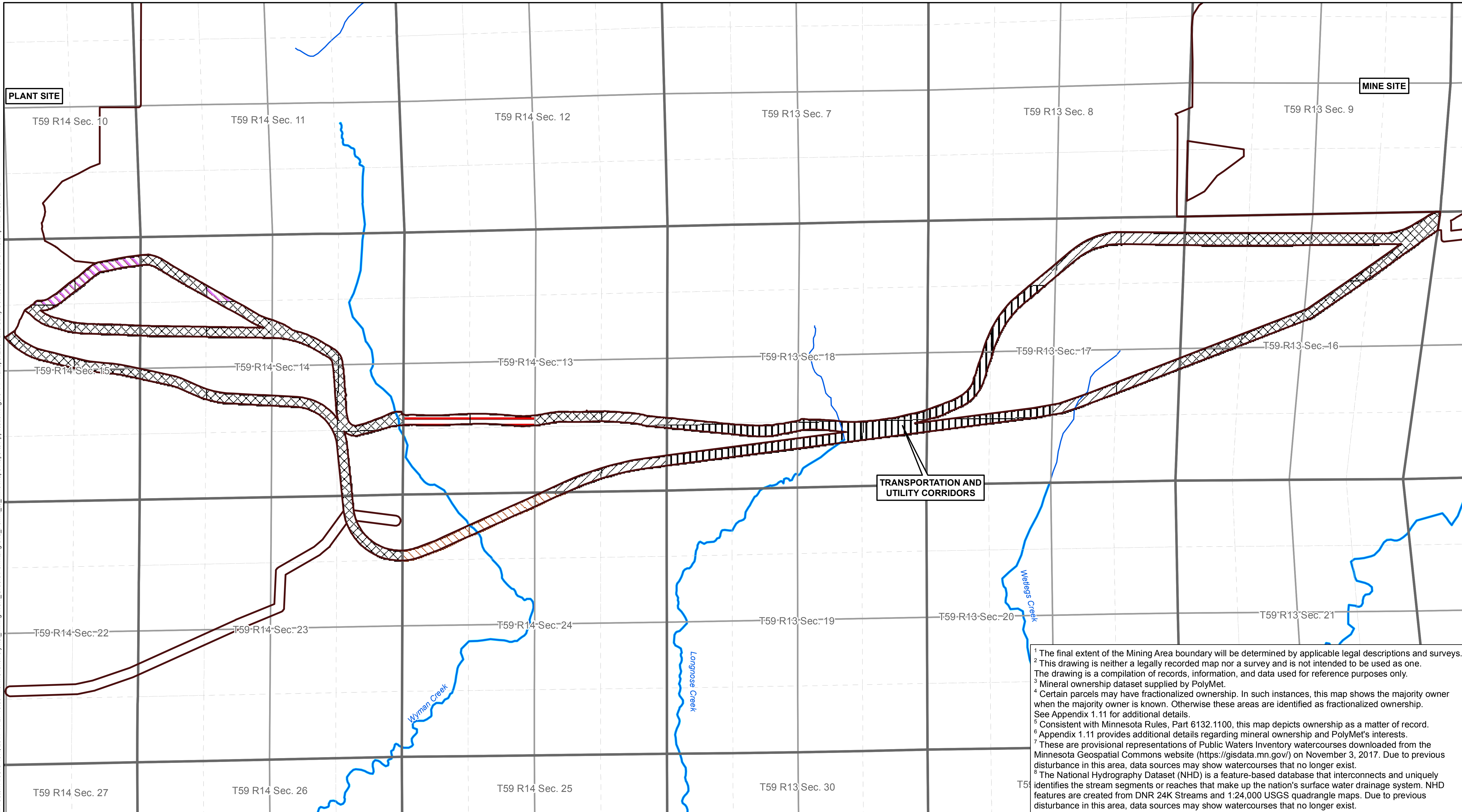
Mineral Ownership[3]

- Burlington Northern Railroad Co
- Carolyn Romberg Trust
- Cliffs Erie; Cliffs Erie LLC
- DuNord; DuNord Land Company
- Florence Lieberman
- Glacier Park
- Fiduciary Trust Co (Tupancy)
- Mesabi Mining LLC
- Mesabi Mining/RGGS
- Mesabi Nugget Delaware LLC
- RGGS
- State of MN, State of MN (by forfeiture) or may claim
- Stephens Family; Stephens Properties Trust
- Supec Investment Co
- Susan and Thomas Haney (State may claim)
- Fractionalized Owners[4]
- Public Waters Inventory (PWI) Watercourses[7]
- National Hydrography Dataset (NHD) Rivers & Streams[8]

0 0.25 0.5 1
Miles

PLANT SITE
MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining, Inc.

Figure 4-6
Permit to Mine Application



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[2] This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
[3] Mineral ownership dataset supplied by PolyMet.
[4] Certain parcels may have fractionalized ownership. In such instances, this map shows the majority owner when the majority owner is known. Otherwise these areas are identified as fractionalized ownership. See Appendix 1.11 for additional details.
[5] Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record.
[6] Appendix 1.11 provides additional details regarding mineral ownership and PolyMet's interests.
[7] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[8] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]
Mineral Ownership[3]
DuNord; DuNord Land Company
James Prest
Longyear/Longyear Mesaba
RGGS - Encampment
RGGS
State of MN, State of MN (by forfeiture) or may claim
Public Waters Inventory (PWI) Watercourses[7]
National Hydrography Dataset (NHD) Rivers & Streams[8]

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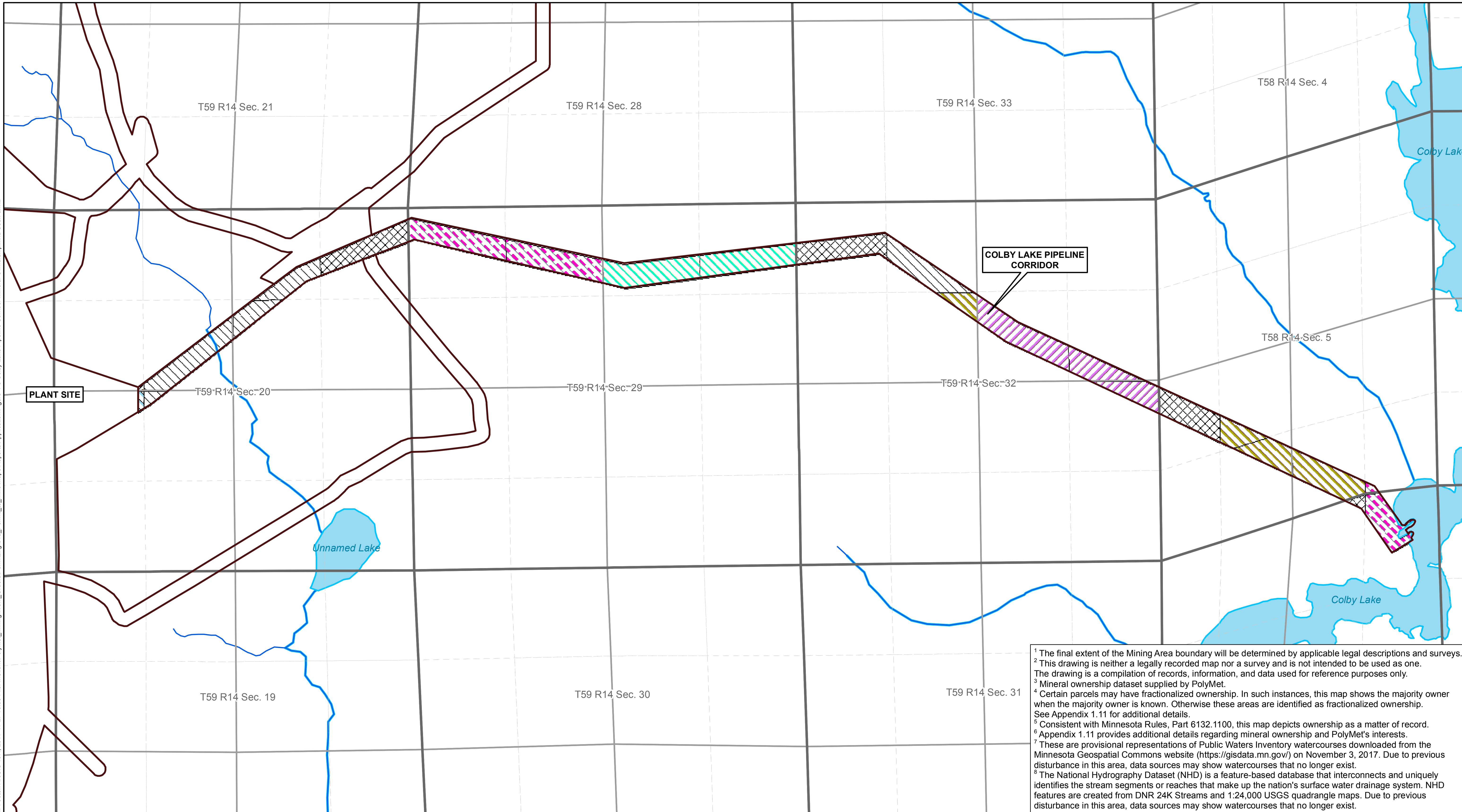
TRANSPORTATION AND UTILITY CORRIDORS MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining, Inc.

Figure 4-7
Permit to Mine Application



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[2] This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
[3] Mineral ownership dataset supplied by PolyMet.
[4] Certain parcels may have fractionalized ownership. In such instances, this map shows the majority owner when the majority owner is known. Otherwise these areas are identified as fractionalized ownership. See Appendix 1.11 for additional details.
[5] Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record.
[6] Appendix 1.11 provides additional details regarding mineral ownership and PolyMet's interests.
[7] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[8] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Mining Area[1]

Mineral Ownership[3]

- Cliffs Erie; Cliffs Erie LLC
- Daniel Scott Cash and State of MN
- DuNord; DuNord Land Company
- Glacier Park
- RGGS
- State of MN, State of MN (by forfeiture) or may claim
- Stephens Family; Stephens Properties Trust
- Fractionalized Owners[4]

Public Waters Inventory (PWI) Basin

Public Waters Inventory (PWI) Watercourses[7]

National Hydrography Dataset (NHD) Rivers & Streams[8]

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Miles

COLBY LAKE
PIPELINE CORRIDOR
MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining, Inc.

Figure 4-8
Permit to Mine Application

5.0 Environmental Setting Information

Minnesota's nonferrous mining rules require that PolyMet submit, as part of its application, specific information relating to the environmental setting of the proposed Mining Area. First, PolyMet must include a copy of an environmental impact statement and environmental reports prepared relative to the mining operations. To satisfy this requirement, PolyMet has included a copy of the FEIS and associated environmental reports in Appendix 16. Second, PolyMet is required to include in its application a series of environmental setting maps that are based on currently available information and that delineate the Mining Area and adjacent lands to show the areas directly or indirectly affected by mining. This Section 5.0 of the Application and the supporting appendices contain this information.

Appendix 16 of the Application contains a copy of the joint federal-state FEIS completed for the Project together with the management plans and data packages which constitute the environmental reports prepared for the Project. As discussed in Section 6.0, PolyMet is filing the FEIS, rather than a draft EIS, in support of this Application. As a result, PolyMet's Application incorporates the information about the environmental setting for the Project Area developed through the environmental review process, which has since been refined for this Application as the Mining Area, which is defined in Minnesota Rules, part 6132.0100, subpart 19. While this Section 5.0 provides, consistent with the applicable rules, a brief overview of the environmental setting, so as to describe the information presented in the required maps, Chapter 4 of the FEIS provides substantially more information regarding the environmental setting for the Project Area (referred to now as the Mining Area). Moreover, Chapters 5 and 6 of the FEIS contain details about the potential environmental impacts associated with the Project and the associated mitigation measures.

Minnesota Rules, part 6132.1100, subpart 5, contemplates that the Environmental Impact Statement (EIS) will provide detailed background on the environmental setting, which will be depicted on the requisite maps. Therefore, this Section 5.0 focuses on providing a brief description of the environmental setting maps rather than restating information contained in the FEIS. PolyMet is providing copies of the environmental setting maps in both hard copy and digital format. As directed by the DNR, the hard copies of the environmental setting maps are 11x17 inch maps of the same scale as 7-1/2 minute U.S. Geological Survey (USGS) quadrangle maps, and these maps depict the environmental setting for the Mining Area as defined by the applicable rules.

Table 5-1 summarizes environmental setting requirements of Minnesota Rules, part 6132.1100, subpart 5, item B and the location of this information in Section 5.0 figures. This Section 5.0 describes the environmental setting maps and how they comply with the requirements of Minnesota Rules, part 6132.1100, subpart 5. Consistent with the PTM Regulations, certain maps include more detailed information and description of data.

5.1 Geology

As required under Minnesota Rules, part 6132.1100, subpart 5, item B(1), Figure 5-1 through Figure 5-3 are environmental setting maps showing bedrock geology, including the general shape of the ore body and appropriate cross-sections that show the horizontal and vertical relationships. The location of the ore body is shown on Figure 5-1 along with the bedrock geology of the area. Figure 5-2 and Figure 5-3 show geologic cross-sections through the proposed mine pits.

5.1.1 Surficial Geology

Surficial deposits at the Mine Site, the Plant Site, along the Transportation and Utility Corridors, and along the Colby Lake Pipeline Corridor are dominated by the Rainy Lobe till; although outwash, reworked glacial sediments, and peat are also found (these deposits are not laterally continuous). The Rainy Lobe till has been described at a regional scale as an unsorted sandy loam mixture with pebbles, cobbles, and boulders (Reference (6)), which is generally consistent with what has been observed in soil borings collected from within the Mine Site and near the Tailings Basin.

Within the Mining Area, upland areas are commonly underlain by local bedrock highs, which are overlain by relatively thin mantles of glacial deposits. Lowlands are commonly characterized by wetlands with peat accumulations several feet thick. The surficial deposits range in thickness from 0 to 60 feet in the vicinity of the Mine Site and are on the order of 3.5 to 42.5 feet near the Tailings Basin at the Plant Site (pages 4-52 and 4-107 of Appendix 16.1). The Process Plant is on a bedrock high with minimal surficial deposits. North and northwest of the Tailings Basin, surficial deposits thicken to as much as 150 feet (Reference (7)). Along the Transportation and Utility Corridors, bedrock is generally near the surface. The depth to bedrock along the Colby Lake Pipeline Corridor increases to the south; near Colby Lake, the depth to bedrock is over 100 feet.

5.1.2 Bedrock Geology

Generalized bedrock geology of the area around the Project is shown on Figure 5-1. The bedrock geology in the vicinity of the Project consists of granites and associated lithologies overlain by metamorphosed sedimentary rock that hosts the northeast trending Biwabik Iron Formation (BIF) and Virginia Formation, and the intruded igneous Duluth Complex, which is the source of the ore to be mined by the Project. Much of the Plant Site is underlain by the Giants Range Granite, which is shown as “Agm” on Figure 5-1.

The Duluth Complex displays a generally layered fabric that dips to the southeast. The mineral constituents that make up the Duluth Complex form an interlocking igneous texture and fabric with no primary porosity or incipient discontinuity in the rock mass. The NorthMet Deposit occurs in troctolitic and gabbroic rocks of the Partridge River Intrusion (PRI). In this area, the PRI is subdivided into seven igneous stratigraphic units. The lowest unit, Unit 1, directly overlies the Virginia Formation. Geologic cross-sections and longitudinal sections through the Mine Pits are shown on Figure 5-2 and Figure 5-3, respectively.

Geotechnical drilling at the Mine Site by Golder Associates (Golder) indicated core recoveries near 100% and excellent rock quality designation (RQD), typically exceeding 95% (Reference (8)). The higher the number, the less fractured the rock. Golder conducted additional geotechnical testing, including Uniaxial Compressive Strength and Young’s modulus (Reference (8)). In addition, over 14,000 RQD measurements were recorded for more than 217,000 feet of core during the resource drilling within the proposed pits.

The RQD data from exploratory drilling indicates that rock quality in the Duluth Complex is generally excellent (>90%), indicating that the bedrock has a low fracture frequency. Average RQD increases from 73% at the top of bedrock to 94% within 40 feet below the top of bedrock (Reference (9)).

5.2 Surface Water Hydrology and Watersheds

Minnesota Rules, part 6132.1100, subpart 5, item B(2), specifies that the application include environmental setting maps showing water basins and water courses that are or could be affected by mining (Section 5.3 addresses the requirement to show wetlands). Subpart 5, item B(3) similarly requires maps showing boundaries of watersheds that are or could be affected by mining. Figure 5-4 through Figure 5-6 depict the water basins, water courses, and watersheds in which the Project is located. Significantly, while the maps depict the boundaries of these water features in relation to the Mining Area, the Project is not expected to impact the entire geographic extent of the water features shown on these maps. The FEIS filed with this Application contains a thorough discussion of potential environmental impacts to these water resources.

The Mining Area is entirely within the Great Lakes Basin (USGS 2-digit Hydrologic Unit Code [HUC] scale). Based on the analysis completed in support of the FEIS, the potential impacts associated with mining operations for the Project are confined to the Great Lakes Basin. No other major water basin is anticipated to be affected by mining.

During the preparation of the FEIS, it was suggested that groundwater from the Mine Site could potentially flow north into the Rainy River Basin via the Northshore Mining Company's Peter Mitchell Pit (Northshore Mine). The Co-Lead Agencies considered this possibility, and concluded that such northward flow was possible, but not reasonably foreseeable. Following publication of the FEIS, additional comments were submitted regarding the possibility of northward flow. DNR's adequacy decision concluded that even if northward flow were to occur, it would be possible to detect and prevent effects within the Rainy River Basin. The USFS similarly concluded that northward flow to the Rainy River Basin was unlikely, and that any potential northward flow could be detected and prevented. A monitoring plan for assessing hydrogeologic conditions in the area between the NorthMet pits and the Northshore Mine has been submitted to the DNR and Minnesota Pollution Control Agency (MPCA) separate from this Application (Reference (10)).

The Mining Area is located within one major watershed (USGS 8-digit HUC scale): the St. Louis River watershed. Within the St. Louis River watershed, the Mining Area sits within two subwatersheds (USGS 10-digit HUC scale): the Partridge River watershed and the Embarrass River watershed. The Mine Site, the Transportation and Utility Corridors, the Process Plant and Areas 1 and 2 portions of the Plant Site, and the Colby Lake Pipeline Corridor are located within the Partridge River watershed. The HRF and Tailings Basin portion of the Plant Site are primarily contained within the Embarrass River watershed, except for a small portion at the southern end of the Tailings Basin that drains to Second Creek, a tributary to the Partridge River. Figure 5-4 shows the Mining Area and its location within the boundaries of these two watersheds. Figure 5-5 and Figure 5-6 provide expanded views of the Partridge and Embarrass River watersheds, respectively. Figure 5-4 through Figure 5-6 also depict the water courses located within several miles of the Mining Area. These water courses include the Partridge River, Embarrass River, and several creeks. Both the Partridge River and the Embarrass River are tributary to the St. Louis River, which ultimately discharges into Lake Superior. The FEIS describes the potential effects the Project may have on some portion of these watersheds and on reaches of these water courses. PolyMet has incorporated measures, such as stream augmentation, into the Project to mitigate any such effects. Further details on these measures are presented in Section 11.4.8 of this Application.

Major hydrological features of the watersheds and water courses depicted in Figure 5-4 to Figure 5-6 include:

- Partridge River Watershed
    - Water Courses
        - The Partridge River headwaters originate just south of the Northshore Mine. The Partridge River then flows approximately 32 miles south/southwest to its confluence with the St. Louis River. Approximately five miles of the Partridge River flows around the northern and eastern perimeter of the Mine Site. The Partridge River flows through Colby Lake, located approximately four miles south of the Plant Site. Colby Lake is connected to the Whitewater Reservoir. Erie Mining Company constructed the Whitewater Reservoir around 1955 as a reliable source of water for their mining operations. The lake and reservoir together comprise approximately 1,749 acres. Tributary streams upstream of Colby Lake include Yelp Creek, Stubble Creek, Unnamed (West Pit Outlet) Creek, the South Branch of the Partridge River, Colvin Creek, Wetlegs Creek, Longnose Creek, and Wyman Creek. Second Creek, which originates near the Tailings Basin, is a tributary to the Partridge River downstream of Colby Lake.
    - Hydrology
        - Representative streamflow from the Partridge River near the Mining Area were obtained from the former USGS Partridge River gaging station (04015475), which is downstream of the Mine Site and above Colby Lake. Daily flow data are available for the Partridge River at this station from years 1978 through 1988. During this period, streamflow data from this station was affected by the periodic and variable dewatering of the Peter Mitchell Pit, which is located at the headwaters of the Partridge River upstream of the Mine Site. The available records indicate:
            - streamflow is generally very low from late fall through the winter (with monthly averages ranging from 6.4 to 63 cubic feet per second (cfs) during the months of November through March)
            - streamflow sharply rises during spring snowmelt (with monthly averages of 242 and 220 cfs during the months of April and May)

        - streamflow recedes during the summer (with monthly averages ranging from 55 to 116 cfs during the months of June through October), except for occasional heavy storms

        - daily minimums of <1 cfs and daily maximums of >1,900 cfs have been observed

    - Recent (2011-present) daily flow data near the Mine Site is available from DNR gage H03155002, located on the Partridge River at the Dunka Road crossing (surface water monitoring location PM-3/SW003). This data is not directly comparable to the USGS gage 04015475 data due to the large difference in tributary watershed size and location. Based on its location, DNR gage H03155002 is more heavily influenced by the dewatering of the Peter Mitchell Pit than the USGS gage 04015475 was when it was operational.

    - Additional flow data for the former USGS Partridge River gaging station downstream of the Mine Site is available in the FEIS (Table 4.2.2-7 of Appendix 16.1).

    - Stream gage locations in the Partridge River watershed are shown on Figure 5-5.

- Embarrass River Watershed

  - Water Courses

    - Most of the Tailings Basin is located within the Embarrass River Watershed. The Embarrass River originates just south of the city of Babbitt and flows approximately 23 miles southwest to its confluence with the St. Louis River. Streams that are tributaries to the Embarrass River, include Spring Mine Creek, Unnamed (Mud Lake) Creek, Trimble Creek, Bear Creek, and Unnamed Creek. Further downstream, the Lower Embarrass River flows through a chain of lakes: Sabin, Wynne, Embarrass, and Esquagama lakes.

  - Hydrology

    - Representative streamflow in the Embarrass River near the Mining Area were obtained from the two former USGS gaging stations along the Embarrass River, with station 04017000 being the closest to the Project. Daily flow data are available for the Embarrass River at station 04017000 from years 1942 through 1964. The available records for station 04017000 indicate:

        - streamflow is generally very low from late fall through the winter (with monthly averages ranging from 5.0 to 33 cfs during the months of November through March)

- streamflow sharply rises during spring snowmelt (with monthly averages of 190 and 194 cfs during the months of April and May)
- streamflow recedes during the summer (with monthly averages ranging from 31 to 114 cfs during the months of June through October), except for occasional heavy storms
- daily minimums of <1 cfs and daily maximums of >1,700 cfs have been observed

- Additional flow data for the Embarrass River gaging station downstream of the Mining Area is available in the FEIS (Table 4.2.2-27 of Appendix 16.1).

5.3 Wetlands

Minnesota Rules, part 6132.1100, subpart 5, item B(2) requires that the application include environmental setting maps showing wetlands that are or could be affected by mining. Figure 5-7 shows delineated wetlands for the Mining Area, which includes the Mine Site and the Plant Site.

Additionally, small acreages of wetlands are found in the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor (Figure 5-7). Section 12.0 has more information on the wetland delineation in each of these areas. Table 5-2 summarizes the wetland acreages and wetland types for the Project. As shown in Table 5-2, bogs are the most prevalent wetland type by acreage. The majority of the wetlands at the Mine Site are identified as high quality wetlands. The Plant Site and Colby Lake Pipeline Corridor have larger proportions of medium and low quality wetlands due to existing disturbances associated with prior development.

Wetland hydrology at the Mine Site is driven primarily by precipitation and local surface runoff, as evidenced by several years of monitoring data documenting fluctuations in water levels that closely mirror precipitation patterns. These data are consistent with hydrogeologic conditions in the area. The Partridge River watershed consists of a thin layer of glacial deposits underlain by bedrock. Bedrock outcrops frequently alter local groundwater flow paths in the surficial aquifer. These flow paths are generally short, with upland recharge areas located close to wetland discharge areas. Within the surficial aquifer, organic and mineral soils tend to lay over silty sands and clays, resulting in perched wetlands. There is a general lack of connectivity between the shallow water table in wetlands and bedrock, and lateral flow within wetland soils in the area is typically very slow. As Section 4.2.3.1.2 of the FEIS explains in more detail (starting on FEIS page 4-173), these factors tend to minimize the potential for indirect drawdown impacts associated with mining activity.

Section 12.0 of the Application describes the acreage of wetlands that may be affected by mining operations and PolyMet's avoidance, minimization, and mitigation of wetland impacts in conformance with federal and state law. The Wetland Replacement Plan (Appendix 18.1) contains the wetland mitigation plans and additional details on potential impacts from the Project.

5.4 Groundwater and Hydrogeology

Minnesota Rules, part 6132.1100, subpart 5, item B(4) provides that the application must include environmental setting maps that identify and describe hydrogeological information including, but not limited to: (a) plan view and cross-section maps of overburden and rock features; and (b) features on maps including, but not limited to, well locations, uses, well logs, pumping rates and capacities. Figure 5-8 through Figure 5-11 depict these hydrogeological features and wells, and this Section 5.4 describes the map features. Information on wells within the Mining Area, shown on Figure 5-8, is provided in Table 5-3, and well logs are provided in Appendix 1.12. Wells shown on Figure 5-8 include wells installed by PolyMet, as well as other wells in the vicinity that are archived in Minnesota's "County Well Index" (Reference (11)). Appendix 16 in this Application includes various background documents on groundwater flow and hydrogeology, including the Water Modeling Data Packages for both the Mine and Plant Sites (Appendix 16.19 and Appendix 16.20, respectively).

5.4.1 Mine Site Hydrogeology

Depth to bedrock at the Mine Site ranges from zero (at the surface) in outcrop areas to approximately 60 feet below ground surface, based on the data available from the borings and wells located at the Mine Site and in the surrounding area. Figure 5-9 shows depth to bedrock. Depth to groundwater is typically 5 feet or less, with the water table near the ground surface in topographic lows occupied by wetlands. Figure 5-10 presents contours of groundwater elevations within the surficial aquifer at the Mine Site.

Figure 5-11 shows existing groundwater heads in bedrock underlying the surficial aquifer. Figure 5-12 through Figure 5-16 present cross-sections showing the elevations of the ground surface, groundwater, and the top of bedrock.

As depicted in these figures, the hydrogeologic conditions for the Mine Site can be summarized as follows:

- **Surficial Aquifer.** The surficial aquifer is generally thin, consisting of poorly sorted glacial deposits, ranging from very dense clay to well-sorted sand with boulders and cobbles. Aquifer tests conducted in wells at the Mine Site show this variability, with hydraulic conductivities ranging between 0.012 to 31 feet/day. Laboratory hydraulic testing has indicated that there are individual layers of relatively low hydraulic conductivity material. Groundwater at the Mine Site flows from the north/northwest to the south/southeast toward the Partridge River. Groundwater elevations vary seasonally between 3 and 10 feet below ground surface. No domestic uses of groundwater exist in the vicinity of the Mine Site.
- **Bedrock Aquifer.** The BIF, Virginia Formation, and Duluth Complex underlie the Mine Site. Hydraulic conductivities in all three formations are generally low, with the BIF having the highest conductivities and the Duluth Complex the lowest. Hydraulic conductivities decline with depth and groundwater flow likely occurs through shallow bedrock that is more fractured than deeper bedrock. Flow direction tends to mirror the surficial aquifer in the uppermost bedrock units. The

FEIS (Section 4.2.2.2.1, page 4-53) concluded that "the hydraulic connection between surficial deposits and the underlying bedrock, although present, is weak or non-existent" (Appendix 16.1).

5.4.2 Plant Site Hydrogeology

The groundwater system at the Plant Site exhibits the same basic characteristics as those present at the Mine Site. The main distinction is the presence of the large partially saturated tailings basin remaining from past LTVSMC operations. The partially saturated tailings deposit sits on top of relatively undisturbed glacial deposits and has raised groundwater elevations within the footprint of the LTVSMC tailings basin to elevations above the former natural ground level.

Depth to bedrock at the Plant Site is less than 45 feet in the vicinity of the LTVSMC tailings basin, with an average thickness at the toe of the LTVSMC tailings basin of approximately 20 feet and ranging from 3 to 45 feet based on-site borings. Figure 5-17 shows the depth to bedrock in the vicinity of the Plant Site. Groundwater elevation contours show groundwater flow is largely directed north and northwest from the LTVSMC tailings basin towards the Embarrass River and its tributaries north of the Plant Site (Figure 5-18). Additionally, seepage from the south-southeastern side of the LTVSMC tailings basin forms the headwaters of Second Creek, a tributary to the Partridge River.

Cross-sections showing the relationship between ground surface, surficial groundwater, and top of bedrock elevations are located on Figure 5-19 through Figure 5-21. As depicted in these figures, the hydrogeologic conditions for the Plant Site can be summarized as follows:

- **Surficial Aquifer.** Hydraulic conductivities within the native unconsolidated deposits vary by several orders of magnitude. Slug tests performed in piezometers in the glacial deposits near the LTVSMC tailings basin, which are believed to be most representative of conditions within the surficial aquifer near the LTVSMC tailings basin, resulted in hydraulic conductivities that ranged from 0.15 to 130 feet/day with a geometric mean of 4.41 feet/day. Groundwater elevations measured around the LTVSMC tailings basin indicate that groundwater flows to the north and northwest, toward the Embarrass River. As the LTVSMC tailings basin was built up over time, a groundwater mound formed within the basin due to infiltration from the various ponds, which altered local flow directions and rates. Groundwater flow to the south and east is generally constricted by the bedrock outcrops and the underlying bedrock unit of the Giants Range Granite, which forms a ridge and drainage divide and makes up the highest topography in the area. There is, however, a gap in the bedrock near the southern end of the LTVSMC tailings basin, which allows some groundwater to flow south toward Cliffs Erie's NPDES/SDS monitoring station SD026, forming the headwaters of Second Creek, a tributary to the lower Partridge River. Recent seepage from the LTVSMC tailings basin towards the Embarrass River was estimated to be approximately 2,590 gallons per minute (gpm). Because this flow rate exceeds the capacity of the aquifer to transmit water in the immediate area of the LTVSMC tailings basin, upwelling occurs, which provides water to the wetlands around the LTVSMC tailings basin, particularly north of the basin. Groundwater elevations in the area north and west of the LTVSMC tailings basin range from 0.33 to 4.6 feet below ground surface.

- **Bedrock.** The Giants Range Granite underlies the surficial deposits at the Plant Site. The geometric mean of hydraulic conductivity values obtained from packer tests performed in bedrock borings near the toe of the LTVSMC tailings basin is 0.16 feet/day. This value was judged by the Co-Lead Agencies "to be the best estimate characterizing the top 20 feet of bedrock around the Plant Site; it is similar to a geometric mean of hydraulic conductivity values quoted in literature for the Giants Range Granite. It was observed that a density of fractures often decreases with increasing core depth, indicating hydraulic conductivity decreases with depth" (Section 4.2.2.4.1, page 4-119 of Appendix 16.1).

5.4.3 Transportation and Utility Corridors and Colby Lake Pipeline Corridor Hydrogeology

The hydrogeology along the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor is expected to be similar to conditions at the Mine Site and Plant Site described above. Given the similar geology of the surficial deposits and the close proximity, information on depth to bedrock and hydraulic conductivity presented above for the Mine Site and Plant Site surficial aquifers should be representative of conditions within these corridors.

The eastern portion of the Transportation and Utility Corridors overlies bedrock similar to that found at the Mine Site (Figure 5-1). The description of the hydrogeology of the bedrock at the Mine Site would be applicable to this area of the Transportation and Utility Corridors. The western portion of the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor overlie the Virginia Formation and the BIF (Figure 5-1). The hydraulic conductivity of the upper portion of the Virginia Formation was estimated to be 0.17 feet/day, while the hydraulic conductivity of the BIF is estimated at 0.9 feet/day (Table 4.2.2-5 of Appendix 16.1).

5.5 Surface Water and Groundwater Compliance Monitoring

Minnesota Rules, part 6132.1100, subpart 5, item B(5) requires that the application include environmental setting maps showing the location of surface and groundwater compliance monitoring locations. Additionally, the rules require the application to include water quality and toxicity standards applicable to surface and groundwater as established by other regulatory authorities.

The environmental setting maps showing the surface and groundwater monitoring stations proposed in the Project's NPDES/SDS Permit Application and the Water Appropriation Permit Application are included as Figure 5-22 through Figure 5-28. While Minnesota Rules, part 6132.1100, subpart 5, item B(5) requires the Application include the compliance monitoring locations, these figures show the various types of monitoring proposed, including compliance monitoring locations and other evaluation points, and indicate the permit with which each monitoring station will be associated. Figure 5-23 and Figure 5-27 identify the compliance monitoring locations proposed for the NPDES/SDS Permit Application. Section 14.0 of the Application summarizes the environmental monitoring programs for the Project including groundwater and surface water monitoring programs regulated under the NPDES/SDS and Water Appropriation permits.

Water quality and toxicity standards are defined in Minnesota Rules, chapter 7050 (Waters of the State), chapter 7052 (Lake Superior Basin Water Standards), and chapter 7060 (Underground Waters). Surface waters in Minnesota are classified and protected for multiple beneficial uses. Minnesota Rules, part 7050.0470 lists individual waters and their associated use classifications. Surface waters not specifically listed are uniformly classified as class 2B, 3C, 4A, 4B, 5, and 6. Wetlands not specifically listed are uniformly classified as class 2D, 3D, 4C, 5, and 6. Because the entire Mining Area is within the Great Lakes Basin, the standards defined in Minnesota Rules, chapter 7052 also apply. Finally, the water quality and toxicity standards applicable to groundwater are presented in Minnesota Rules, chapter 7060.

The numerical water quality and toxicity standards are provided in Table 5-4 by classification. Note that all surface waters are protected for Class 6, but this class has no numeric standards so it is not included in Table 5-4. The classifications for each surface water near the Mining Area and groundwater is provided below. The applicable water quality and toxicity standards will be determined by the MPCA and defined in the Project's NPDES/SDS Permit.

5.5.1 Mine Site and Transportation and Utility Corridors

Figure 5-22 and Figure 5-23 depict the proposed groundwater monitoring stations for the surficial aquifer and bedrock at and near the Mine Site. Figure 5-24 and Figure 5-25 show the locations of proposed surface water monitoring stations in the Partridge River watershed at and near the Mine Site and along the Transportation and Utility Corridors.

Colby Lake and Wyman Creek are both listed waters in Minnesota Rules, part 7050.0470, with other waters near the Mining Area unclassified. The following use classifications and associated water quality standards promulgated by MPCA apply to surface waters at the Mine Site and Transportation and Utility Corridors:

- Colby Lake: Class 1B, 2Bd, 3C, 4A, 4B, 5, and 6
- Wyman Creek: Class 1B, 2A, 3B, 3C, 4A, 4B, 5, and 6
- Other surface waters: Class 2B, 3C, 4A, 4B, 5, and 6
- Wetlands: Class 2D, 3D, 4C, 5, and 6

Groundwater is protected for domestic consumption by the Class 1 standards under Minnesota Rules, part 7060.0400.

5.5.2 Plant Site

Proposed groundwater monitoring stations for the surficial aquifer and bedrock at and near the Plant Site are shown on Figure 5-26 and Figure 5-27. Proposed surface water monitoring stations for the Embarrass River watershed near the Plant Site are presented on Figure 5-28 and Figure 5-29.

None of the waters at the Plant Site are listed waters in Minnesota Rules, part 7050.0470. The following use classifications and associated water quality standards promulgated by MPCA apply to surface waters at the Plant Site:

- Surface waters: Class 2B, 3C, 4A, 4B, 5, and 6
- Wetlands: Class 2D, 3D, 4C, 5, and 6

Groundwater is protected for domestic consumption by the Class 1 standards under Minnesota Rules part 7060.0400.

5.5.3 Colby Lake Pipeline Corridor

There are no proposed compliance monitoring stations along the Colby Lake Pipeline Corridor.

Colby Lake is a listed water in Minnesota Rules, part 7050.0470, with other waters near the Colby Lake Pipeline Corridor unclassified. The following use classifications and associated water quality standards promulgated by MPCA apply to surface waters at the Colby Lake Pipeline Corridor:

- Colby Lake: Class 1B, 2Bd, 3C, 4A, 4B, 5, and 6
- Other surface waters: Class 2B, 3C, 4A, 4B, 5, and 6
- Wetlands: Class 2D, 3D, 4C, 5, and 6

Groundwater is protected for domestic consumption by the Class 1 standards under Minnesota Rules, part 7060.0400.

5.6 Soil Inventory

Figure 5-30 is an environmental setting map that shows a soil inventory that includes soil type, extent, and thickness in compliance with Minnesota Rules, part 6132.1100, subpart 5, item B(6). This soil inventory map distinguishes hydric from non-hydric soils. With respect to the Mine Site, the USFS has classified the soils using the Superior National Forest Ecological Classification System, which classifies by different categories of Ecological Land Types (ELT). Table 5-5 shows the ELTs present at the Mine Site and the soil descriptions. For remaining sections of the Mining Area, including the Plant Site, the Colby Lake Pipeline, and most of the Transportation and Utility Corridors, the National Resources Conservation Service (NRCS) has mapped the soils. The NRCS soil names and descriptions for the Project Area are shown in Table 5-6. Soil thicknesses are shown on Figure 5-30.

5.7 Rare, Threatened, and Endangered Species

PolyMet conducted database searches and field surveys to evaluate the presence of protected plant and wildlife species in the vicinity of the Project, as summarized in the Wetland Replacement Plan and FEIS (FEIS Section 4.2.4.2.3, Page 4-207 for plants and FEIS Section 4.2.5, page 4-233 for wildlife; additional details in FEIS Section 5.2.4 and 5.2.5, respectively). The Co-Lead Agencies for the FEIS have examined the potential impact, if any, on these species, as part of the required federal and state consultation process, and developed appropriate mitigation measures to address potential impacts. The focus of these studies was to identify species listed by the state of Minnesota as endangered, threatened, or special concern or listed by the U.S. Fish and Wildlife Service (USFWS) as endangered or threatened. State of Minnesota endangered and threatened species are protected under the Minnesota Endangered Species Statute (Minnesota Statutes, section 84.0895), and are regulated under Minnesota Rules, chapter 6134 and part 6212.1800 to part 6212.2300. Taking of a state endangered or threatened species requires a permit from the DNR. Federally endangered and threatened species are protected under the Endangered Species Act of 1973 (ESA; 16 USC 1531-1544). In addition, there are additional federal protections for bald and golden eagles under the Bald and Golden Eagle Protection Act (BGEPA, 16 USC 668-668c), and for migratory birds under the Migratory Bird Treaty Act of 1918 (16 USC 703-712). Taking, including incidental taking, of federally endangered or threatened species requires coordination with USFWS to obtain an incidental taking permit under ESA Section 7. Incidental taking, if any, of bald eagles should be coordinated with USFWS under BGEPA.

5.7.1 Plants

As summarized in Section 5.2.4 of the FEIS (page 5-409), there are no federally-listed plant species identified in the Project area. There are eleven state-listed plant species identified within the Project area, one of which is identified by the state as endangered (floating marsh marigold; *Caltha natans*, Figure 5-31) and ten of which are identified by the state as special concern (Table 5-7). The special concern species have no legal protection provided by the state. *Caltha natans* will be directly affected by the Project, which will require a takings permit from the state. Effects to the *Caltha natans* will involve the complete loss of individuals or colonies within a population as a result of excavation of the mine pits, burial under stockpiles, or disturbance during infrastructure construction.

Taking of *Caltha natans* will require a permit from DNR under Minnesota Rules, part 6212.1800. PolyMet will work with the DNR and other appropriate agencies to determine acceptable mitigation for directly impacted species.

5.7.2 Wildlife

As summarized in Section 5.2.5 of the FEIS (page 5-433), the Project is expected to affect three federally-listed wildlife species, including Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), and northern long-eared bat (*Myotis septentrionalis*). The BA for the Project, submitted by the USACE and the USFS Superior National Forest in April, 2015, found that the Project may affect and is likely to adversely affect Canada lynx, Canada lynx critical habitat, gray wolf, gray wolf critical habitat (Figure 5-31), and northern long-eared bat. The subsequent Biological Opinion issued by the USFWS in February 2016 for the Project (Appendix 18.2) was based on the BA and found that the Project, as proposed, is not likely to jeopardize the continued existence of Canada lynx, gray wolf, or northern long-eared bat. It is also not likely to adversely modify critical habitat for lynx or wolf.

Both the Canada lynx and northern long-eared bat are also state-listed as species of special concern. During Project design, PolyMet has avoided and minimized impacts to Canada lynx, gray wolf, and northern long-eared bat habitats to the extent practicable. PolyMet participated in consultation with the

USFWS under Section 7 of the ESA of 1973, as amended, 16 U.S.C. 1531 *et seq*., to develop and finalize conservation measures in the Biological Opinion to further reduce potential impacts to these species.

In order to preserve and protect undisturbed habitat adjacent to the Project areas, conservation measures in the Biological Opinion stated that PolyMet will manage these areas to provide suitable habitat for use by Canada lynx, gray wolf, and northern long-eared bat. These forestlands would likely be used by Canada lynx and gray wolf as a travel corridor between lands adjacent to the Project area, and for foraging and roosting habitat by northern long-eared bat.

PolyMet intends to clear trees outside of the bat's pup season, which is from June 1 through July 31, to the extent practicable, in order to avoid potential indirect taking of the northern long-eared bat, per the Final 4(d) rule published on January 14, 2016. In the event that trees need to be cleared during the pup season, PolyMet will contact USFWS prior to any tree clearing, to determine whether any known, occupied maternal roost trees are documented within 150 feet of the proposed tree clearing. PolyMet will not remove any known occupied maternal roost trees or other trees within 150 feet of a known occupied roost tree during the pup season.

Neither the Partridge River watershed nor the Embarrass River watershed has any recorded locations of federally-listed or state-listed threatened or endangered fish or macroinvertebrate species (Reference (12)). The DNR Natural Heritage Information System (NHIS) database has a 2004 record for wood turtle (*Glyptemys insculpta*), a threatened aquatic turtle species under the state list, in a reach of the Partridge River approximately 0.6 mile south of the Mine Site. The Project will not result in direct taking of wood turtles. Furthermore, there will be no significant degradation in water quality in the reach of the Partridge River where the NHIS record is located, that would result in indirect effects on wood turtles (Section 6.5 of Appendix 18.1). Additionally, as discussed in Section 12.1.1 of Appendix 18.2, it is not likely that populations of wood turtles would be found at the Mine Site, because its preferred habitat include sandy-gravelly streams and bars, which are not present within the Mine Site .

There are no NHIS-documented eagle or osprey nests on the Mine Site. PolyMet is aware that removal of an eagle nest requires an USFWS permit under BGEPA, as well as a DNR permit, and will coordinate with USFWS and DNR in the event that an eagle nest is found and must be removed. PolyMet will also coordinate with DNR in the event that an osprey nest is found and needs to be removed. In addition, a northern goshawk nest documented in the NHIS database in the north-central area of the Mine Site would not be affected by the current Mining Plan.

5.8 Past Mining Facilities

Figure 5-32 is an environmental setting map showing past mining facilities including stockpiles, tailings basins, mine pits, and beneficiating plants in accordance with Minnesota Rules, part 6132.1100, subpart 5, item B(8).

Mining in the vicinity of the Mining Area began with the development of natural iron ore deposits near Aurora around 1907. The Mining Area includes the following past mining facilities: the former LTVSMC taconite processing plant and associated LTVSMC tailings basin, the Area 1 and Area 2 shops (see

Figure 5-32 for locations), with a number of former taconite mining pits in the vicinity of the Mining Area that are identified on the figure that were from the former LTVSMC operations and its immediate predecessor Erie Mining Company. As discussed in Sections 8.0 through 10.0, the Project is using a number of these existing facilities in its operations consistent with Minnesota's policies encouraging the reuse of existing mining facilities.

5.9 Archeological and Historic Sites

Figure 5-33 and Figure 5-37 are the environmental setting maps related to the evaluation of archeological and historic sites within the Mining Area.

The area in which potential effects on cultural resources was evaluated, including archaeological and historic sites, is called the Area of Potential Effects (APE). The APE for the NorthMet Site, which was discussed extensively in Section 4.2.9 of the FEIS (starting on page 4-303), is shown on Figure 5-33. The determination of the APE took into consideration direct effects from surface disturbance, as well as indirect effects related to viewshed, noise, aesthetics, air, and water.

Table 5-8 and Table 4.2.9-1 of Appendix 16.1 list the properties that were identified within the APE, whether the properties were deemed eligible for listing in the National Register of Historic Places (NRHP), and note Minnesota Historic Preservation Office (MnHPO) concurrence with the findings. It should be noted that MnHPO was previously identified as the State Historic Preservation Office (SHPO). Figure 5-37 shows sites in the Registry of State Historical Places near and within the Mining Area for consideration of excluded, prohibited, and restricted areas, as described in Section 5.11. Table 5-9 and Table 4.2.9-2 of Appendix 16.1 list the sites within the APE that are contributing components of the Erie Mining Company Historic District and identify whether the components were deemed eligible for listing in the NRHP. MnHPO was the consulting party throughout the process of identifying eligible properties within the APE. MnHPO concurred with the adequacy of the APE and eligibility determinations.

5.10 Surface and Subsurface Uses

Figure 5-34 through Figure 5-36 are environmental setting maps that show the known surface and subsurface uses, such as pipelines and cables, within the Mining Area, in accordance with Minnesota Rules, part 6132.1100, subpart 5, and item B(10).

Figure 5-34 shows aboveground and underground facilities and land uses known to exist in the vicinity of the Mine Site, and Figure 5-35 and Figure 5-36 show surface and subsurface facilities known to exist in the vicinity of the Plant Site. The most common land uses in the Mining Area are those associated with mining, including taconite pits, pit lakes, and overburden and rock stockpiles. Additional facilities and uses include several private railroad lines, overhead power lines, various pipelines, and public and private roads (including forest roads). Numerous buildings and aboveground ore-processing infrastructure are located in the southern portion of the Plant Site (Figure 5-36). North and west of the Plant Site, land use includes residences and small-scale agricultural operations located approximately one mile away.

5.11 State Mining Excluded, Prohibited, and Restricted Areas

Consistent with Minnesota Rules, part 6132.1100, subpart 5, item B(11), Figure 5-37 shows the Mining Area and those areas where Minnesota Rules, part 6132.2000 excludes, prohibits, or restricts certain mining or surface activities.

As Section 7.0 through Section 10.0 describe in more detail, the Project facilities will comply with the exclusions, prohibitions, and restrictions described in Minnesota Rules, part 6132.2000. Figure 5-37 depicts the Mining Area and various prohibited and restricted areas. Excluded areas are not found within the vicinity of the Project. Specific requirements are summarized in Table 5-10, categorized by the rule subparts.

5.12 Zoning Ordinances and Applicable Land Use Plans

Figure 5-38 is an environmental setting map showing the zoning ordinances and land use plans applicable to the Mining Area as required by Minnesota Rules, part 6132.1100, subpart 5, item B(12). Additional details on land use plans can be found in Section 5.2.1 of the FEIS (Appendix 16.1).

The Mine Site and the eastern portions of the Transportation and Utility Corridors are within the incorporated limits of the city of Babbitt. This area of Babbitt is zoned for mineral mining activities, including exploration, extraction, processing, and tailings disposal.

The majority of the Plant Site and the western portions of the Transportation and Utility Corridors are within the incorporated limits of the city of Hoyt Lakes. The portion of the Project within the city of Hoyt Lakes is currently zoned for mining and mining-related activities. The northernmost portion of the Plant Site is in Waasa Township and is regulated by the St. Louis County zoning requirements. This area is currently zoned for industrial use under the St. Louis County Comprehensive Land Use Plan. Accordingly, the Project is consistent with applicable zoning ordinances.

The St. Louis River Management Plan identifies guidelines for the development of the St. Louis River and its adjacent (within 0.5 mile) lands. While the Project is greater than 0.5 mile from the St. Louis River shoreline, the St. Louis River Management Plan is part of the St. Louis County Comprehensive Land Use Plan. The Project complies with the St. Louis River Management Plan and the St. Louis County Comprehensive Land Use Plan because it meets specified setbacks for development, such as setbacks for structures and sanitary facilities. The largest setback required as part of this plan is 300 feet for structures around primitive areas along the river. The Project does not have any structures within 300 feet of the St. Louis River.

5.13 Surface and Mineral Ownership

Figure 4-1 depicts the surface ownership within the Mining Area. As discussed in Section 4.0, there are numerous agreements that provide PolyMet with various property, access, and use rights to the surface lands necessary to construct and operate the Project. In addition, as described in its Final Record of Decision (Appendix 16.2.2), the USFS approved a decision to execute a land exchange that would make

PolyMet the fee title owner (surface ownership) of much of the federal land within the Mining Area at the Mine Site. Section 4.0 provides specific details on land ownership.

Figure 1-7 shows mineral ownership within the Mining Area. As discussed in Section 4.0, PolyMet holds private mineral leases that provide the company with the necessary rights to develop the minerals as proposed in this Application. Section 4.0 provides specific details on mineral ownership.

Table 5-1 Index of Minnesota Rules, part 6132.1100, subpart 5, item B Environmental Settings Information and Corresponding Figure Numbers

Minnesota Rules, part 6132.1100, subpart 5, item B Environmental Settings Required Information	Corresponding Figure(s) Number[(1)]
(1) bedrock geology, including the general shape of the ore body and appropriate cross-sections that show the horizontal and vertical relationships	Figure 5-1 through Figure 5-3
(2) water basins, water courses, and wetlands that are or could be affected by mining	Figure 5-4 through Figure 5-7
(3) boundaries of watersheds that are or could be affected by mining	Figure 5-4 through Figure 5-6
(4) identification and description of hydrogeologic information including, but not limited to: (a) plan view and cross-section maps of overburden and rock features; and (b) description of features on maps including, but not limited to, well locations, uses, well logs, pumping rates and capacities[(2)]	Figure 5-8 through Figure 5-21
(5) surface water and groundwater compliance monitoring sites as well as water quality and toxicity standards established by other regulatory authorities	Figure 5-22 through Figure 5-29
(6) a soil inventory including soil type, extent, and thickness	Figure 5-30
(7) recorded locations of rare, endangered, and threatened species	Figure 5-31
(8) past mining facilities including storage piles, tailings basins, mines, and beneficiating plants	Figure 5-32
(9) recorded archeological or historic sites	Figure 5-33
(10) all known surface and subsurface uses, such as pipelines and cables	Figure 5-34 through Figure 5-36
(11) excluded areas identified under part 6132.2000	Figure 5-37
(12) zoning ordinances and associated land use plans applicable to the proposed mining area	Figure 5-38
(13) surface and mineral rights ownership within the mining area based on information of record in the county recorder's office	Figure 1-5, Figure 1-6, Figure 4-1

Notes:

(1) Based on discussions with DNR, the required maps are provided as 11x17-inch maps.

(2) Well locations, uses, pumping rates and capacities are provided in Table 5-3; well logs are provided in Appendix 1.12

Table 5-2 Wetland Summary by Acreage, Quality, Type for Project Areas

Project Area	Wetland Acreage (acres)	Wetland Quality (H = High; M = Moderate; L = Low) (percent)	Dominant Eggers and Reed Wetland Community[1] [2] (percent)	
Mine Site	1,297.8	H = 92 M = 8	Coniferous Bog = 67 Alder Thicket = 13 Coniferous Swamp = 10 Shallow Marsh = 3 Sedge Meadow = 2	Open Bog = 1 Wet Meadow = 1 Hardwood Swamp = 1 Shrub-carr = <1 Deep marsh = <1
Flotation Tailings Basin	257.6	M = 11 L = 89	Deep Marsh = 49 Shallow Marsh = 39 Coniferous Swamp = 6 Alder Thicket = 5 Shrub-Carr = 1	Wet Meadow = <1 Hardwood Swamp = <1 Deep Water = <1 Sedge Meadow = <1
Hydrometallurgical Residue Facility	36.1	L = 100	Shallow Marsh = 100	
Dunka Road and Utility Corridor	6.8	H = 100	Alder Thicket = 56 Coniferous Swamp = 23	Coniferous Bog = 13 Shallow marsh = 8
Railroad Connection Corridor	0.44	H = 100	Alder Thicket = 45 Shrub-Carr = 23	Coniferous Swamp = 16 Shallow Marsh = 16
Colby Lake Pipeline	7.0	M = 7 L = 93	Shallow Marsh = 37 Shrub-carr = 24 Wet Meadow = 19	Deep Marsh = 14 Alder Thicket = 6
Second Creek	291.8	L = 100	Alder Thicket = 44 Shallow Marsh = 36 Hardwood Swamp = 7 Coniferous Swamp = 6	Deep Marsh = 5 Shrub-Carr = 2 Shallow, Open Water = <1

Notes:

Wetland information source: Large Table 1 of NorthMet Project - Wetland Replacement Plan, which is included in Appendix 18.1 of this Application.

(1) Shrub swamp includes alder thicket and shrub-carr communities.

(2) Reference (13)

Table 5-3 Information on Wells within Mining Area

Unique #	Name	Use	Pumping Rates (gpm)	Pumping Capacity (gpm)	Status
483498	MW-1B	Monitoring Well	--	--	
513433	MW-20	Monitoring Well	--	--	
513434	MW-3B	Monitoring Well	--	--	Sealed
513435	MW-5B	Monitoring Well	--	--	
513436	MW-4B	Monitoring Well	--	--	Sealed
551772	MW-2	Monitoring Well	--	--	
584559	LTV STEEL	Public Supply/ Non-Community	Unknown	12	Sealed
597383	MW-1B	Monitoring Well	--	--	
597384	MW-3	Abandoned	--	--	
625042	MW-1	Monitoring Well	--	--	
625043	MW-2	Monitoring Well	--	--	
625044	MW-3	Monitoring Well	--	--	
665923	LTV STEEL	Domestic	Unknown	20	Active
717972	NORTHMET	Industrial	Unknown	40	Active
722057	SUPERIOR (MW-05-08)	Monitoring Well	--	--	
722058	SUPERIOR (MW-05-09)	Monitoring Well	--	--	
722060	SUPERIOR (MW-05-02)	Monitoring Well	--	--	
736114	P1	Monitoring Well	--	--	
736115	P2	Monitoring Well	--	--	
736116	P3	Monitoring Well	--	--	
736117	P4	Monitoring Well	--	--	
736118	OB4	Environ. Bore hole	--	--	
736119	OB5	Environ. Bore hole	--	--	
736120	OB2	Environ. Bore hole	--	--	
736121	OB1	Environ. Bore hole	--	--	
736122	OB3A	Environ. Bore hole	--	--	
736123	OB3	Environ. Bore hole	--	--	
767603	MW-1 SHALLOW	Monitoring Well	--	--	
767604	MW-1 DEEP	Monitoring Well	--	--	
767605	MW-2 SHALLOW	Monitoring Well	--	--	

Unique #	Name	Use	Pumping Rates (gpm)	Pumping Capacity (gpm)	Status
767606	MW-2 DEEP	Monitoring Well	--	--	
767607	MW-3 SHALLOW	Monitoring Well	--	--	
767608	MW-3 DEEP	Monitoring Well	--	--	
767609	MW-4 SHALLOW	Monitoring Well	--	--	
767610	MW-4 DEEP	Monitoring Well	--	--	
767968	GW-012	Monitoring Well	--	--	
786386	POLYMET	Industrial	Unknown	10	Active
786708	MW-5/RS-33	Monitoring Well	--	--	
786712	MW-8S/RS-31	Monitoring Well	--	--	
786713	MW-2/RS-32	Monitoring Well	--	--	
786714	MW-1/RS-37	Monitoring Well	--	--	
786715	MW-9/RS38	Monitoring Well	--	--	
786717	MW-3/RS-48	Monitoring Well	--	--	
786718	MW-4/RS-49	Monitoring Well	--	--	
786719	MW-17	Monitoring Well	--	--	
786720	MW-13/RS 52	Monitoring Well	--	--	
786728	MW-8D/RS-31	Monitoring Well	--	--	
786729	MW-18/RS-44	Monitoring Well	--	--	
Unknown[1]	GW001	Monitoring Well	--	--	

(1) Unique well number for this well is unknown

Table 5-4 Water Quality and Toxicity Standards

Table 5-4a Water Quality and Toxicity Standards: 7050 Standards – Class 1B

Parameter	CAS Number	Unit	Class 1B, Based on US EPA Standards	
			Maximum Contaminant Levels	Secondary Drinking Water
1,1,1-Trichloroethane	71-55-6	µg/l	200	
1,1,2-Trichloroethane	79-00-5	µg/l	5	
1,1-Dichloroethylene	75-35-4	µg/l	7	
1,2,4-Trichlorobenzene	120-82-1	µg/l	70	
1,2-Dibromo-3-chloropropane	96-12-8	µg/l	0.2	
1,2-Dibromoethane	106-93-4	µg/l	0.05	
1,2-Dichlorobenzene	95-50-1	µg/l	600	
1,2-Dichloroethane	107-06-2	µg/l	5	
1,2-Dichloroethylene, cis	156-59-2	µg/l	70	
1,2-Dichloroethylene, trans	156-60-5	µg/l	100	
1,2-Dichloropropane	78-87-5	µg/l	5	
1,4-Dichlorobenzene	106-46-7	µg/l	75	
2,3,7,8-Dioxin, tetra	1746-01-6	µg/l	0.00003	
2,4,5-TP (Silvex)	93-72-1	µg/l	50	
2,4-D	94-75-7	µg/l	70	
Acrylamide	79-06-1	µg/l	TT (8)	
Alachlor	15972-60-8	µg/l	2	
Aluminum	7429-90-5	µg/l		50 - 200
Antimony	7440-36-0	µg/l	6	
Arsenic	7440-38-2	µg/l	10	
Asbestos	1332-21-4	mfl	7	
Atrazine	1912-24-9	µg/l	3	
Bacteria, coliform fecal	FECOL	%	5.0 (4)	
Bacteria, e. Coli	ECOLI	%	5.0 (4)	
Bacteria, standard plate count	SPC		TT (3)	
Bacteria, total coliforms	TCOL	%	5.0 (4)	
Barium	7440-39-3	µg/l	2000	
Benzene	71-43-2	µg/l	5	

Parameter	CAS Number	Unit	Class 1B, Based on US EPA Standards	
			Maximum Contaminant Levels	Secondary Drinking Water
Benzo(a)pyrene	50-32-8	µg/l	0.2	
Beryllium	7440-41-7	µg/l	4	
Bis(2-ethylhexyl)phthalate	117-81-7	µg/l	6	
Bromate	15541-45-4	µg/l	10	
Bromodichloromethane	75-27-4	µg/l	80 (6)	
Bromoform	75-25-2	µg/l	80 (6)	
Cadmium	7440-43-9	µg/l	5	
Carbofuran	1563-66-2	µg/l	40	
Carbon tetrachloride	56-23-5	µg/l	5	
Chlordane, alpha & gamma	57-74-9	µg/l	2	
Chloride	16887-00-6	µg/l		250000
Chlorine dioxide	10049-04-4	µg/l	800	
Chlorine, total residual	7782-50-5	µg/l	4000 (5)	
Chlorite	14998-27-7	µg/l	1000	
Chlorobenzene	108-90-7	µg/l	100	
Chlorodibromomethane	124-48-1	µg/l	80 (6)	
Chloroform	67-66-3	µg/l	80 (6)	
Chromium	7440-47-3	µg/l	100	
Color	COLOR	color units		15
Copper	7440-50-8	µg/l	1300 TT (7)	1000
Corrosivity	CORR	µg/l		NC
Cyanide	57-12-5	µg/l	200	
Cyanide, free	CNFR	µg/l	200	
Dalapon	75-99-0	µg/l	200	
Di(2-ethylhexyl)adipate	103-23-1	µg/l	400	
Dinoseb (DNBP)	88-85-7	µg/l	7	
Diquat	85-00-7	µg/l	20	
Endothall	145-73-3	µg/l	100	
Endrin	72-20-8	µg/l	2	
Ethyl benzene	100-41-4	µg/l	700	
Fluoride	16984-48-8	µg/l	4.0	2000

Parameter	CAS Number	Unit	Class 1B, Based on US EPA Standards	
			Maximum Contaminant Levels	Secondary Drinking Water
Foaming Agents	FOAM	µg/l		500
g-BHC (Lindane)	58-89-9	µg/l	0.2	
Glyphosate	1071-83-6	µg/l	700	
Gross Alpha (radiation)	12587-46-1	pCi/l	15	
Gross Beta (radiation)	12587-47-2	mrem/yr	4	
Haloacetic acids, total (HAA5)	HAA5	µg/l	60	
Heptachlor	76-44-8	µg/l	0.4	
Heptachlor epoxide	1024-57-3	µg/l	0.2	
Heterotrophic Plate Count	HPC	count	(10)	
Hexachlorobenzene	118-74-1	µg/l	1	
Hexachlorocyclopentadiene	77-47-4	µg/l	50	
Iron	7439-89-6	µg/l		300
Lead	7439-92-1	µg/l	15 TT (7)	
Manganese	7439-96-5	µg/l		50
Mercury	7439-97-6	µg/l	2	
Methoxychlor	72-43-5	µg/l	40	
Methylene chloride	75-09-2	µg/l	5	
Nitrogen, Nitrate + Nitrite, as N	N+N	mg/l	1 N	
Nitrogen, Nitrate, as N	NITA	mg/l	10	
Nitrogen, Nitrite, as N	NITI	mg/l	1	
Odor	ODOR			3
Pentachlorophenol	87-86-5	µg/l	1	
pH	PH	units		6.5 - 8.5
Picloram	1918-02-1	µg/l	500	
Polychlorinated biphenyls	1336-36-3	µg/l	0.5	
Radium 226	13982-63-3	pCi/l	5 (9)	
Radium 228	15262-20-1	pCi/l	5 (9)	
Radium, total	7440-14-4	pCi/l	5	
Selenium	7782-49-2	µg/l	50	
Silver	7440-22-4	µg/l		100
Simazine	122-34-9	µg/l	4	

Parameter	CAS Number	Unit	Class 1B, Based on US EPA Standards	
			Maximum Contaminant Levels	Secondary Drinking Water
Sodium chlorite	7758-19-2	µg/l	1000 (5)	
Solids, total dissolved	TDS	µg/l		500000
Styrene	100-42-5	µg/l	100	
Sulfate, as SO4	14808-79-8	µg/l		250000
TCDD Equivalent	TCDDEQ	µg/l	0.00003	
Tetrachloroethylene	127-18-4	µg/l	5	
Thallium	7440-28-0	µg/l	2	
Toluene	108-88-3	µg/l	1000	
Toxaphene	8001-35-2	µg/l	3	
Trichloroethylene	79-01-6	µg/l	5	
Trihalomethanes, total (TTHMs)	TTHM	µg/l	80 (6)	
Turbidity	TURB		TT (3)	
Uranium	7440-61-1	µg/l	30	
Vinyl chloride	75-01-4	µg/l	2	
Vydate	23135-22-0	µg/l	200	
Xylene, total	1330-20-7	µg/l	10000	
Zinc	7440-66-6	µg/l		5000

Table 5-4a Water Quality and Toxicity Standards: 7050 Standards – Class 1B footnotes

Criteria	Footnote	Footnote Remark
US EPA Maximum Contaminant Levels	N	Based on the criteria for Nitrogen, Nitrite as N.
	TT	Treatment Technique - A required process intended to reduce the level of a contaminant in drinking water.
	(3)	See rules for specific guidance.
	(4)	No more than 5.0% samples total coliform-positive (TC-positive) in a month. (For water systems that collect fewer than 40 samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli if two consecutive TC-positive samples, and one is also positive for E.coli fecal coliforms, system has an acute MCL violation.
	(5)	MRDLG - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the uses of disinfectants to control microbial contaminants.
	(6)	Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants: Trihalomethanes: bromodichloromethane (zero), bromoform (zero); dibromochloromethane (0.06 mg/l); chloroform (0.07 mg/l). Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.02 mg/l); monochloroacetic acid (0.07 mg/l). Bromoacetic acid and dibromoacetic acid are regulated with this group but have no MCLGs.
	(7)	Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/l, and for lead is 0.015 mg/l.
	(8)	Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide equals 0.05% dosed at 1 mg/l (or equivalent).
	(9)	Based on the criteria for Radium, total.
	(10)	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.
US EPA Secondary Drinking Water Regulations	NC	Non-corrosive.

Table 5-4b Water Quality and Toxicity Standards: 7050 Standards – Class 2A, Class 2Bd, Class 2B and Class 2D

Parameter	CAS Number	Fraction	Unit	Class 2A			Class 2Bd			Class 2B and Class 2D		
				Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value
1,1,1-Trichloroethane	71-55-6		µg/l	329	2957	5913	329	2957	5913	329	2957	5913
1,1,2,2-Tetrachloroethane	79-34-5		µg/l	1.1	1127 (1)	2253 (1)	1.5	1127 (1)	2253 (1)	13	1127	2253
1,2-Dichloroethane	107-06-2		µg/l	3.5	45050 (1)	90100 (1)	3.8	45050 (1)	90100 (1)	190	45050 (1)	90100 (1)
2,4,6-Trichlorophenol	88-06-2		µg/l	2.0	102	203	2.0	102	203	2.0	102	203
4,4'-DDT	50-29-3		µg/l	0.11	550 (1)	1100 (1)	0.0017	0.55 (1)	1.1 (1)	0.0017	0.55 (1)	1.1 (1)
Acenaphthene	83-32-9		µg/l	20	56	112	20	56	112	20	56	112
Acetochlor	34256-82-1		µg/l	3.6	86	173	3.6	86	173	3.6	86	173
Acrylonitrile	107-13-1		µg/l	0.38	1140 (1)	2281 (1)	0.38	1140 (1)	2281 (1)	0.89	1140 (1)	2281 (1)
Alachlor	15972-60-8		µg/l	3.8	800 (1)	1600 (1)	4.2	800 (1)	1600 (1)	59	800	1600
Aluminum	7429-90-5		µg/l	87	748	1496	125	1072	2145	125	1072	2145
Anthracene	120-12-7		µg/l	0.035	0.32	0.63	0.035	0.32	0.63	0.035	0.32	0.63
Antimony	7440-36-0		µg/l	5.5	90	180	5.5	90	180	31	90	180
Arsenic	7440-38-2		µg/l	2.0	360	720	2.0	360	720	53	360	720
Atrazine	1912-24-9		µg/l	3.4	323	645	3.4	323	645	10	323	645
Bacteria, e. Coli	ECOLI			(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Benzene	71-43-2		µg/l	5.1	4487 (1)	8974 (1)	6.0	4487 (1)	8974 (1)	98	4487	8974
Biochemical Oxygen Demand, 5-day	BOD5			(4)	(4)	(4)				(4)	(4)	(4)
Bis(2-ethylhexyl)phthalate	117-81-7		µg/l	1.9	(1)	(1)	1.9	(1)	(1)	2.1	(1)	(1)
Bromoform	75-25-2		µg/l	33	2900	5800	41	2900	5800	466	2900	5800
Cadmium (HD CF)	7440-43-9	Dissolved	µg/l	1.0	3.7	7.4	1.0	31	63	1.0	31	63
Cadmium (HD)	7440-43-9	Total	µg/l	1.1	3.9	7.8	1.1	33	67	1.1	33	67
Carbon tetrachloride	56-23-5		µg/l	1.9	1750 (1)	3500 (1)	1.9	1750 (1)	3500 (1)	5.9	1750 (1)	3500 (1)
Chlordane, alpha & gamma	57-74-9		µg/l	0.000073	1.2 (1)	2.4 (1)	0.00029	1.2 (1)	2.4 (1)	0.00029	1.2 (1)	2.4 (1)
Chloride	16887-00-6		mg/l	230	860	1720	230	860	1720	230	860	1720
Chlorine, total residual	7782-50-5		µg/l	11	19	38	11	19	38	11	19	38
Chlorobenzene	108-90-7		µg/l	20	423	846	20	423	846	20	423	846
Chloroform	67-66-3		µg/l	53	1392	2784	53	1392	2784	155	1392	2784
Chlorophyll a, not pheophytin-adjusted	42617-16-3			(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Chlorpyrifos	2921-88-2		µg/l	0.041	0.083	0.17	0.041	0.083	0.17	0.041	0.083	0.17
Chromium (CF CR6)	7440-47-3	Dissolved	µg/l	11	16	31	11	16	31	11	16	31

Parameter	CAS Number	Fraction	Unit	Class 2A			Class 2Bd			Class 2B and Class 2D		
				Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value
Chromium (CR6)	7440-47-3	Total	µg/l	11	16	32	11	16	32	11	16	32
Chromium, hexavalent (CF)	18540-29-9	Dissolved	µg/l	11	16	31	11	16	31	11	16	31
Chromium, hexavalent	18540-29-9	Total	µg/l	11	16	32	11	16	32	11	16	32
Chromium, trivalent (HD CF)	16065-83-1	Dissolved	µg/l	178	549	1096	178	549	1096	178	549	1096
Chromium, trivalent (HD)	16065-83-1	Total	µg/l	207	1737	3469	207	1737	3469	207	1737	3469
Cobalt	7440-48-4		µg/l	2.8	436	872	2.8	436	872	5	436	872
Copper (HD CF)	7440-50-8	Dissolved	µg/l	9.4	17	34	9.4	17	34	9.4	17	34
Copper (HD)	7440-50-8	Total	µg/l	9.8	18	35	9.8	18	35	9.8	18	35
Cyanide (5)	57-12-5		µg/l	5.2	22	45	5.2	22	45	5.2	22	45
Cyanide, free	CNFR		µg/l	5.2	22	45	5.2	22	45	5.2	22	45
Dieldrin	60-57-1		µg/l	0.0065	1300 (1)	2500 (1)	0.000026	1.3 (1)	2.5 (1)	0.000026	1.3 (1)	2.5 (1)
Di-n-octyl phthalate	117-84-0		µg/l	30	825	1650	30	825	1650	30	825	1650
Dissolved oxygen	DO			(6)			(10)			(11) (13)		
Endosulfan	115-29-7		µg/l	0.0076	0.084	0.17	0.029	0.28	0.56	0.031	0.28	0.56
Endrin	72-20-8		µg/l	0.0039	0.090	0.18	0.016	0.090	0.18	0.016	0.090	0.18
Ethyl benzene	100-41-4		µg/l	68	1859	3717	68	1859	3717	68	1859	3717
Fluoranthene	206-44-0		µg/l	1.9	3.5	6.9	1.9	3.5	6.9	1.9	3.5	6.9
g-BHC (Lindane)	58-89-9		µg/l	0.0087	1.0 (1)	2.0 (1)	0.032	4.4 (1)	8.8 (1)	0.036	4.4 (1)	8.8 (1)
Heptachlor	76-44-8		µg/l	0.10	260 (1)	520 (1)	0.00039	0.26 (1)	0.52 (1)	0.00039	0.26 (1)	0.52 (1)
Heptachlor epoxide	1024-57-3		µg/l	0.12	270 (1)	530 (1)	0.00048	0.27 (1)	0.53 (1)	0.00048	0.27 (1)	0.53 (1)
Hexachlorobenzene	118-74-1		µg/l	0.000061	(1)	(1)	0.00024	(1)		0.00024	(1)	(1)
Lead (HD CF)	7439-92-1	Dissolved	µg/l	2.5	65	130	2.5	65	130	2.5	65	130
Lead (HD)	7439-92-1	Total	µg/l	3.2	82	164	3.2	82	164	3.2	82	164
Mercury (CF)	7439-97-6	Dissolved	µg/l	0.0069	2.0 (1)	4.2 (1)	0.0069	2.0	4.2	0.0069	2.0 (1)	4.2 (1)
Mercury	7439-97-6	Total	µg/l	0.0069	2.4 (1)	4.9 (1)	0.0069	2.4 (1)	4.9 (1)	0.0069	2.4 (1)	4.9 (1)
Methylene chloride	75-09-2		µg/l	45	13875 (1)	27749 (1)	46	13875	27749 (1)	1940	13875	27749
Metolachlor	51218-45-2		µg/l	23	271	543	23	271	543	23	271	543
Naphthalene	91-20-3		µg/l	65	409	818	81	409	818	81	409	818
Nickel (HD CF)	7440-02-0	Dissolved	µg/l	158	1415	2830	158	1415	2830	158	1415	2830
Nickel (HD)	7440-02-0	Total	µg/l	158	1418	2836	158	1418	2836	158	1418	2836
Nitrogen, ammonia, as N	7664-41-7		µg/l	16 (3)			40 (3)			40 (3)		

Parameter	CAS Number	Fraction	Unit	Class 2A			Class 2Bd			Class 2B and Class 2D		
				Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value	Chronic	Maximum	Final Acute Value
Nitrogen, unionized ammonia, as N	UNAM		µg/l	16			40			40		
Oil and Grease	OILGREASE		µg/l	500	5000	10000	500	5000	10000	500	5000	10000
Parathion (ethyl)	56-38-2		µg/l	0.013	0.07	0.13	0.013	0.07	0.13	0.013	0.07	0.13
Pentachlorophenol	87-86-5		µg/l	0.93	9.1 (8)	18 (8)	1.9 (8)	9.1 (8)	18 (8)	5.5 (8)	9.1 (8)	18 (8)
pH	PH		units	6.5 - 8.5			6.5 - 9.0			6.5 - 9.0 (14)		
Phenanthrene	85-01-8		µg/l	3.6	32	64	3.6	32	64	3.6	32	64
Phenol	108-95-2		µg/l	123	2214	4428	123	2214	4428	123	2214	4428
Phosphorus, total, as P	7723-14-0			(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Polychlorinated biphenyls	1336-36-3		µg/l	0.014	1000 (1)	2000 (1)	0.000029	1 (1)	2	0.000029	1 (1)	2 (1)
Secchi disc	SHE			(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Selenium	7782-49-2		µg/l	5.0	20	40	5.0	20	40	5.0	20	40
Silver (CF)	7440-22-4	Dissolved	µg/l	0.10	1.7 HD	3.5 HD	0.85	1.7 HD	3.5 HD	0.85	1.7 HD	3.5 HD
Silver	7440-22-4	Total	µg/l	0.12	2.0 HD	4.1 HD	1.0	2.0 HD	4.1 HD	1.0	2.0 HD	4.1 HD
Solids, total suspended	SS		mg/l	10 (9)			(4)	(4)	(4)	(4)		
Temperature	TEMP			(7)			'(12)			(12) (14)		
Tetrachloroethylene	127-18-4		µg/l	3.8	428 (1)	857 (1)	3.8	428 (1)	857	8.9	428	857
Thallium	7440-28-0		µg/l	0.28	64	128	0.28	64	128	0.56	64	128
Toluene	108-88-3		µg/l	253	1352	2703	253	1352	2703	253	1352	2703
Toxaphene	8001-35-2		µg/l	0.31	730 (1)	1500 (1)	0.0013	0.73 (1)	1.5	0.0013	0.73 (1)	1.5
Trichloroethylene	79-01-6		µg/l	25	6988 (1)	13976 (1)	25	6988 (1)	13976	120	6988	13976
Turbidity	TURB		NTU				25			25		
Vinyl chloride	75-01-4		µg/l	0.17	(1)	(1)	0.18	(1)	(1)	9.2	(1)	(1)
Xylene, total	1330-20-7		µg/l	166	1407	2814	166	1407	2814	166	1407	2814
Zinc (HD CF)	7440-66-6	Dissolved	µg/l	105	114	229	105	114	229	105	114	229
Zinc (HD)	7440-66-6	Total	µg/l	106	117	234	106	117	234	106	117	234

Table 5-4b Water Quality and Toxicity Standards: 7050 Standards – Class 2A, Class 2Bd, Class 2B and Class 2D footnotes

Criteria	Footnote	Footnote Remark
Standard 7050	HD	Hardness Dependent. Based on a hardness value of 100.
	CR6	Value represents the criteria for Hexavalent Chromium.
	CF	Conversion Factor.
	(1)	Subpart 7, item E applies.
	(2)	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 10% of all samples taken during any calendar month individually exceed 1260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.
	(3)	Value represents the criteria for Ammonia, unionized as N.
	(4)	See 7050 rules for guidance on criteria applicable to certain areas.
	(5)	Value based on the criteria for cyanide, free.
	(6)	7.0 mg/l as a daily minimum. This dissolved oxygen standard requires compliance with the standard 50% of the days at which the flow of the receiving water is equal to the 7Q10.
	(7)	No material increase.
	(8)	pH Dependent. Based on a pH value of 7.0.
	(9)	TSS standards for Class 2A may be exceeded for no more than 10% of the time. This standard applies April 1 through September 30.
	(10)	5.0 mg/l as a 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% of the days at which the flow of the receiving water is equal to the 7Q10.
	(11)	For Class 2B waters, 5.0 mg/l as a 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% of the days at which the flow of the receiving water is equal to the 7Q. This standard applies to all Class 2B waters except for those portions of the Mississippi River from the outlet of the Metro Wastewater Treatment Works in Saint Paul (River Mile 835) to Lock and Dam No. 2 at Hastings (River Mile 815). For this reach of the Mississippi River, the standard is not less than 5 mg/l as a daily average from April 1 through November 30, and not less than 4 mg/l at other times.
	(12)	For Class 2B waters, 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.
	(13)	For Class 2D waters, standard is if background is less than 5.0 mg/L as a daily minimum, maintain background
	(14)	For Class 2D waters, standard is to maintain background

Table 5-4c Water Quality and Toxicity Standards: 7050 Standards – Class 2C, Class 3B, Class 3C, Class 4A, Class 4B, Class 4C and Class 5

	CAS Number	Unit	Class 2C	Class 3B	Class 3C	Class 3D	Class 4A	Class 4B	Class 4C	Class 5
Alkalinity, bicarbonate, as CaCO3	BALKA	mg/l					250		250	
Alkalinity, bicarbonate, as HCO3	BICAR	mg/l					305		305	
Bacteria, e. Coli	ECOLI		(2)							
Boron	7440-42-8	µg/l					500		500	
Chloride	16887-00-6	mg/l		100	250	Maintain Background				
Dissolved Oxygen	DO		(3)							
Hardness, as CaCO3	HARD	mg/l		250	500	Maintain Background				
Hydrogen sulfide	7783-06-4	mg/l								0.02
pH	PH	units		6.0 - 9.0	6.0 - 9.0	Maintain Background	6.0 - 8.5	6.0 - 9.0	Maintain Background	6.0 - 9.0
Salinity	SALIN	mg/l						1000	1000	
Sodium	7440-23-5	µg/l					(1)			
Solids, total dissolved	TDS	mg/l					700	1000 S	(5)	
Specific Conductance @ 25 °C	SPCON	µmhos/cm					1000		1000	
Sulfate, as SO4	14808-79-8	mg/l					10 Wild Rice		10 Wild Rice	
Temperature	TEMP		(4)							

Table 5-4c Water Quality and Toxicity Standards: 7050 Standards – Class 2C, Class 3B, Class 3C, Class 4A, Class 4B, Class 4C and Class 5 footnotes

Criteria	Footnote	Footnote Remark
Standard 7050	(1)	60% of total cations as milliequivalents per liter.
	(2)	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 10% 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.
	(3)	5 mg/L as a 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% of the days at which the flow of the receiving water is equal to the 7Q10. This dissolved oxygen standard applies to all class 2C waters except for those portions of the Mississippi River from the outlet of the metro wastewater treatment works in Saint Paul (River Mile 835) to Lock and Dam No. 2 at Hastings (River Mile 815) and except for the reach of the Minnesota River from the outlet of the Blue Lake wastewater treatment works (River Mile 21) to the mouth at Fort Snelling. For this reach of the Mississippi River the standard is not less than 5 mg/L as a daily average from April 1 through November 30, and not less than 4 mg/L at other times. For the specified reach of the Minnesota River the standard shall be not less than 5 mg/L as a daily average year-round.
	(4)	5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperature, except in no case shall it exceed the daily average temperature of 90°F.
	(5)	Settleable solids shall not be allowed in concentrations sufficient to create the potential for significant adverse impacts on one or more designated uses.
	S	Value represents the criteria for Total Salinity.
	Wild Rice	Applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

Table 5-4d Water Quality and Toxicity Standards: 7052 Standards – Class 2A, Class 2Bd, Class 2B, Class 2C and Class 2D

Parameter	CAS Number	Fraction	Unit	Class 2A						Class 2Bd						Class 2B, Class 2C and Class 2D					
				Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value	Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value	Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value
2,3,7,8-Dioxin, tetra	1746-01-6		ng/l	0.0000020	0.0000020	0.0000031				0.0000031	0.0000080	0.0000031				0.0000031	0.0000080	0.0000031			
2,4-Dimethylphenol	105-67-9		µg/l	21	391		21	137	274	21	441		21	137	274	21	7182		21	137	274
2,4-Dinitrophenol	51-28-5		µg/l	53	53		71	379	758	55	55		71	379	758	71	1982		71	379	758
4,4'-DDT	50-29-3		µg/l	0.000011	0.000035	0.000011				0.000011	0.000142	0.000011				0.000011	0.000142	0.000011			
Arsenic	7440-38-2		µg/l	2	2 (1)		148	340	680	2	2 (1)		148	340	680	53	53 (1)		148	340	680
Benzene	71-43-2		µg/l	11	11					12	12					114	237		114 (1)	4487 (1)	8974 (1)
Cadmium (HD CF)	7440-43-9	Dissolved	µg/l	2.3			2.3	4.2	8.5	2.3			2.3	4.3	8.5	2.3			2.3	4.3	8.5
Cadmium (HD)	7440-43-9	Total	µg/l	2.5			2.5	4.5	9.0	2.5			2.5	4.5	9.0	2.5			2.5	4.5	9.0
Chlordane, alpha & gamma	57-74-9		µg/l	0.000056	0.000056					0.000225	0.000225					0.000225	0.000225				
Chlorobenzene	108-90-7		µg/l	10	324		10 (1)	423 (1)	846 (1)	10	461		10 (1)	423 (1)	846 (1)	10	2916		10 (1)	423 (1)	846 (1)
Chromium (CF CR6)	7440-47-3	Dissolved	µg/l	11			11	16	31	11			11	16	31	11			11	16	31
Chromium (CR6)	7440-47-3	Total	µg/l	11			11	16	32	11			11	16	32	11			11	16	32
Chromium, hexavalent (CF)	18540-29-9	Dissolved	µg/l	11			11	16	31	11			11	16	31	11			11	16	31
Chromium, hexavalent	18540-29-9	Total	µg/l	11			11	16	32	11			11	16	32	11			11	16	32
Chromium, trivalent (HD CF)	16065-83-1	Dissolved	µg/l	74			74	570	1139	74			74	570	1139	74			74	570	1139
Chromium, trivalent (HD)	16065-83-1	Total	µg/l	86			86	1803	3606	86			86	1803	3606	86			86	1803	3606
Copper (HD CF)	7440-50-8	Dissolved	µg/l	8.9			8.9	13	27	8.9			8.9	13	27	8.9			8.9	13	27
Copper (HD)	7440-50-8	Total	µg/l	9.3			9.3	14	28	9.3			9.3	14	28	9.3			9.3	14	28
Cyanide, free	CNFR		µg/l	5.2	596		5.2	22	44	5.2	596		5.2	22	44	5.2	30240		5.2	22	44
Dieldrin	60-57-1		µg/l	0.0000016	0.0000016		0.056	0.24	0.48	0.0000065	0.0000065		0.056	0.24	0.48	0.0000065	0.0000065		0.056	0.24	0.48
Endrin	72-20-8		µg/l	0.0039	0.0039 (1)		0.036	0.086	0.17	0.016	0.016 (1)		0.036	0.086	0.17	0.016	0.016 (1)		0.036	0.086	0.17
g-BHC (Lindane)	58-89-9		µg/l	0.11	0.11			0.95	1.9	0.43	0.43			0.95	1.9	0.46	0.46			0.95	1.9
Hexachlorobenzene	118-74-1		µg/l	0.000105	0.000105					0.000418	0.000418					0.000419	0.000419				
Hexachloroethane	67-72-1		µg/l	1.5	1.5					5.0	5.0					6.2	6.2				
Mercury	7439-97-6	Dissolved	µg/l	0.0013	0.00153	0.0013	0.91	1.4 CF	2.9 CF	0.0013	0.00153	0.0013	0.91	1.4 CF	2.9 CF	0.0013	0.00153	0.0013	0.91	1.4 CF	2.9 CF

Parameter	CAS Number	Fraction	Unit	Class 2A						Class 2Bd						Class 2B, Class 2C and Class 2D					
				Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value	Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value	Applicable Chronic	Human Health Chronic	Wildlife Chronic	Aquatic Life Chronic	Aquatic Life Maximum	Aquatic Life Final Acute Value
Mercury	7439-97-6	Total	µg/l	0.0013	0.00153	0.0013	0.91	1.7	3.4	0.0013	0.00153	0.0013	0.91	1.7	3.4	0.0013	0.00153	0.0013	0.91	1.7	3.4
Methylene chloride	75-09-2		µg/l	46	46					47	47					1561	1994		1561 (1)	9600 (1)	19200 (1)
Nickel (HD CF)	7440-02-0	Dissolved	µg/l	52			52	468	936	52			52	468	936	52			52	468	936
Nickel (HD)	7440-02-0	Total	µg/l	52			52	469	938	52			52	469	938	52			52	469	938
Parathion (ethyl)	56-38-2		µg/l	0.013			0.013	0.065	0.13	0.013			0.013	0.065	0.13	0.013			0.013	0.065	0.13
Pentachlorophenol	87-86-5		µg/l	0.93	0.93 (1)			8.7 PD	17 PD	1.9	1.9 (1)			8.7 PD	17 PD	25.2	5.5 (1)		5.5 PD	8.7 PD	17 PD
Polychlorinated biphenyls	1336-36-3		µg/l	0.0000063	0.0000063	0.000122				0.0000252	0.0000252	0.000122				0.0000252	0.0000252	0.000122			
Selenium	7782-49-2		µg/l	5.0			5.0	20 (1)	40 (1)	5.0			5.0	20 (1)	40 (1)	5.0			5.0	20 (1)	40 (1)
Toluene	108-88-3		µg/l	253	4214		253 (1)	1352 (1)	2703 (1)	253	5517		253 (1)	1352 (1)	2703 (1)	253	45679		253 (1)	1352 (1)	2703 (1)
Toxaphene	8001-35-2		µg/l	0.000015	0.000015					0.000062	0.000062					0.000062	0.000062				
Trichloroethylene	79-01-6		µg/l	24	24					29	29					330	330				
Zinc (HD CF)	7440-66-6	Dissolved	µg/l	117			118	117	235	117			118	117	235	117			118	117	235
Zinc (HD)	7440-66-6	Total	µg/l	120			120	120	240	120			120	120	240	120			120	120	240

Table 5-4d Water Quality and Toxicity Standards: 7052 Standards – Class 2A, Class 2Bd, Class 2B, Class 2C and Class 2D footnotes

Criteria	Footnote	Footnote Remark
Standard 7052	HD	Hardness Dependent. Based on a hardness value of 100.
	CF	Conversion Factor.
	CR6	Value represents the criteria for Hexavalent Chromium.
	PD	pH dependent, based on a pH of 7.0.
	(1)	This standard or FAV was derived under chapter 7050.

Table 5-5 USFS Soils Label Index – Mine Site

USFS Label	USFS Label Description
Non-hydric Soils	
16	Upland Shallow Loamy Dry
Hydric Soils	
1	Lowland Loamy Moist
2	Lowland Loamy Wet
6	Lowland Organic Acid to Neutral
Other	
89	Water (Lake or River), Intermittent Water Body

Notes:
USFS = United States Forest Service
Labels and descriptions are based on the Superior National Forest Ecological Classification System

Table 5-6 NRCS Soils Label Index – Plant Site, Transportation and Utility Corridors, and Colby Lake Pipeline Corridor

Map Unit Symbol	NRCS Map Unit Name	Geomorphic Description
Non-hydric Soils		
1003B	Udorthents, loamy (cut and fill land)	fills on moraines, beveled cuts on moraines
F11B	Eaglesnest stony loam, 2 to 8 percent slopes, bouldery	till plains
F12B	Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	till plains
F13A	Babbitt, bouldery-Aquepts, rubbly, complex, 0 to 3 percent slopes	till plains
F14D	Eveleth stony loam, 8 to 18 percent slopes, bouldery	till plains
F165C	Insula, very bouldery-Rock outcrop-Wahlsten, very bouldery, complex, 2 to 12 percent slopes	drainageways on moraines
F177C	Eveleth-Eaglesnest complex, 2 to 20 percent slopes, very bouldery	moraines
F1C	Eaglesnest stony loam, 4 to 12 percent slopes, very bouldery	moraines, moraines
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	moraines
F26E	Shagawa-Beargrease complex, 8 to 30 percent slopes, extremely bouldery	end moraines
F2B	Eaglesnest-Wahlsten complex, 2 to 8 percent slopes, bouldery	moraines
F30G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	moraines
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly, complex, 0 to 18 percent slopes	till plains
F3D	Eveleth-Eaglesnest-Conic complex, 6 to 18 percent slopes, bouldery	moraines
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	moraines
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes	moraines
F6B	Soudan-Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	moraines
F9B	Cloquet loam, 2 to 8 percent slopes	outwash plains
Hydric Soils		
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	flats on flood plains
1021A	Rifle soils, 0 to 1 percent slopes	swamps on end moraines, outwash and till plains
1022A	Greenwood soils, 0 to 1 percent slopes	bogs on end moraines, outwash plains, till plains

Map Unit Symbol	NRCS Map Unit Name	Geomorphic Description
F34A	Cathro muck, depressional, 0 to 1 percent slopes	rims on end moraines, outwash and till plains
F129A	Tacoosh mucky peat, 0 to 1 percent slopes	rims on end moraines, outwash and till plains
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	drainageways on moraines
Other		
1048	Dumps, iron mine	Not applicable
1049	Pits, iron mine	Not applicable
1050	Tailings basin	Not applicable
W	Water	Not applicable

Notes:
NRCS = National Resources Conservation Service
Reference (14)

Table 5-7 Summary of State-Listed Plants

Scientific Name	Common Name	Minnesota Status	Reference
Caltha natans	Floating Marsh Marigold	Endangered	Walton (2004)(1)
Botrychium campestre	Prairie moonwort	Special Concern	Barr (2011)(2)
Botrychium pallidum	Pale moonwort	Special Concern	Johnson-Groh (2004)(3), Barr (2008)(4)
Botrychium rugulosum	St. Lawrence moonwort	Special Concern	Barr (2007)(5), Johnson-Groh (2004)(3)(6)
Botrychium simplex	Least moonwort	Special Concern	Johnson-Groh (2004)(4), Barr (2011)(2)
Eleocharis nitida	Neat Spikerush	Special Concern	Walton (2004)(1), Barr (2011)(2), Foth Van Dyke (1999)(7)
Juncus stygius var. americanus	Bog Rush	Special Concern	Barr (2011)(2)
Platanthera clavellata	Club-spur Orchid	Special Concern	Barr (2011)(2)
Pyrola minor	Small Shinleaf	Special Concern	Barr (2011)(2)
Ranunculus lapponicus	Lapland Buttercup	Special Concern	Walton (2004)(1)
Torreyochloa pallida	Pale Manna Grass	Special Concern	Walton (2004)(1)

(1) Reference (15)
(2) Reference (16)
(3) Reference (17)
(4) Reference (18)
(5) Reference (19)
(6) *Botrychium rugulosum* plants were documented in one location in the Mine Site (Section 2 and 11 of Township 59N, Range 13W); however, it is not certain that the plants identified at either location are *Botrychium rugulosum*
(7) Reference (20)

Table 5-8 Cultural Resources Identified in the Project Area

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-Lead Agencies	MnHPO Concurrence with Co-Lead Agencies' Findings
SL-HLC-002/040	Erie Mining Company Coarse Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-003/041	Erie Mining Company Fine Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-004/042	Erie Mining Company Conveyor and Drive House	Architectural Property	Not Eligible	Concur
SL-HLC-005/043	Erie Mining Company General Shops	Architectural Property	Not Eligible	Concur
SL-HLC-006/044	Erie Mining Company Reservoir	Architectural Property	Not Eligible	Concur
SL-HLC-007/045	Erie Mining Company Water Tower	Architectural Property	Not Eligible	Concur
SL-HLC-008/046	Erie Mining Company Concentrator Building	Architectural Property	Eligible	Concur
SL-HLC-009/047	Erie Mining Company Tailings Thickener Tank	Architectural Property	Not Eligible	Concur
SL-HLC-010/048	Erie Mining Company Pelletizing Building (razed)	Architectural Property	Not Eligible	Concur
SL-HLC-011/049	Erie Mining Company Central Heating Plant	Architectural Property	Not Eligible	Concur
SL-HLC-012/050	Erie Mining Company Fuel Oil Tanks	Architectural Property	Not Eligible	Concur
SL-HLC-013/051	Erie Mining Company Pellet Stockpile and Stacker	Architectural Property	Not Eligible	Concur
SL-HLC-014/052	Erie Mining Company Mine Area No. 2 Shops	Architectural Property	Not Eligible	Concur
SL-HLC-015/053	Erie Mining Company Railroad Mine and Plant Track, Main Line Segment, and Dunka Railroad Segment	Architectural Property	Eligible	Concur
SL-HLC-016/054	Erie Mining Company Tailings Basin	Architectural Property	Not Eligible	Concur

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-Lead Agencies	MnHPO Concurrence with Co-Lead Agencies' Findings
SL-HLC-017/055	Erie Mining Company Mine Area No. 1 Shops	Architectural Property	Not Eligible	Concur
SL-HLC-018/056	Erie Mining Company Concentration Plant Complex	Historic District	Not Eligible	Concur
SL-HLC-pending	DM&IR Segment	Architectural Property	Eligible	Concur
SL-HLC-pending	Erie Mining Company Colby Lake Pumping Station and Pipeline	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Administration Building	Architectural Property	Eligible	Concur
SL-HLC-pending	Spring Mine and Stockpiles	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 2	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 3	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 5	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Dunka Road Segment	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company High Voltage Transmission Line Segment	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Reserve Crusher No. 2 (Northshore Mining)	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Hoyt Lakes Operation Mining Landscape Historic District	Historic District	Eligible	Concur
21SLpending	Spring Mine Lake Sugarbush	Archaeological Site	Eligible	Concur
SL-HLC-065	*Mesabe Widjiu* (Laurentian Divide)	Cultural Landscape	Eligible	Concur
SL-HLC-pending	Overlook	Natural Feature	Not Eligible	Concur

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-Lead Agencies	MnHPO Concurrence with Co-Lead Agencies' Findings
SL-HLC-069	BBLV Trail Segment[1]	Archaeological Site	Eligible	Concur
21SLpending	NorthMet Archaeological Site	Archaeological Site	Not Eligible	Concur
21SLmn	Knot Logging Camp	Archaeological Site	Not Eligible	Concur

Note: Table 4.2.9-1 of Appendix 16.1. The status of the sites listed as eligible has not changed and the Undertaking of the Project shall be implemented in accordance with the stipulation measures outlined in the Memorandum of Agreement signed among the USFS, USACE, MnHPO, Advisory Council on Historic Preservation, and PolyMet in December of 2016. (Refernece (21))

(1) USFS designation BBLV Trail Segment #1 (USFS #01-569)

Table 5-9 Historic Resources Associated with the Erie Mining Company Historic District

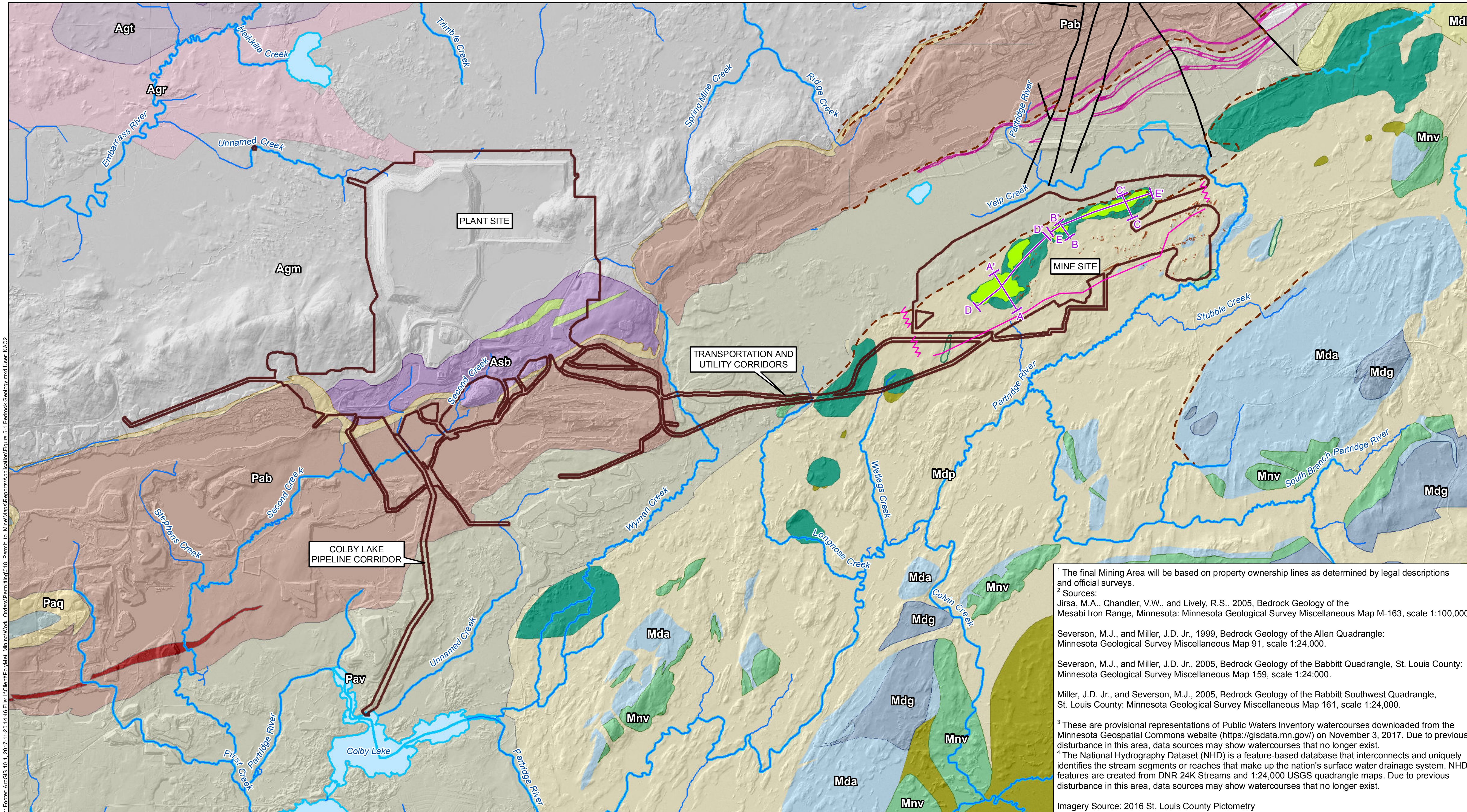
Resource ID	Resource Name	Individual Eligibility	Landscape District
SL-HLC-002/040	Erie Mining Company Coarse Crusher	Not Eligible	Contributing
SL-HLC-003/041	Erie Mining Company Fine Crusher	Not Eligible	Contributing
SL-HLC-004/042	Erie Mining Company Conveyor and Drive House	Not Eligible	Contributing
SL-HLC-005/043	Erie Mining Company General Shops	Not Eligible	Contributing
SL-HLC-006/044	Erie Mining Company Reservoir	Not Eligible	Contributing
SL-HLC-007/045	Erie Mining Company Water Tower	Not Eligible	Contributing
SL-HLC-008/046	Erie Mining Company Concentrator Building	Eligible	Contributing
SL-HLC-009/047	Erie Mining Company Tailings Thickener Tanks	Not Eligible	Contributing
SL-HLC-010/048	Erie Mining Company Pelletizing Building (razed)	Demolished	NIA
SL-HLC-011/049	Erie Mining Company Central Heating Plant	Not Eligible	Contributing
SL-HLC-012/050	Erie Mining Company Fuel Oil Tanks	Not Eligible	Contributing
SL-HLC-013/051	Erie Mining Company Pellet Stockpile and Stacker	Not Eligible	Contributing
SL-HLC-014/052	Erie Mining Company Mine Area No. 2 Shops	Not Eligible	Contributing
SL-HLC-015/053	Erie Mining Company Railroad Mine and Plant Track, Main Line Segment, and Dunka Railroad Segment	Eligible	Contributing
SL-HLC-016/054	Erie Mining Company Tailings Basin	Not Eligible	Contributing
SL-HLC-017/055	Erie Mining Company Mine Area No. 1 Shops	Not Eligible	Contributing
SL-HLC-018/056	Erie Mining Company Concentration Plant Complex	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Colby Lake Pumping Station and Pipeline	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Administration Building	Eligible	Contributing
SL-HLC-pending	Spring Mine and Stockpiles	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 2	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 3	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 5	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Dunka Road Segment	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company High Voltage Transmission Line Segment	Not Eligible	Contributing

Note: Table 4.2.9-2 of Appendix 16.1

Table 5-10 Areas Excluded, Prohibited, and Restricted from Mining

Considerations for Mining Exclusion Areas Minnesota Rules, part 6132.2000 Siting			
Subpart 2 Mining Exclusion Areas(1)	Subpart 3 Surface Disturbance Prohibition Areas(1)	Subpart 4 Mining Restricted Areas1	Comments on Applicability2
A. BWCAW	A. BWCAW	A. Within national wildlife refuge, national waterfowl production area, or national trail.	The Project is approximately 18 miles from the BWCAW.
B. Voyageurs National Park	B. Voyageurs National Park		The Project is approximately 48 miles from the Voyageurs National Park.
C. State wilderness areas	C. State wilderness areas	B. Within state wildlife management area or state designated trail.	The Project is approximately 2 miles from the Darwin S. Myers state wildlife management area.
D. Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments	D. Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments		The Project is greater than 2 miles from the Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments.
E. State scientific and natural areas	E. State scientific and natural areas		The Project is greater than 2 miles from Scenic and Natural Areas.
F. State peatland scientific and natural areas		C. Peatlands identified as peatland watershed protection areas.	The Project is not within these areas (Reference (22)).
G. Calcareous fens	G. Calcareous fens		There are no calcareous fens identified in St. Louis or Lake Counties (Reference (23)).
H. A state park	F. State parks		The Project is greater than 2 miles from state parks.
	H. Sites Registered in the National Register of Historic Places		There are no sites listed in the National Register of Historic Places in the Mining Area.
	I. Sites Registered in the Registry of State Historic Sites		There are no sites listed in the State Register of Historic Places in the Mining Area.
	J. National wild, scenic, or recreational river districts of a national wild, scenic or recreational river		The Project is greater than 2 miles from a national wild, scenic, or recreational river. Segments of the St. Croix River are the only Minnesota waterways listed nationally. (Reference (24)).
	K. Designated state land use districts of a state wild, scenic, or recreational river.		The Project is greater than 2 miles from a state wild, scenic, or recreational river Reference (25)).
	L. Adjacent to the north shore of Lake Superior		The Project is greater than 2 miles from the Lake Superior north shore.
	M. Within 500 feet of a dwelling, or other community building; within 100 feet of a cemetery or outside right-of-way line of a public roadway.3		The Project is not within 500 feet of a dwelling, public school, church, public institution, or county or municipal park; nor is it within 100 feet of a cemetery. The Colby Lake Pipeline is at some locations in close proximity to CR 666, especially in the vicinity of the Plant entrance.4
		D. Within waters identified in the public waters inventory	The Project is within 300 feet of the following public waters (from west to east): Second Creek, unnamed tributary to Wyman Creek, Wyman Creek, Longnose Creek, Wetlegs Creek, and Partridge River. The only public water that will be impacted by the Project is the unnamed tributary to Wyman Creek, which will require installation of a culvert extension, requiring a Work in Public Waters Permit from the DNR. Mining will not occur within any of these public waters.

Notes:
(1) See the rule for the full description of the requirement.
(2) The Project is considered to not be within close proximity to exclusion, prohibition, and restricted areas if the distance between the Project and the area is greater than 2 miles.
(3) Minnesota Rule, part 6132.2000, subpart 3 M(2) states the outside right-of-way line of a public roadway, except where mine access or haul roads cross the right-of-way.
(4) Both the Colby Lake Pipeline and CR 666 were constructed to support previous mining activates and are utilitarian in nature (not an active mining area).
Abbreviations:
BWCAW = Boundary Waters Canoe Area Wilderness



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.

[2] Sources:

Jirsa, M.A., Chandler, V.W., and Lively, R.S., 2005, Bedrock Geology of the Mesabi Iron Range, Minnesota: Minnesota Geological Survey Miscellaneous Map M-163, scale 1:100,000.

Severson, M.J., and Miller, J.D. Jr., 1999, Bedrock Geology of the Allen Quadrangle: Minnesota Geological Survey Miscellaneous Map 91, scale 1:24,000.

Severson, M.J., and Miller, J.D. Jr., 2005, Bedrock Geology of the Babbitt Quadrangle, St. Louis County: Minnesota Geological Survey Miscellaneous Map 159, scale 1:24:000.

Miller, J.D. Jr., and Severson, M.J., 2005, Bedrock Geology of the Babbitt Southwest Quadrangle, St. Louis County: Minnesota Geological Survey Miscellaneous Map 161, scale 1:24,000.

[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]

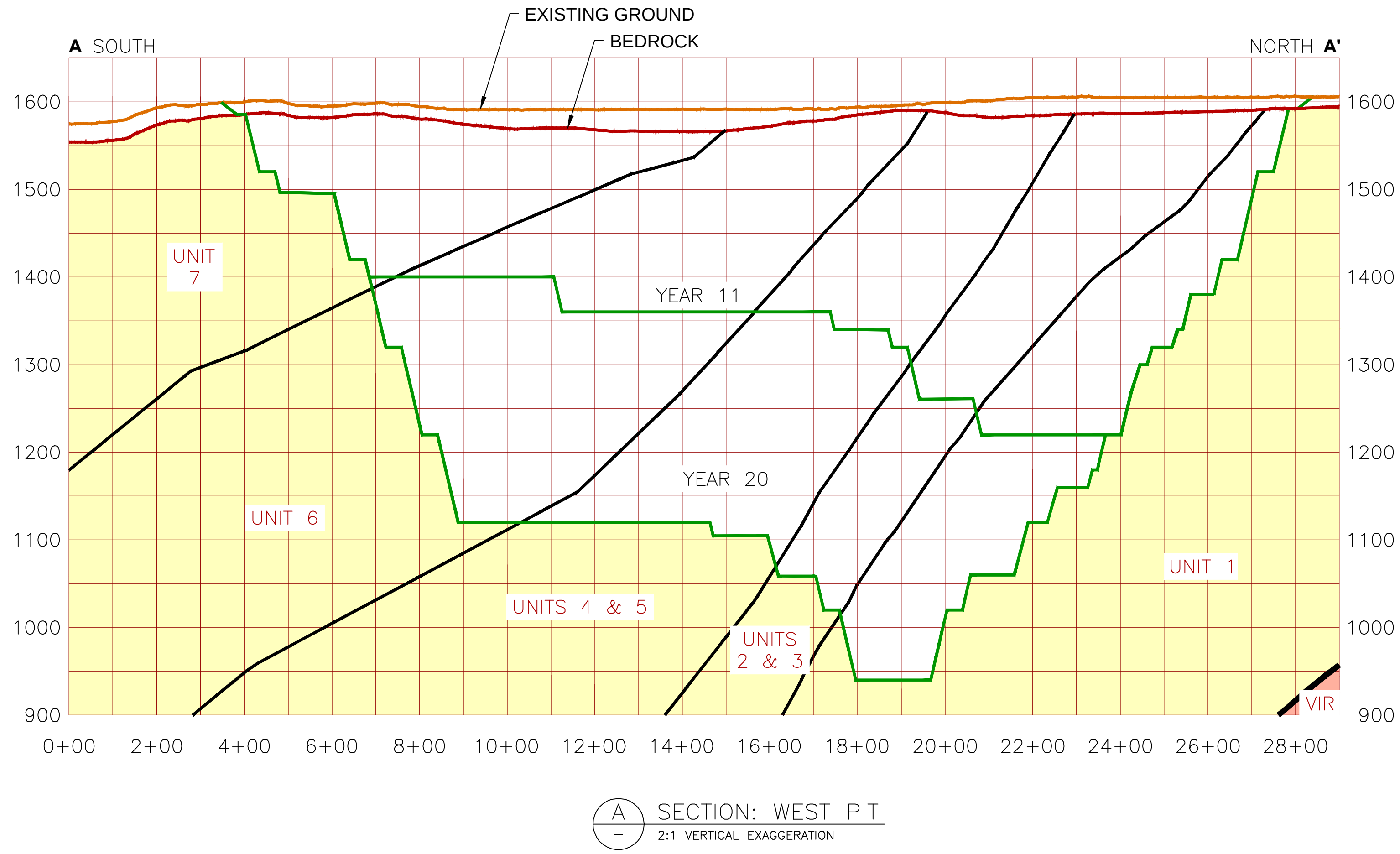
Bedrock Geology[2]

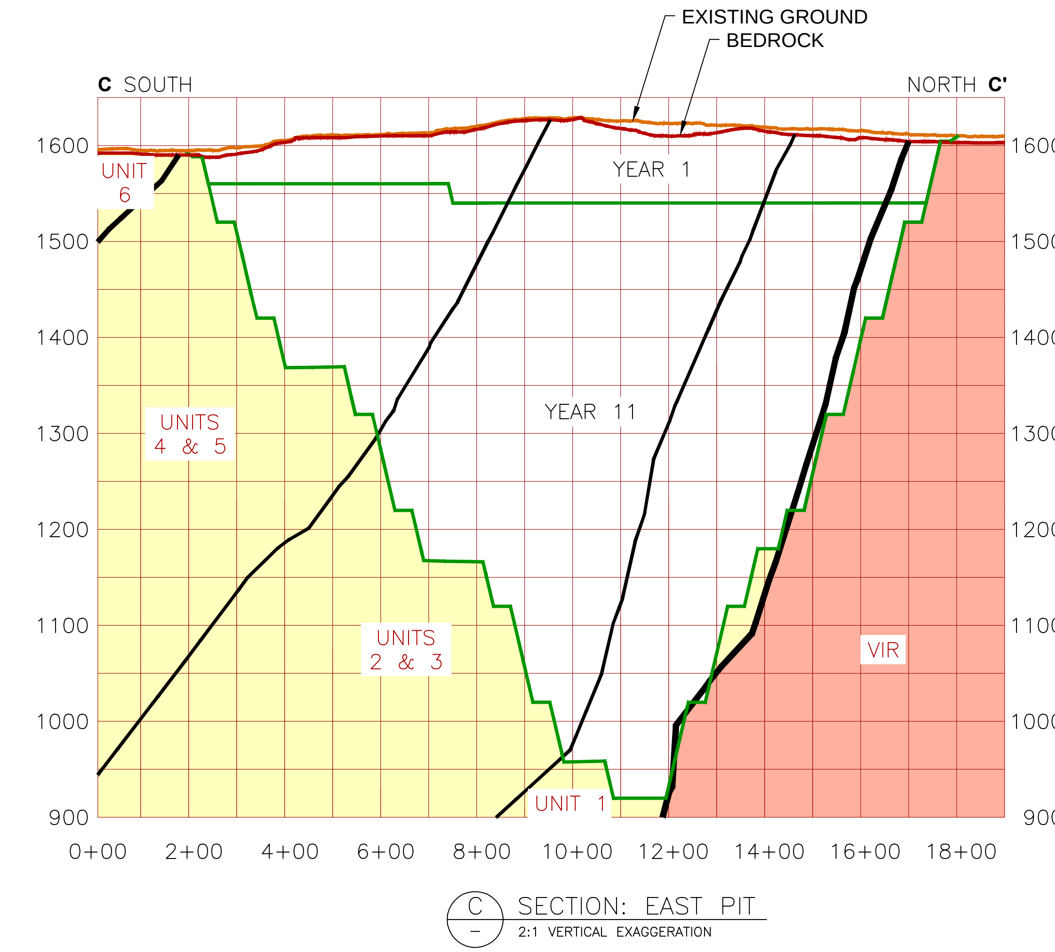
- Agm - Quartz monzonite and monzodiorite
- Agr - Quartz monzonite, monzodiorite, and monzogranite
- Agt - Tonalite to granodiorite
- Amv - Tholeiitic to calc-alkalic volcanic rocks
- Asb - Schist of sedimentary protolith
- Asv - Schist of mafic to intermediate volcanic protlith
- Mda - Anorthositic series subsuite of the Duluth Complex
- Mdg - Gabbro
- Mdk - South Kawishiwi intrusion
- Mdp - Partridge River intrusion
- Mdu - Ultramafic, oxide-rich intrusions
- Mia - Aurora sill
- Mmi - Mafic intrusions
- Mnv - North Shore Volcanic Group
- Pab - Biwabik Iron Formation
- Paq - Pokegama Quartzite
- Pav - Virginia Formation
- Bedrock Outcrop
- Duluth Complex Deposits
- Mine Site Block Model Ore Body
- Geologic Contact (Approximately Located)
- Fault (Approximately Located)
- Limits of Detailed Geologic Model
- Cross-Section Locations
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourse[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

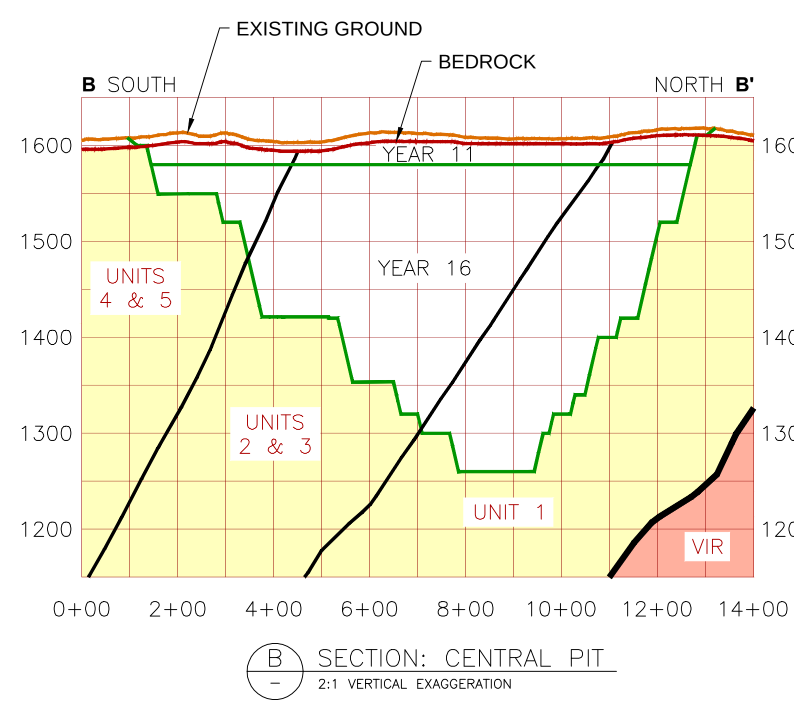
0 0.5 1
Miles

BEDROCK GEOLOGY
NorthMet Project
Poly Met Mining, Inc.

Figure 5-1
Permit to Mine Application





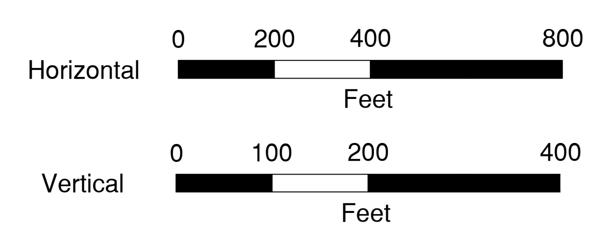


LEGEND

UNIT 1–7	PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
VIR	VIRGINIA FORMATION
	GEOLOGIC CONTACT

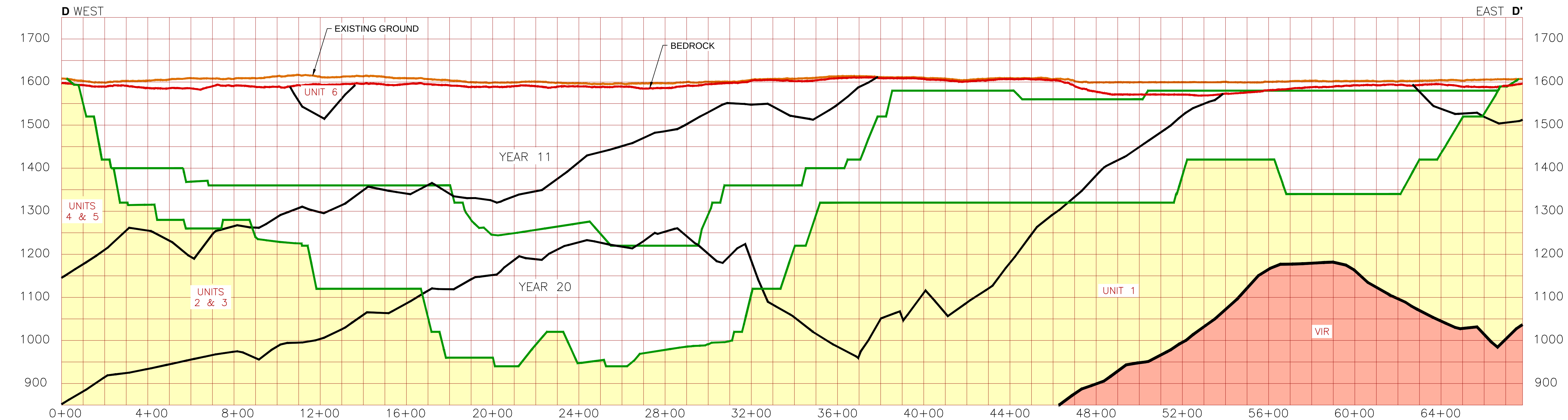
NOTES:

1. CROSS–SECTION LOCATIONS SHOWN ON FIGURE 7–5.
2. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.
3. CENTRAL PIT MINING WILL BE COMPLETED IN MINE YEAR 16, AT WHICH TIME, BACKFILLING WILL BEGIN.

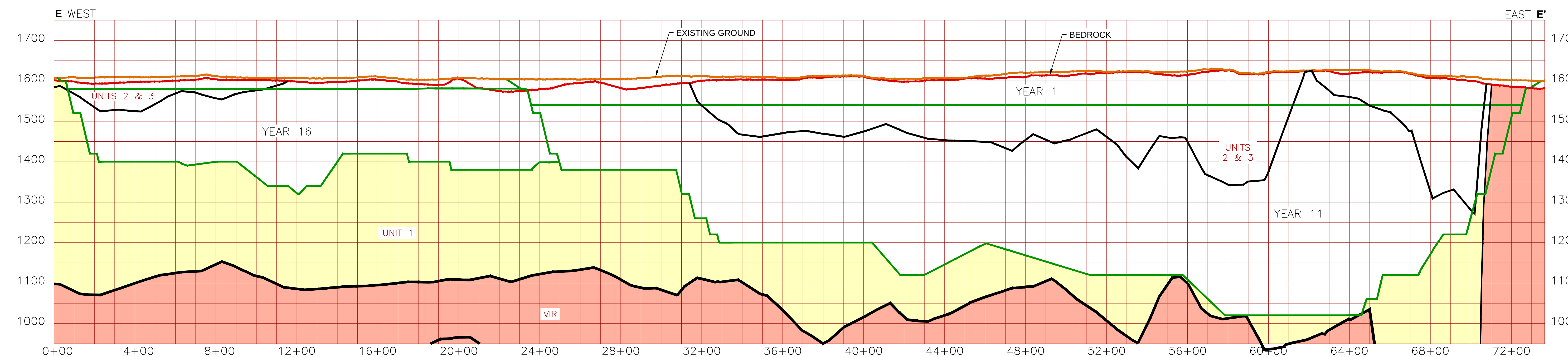


PIT CROSS-SECTIONS A, B, C
NorthMet Project
Poly Met Mining, Inc.

Figure 5-2
Permit to Mine Application



D SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



E SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION

LEGEND

- UNIT 1–7 — PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
- VIR — VIRGINIA FORMATION
- GEOLOGIC CONTACT

NOTES:

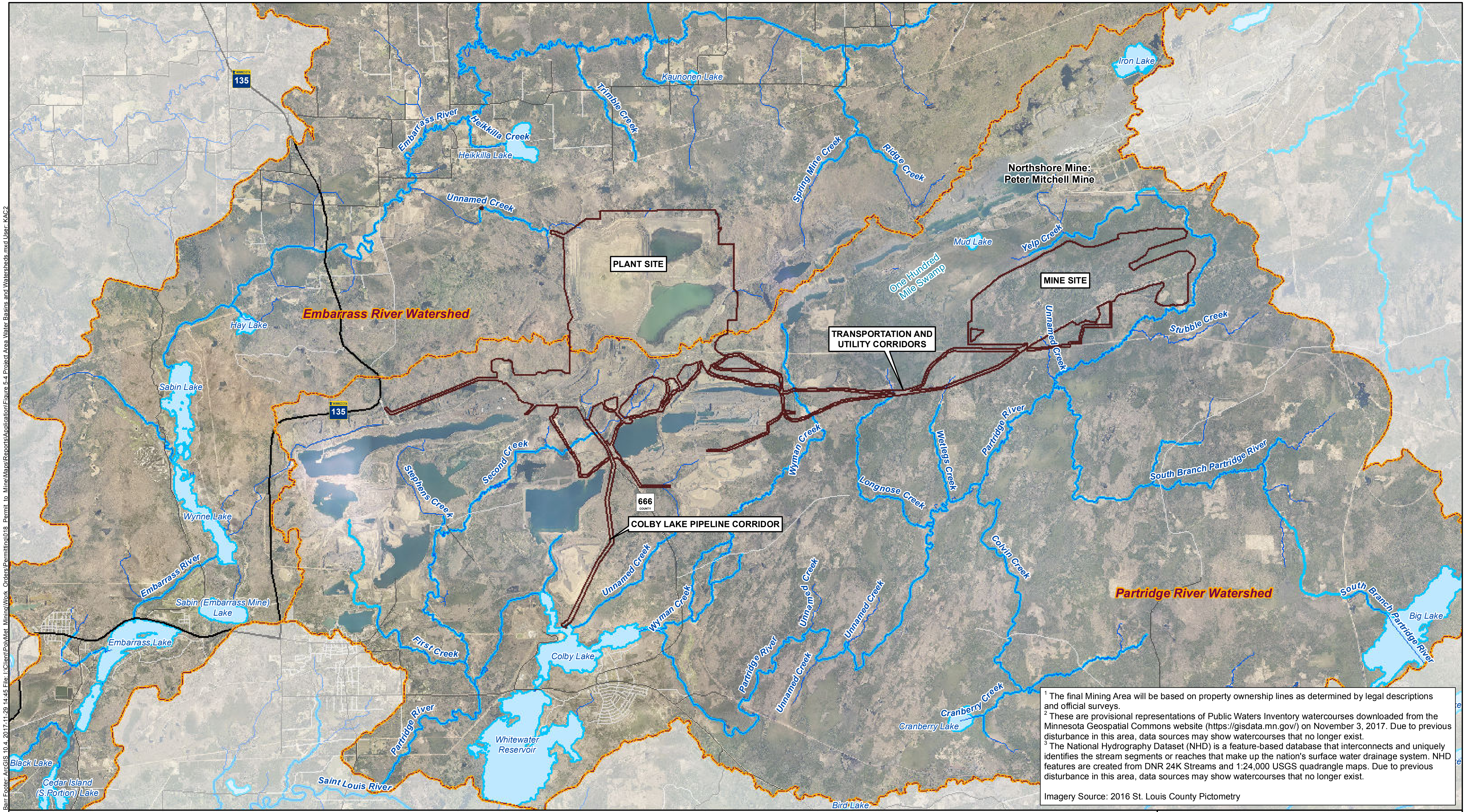
1. CROSS–SECTION LOCATIONS SHOWN ON FIGURE 7–5.
2. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.
3. CENTRAL PIT MINING WILL BE COMPLETED IN MINE YEAR 16, AT WHICH TIME, BACKFILLING WILL BEGIN.

Horizontal: 0 250 500 1,000 Feet

Vertical: 0 125 250 500 Feet

PIT CROSS-SECTIONS D, E
NorthMet Project
Poly Met Mining, Inc.

Figure 5-3
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

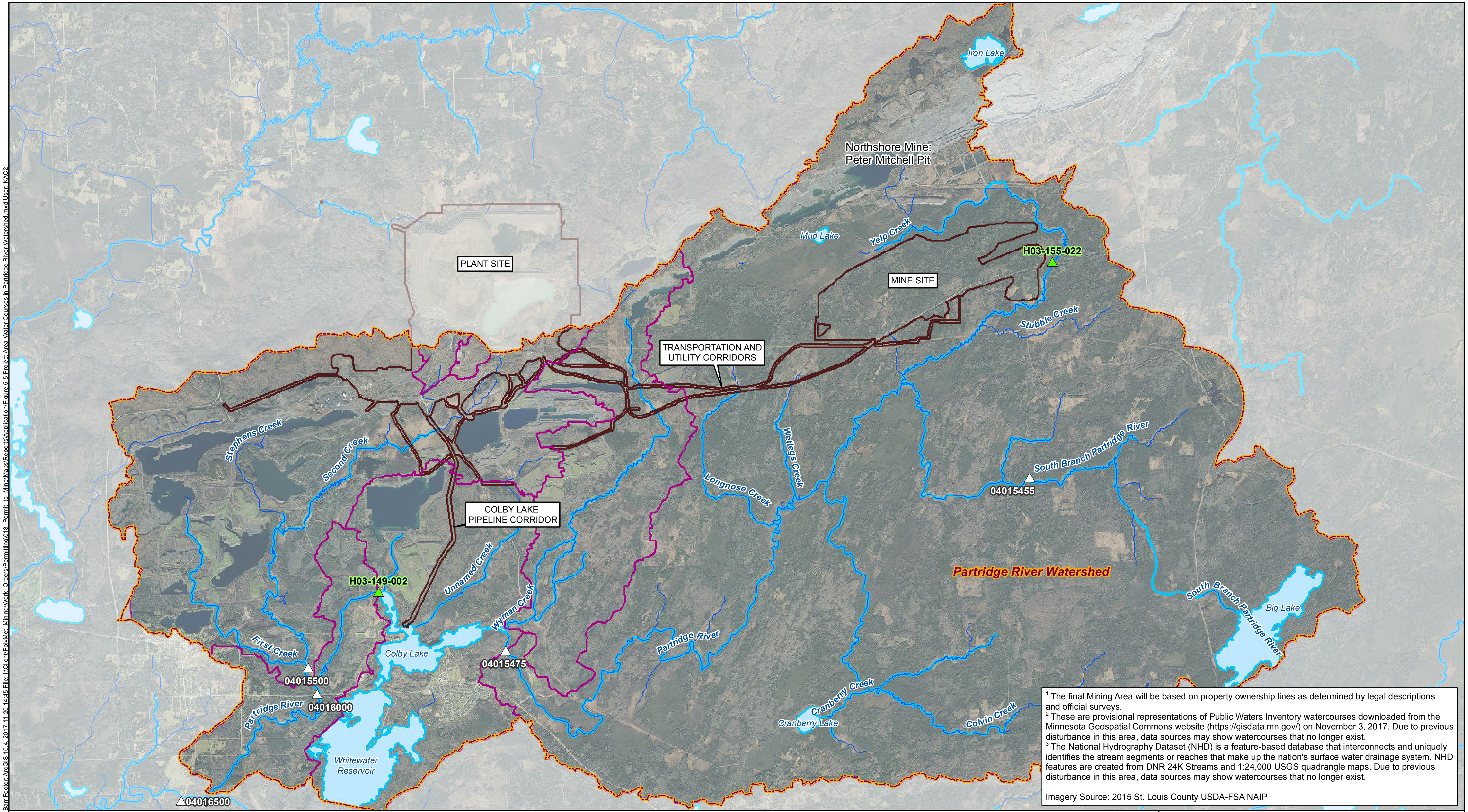
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Watershed Divide
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 0.75 1.5 3
Miles

PROJECT AREA WATER BASINS AND WATERSHEDS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-4
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

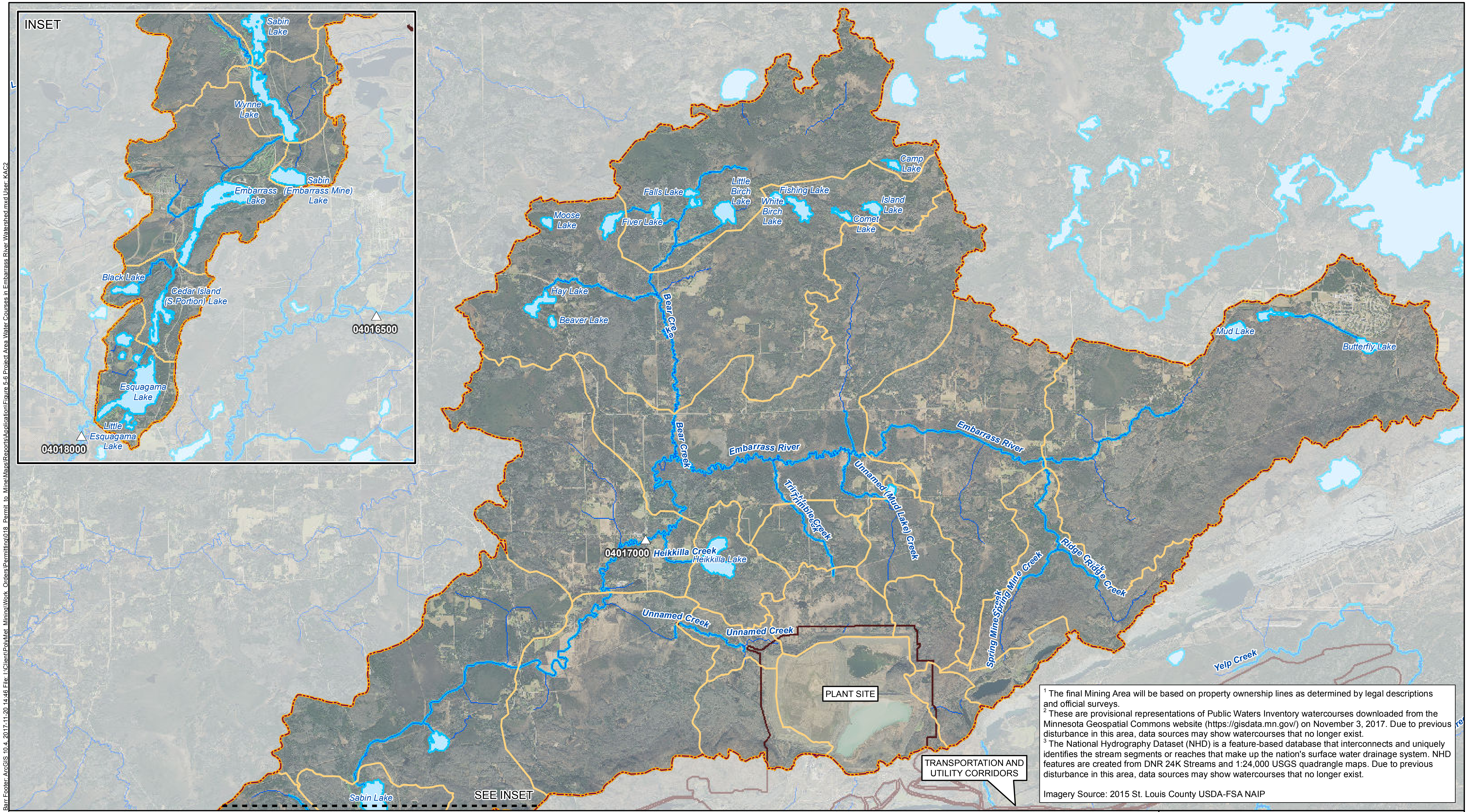
Imagery Source: 2015 St. Louis County USDA-FSA NAIP

Mining Area[1]
USGS Gage Station
MDNR Gage Station
Watershed Boundary
Partridge River Subwatersheds
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 0.75 1.5 3
Miles

PROJECT AREA WATER COURSES IN PARTRIDGE RIVER WATERSHED
NorthMet Project
Poly Met Mining, Inc.

Figure 5-5
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

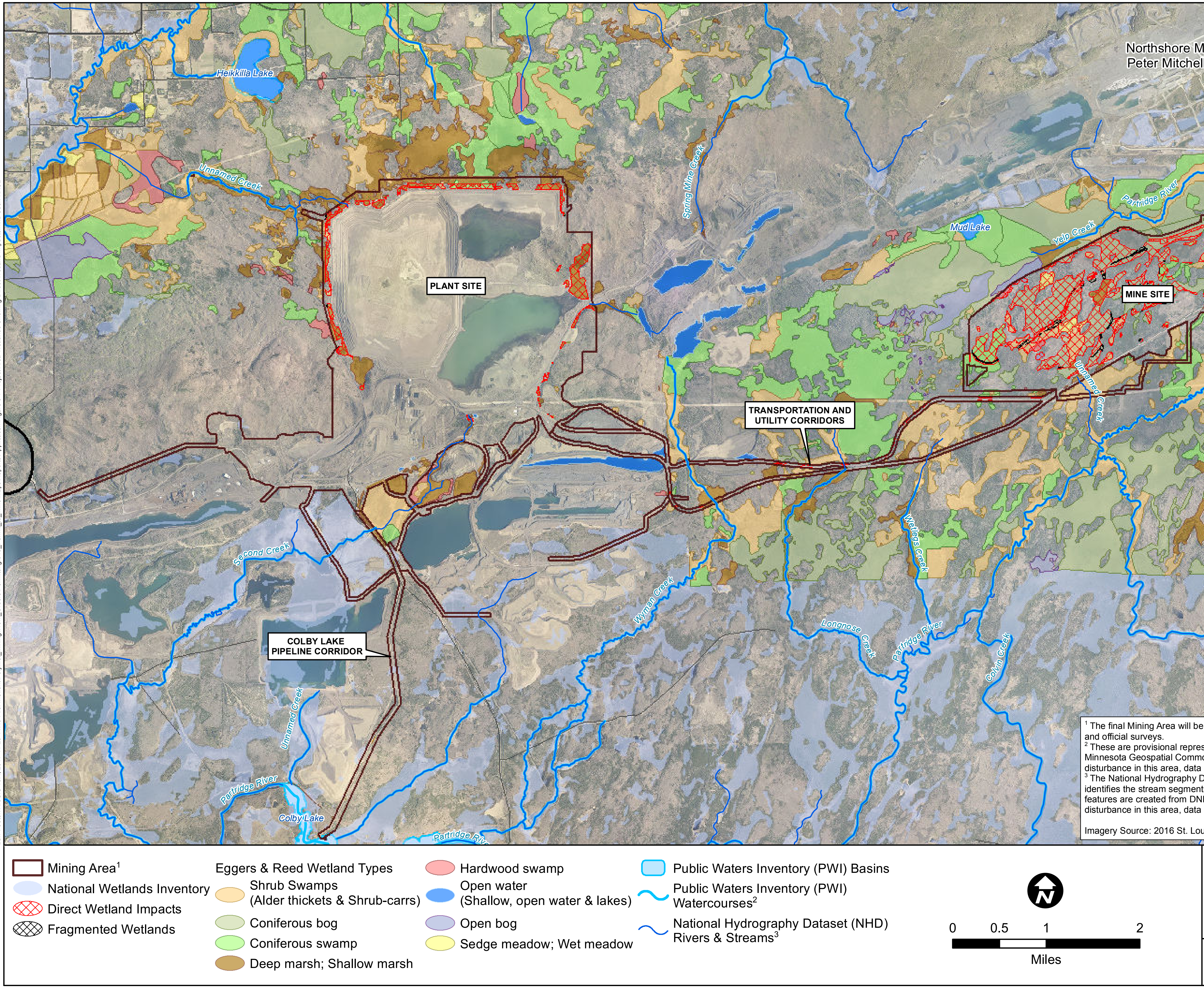
Imagery Source: 2015 St. Louis County USDA-FSA NAIP

Mining Area[1]
USGS Gage Station
Watershed Boundary
Embarrass River Subwatersheds
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 0.75 1.5 3
Miles

PROJECT AREA WATER COURSES IN EMBARRASS RIVER WATERSHED
NorthMet Project
Poly Met Mining, Inc.

Figure 5-6
Permit to Mine Application

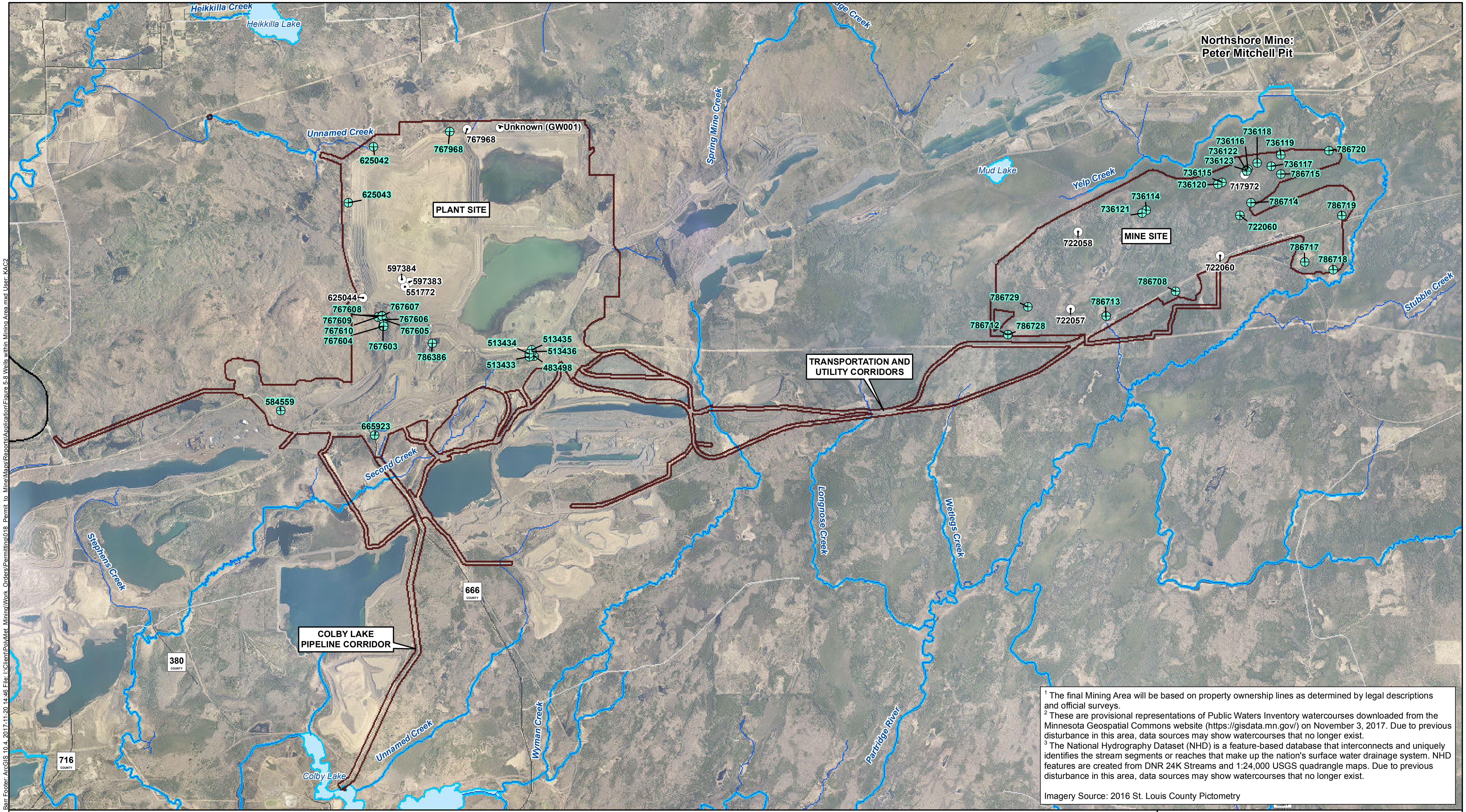


[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

PROJECT AREA WETLANDS
SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-7
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

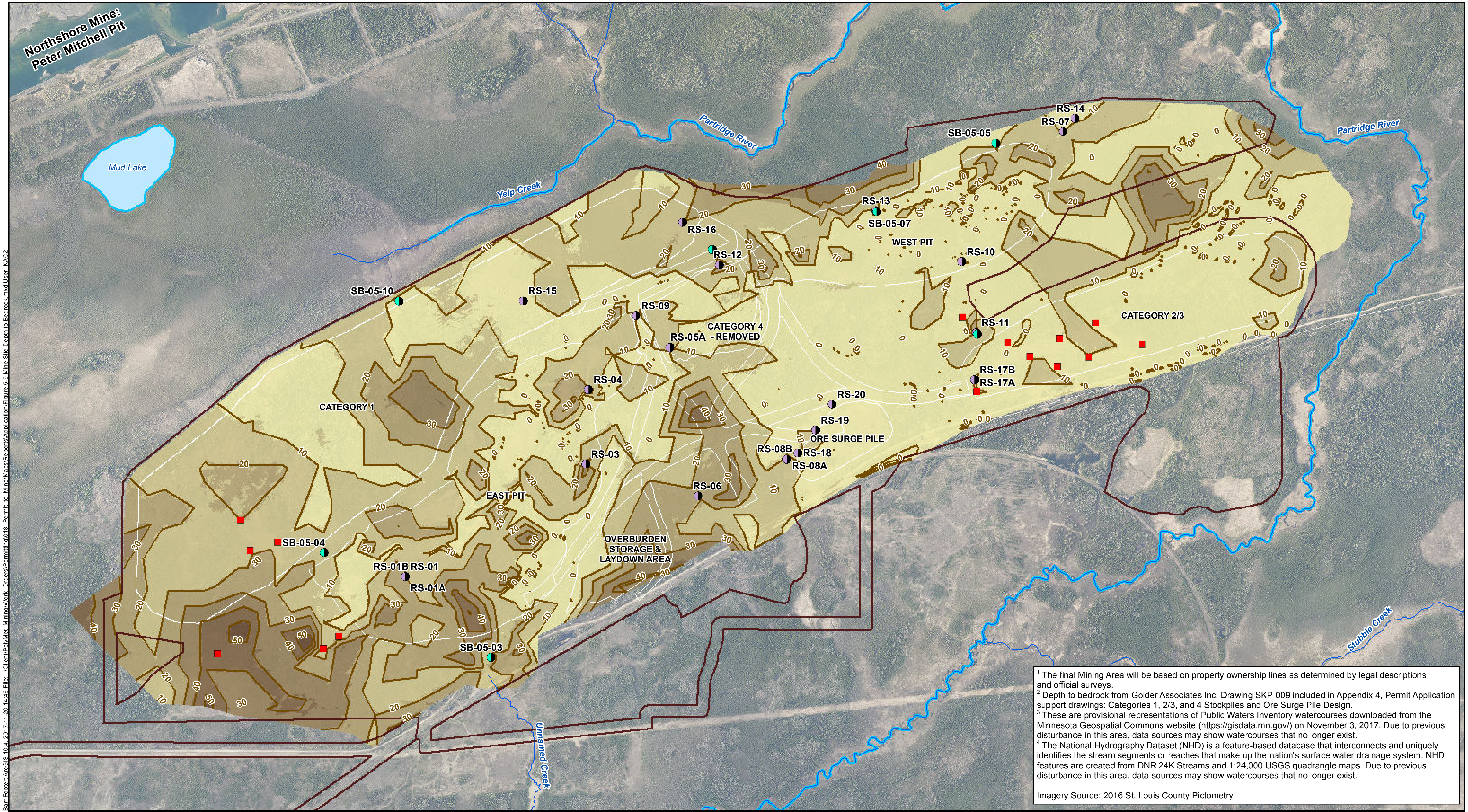
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Wells in County Well Index
Other Known Wells
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 2,500 5,000 10,000
Feet

WELLS WITHIN MINING AREA
NorthMet Project
Poly Met Mining, Inc.

Figure 5-8
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Depth to bedrock from Golder Associates Inc. Drawing SKP-009 included in Appendix 4, Permit Application support drawings: Categories 1, 2/3, and 4 Stockpiles and Ore Surge Pile Design.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Select Mine Year 11 Features
Depth to Bedrock 10' Contour

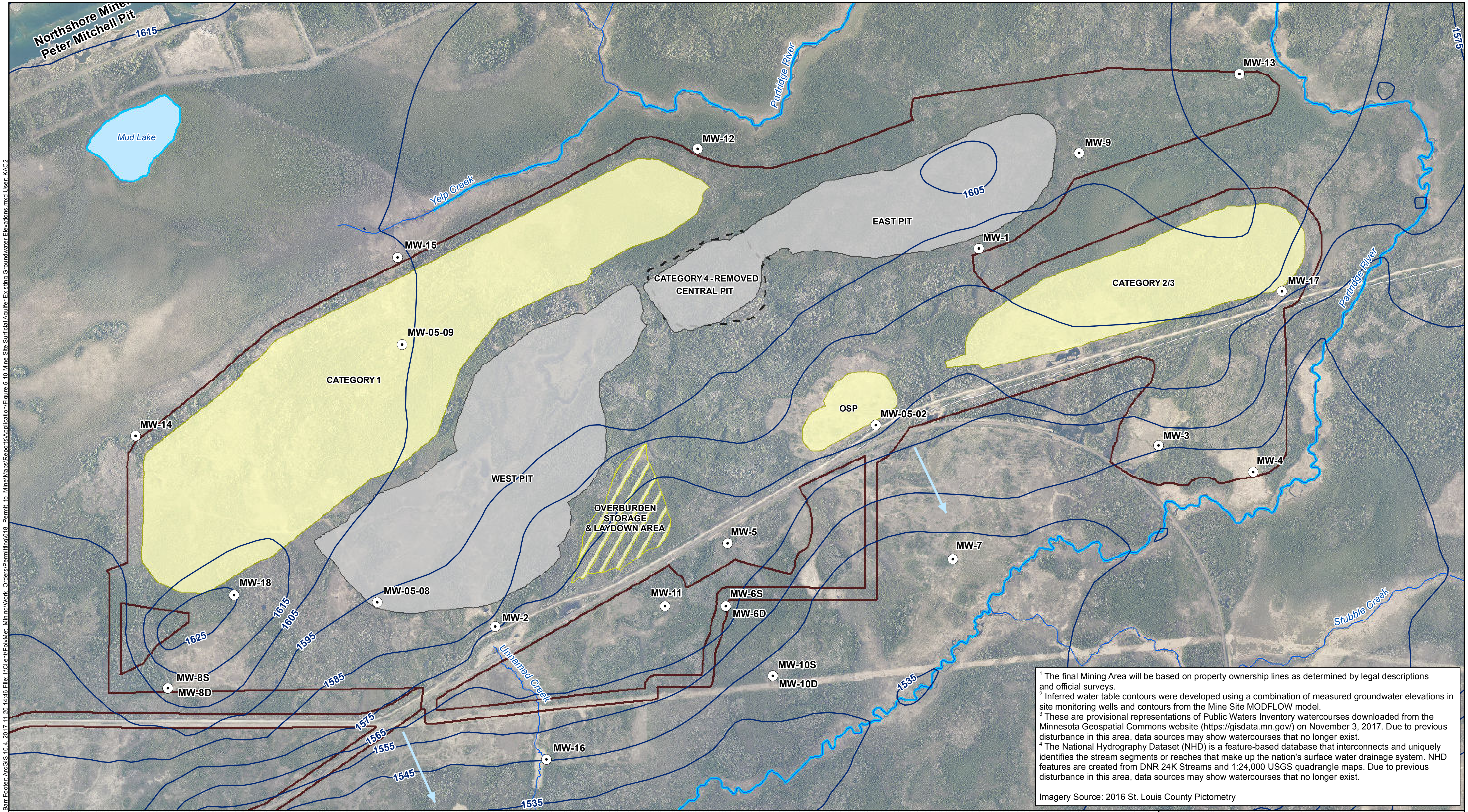
Depth to Bedrock (ft)[2]
- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 58

Soil Boring - 2005
Overburden Geochem/Geotech Boring - 2008
Golder Test Trench - 2006
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE SITE DEPTH TO BEDROCK
NorthMet Project
Poly Met Mining, Inc.

Figure 5-9
Permit to Mine Application



Mining Area[1]
Existing Surficial Groundwater Monitoring Well Locations
Existing Groundwater Elevation Contours (ft MSL)[2]
Groundwater Flow Direction

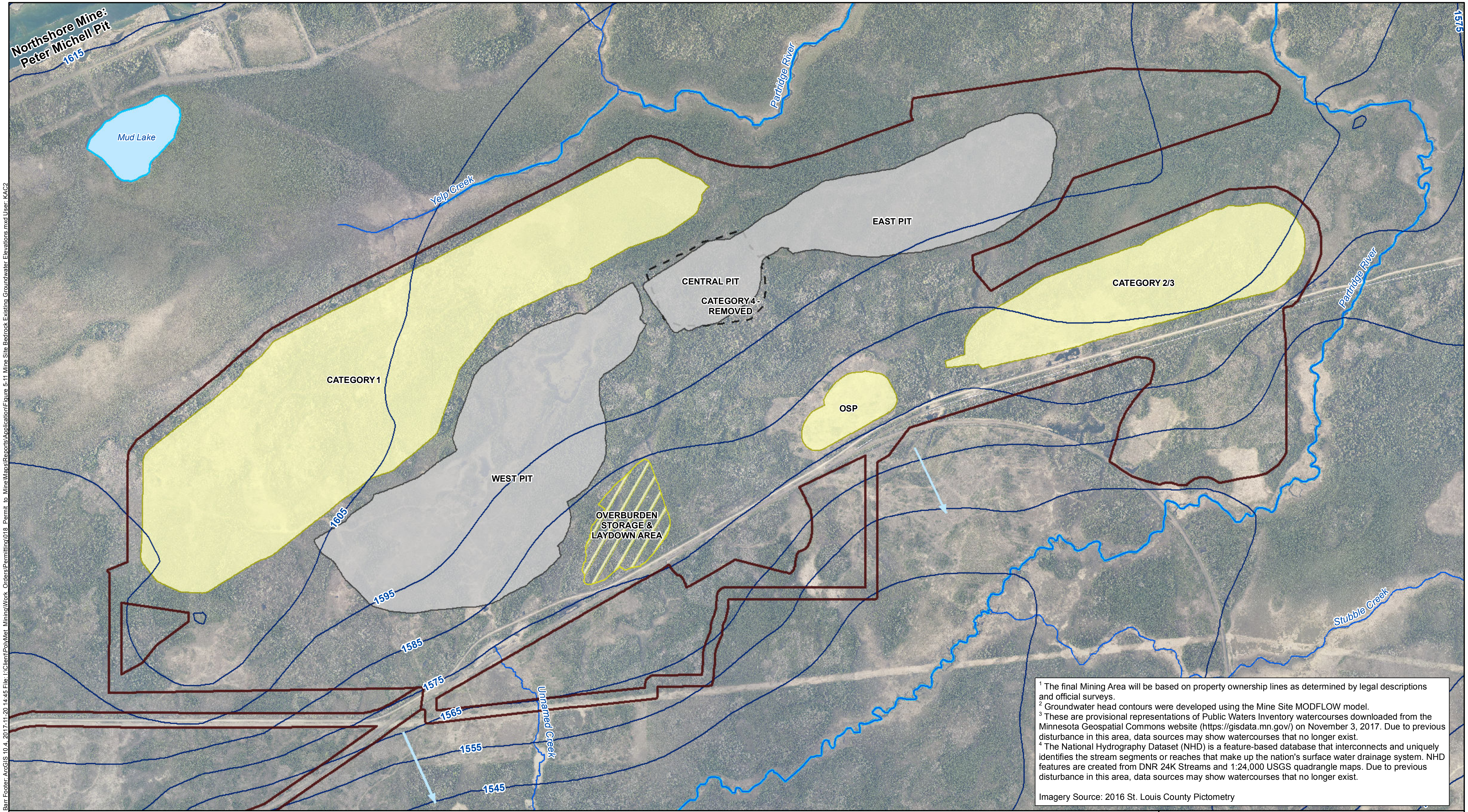
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Public Waters Inventory (PWI) Basins

Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE SITE SURFICIAL AQUIFER EXISTING GROUNDWATER ELEVATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-10
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Groundwater head contours were developed using the Mine Site MODFLOW model.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

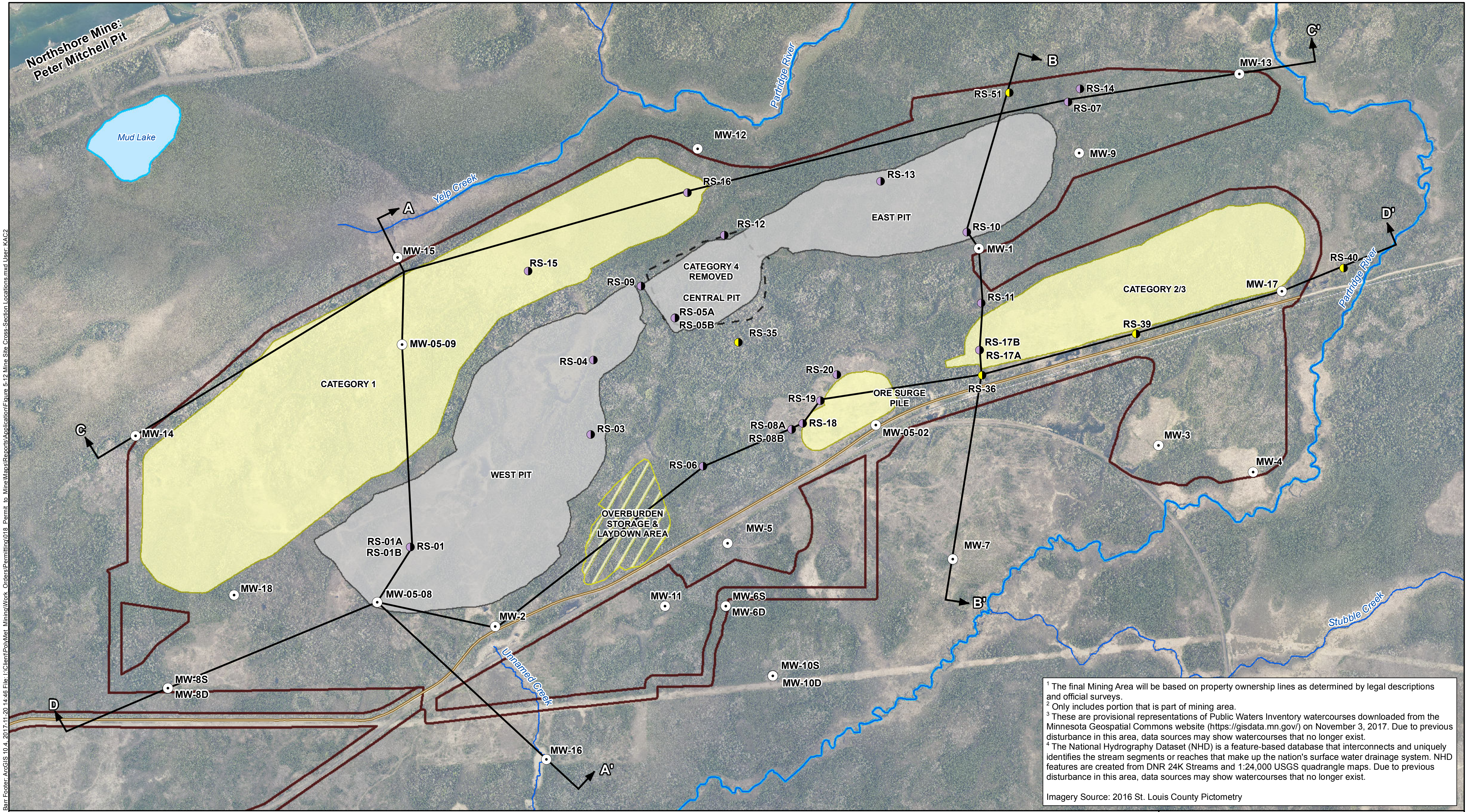
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Existing Bedrock Groundwater Head Contours (ft MSL) [2]
Groundwater Flow Direction
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers Streams[4]

0 750 1,500 3,000
Feet

MINE SITE BEDROCK EXISTING GROUNDWATER HEAD CONTOURS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-11
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Overburden Geochem/Geotech Boring - 2008
Rotasonic Borings - 2011/2012
Existing Surficial Groundwater Monitoring Well Locations
Cross-Section Locations

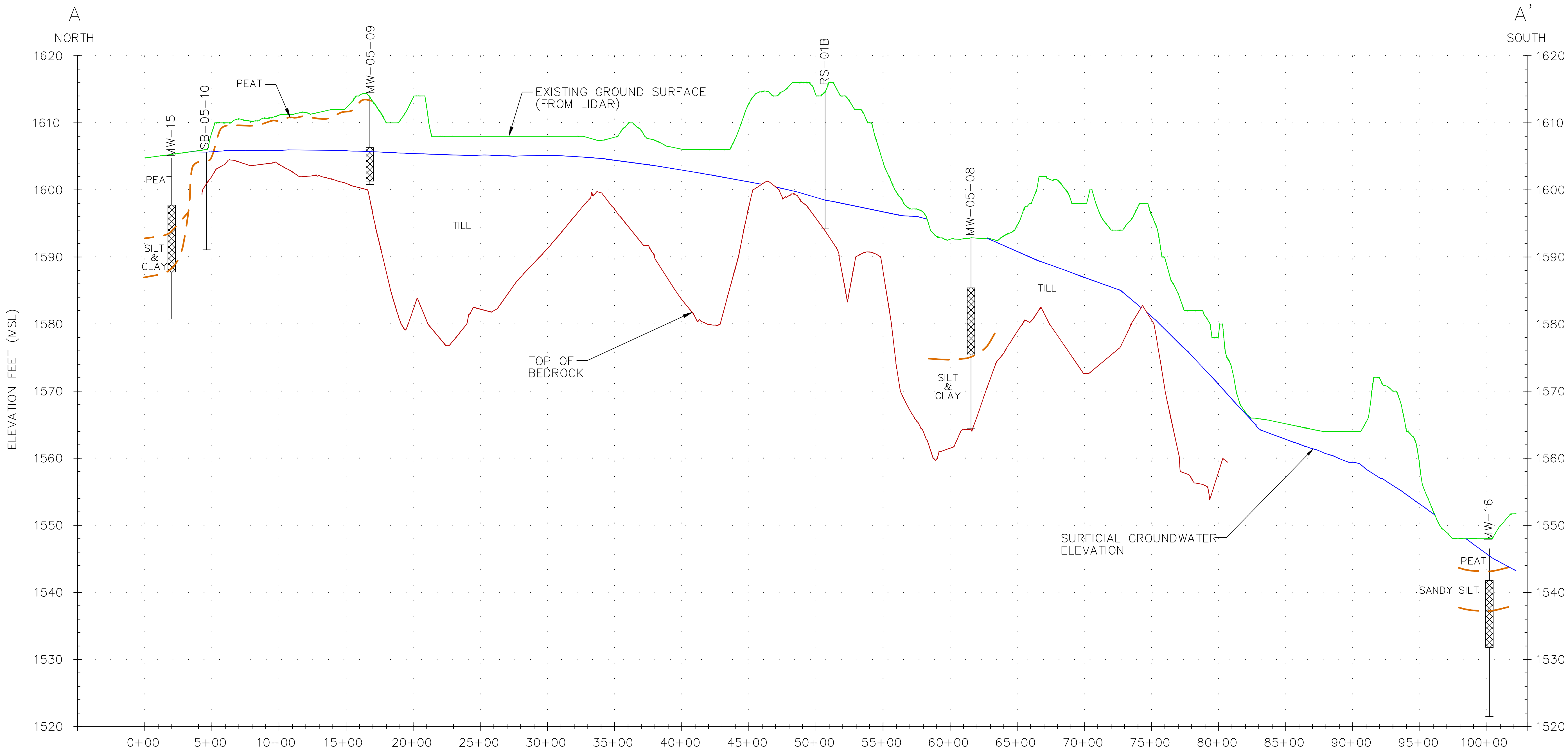
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]

National Hydrography Dataset (NHD) Rivers Streams[4]

0 750 1,500 3,000
Feet

MINE SITE CROSS-SECTION LOCATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-12
Permit to Mine Application



LEGEND

EXISTING GROUND

BEDROCK SURFACE

SURFICIAL GROUNDWATER ELEVATION

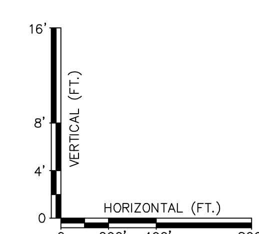
DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS

WELL SCREEN

BORING EXTENT

NOTES:

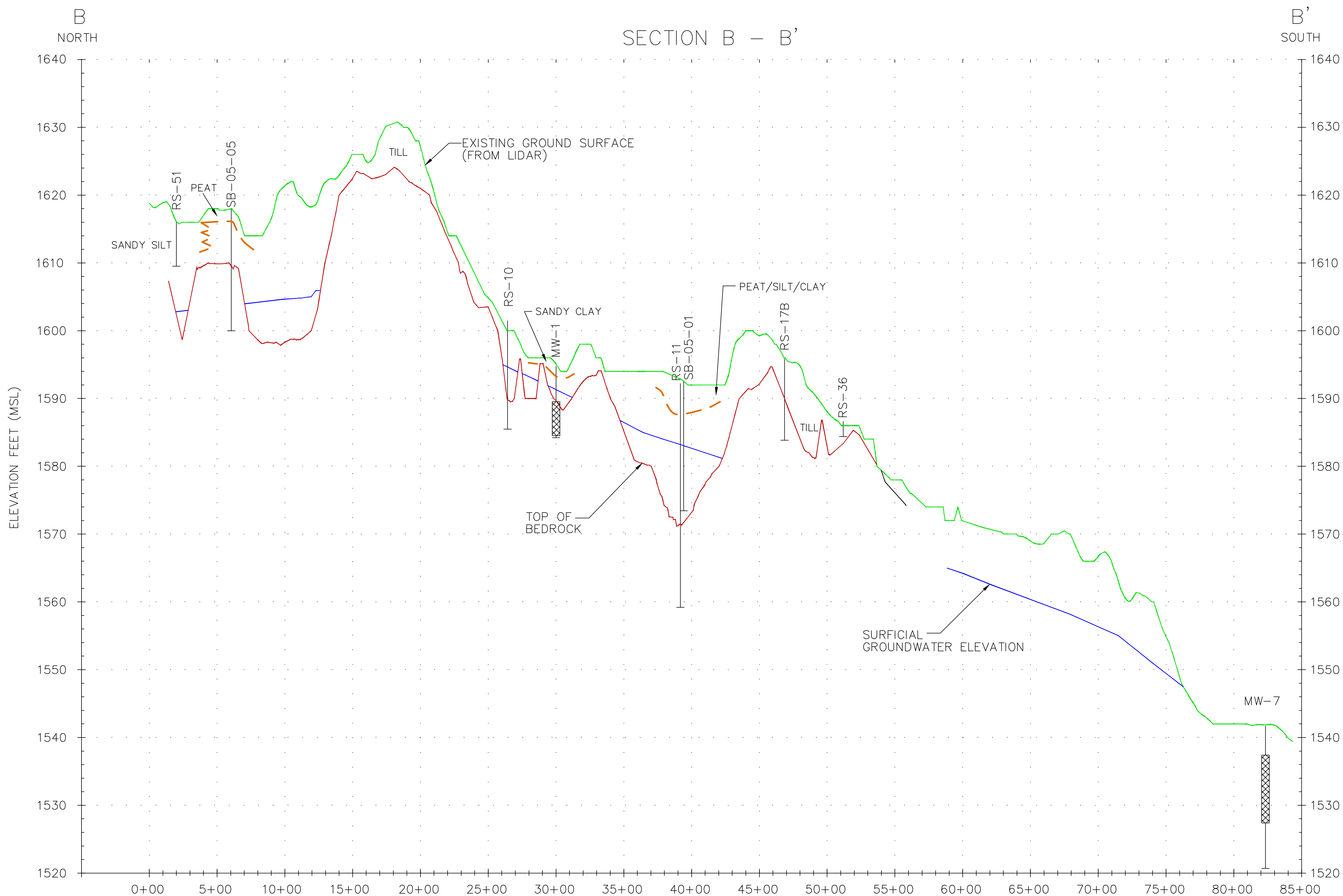
1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH.
4. CROSS-SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

MINE SITE CROSS-SECTION A-A'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-13
Permit to Mine Application



LEGEND

EXISTING GROUND

BEDROCK SURFACE

SURFICIAL GROUNDWATER ELEVATION

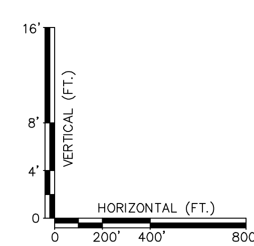
DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS

WELL SCREEN

BORING EXTENT

NOTES:

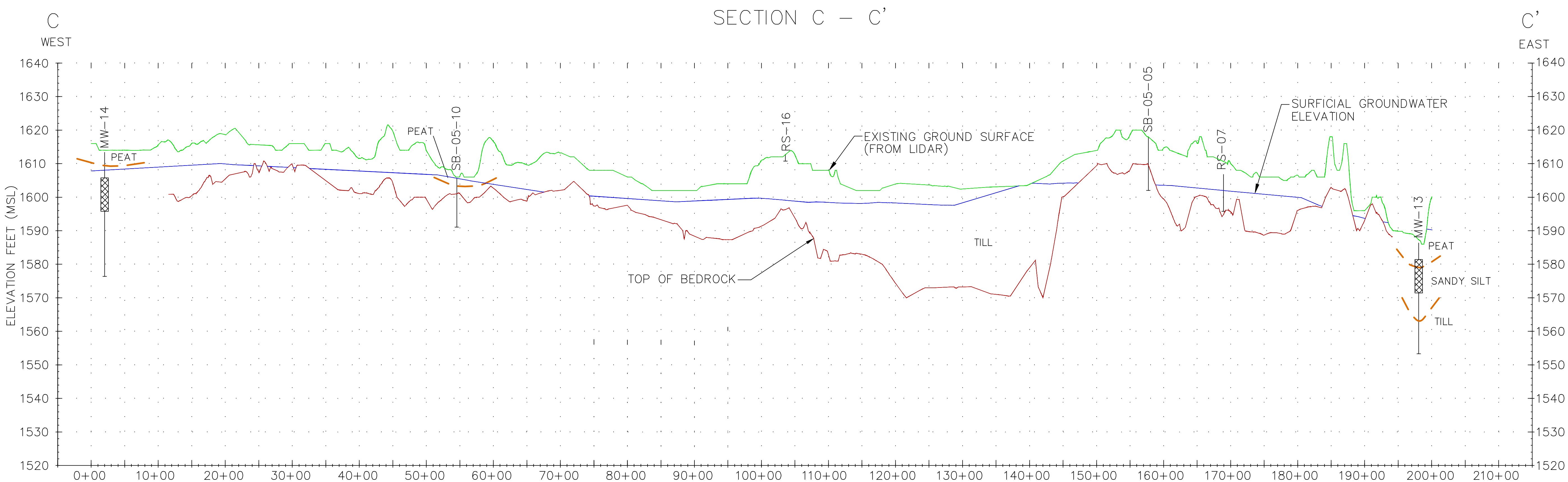
1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH.
4. CROSS-SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

MINE SITE CROSS-SECTION B-B'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-14
Permit to Mine Application



LEGEND

EXISTING GROUND

BEDROCK SURFACE

SURFICIAL GROUNDWATER ELEVATION

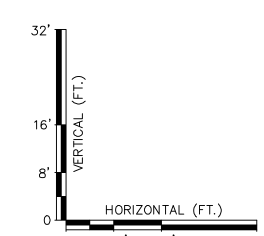
DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS

WELL SCREEN

BORING EXTENT

NOTES:

1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH.
4. CROSS-SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.

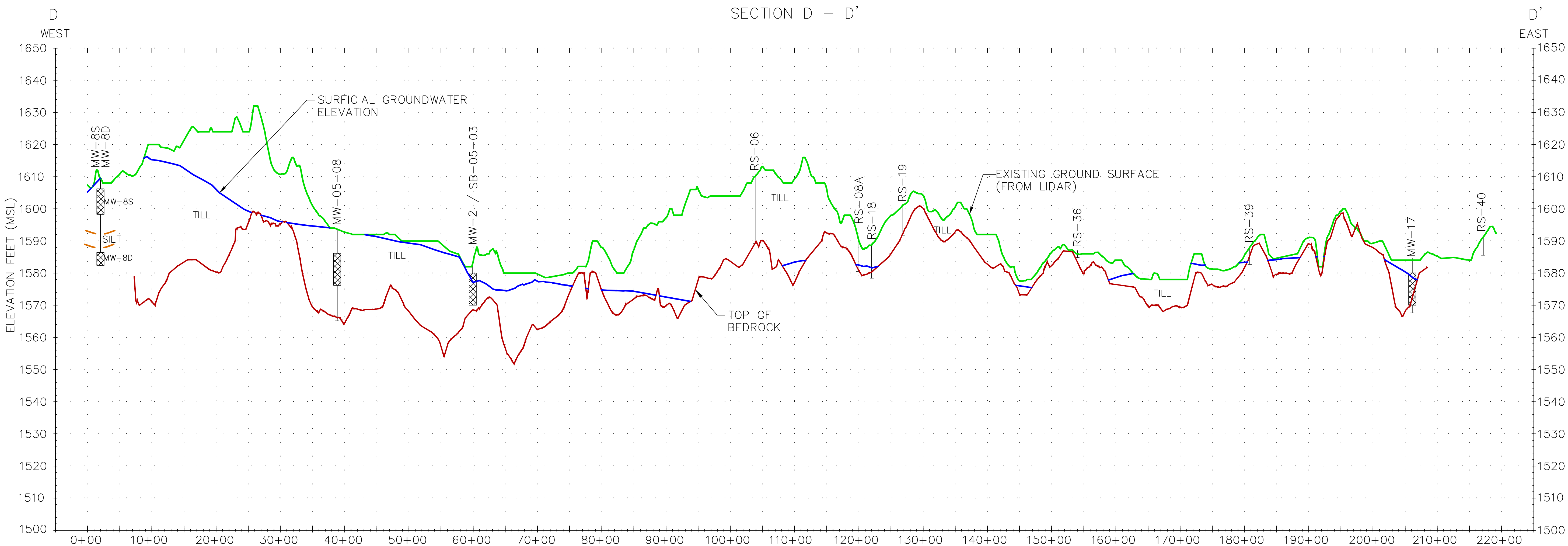


SCALE
(50x VERTICAL EXAGGERATION)

MINE SITE CROSS-SECTION C-C'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-15
Permit to Mine Application

CADD USER: Veronica Wourms FILE: K:\DESIGN\23690C29.99\PERMIT_PTM_FIGURE 5-15_MINE SITE CROSS SECTION C-C.DWG PLOT SCALE: 1:2010.9926 PLOT DATE: 11/13/2017 2:27 PM
BAR M:\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50

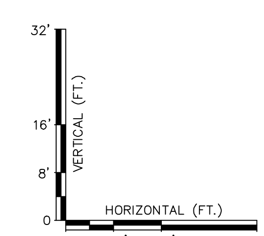


LEGEND

- EXISTING GROUND
- BEDROCK SURFACE
- SURFICIAL GROUNDWATER ELEVATION
- DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS
- WELL SCREEN
- BORING EXTENT

NOTES:

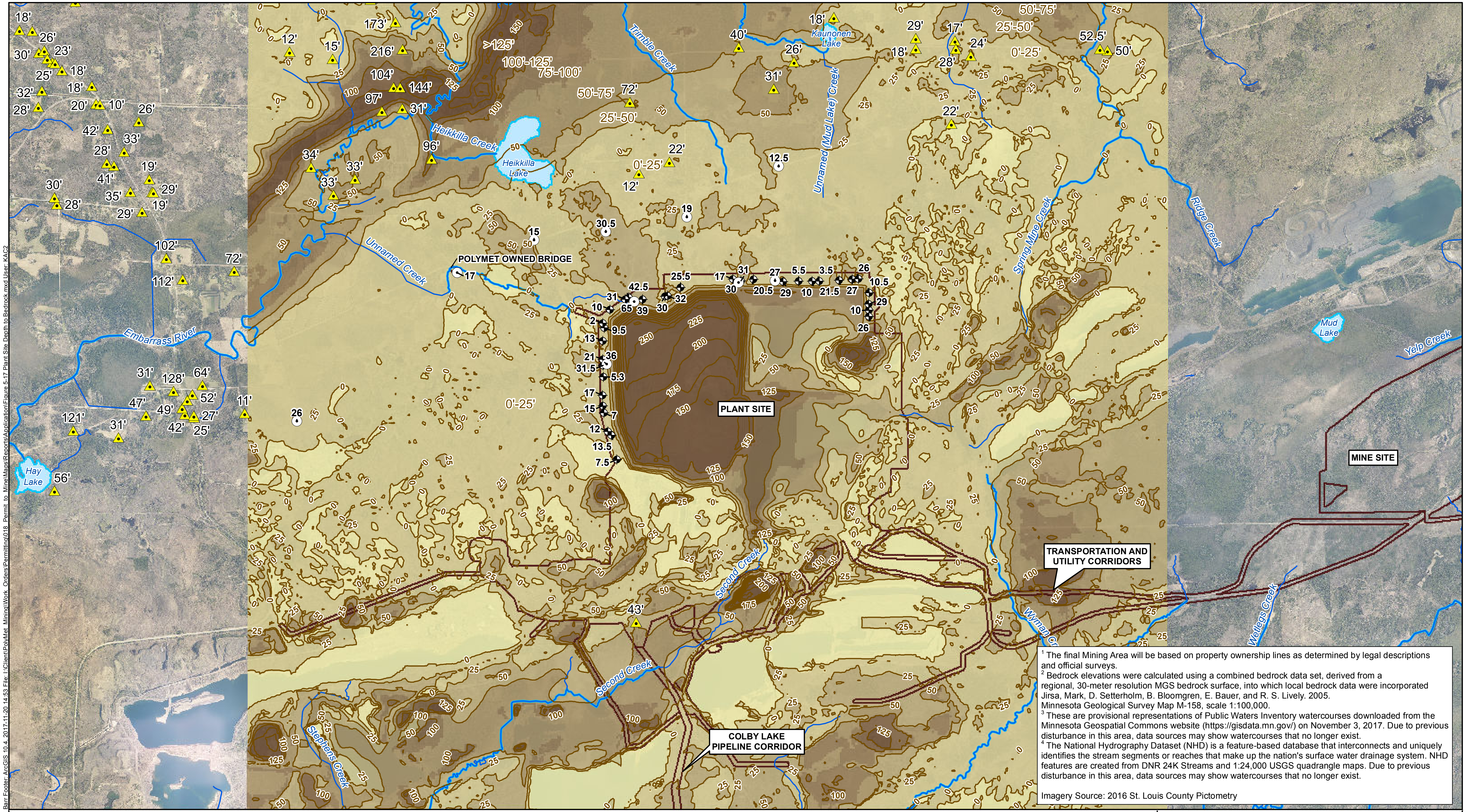
1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH.
4. CROSS-SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

MINE SITE CROSS-SECTION D-D'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-16
Permit to Mine Application



¹ The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
² Bedrock elevations were calculated using a combined bedrock data set, derived from a regional, 30-meter resolution MGS bedrock surface, into which local bedrock data were incorporated Jirsa, Mark, D. Setterholm, B. Bloomgren, E. Bauer, and R. S. Lively. 2005. Minnesota Geological Survey Map M-158, scale 1:100,000.
³ These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
⁴ The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Barr Footer: ArcGIS 10.4, 2017-11-20 14:53 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 5-17 Plant Site Depth to Bedrock.mxd User: KAC2

Mining Area[1]
Groundwater Wells
Boring Location
Residential Wells from County Well Index
33' Depth to Bedrock

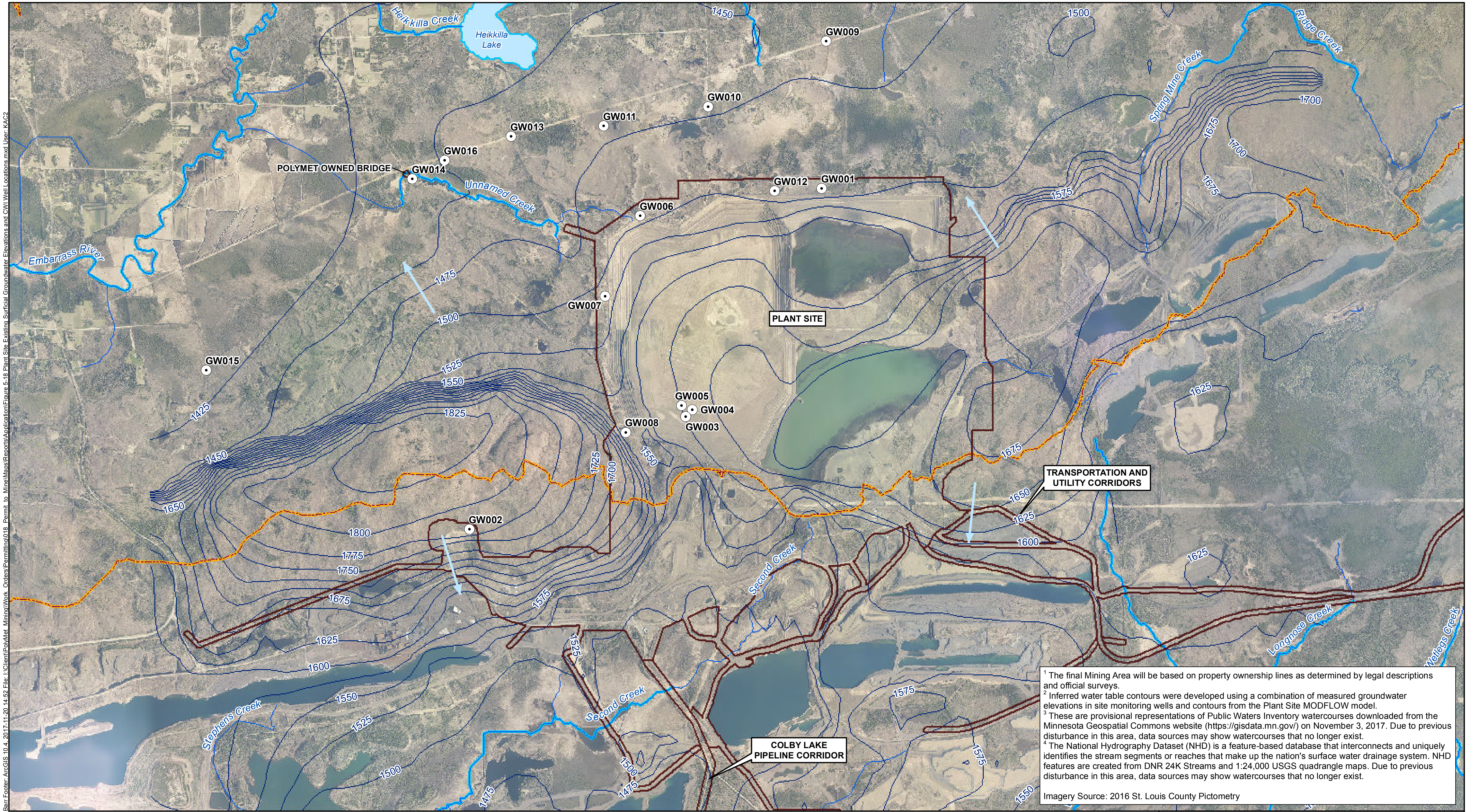
Depth to Bedrock (ft) [2]
Surface (0)
0 - 25
25 - 50
50 - 75
75 - 100
100 - 125
>125

Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers Streams[4]

0 2,250 4,500 9,000
Feet

PLANT SITE
DEPTH TO BEDROCK
NorthMet Project
Poly Met Mining, Inc.

Figure 5-17
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Inferred water table contours were developed using a combination of measured groundwater elevations in site monitoring wells and contours from the Plant Site MODFLOW model.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

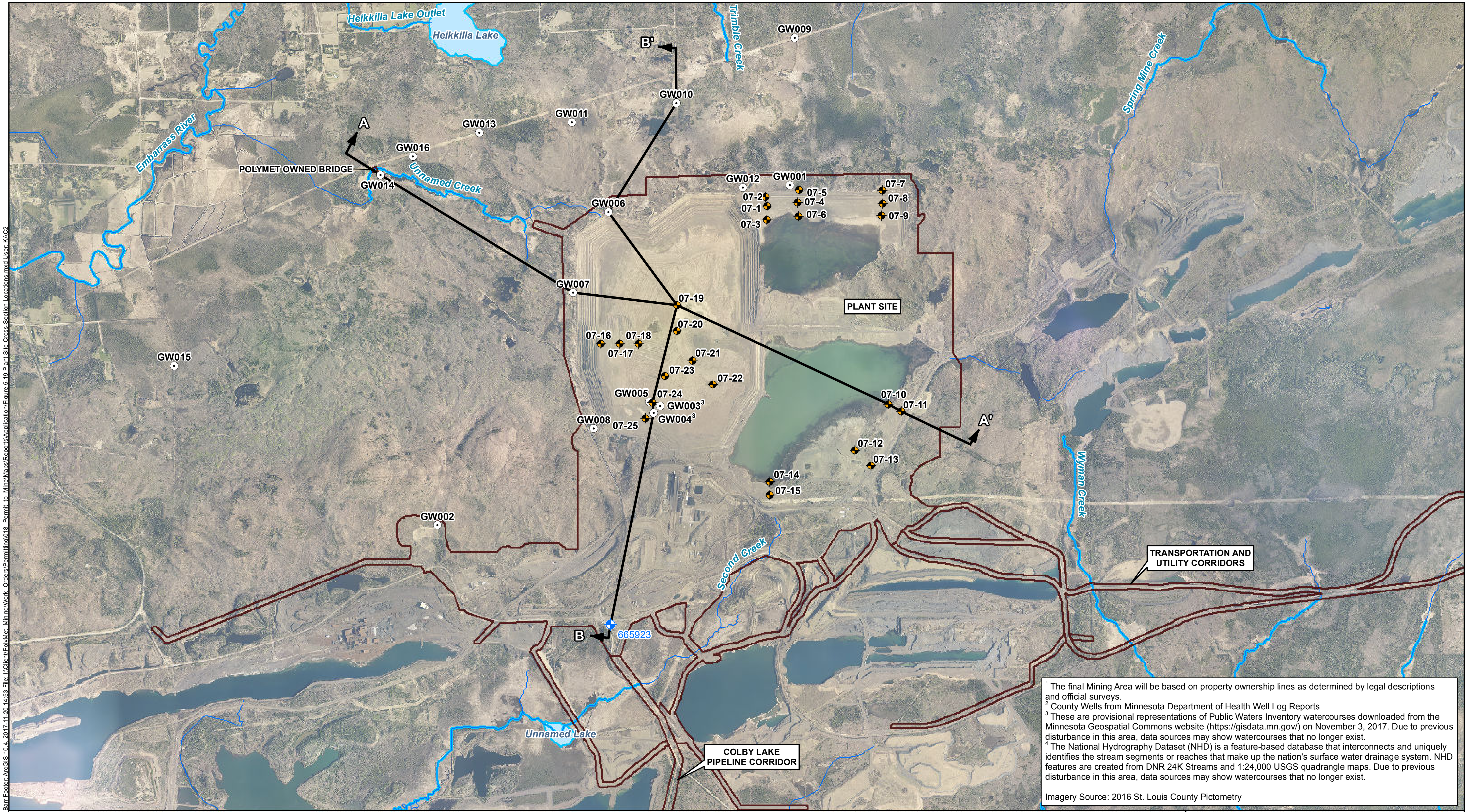
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Existing Surficial Groundwater Monitoring Well Locations
- Existing Groundwater Elevation Contours (ft MSL)[2]
- Groundwater Flow Direction
- Watershed Divide
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,750 3,500 7,000
Feet

PLANT SITE EXISTING SURFICIAL GROUNDWATER ELEVATION
NorthMet Project
Poly Met Mining, Inc.

Figure 5-18
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] County Wells from Minnesota Department of Health Well Log Reports
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

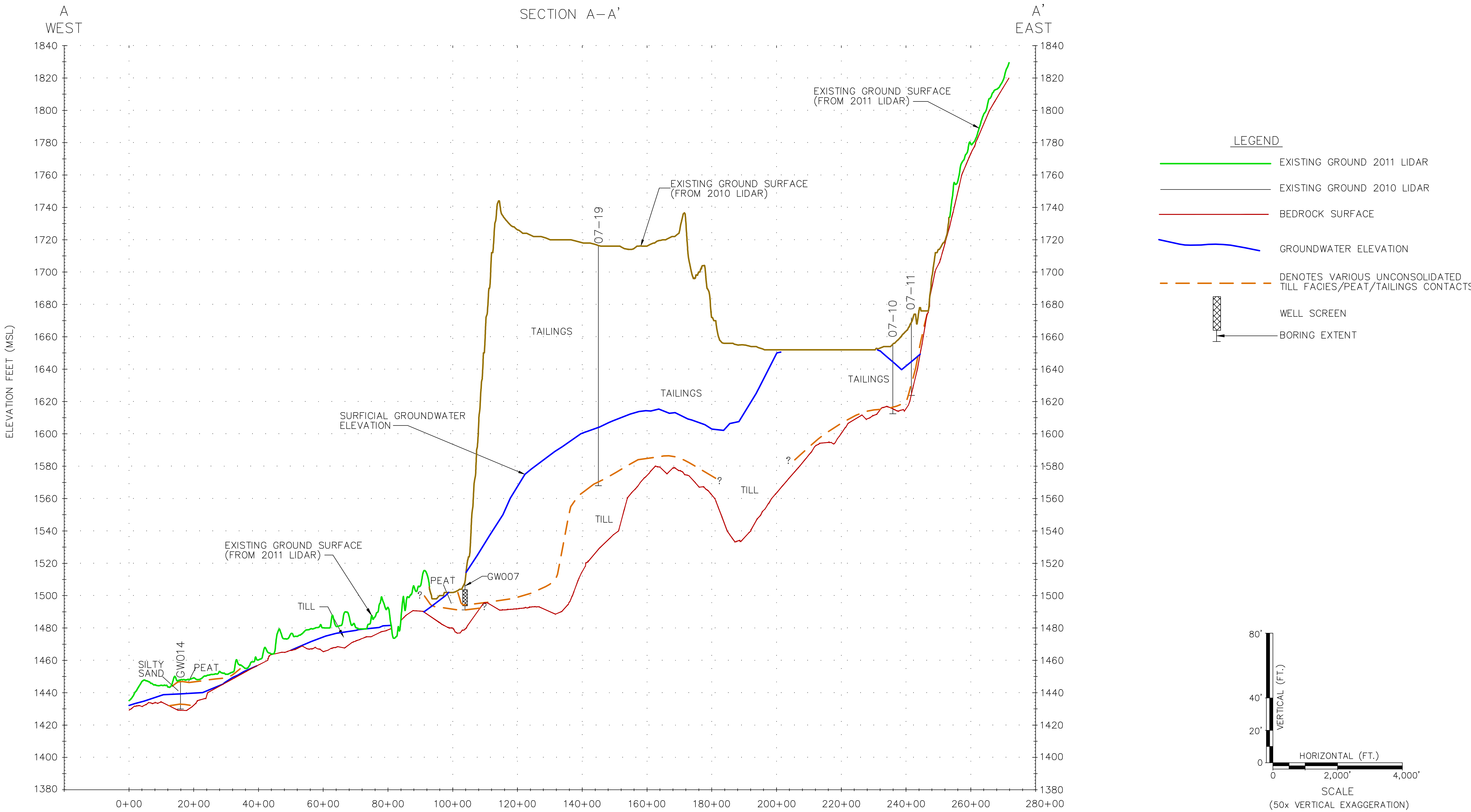
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Select Test Hole - County Well Index[2]
- Existing Surficial Aquifer Monitoring Well Locations
- Boring Locations
- Cross-Section Locations
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,750 3,500 7,000
Feet

PLANT SITE CROSS SECTION LOCATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-19
Permit to Mine Application

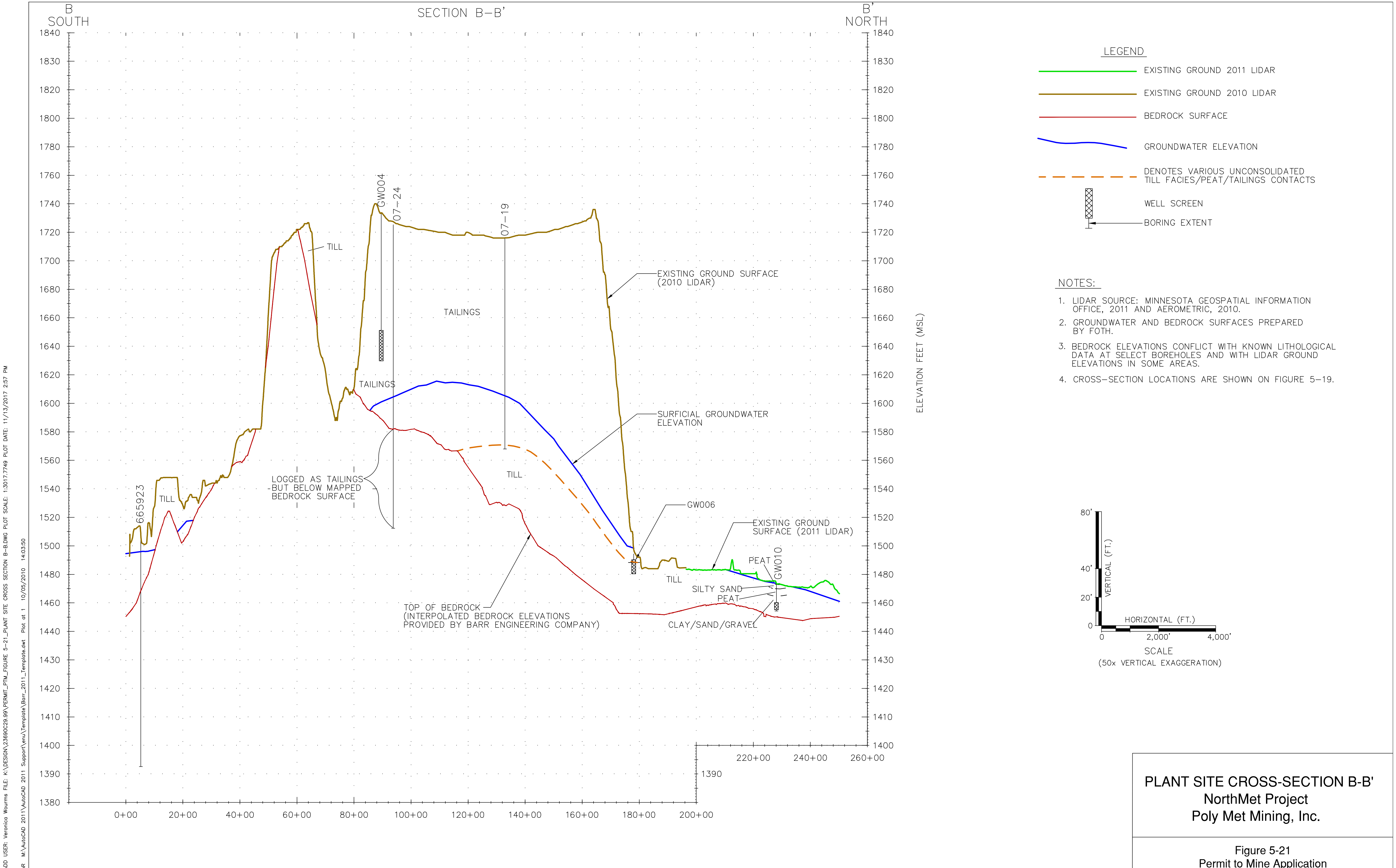


NOTES:

1. LIDAR SOURCE: MINNESOTA GEOSPATIAL INFORMATION OFFICE, 2011 AND AEROMETRIC, 2010.
2. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH.
3. CROSS–SECTION LOCATIONS ARE SHOWN ON FIGURE 5–19.

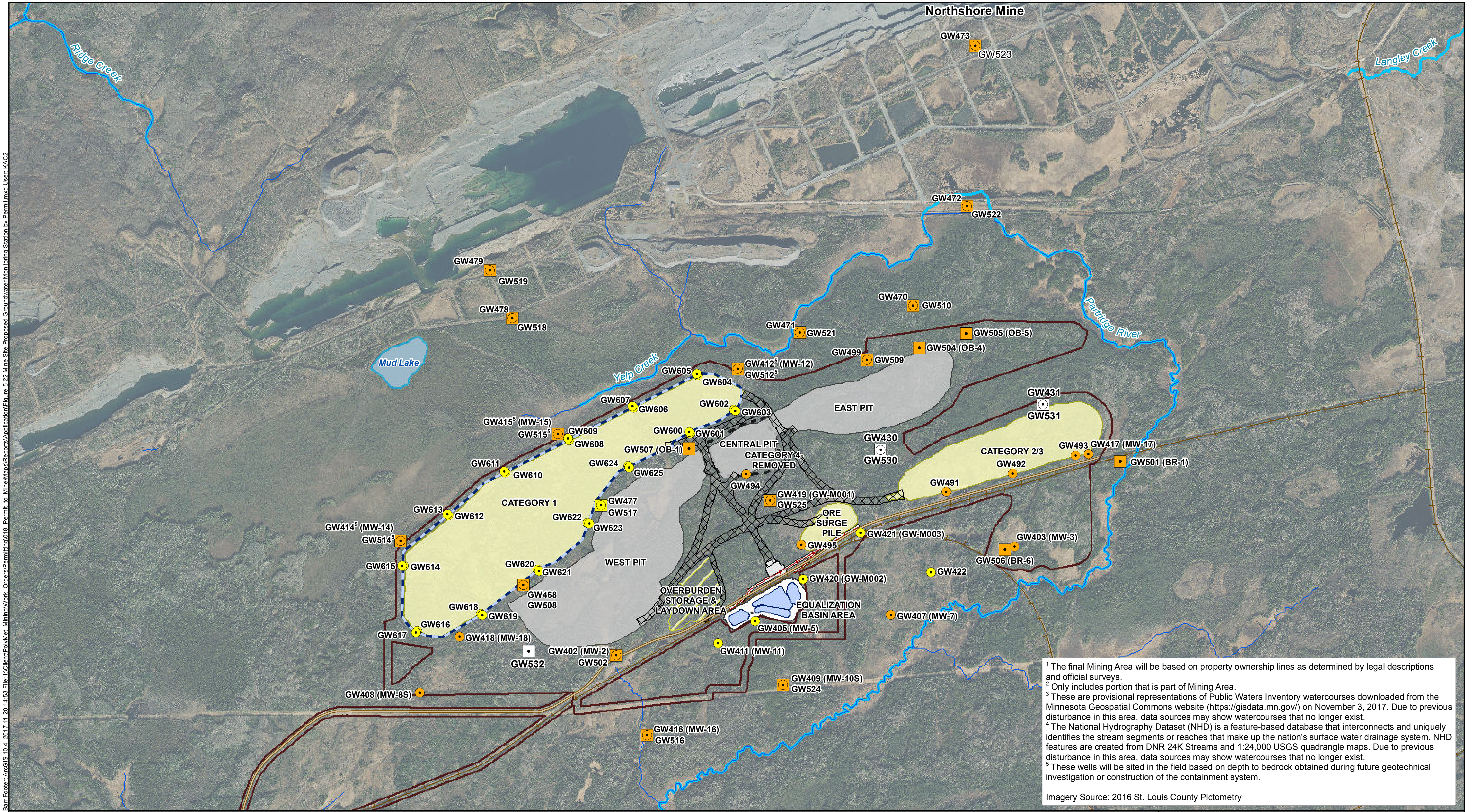
PLANT SITE CROSS-SECTION A-A'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-20
Permit to Mine Application



PLANT SITE CROSS-SECTION B-B'
NorthMet Project
Poly Met Mining, Inc.

Figure 5-21
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] These wells will be sited in the field based on depth to bedrock obtained during future geotechnical investigation or construction of the containment system.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Proposed Surficial Aquifer Monitoring Stations
- NPDES/SDS Only
- Water Appropriation Only
- NPDES/SDS and Water Appropriation

Proposed Bedrock Monitoring Stations
- NPDES/SDS Only
- Water Appropriation Only
- NPDES/SDS and Water Appropriation Only

GW405 (MW-5) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

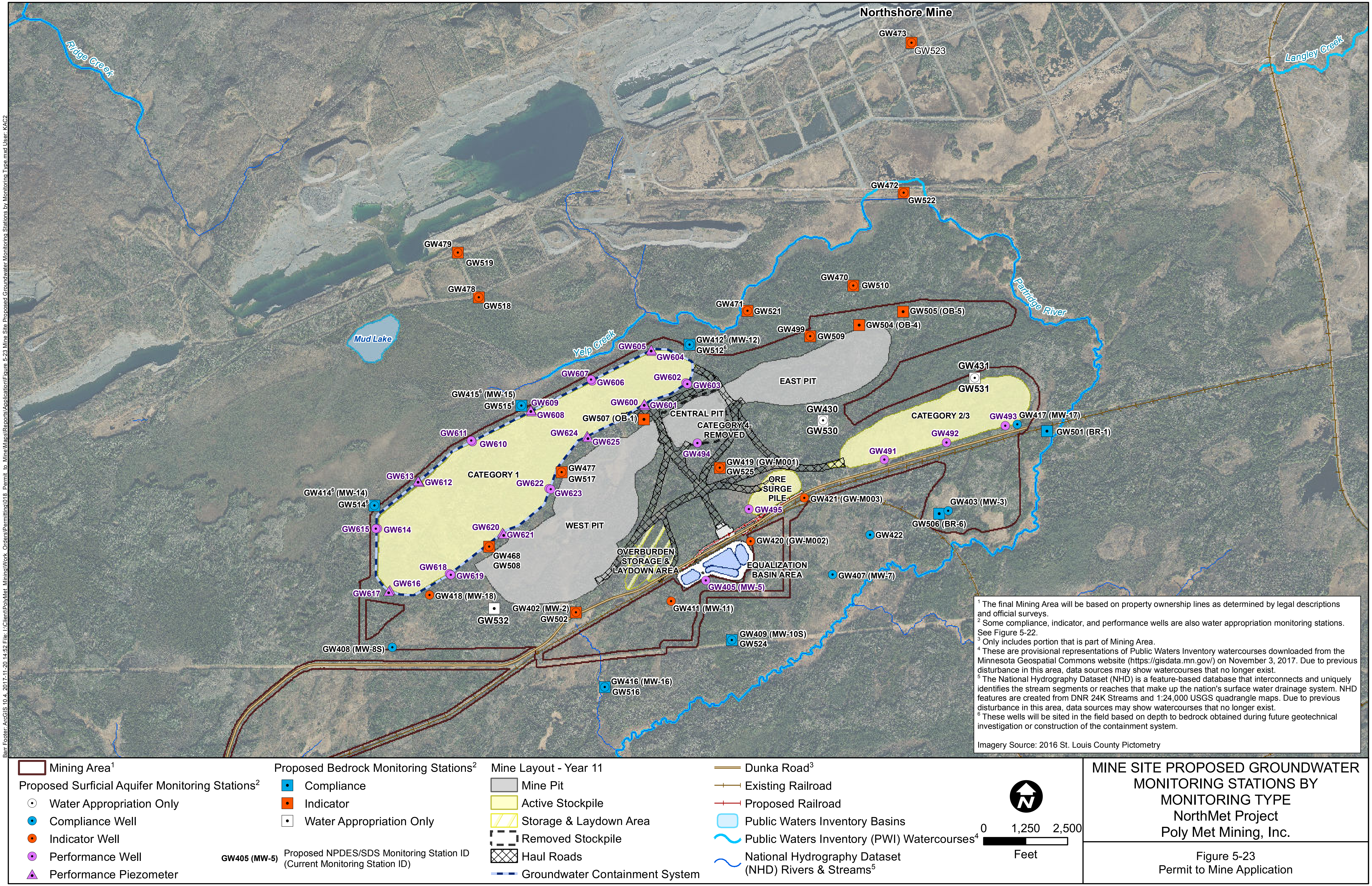
Mine Year 11 Footprints
- Mine Pit
- Active Stockpile
- Storage & Laydown Area
- Removed Stockpile
- Haul Roads
- Groundwater Containment System

- Dunka Road[2]
- Existing Railroad
- Proposed Railroad
- Public Waters Inventory Basins
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,250 2,500
Feet

MINE SITE PROPOSED GROUNDWATER MONITORING STATIONS BY PERMIT
NorthMet Project
Poly Met Mining, Inc.

Figure 5-22
Permit to Mine Application

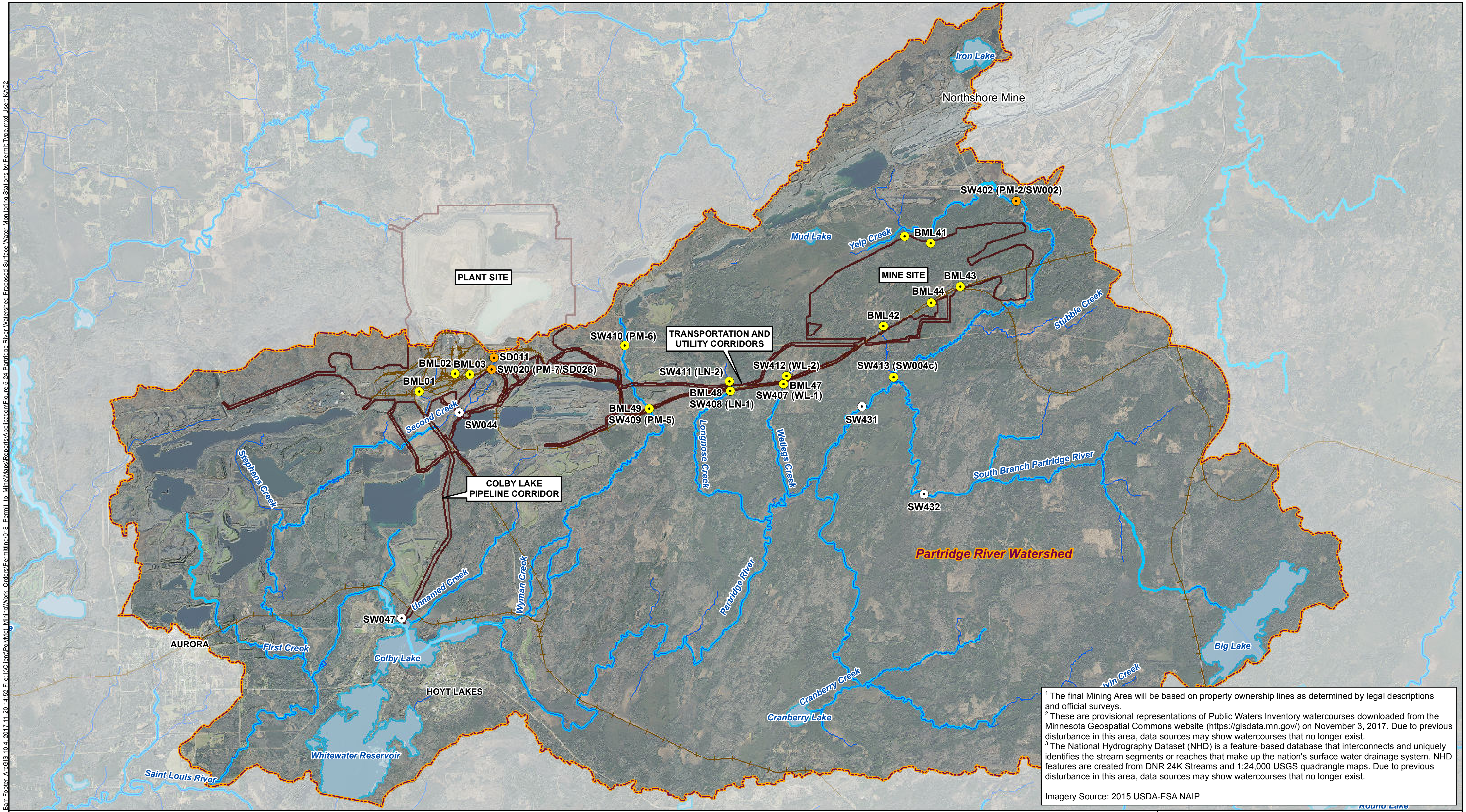


[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Some compliance, indicator, and performance wells are also water appropriation monitoring stations. See Figure 5-22.
[3] Only includes portion that is part of Mining Area.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] These wells will be sited in the field based on depth to bedrock obtained during future geotechnical investigation or construction of the containment system.

Imagery Source: 2016 St. Louis County Pictometry

MINE SITE PROPOSED GROUNDWATER MONITORING STATIONS BY MONITORING TYPE
NorthMet Project
Poly Met Mining, Inc.

Figure 5-23
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2015 USDA-FSA NAIP

Mining Area[1]
Proposed Monitoring Locations
- NPDES/SDS Only
- Water Appropriation Only
- NPDES/SDS and Water Appropriation

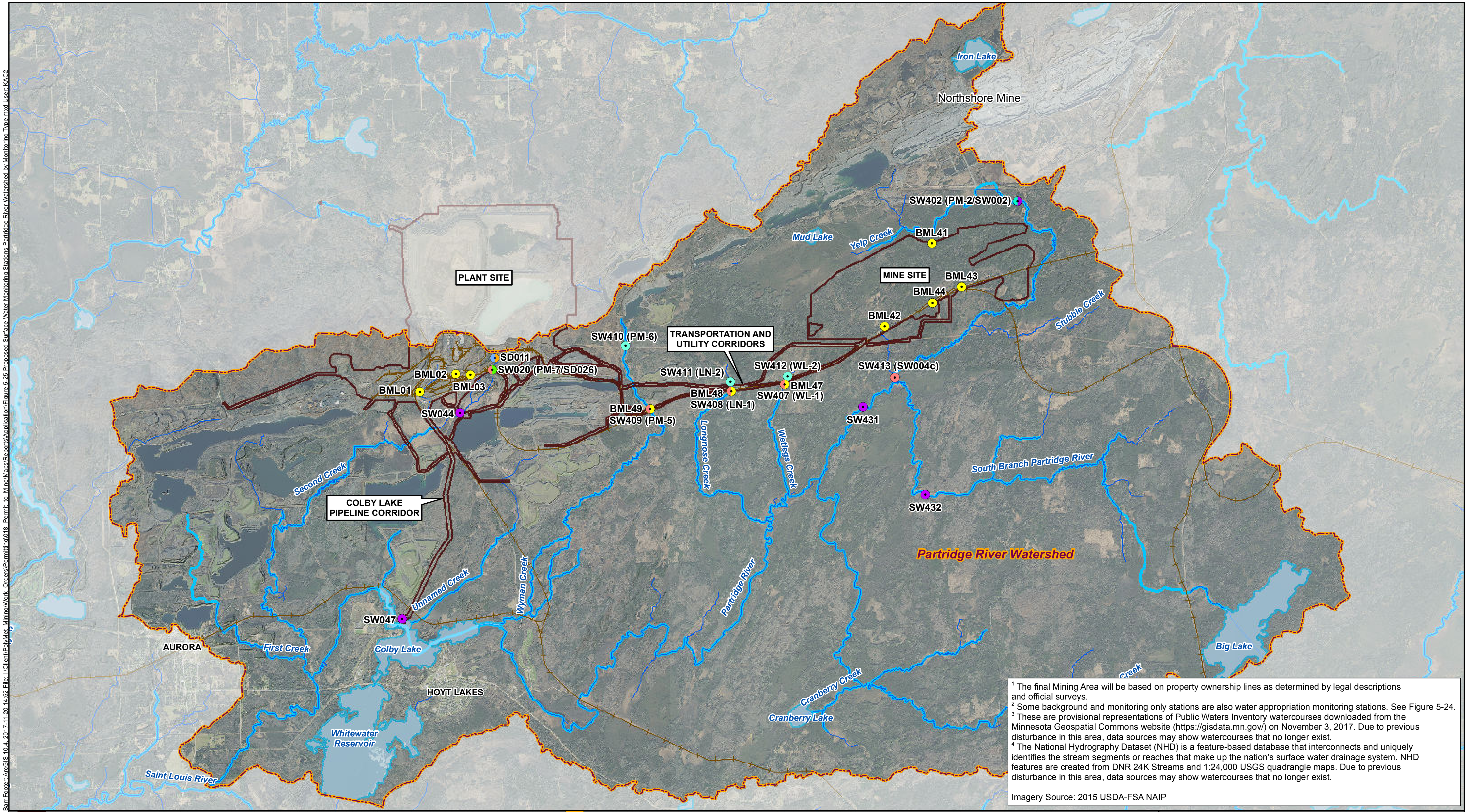
SW402 (SW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

Watershed Boundary
Public Waters Inventory Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 0.75 1.5 3
Miles

PARTRIDGE RIVER WATERSHED
PROPOSED SURFACE WATER
MONITORING STATIONS
BY PERMIT TYPE
NorthMet Project
Poly Met Mining, Inc.

Figure 5-24
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Some background and monitoring only stations are also water appropriation monitoring stations. See Figure 5-24.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2015 USDA-FSA NAIP

Mining Area[1]
Proposed Surface Water Monitoring Stations[2]
- Background
- Benchmark Stormwater
- Monitor Only
- Monitor Only/Benchmark Stormwater
- Monitor Only/Macroinvertebrate
- Streamflow
- Background/Streamflow
- Surface Water Discharge/Augmentation Flow

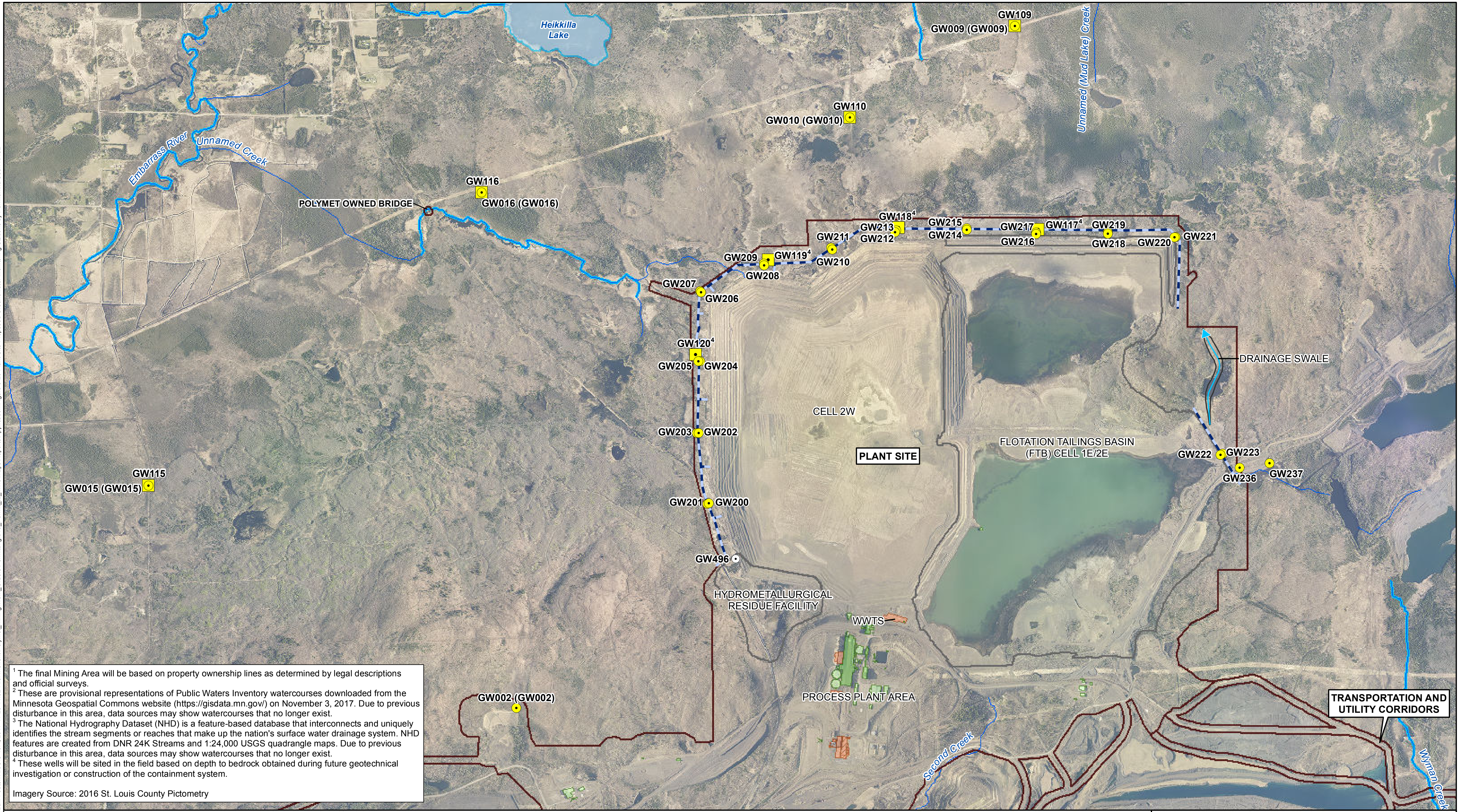
SW402 (SW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

Watershed Boundary
Public Waters Inventory Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 0.75 1.5 3
Miles

PARTRIDGE RIVER WATERSHED
PROPOSED SURFACE WATER
MONITORING STATIONS
BY MONITORING TYPE
NorthMet Project
Poly Met Mining, Inc.

Figure 5-25
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] These wells will be sited in the field based on depth to bedrock obtained during future geotechnical investigation or construction of the containment system.

Imagery Source: 2016 St. Louis County Pictometry

Barr Footer: ArcGIS 10.4, 2017-11-20 14:52 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 5-26 Plant Site Proposed Groundwater Monitoring Stations by Permit.mxd User: KAC2

Mining Area[1]

Proposed Surficial Aquifer Monitoring Stations
- NPDES/SDS Only
- Water Appropriation Only

Proposed Bedrock Monitoring Stations
- NPDES/SDS Only

GW002 (GW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

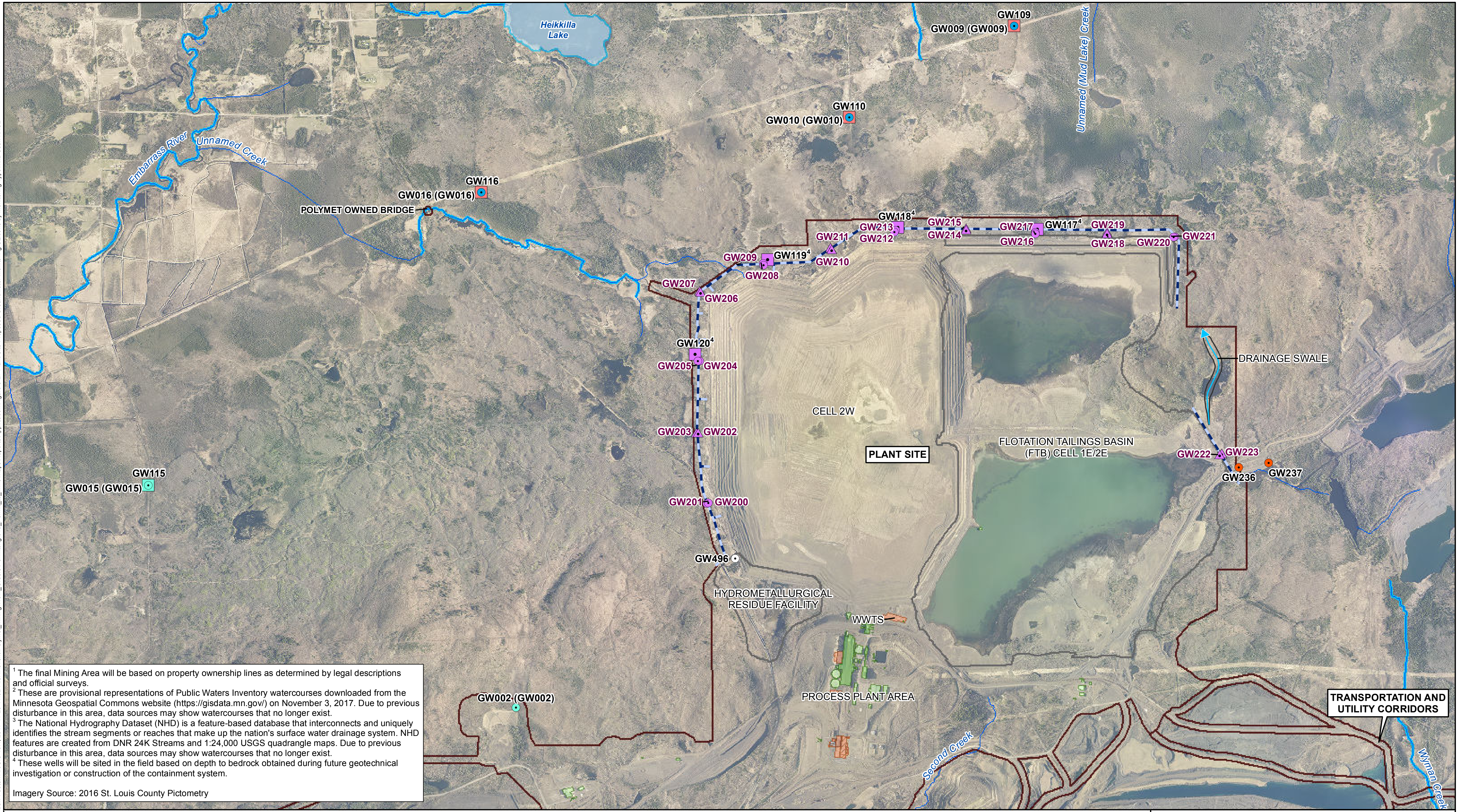
FTB Seepage Containment System
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building

Public Waters Inventory Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 1,250 2,500 5,000
Feet

PLANT SITE PROPOSED GROUNDWATER MONITORING STATIONS BY PERMIT
NorthMet Project
Poly Met Mining, Inc.

Figure 5-26
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] These wells will be sited in the field based on depth to bedrock obtained during future geotechnical investigation or construction of the containment system.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]

Proposed Surficial Aquifer Monitoring Stations
- Background Well
- Compliance Well
- Indicator Well
- Performance Well
- Performance Piezometer

Water Appropriation Only

Proposed Bedrock Monitoring Stations
- Background
- Monitor Only
- Performance

GW002 (GW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

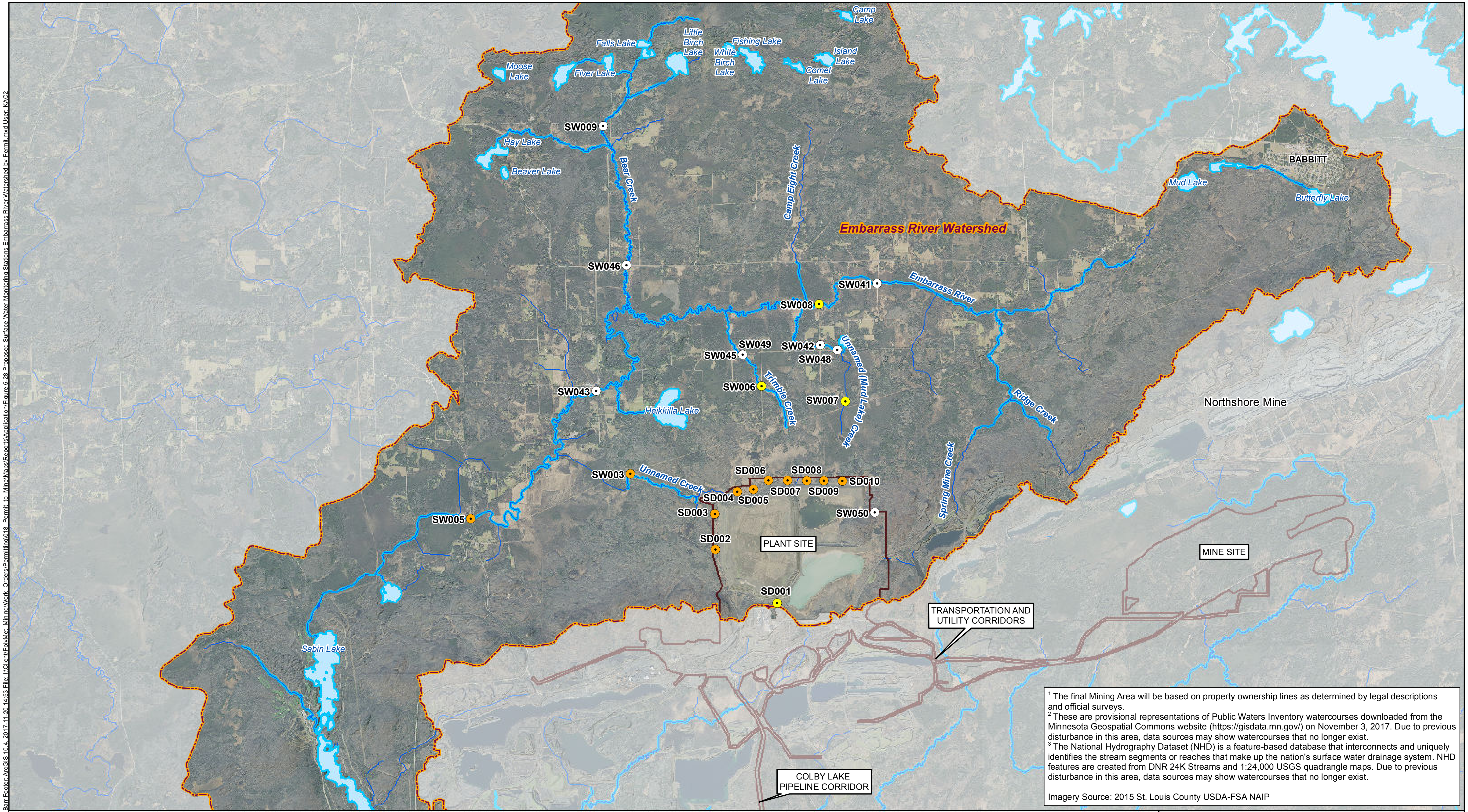
FTB Seepage Containment System
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building

Public Waters Inventory Basins
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 1,250 2,500 5,000
Feet

PLANT SITE PROPOSED GROUNDWATER MONITORING STATIONS BY MONITORING TYPE
NorthMet Project
Poly Met Mining, Inc.

Figure 5-27
Permit to Mine Application



Mining Area[1]

Proposed Surface Water Monitoring Stations

- NPDES/SDS Only
- Water Appropriation Only
- NPDES/SDS and Water Appropriation Only

SW402 (SW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

Watershed Boundary

Public Waters Inventory (PWI) Basins

Public Waters Inventory (PWI) Watercourses[2]

National Hydrography Dataset (NHD) Rivers & Streams[3]

0 0.75 1.5 3

Miles

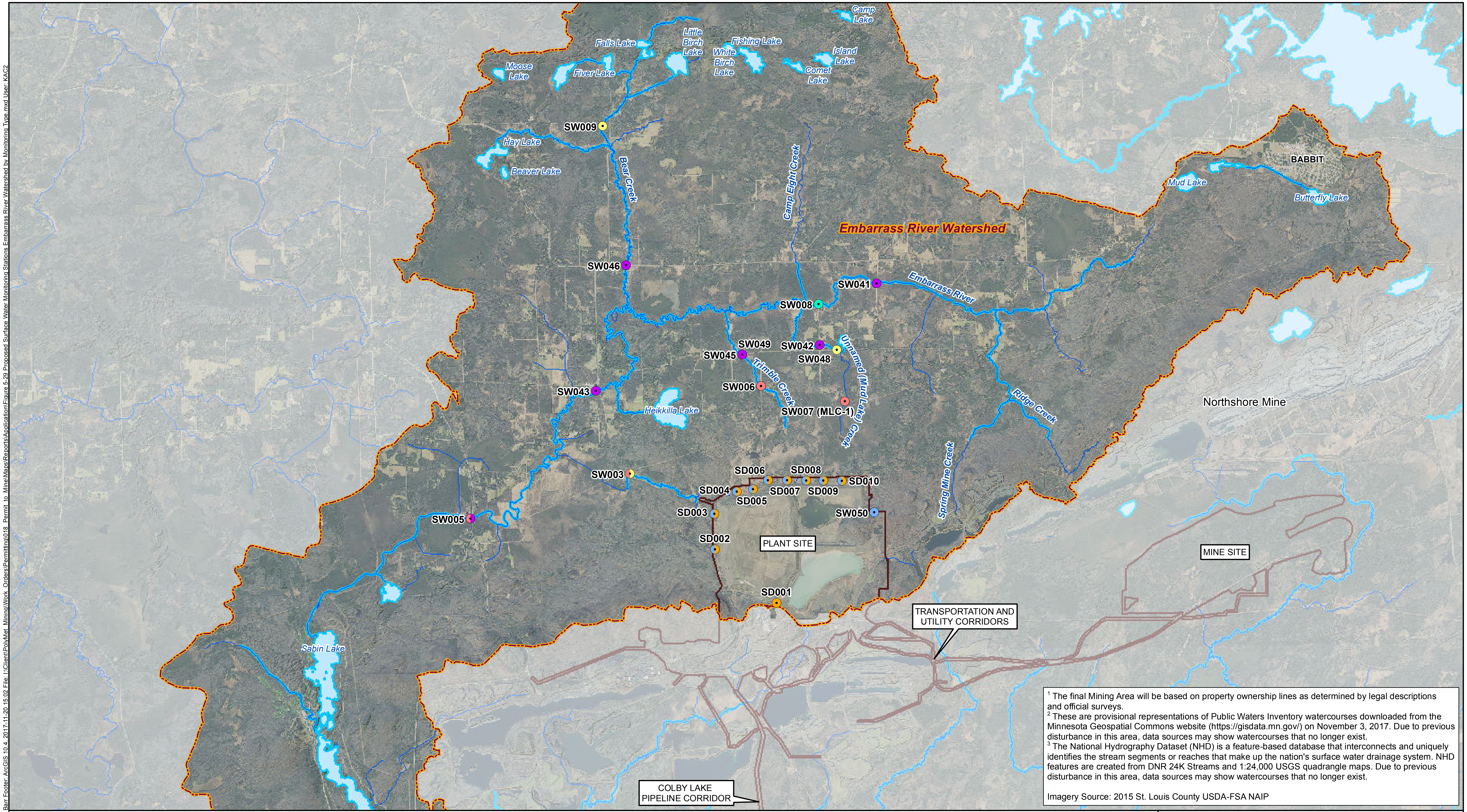
PROPOSED SURFACE WATER MONITORING STATIONS EMBARRASS RIVER WATERSHED BY PERMIT

NorthMet Project

Poly Met Mining, Inc.

Figure 5-28

Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2015 St. Louis County USDA-FSA NAIP

Mining Area[1]

Proposed Surface Water Monitoring Stations
- Background
- Monitor Only
- Augmentation Flow

SW402 (SW002) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

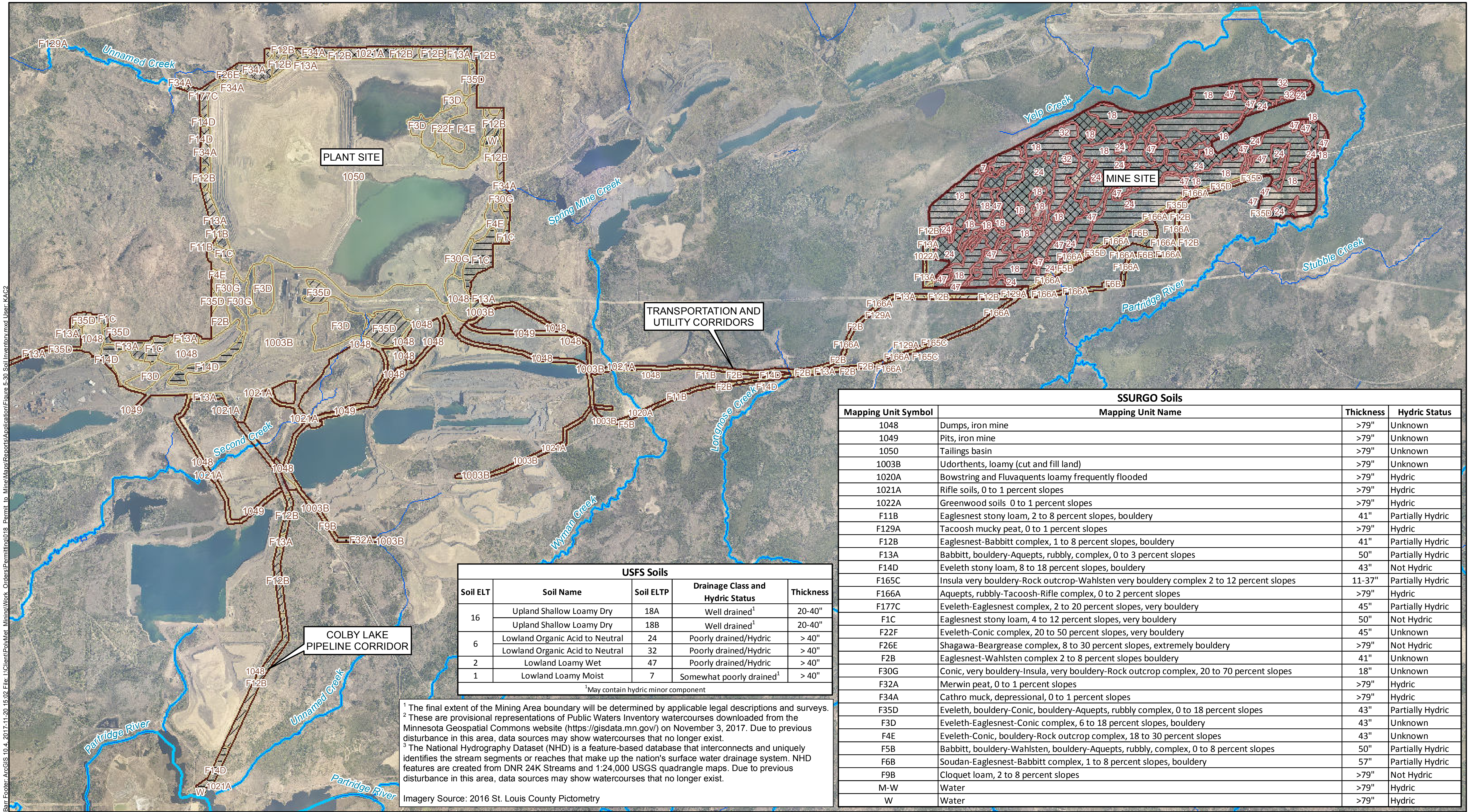
- Stream Flow
- Macroinvertebrate
- Monitor Only/Macroinvertebrate
- Monitor Only/Stream Flow
- Surface Water Discharge
- Surface Water Discharge/Augmentation Flow

- Watershed Boundary
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 0.75 1.5 3
Miles

PROPOSED SURFACE WATER MONITORING STATIONS EMBARRASS RIVER WATERSHED BY MONITORING TYPE
NorthMet Project
Poly Met Mining, Inc.

Figure 5-29
Permit to Mine Application



USFS Soils				
Soil ELT	Soil Name	Soil ELTP	Drainage Class and Hydric Status	Thickness
16	Upland Shallow Loamy Dry	18A	Well drained[1]	20-40"
	Upland Shallow Loamy Dry	18B	Well drained[1]	20-40"
6	Lowland Organic Acid to Neutral	24	Poorly drained/Hydric	> 40"
	Lowland Organic Acid to Neutral	32	Poorly drained/Hydric	> 40"
2	Lowland Loamy Wet	47	Poorly drained/Hydric	> 40"
1	Lowland Loamy Moist	7	Somewhat poorly drained[1]	> 40"

[1]May contain hydric minor component

SSURGO Soils			
Mapping Unit Symbol	Mapping Unit Name	Thickness	Hydric Status
1048	Dumps, iron mine	>79"	Unknown
1049	Pits, iron mine	>79"	Unknown
1050	Tailings basin	>79"	Unknown
1003B	Udorthents, loamy (cut and fill land)	>79"	Unknown
1020A	Bowstring and Fluvaquents loamy frequently flooded	>79"	Hydric
1021A	Rifle soils, 0 to 1 percent slopes	>79"	Hydric
1022A	Greenwood soils 0 to 1 percent slopes	>79"	Hydric
F11B	Eaglesnest stony loam, 2 to 8 percent slopes, bouldery	41"	Partially Hydric
F129A	Tacoosh mucky peat, 0 to 1 percent slopes	>79"	Hydric
F12B	Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	41"	Partially Hydric
F13A	Babbitt, bouldery-Aquepts, rubbly, complex, 0 to 3 percent slopes	50"	Partially Hydric
F14D	Eveleth stony loam, 8 to 18 percent slopes, bouldery	43"	Not Hydric
F165C	Insula very bouldery-Rock outcrop-Wahlsten very bouldery complex 2 to 12 percent slopes	11-37"	Partially Hydric
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	>79"	Hydric
F177C	Eveleth-Eaglesnest complex, 2 to 20 percent slopes, very bouldery	45"	Partially Hydric
F1C	Eaglesnest stony loam, 4 to 12 percent slopes, very bouldery	50"	Not Hydric
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	45"	Unknown
F26E	Shagawa-Beargrease complex, 8 to 30 percent slopes, extremely bouldery	>79"	Not Hydric
F2B	Eaglesnest-Wahlsten complex 2 to 8 percent slopes bouldery	41"	Unknown
F30G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	18"	Unknown
F32A	Merwin peat, 0 to 1 percent slopes	>79"	Hydric
F34A	Cathro muck, depressional, 0 to 1 percent slopes	>79"	Hydric
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly complex, 0 to 18 percent slopes	43"	Partially Hydric
F3D	Eveleth-Eaglesnest-Conic complex, 6 to 18 percent slopes, bouldery	43"	Unknown
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	43"	Unknown
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes	50"	Partially Hydric
F6B	Soudan-Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	57"	Partially Hydric
F9B	Cloquet loam, 2 to 8 percent slopes	>79"	Not Hydric
M-W	Water	>79"	Hydric
W	Water	>79"	Hydric

[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

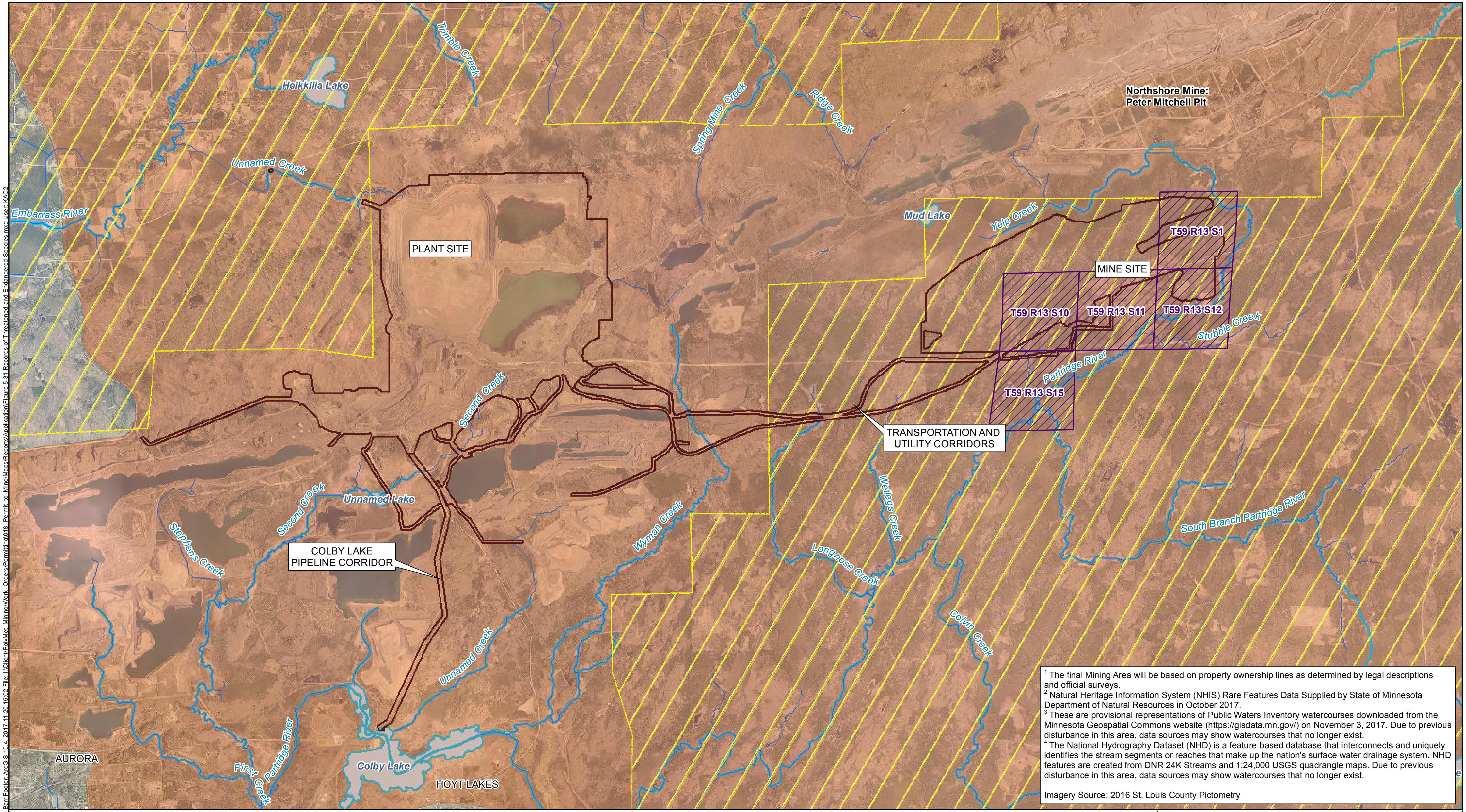
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
SSURGO Soils - Embarrass Subset (Mapping Unit Symbol)
Ecological Landtype Phase - USFS
Hydric Rating/Drainage Class
All Hydric/Poorly drained
Partially Hydric/Somewhat poorly drained
Not Hydric/Well drained
Unknown Hydric
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 2,250 4,500 9,000
Feet

SOIL INVENTORY
NorthMet Project
Poly Met Mining, Inc.

Figure 5-30
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Natural Heritage Information System (NHIS) Rare Features Data Supplied by State of Minnesota Department of Natural Resources in October 2017.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

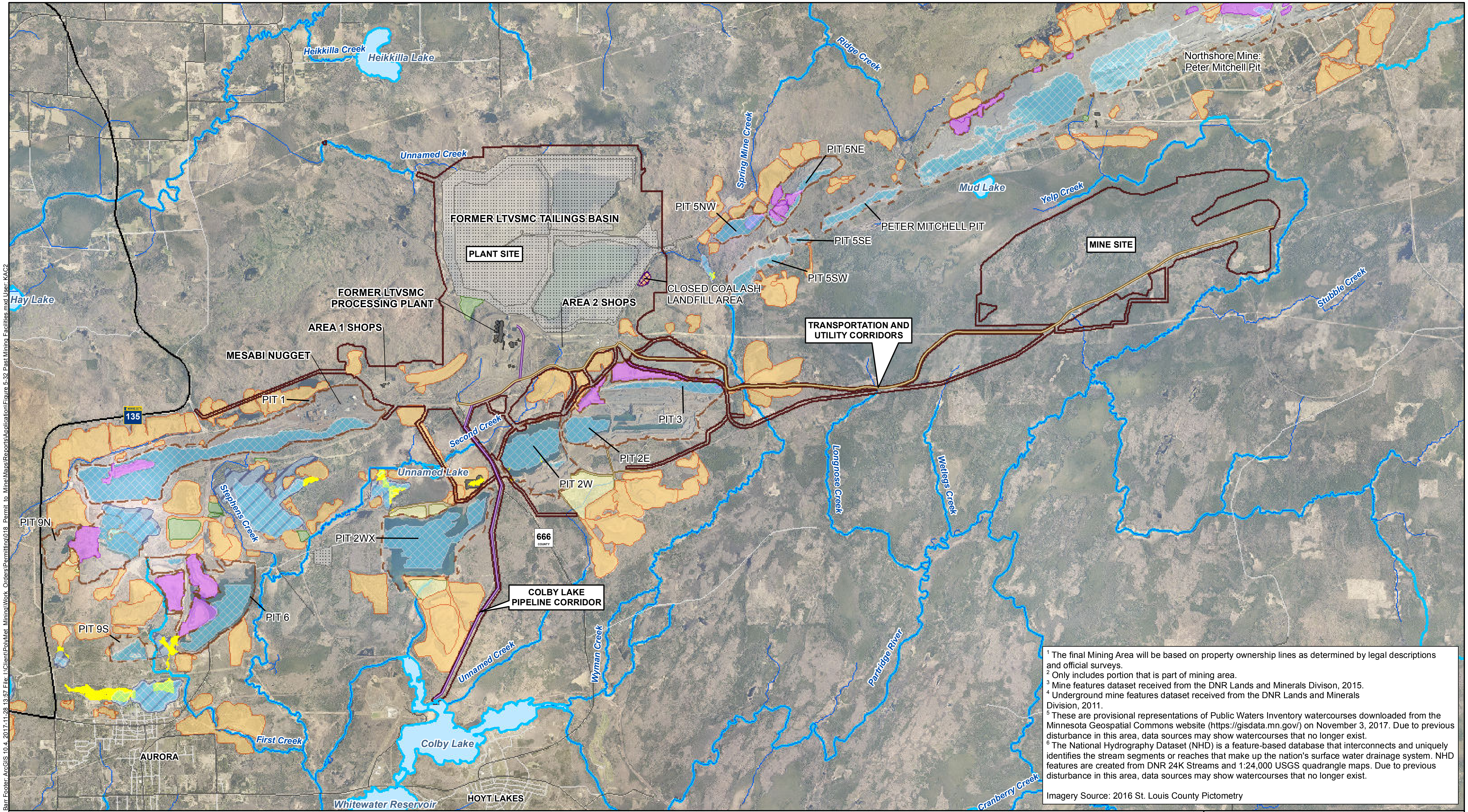
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Sections Containing NHIS Records[2]
USFWS Critical Habitat Designation for Canada Lynx
USFWS Critical Habitat Designation for Gray Wolf
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1 2
Miles

RECORDS OF THREATENED AND ENDANGERED SPECIES
NorthMet Project
PolyMet Mining, Inc.

Figure 5-31
Permit to Mine Application

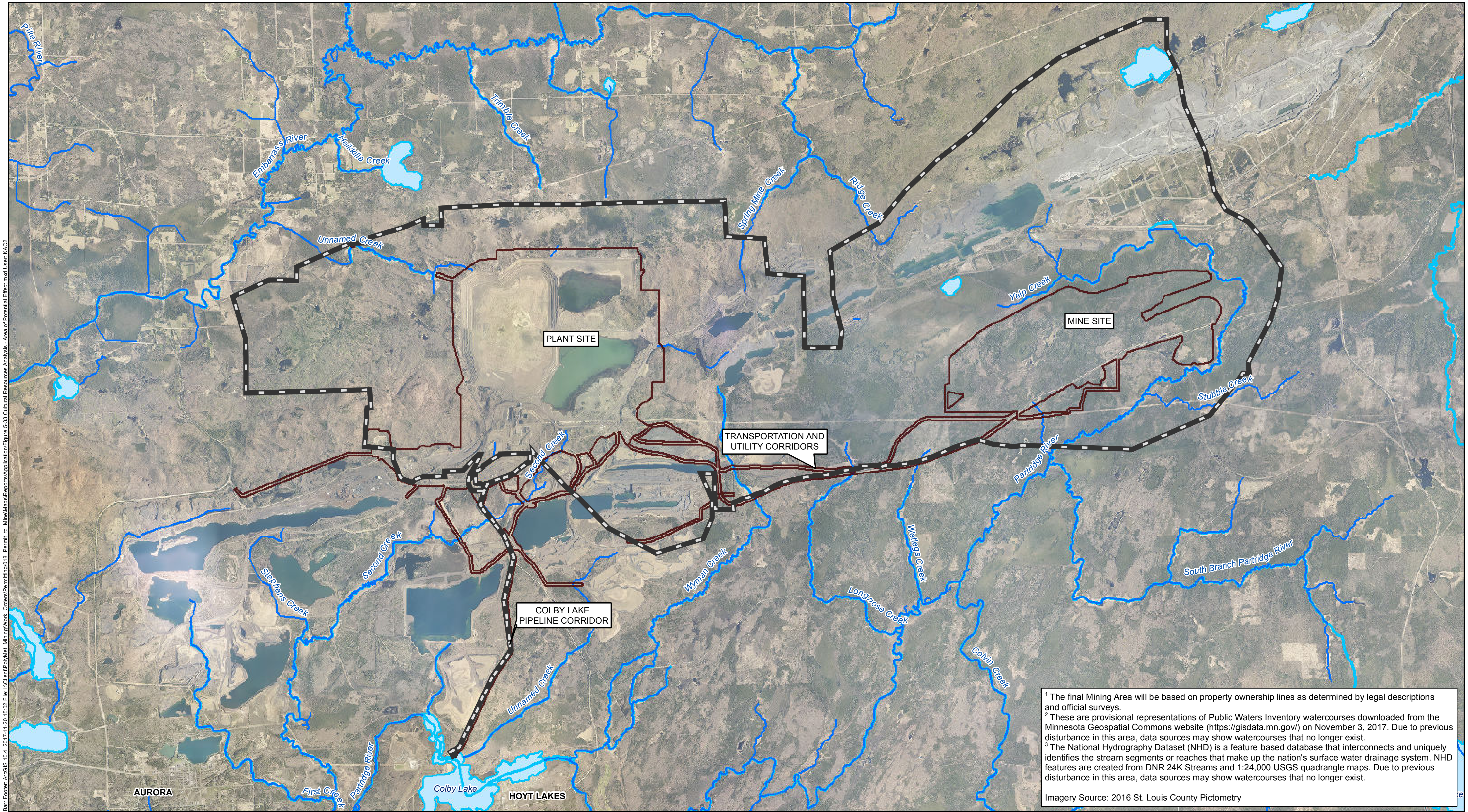


Mining Area[1]
Dunka Road[2]
Colby Lake Pipeline
Closed Coal Ash Landfill Area
Pit Lakes
DNR Lands and Minerals Mine Features (2015)[3]
Stockpile
In-Pit Stockpile
Taconite Pit
Natural Ore Pit
Reservoir or Settling Basin
Tailings Basin
Plant or Shop Area
Haul Road
Undisturbed/Natural Ground
Underground Mine Features (2011)[4]
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[5]
National Hydrography Dataset (NHD) Rivers & Streams[6]

0 6,000 12,000
Feet

PAST MINING FACILITIES
NorthMet Project
Poly Met Mining, Inc.

Figure 5-32
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.

[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

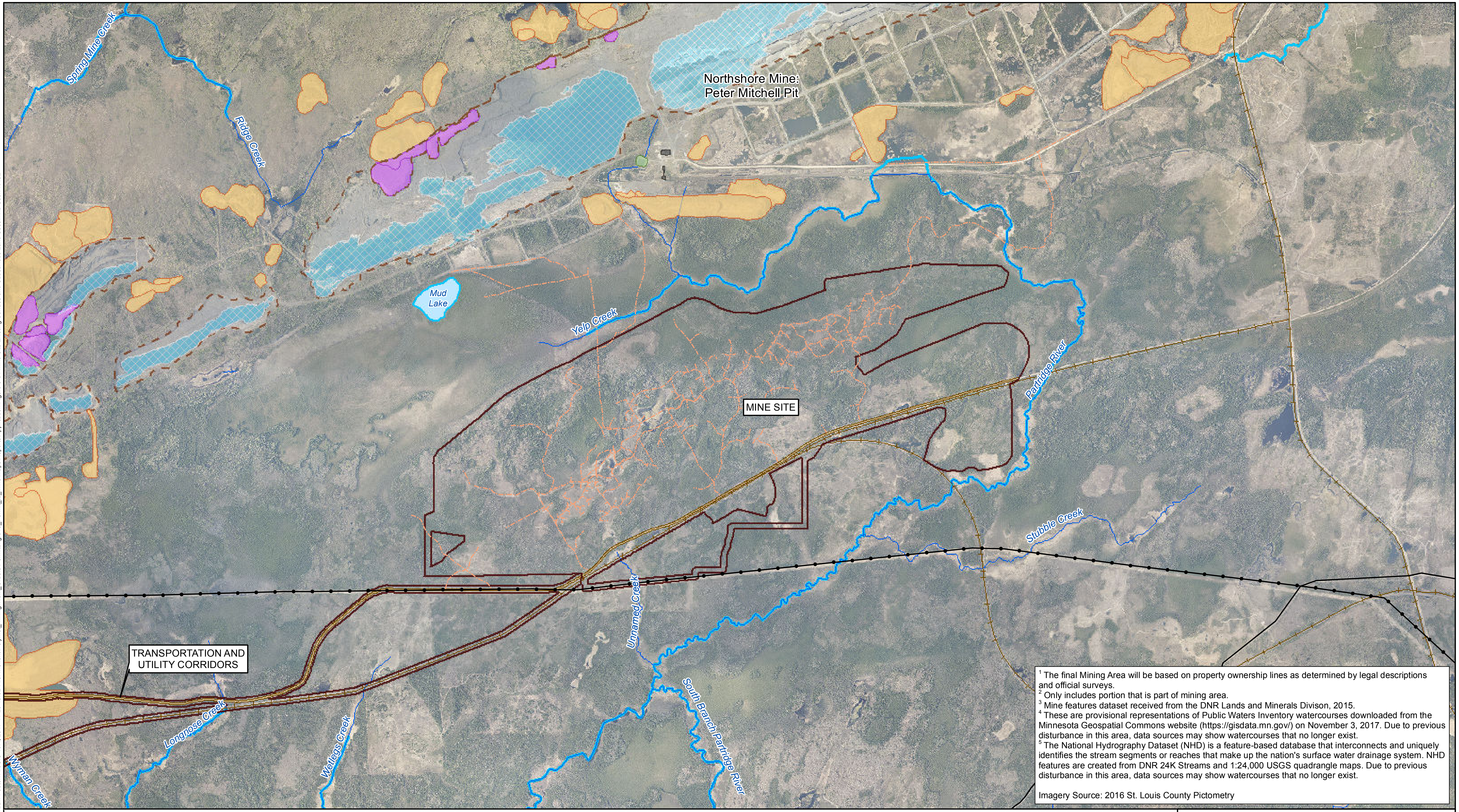
[3] The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Cultural Resources Area of Potential Effect (APE)
Public Waters Inventory (PWI) Basins
Public Waters Inventory Watercourse[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

CULTURAL RESOURCES ANALYSIS - AREA OF POTENTIAL EFFECT
NorthMet Project
Poly Met Mining, Inc.

Figure 5-33
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Mine features dataset received from the DNR Lands and Minerals Divison, 2015.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Roads
National Forest System Trail
Existing Private Railroad
Minnesota Power Transmission Line

Pit Lakes
DNR Lands and Minerals Mine Features (2015)[3]
Stockpile
In-Pit Stockpile
Taconite Pit
Reservoir or Settling Basin

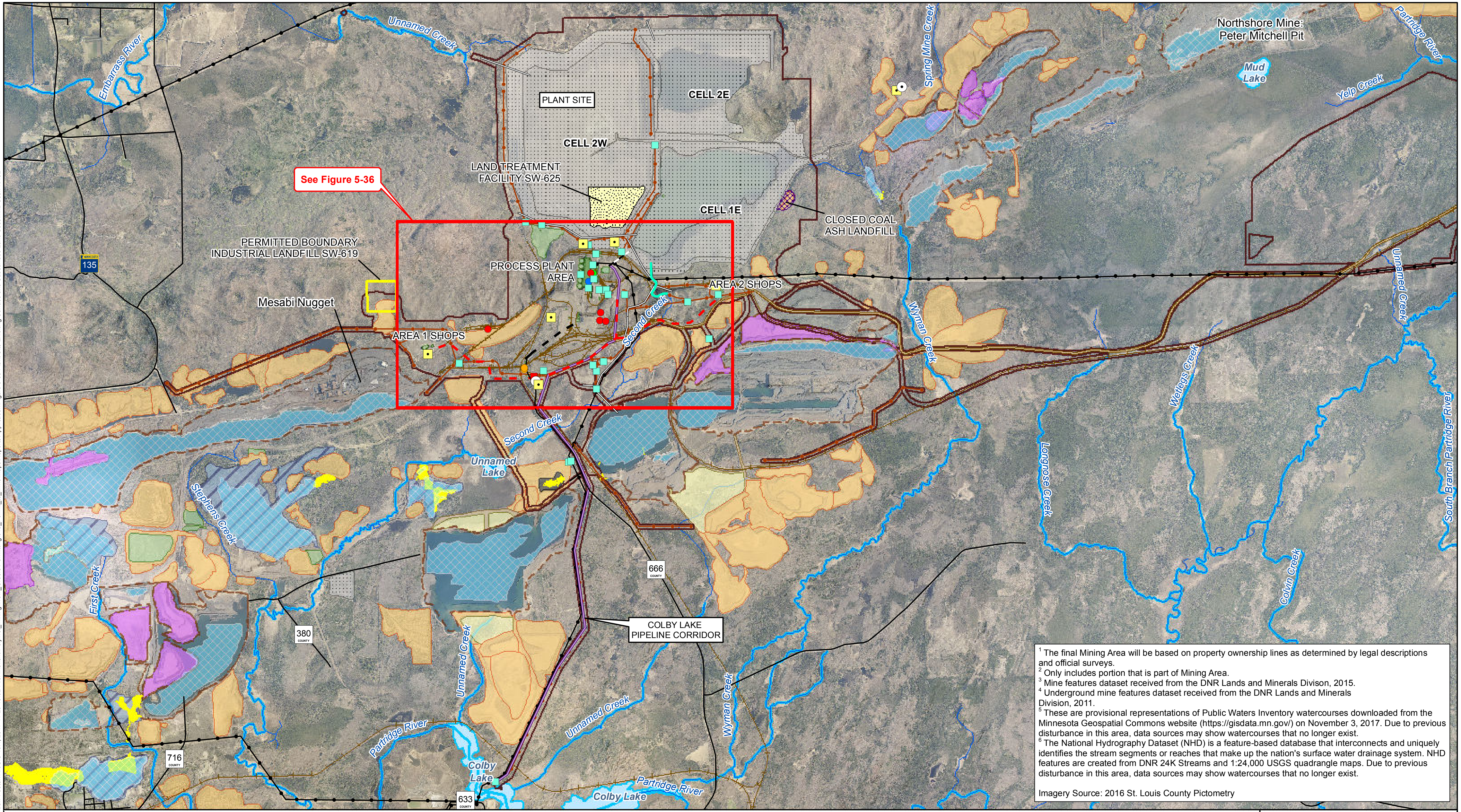
Plant or Shop Area
Public Waters Inventory (PWI) Basins
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000 6,000
Feet

MINE SITE EXISTING SURFACE AND SUBSURFACE LAND USES
NorthMet Project
Poly Met Mining, Inc.

Figure 5-34
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 15:02 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 5-34 Mine Site Existing Surface and Subsurface Land Uses.mxd User: KAC2



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of Mining Area.
[3] Mine features dataset received from the DNR Lands and Minerals Divison, 2015.
[4] Underground mine features dataset received from the DNR Lands and Minerals Division, 2011.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Closed Coal Ash Landfill Area
- Land Treatment Facility SW-625
- Permitted Boundary Industrial Landfill SW-619
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Septic System
- Well
- Fuel Oil (Underground)

Aboveground Tanks
- Fuel Oil
- Gasoline
- Mineral Oil
- Waste Oil
- Roads
- Dunka Road[2]
- Colby Lake Pipeline
- Existing Private Railroad
- Substations
- PolyMet Power Distribution Lines - Existing
- Minnesota Power Transmission Line

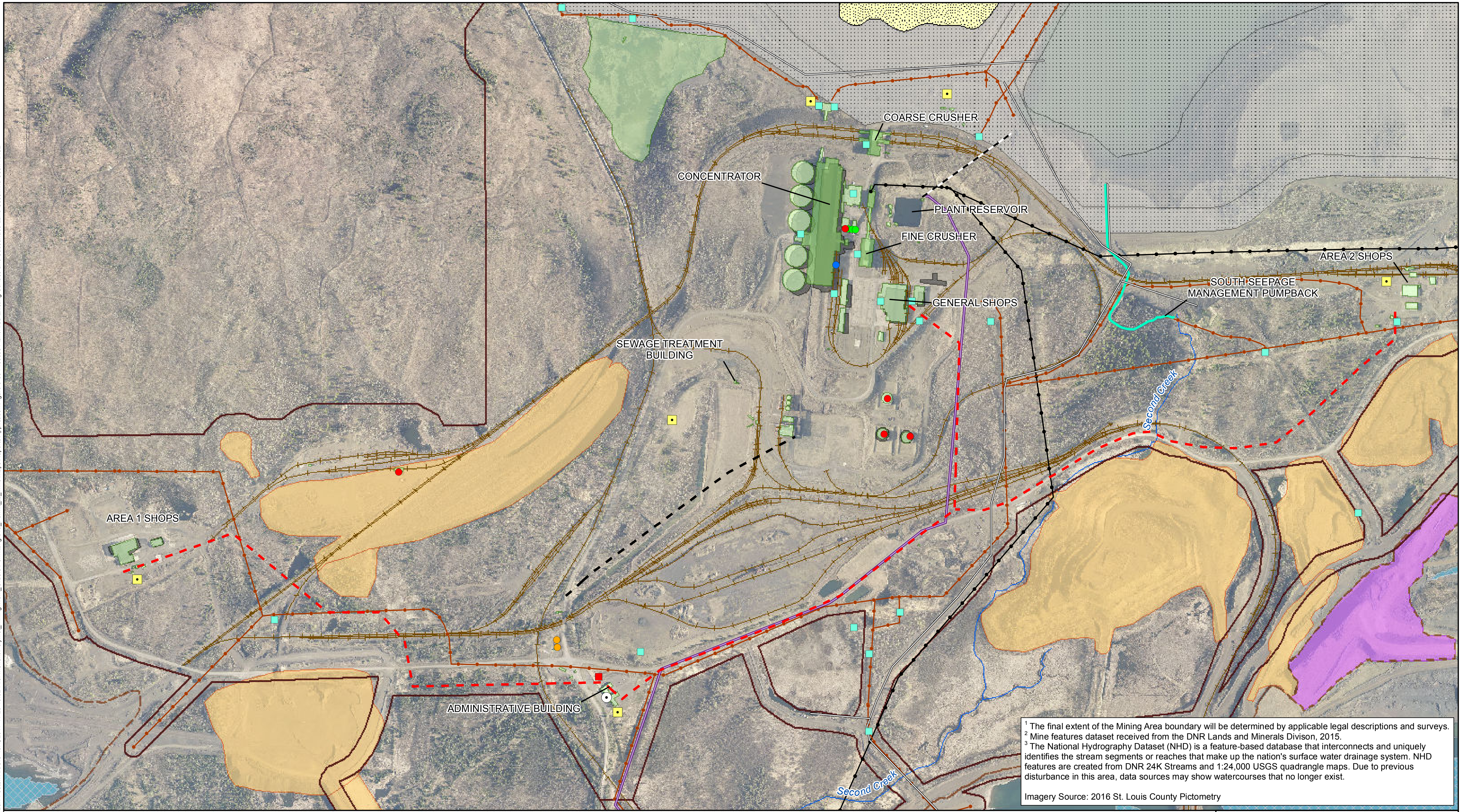
Existing Pipelines
- Tailings Water Managment (Suface)
- Tailings Water Management (Underground)
- Potable Water Pipeline (Underground)
- Natural Gas Line (Underground)
- SD026 Pipeline

DNR Lands and Minerals Mine Features (2015)[3]
- Stockpile
- In-Pit Stockpile
- Taconite Pit
- Natural Ore Pit
- Pit Lakes
- Reservoir or Settling Basin
- Tailings Basin
- Plant or Shop Area
- Haul Road
- Undisturbed/Natural Ground
- Underground Mine Features (2011)[4]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[5]
- National Hydrography Dataset (NHD) Rivers & Streams[6]

0 2,000 4,000
Feet

PLANT SITE EXISTING SURFACE AND SUBSURFACE LAND USES
NorthMet Project
Poly Met Mining, Inc.

Figure 5-35
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Mine features dataset received from the DNR Lands and Minerals Divison, 2015.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Land Treatment Facility SW-625
Existing Beneficiation Plant Building
Existing Other Plant Building
Septic System
Well
Fuel Oil (Underground)

Aboveground Tanks
Fuel Oil
Gasoline
Mineral Oil
Waste Oil
Existing Private Railroad
Substations

PolyMet Power Distribution Lines - Existing
Minnesota Power Transmission Line
Existing Pipelines
Tailings Water Managment (Suface)
Tailings Water Management (Underground)

Potable Water Pipeline (Underground)
Natural Gas Line (Underground)
Colby Lake Pipeline
SD026 Pipeline
Pit Lakes

DNR Lands and Minerals Mine Features (2015)[2]
Stockpile
In-Pit Stockpile
Taconite Pit
Reservoir or Settling Basin
Tailings Basin

Plant or Shop Area
National Hydrography Dataset (NHD) Rivers & Streams[3]

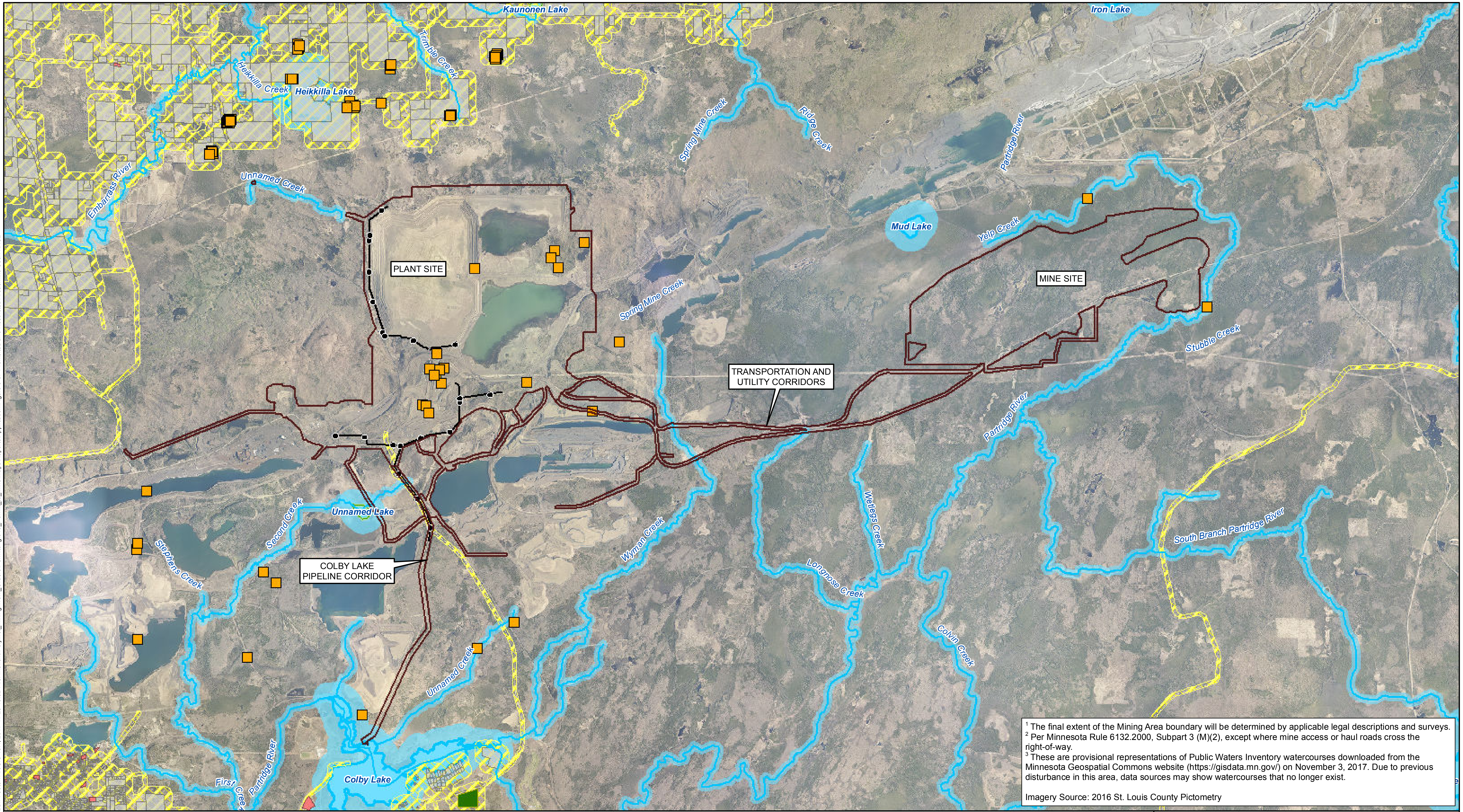
N

0 500 1,000 2,000
Feet

PROCESS PLANT AREA INSET
EXISTING SURFACE AND
SUBSURFACE LAND USES
NorthMet Project
Poly Met Mining, Inc.

Figure 5-36
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 15:02 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 5-36 Process Plant Area Existing Surface and Subsurface Land Uses.mxd User: KAC2



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Per Minnesota Rule 6132.2000, Subpart 3 (M)(2), except where mine access or haul roads cross the right-of-way.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Barr Footer: ArcGIS 10.4, 2017-11-28 13:52 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 5-37 Prohibited and Restricted Areas.mxd User: KAC2

Mining Area[1]
Registry of State Historic Places Data
Surface Disturbance Prohibited[2]
Cemetery
Public Institution
Residential Dwellings

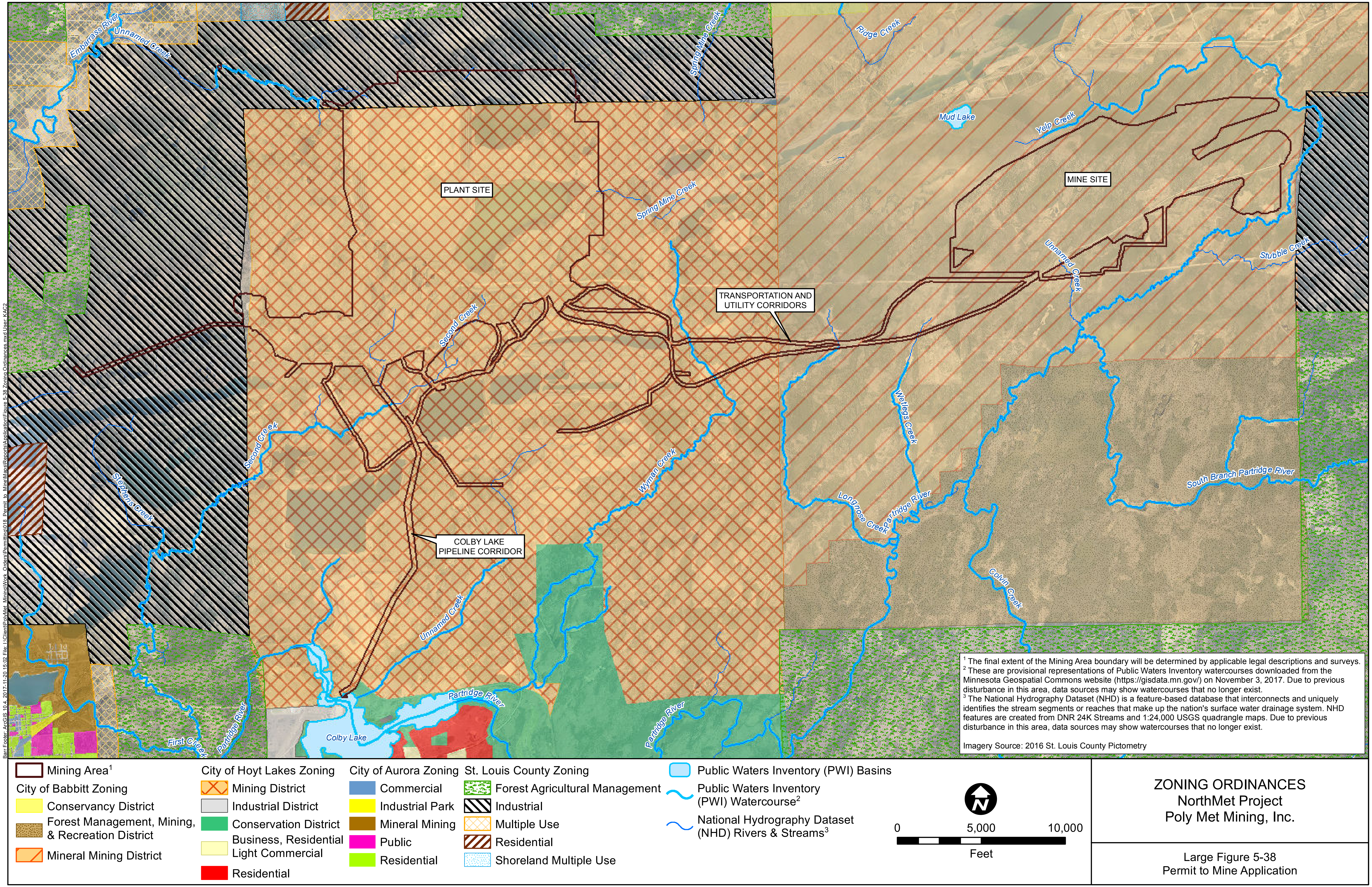
Mining Restricted Areas
Approximate Shoreland Area
Public Waters Inventory Basin
Public Waters Inventory Wetland
Public Waters Inventory Watercourse[3]

N

0 0.5 1 2
Miles

EXCLUDED, PROHIBITED AND RESTRICTED AREAS
NorthMet Project
Poly Met Mining, Inc.

Figure 5-37
Permit to Mine Application



ZONING ORDINANCES
NorthMet Project
Poly Met Mining, Inc.

Large Figure 5-38
Permit to Mine Application

6.0 Related Environmental Review and Permitting

Under Minnesota's law governing nonferrous mining, the Application is intended to demonstrate that the Project will promote the orderly development of mining, encourage the use of good mining practices, preserve and protect natural resources, eliminate or control potential adverse environmental effects, and facilitate planning of future land utilization. To achieve these objectives, Minnesota Statutes, chapter 93, and Minnesota Rules, chapter 6132, require the use of mining methods, mine waste management, and passive reclamation that maximize physical, chemical, and biological stabilization of areas disturbed by mining, along with the use of active treatment technologies when necessary.

Minnesota law contemplates that the Permit to Mine framework will evaluate environmental considerations from the initial planning stages of mining through ongoing operations and ultimately to reclamation, closure, and postclosure maintenance. The PTM Regulations achieve this result through performance-based requirements that allow site-specific tailoring of operations in the Permit to Mine rather than by setting blanket design or operational requirements for mining operations without regard for specific operational considerations. This approach appropriately allows other permitting programs, such as MPCA's water quality program, to develop and apply necessary numeric criteria to achieve specific regulatory objectives. Accordingly, PolyMet's Application demonstrates that the Project meets the requirements set forth in the applicable nonferrous mining rules, complies with the regulatory requirements established by DNR as a result of these rules, and protects natural resources and the environment.

This Application and the ultimate Permit to Mine are informed by the associated environmental review and other permitting efforts for the Project. As prescribed in Minnesota Rules, part 4410.0300, subpart 3, the detailed environmental analysis, mitigation measures, and changes to the Project that emerged from the EIS process are to be used "as guides in issuing, amending, and denying permits and carrying out other responsibilities of government units to avoid or minimize adverse environmental effects and to restore and enhance environmental quality." The related federal and state environmental permitting and regulatory approval processes provide an additional basis for this Application to show compliance with the DNR requirements. These related permits which include, among others, permits for wetlands, water quality, air quality, dam safety, and water appropriation are the mechanism by which the responsible agency or agencies can develop and apply performance-based standards (when allowable by applicable permit regulations) for Project operations. These standards will help achieve the goals of the PTM Regulations. This Application includes many conditions that PolyMet anticipates will emerge from these related permitting and regulatory processes and acknowledges that, as the independent review of PolyMet's other permit applications proceeds; there could be additional conditions imposed by other agencies that further inform the Permit to Mine.

Given the relationship between the PTM and the FEIS, regulatory approvals like those required for the federal land exchange, and other permitting processes, Section 6.0 provides a high-level overview of these other regulatory frameworks.

6.1 Environmental Review

PolyMet's Project triggered environmental review under both NEPA and MEPA, which specified completion of an EIS before local, state or federal agencies could issue regulatory decisions for the proposed mining operations (DNR), federal Clean Water Act (CWA) Section 404 permit (USACE), federal land exchange (USFS), and other required permits. Therefore, consistent with the Minnesota Statutes and Rules governing nonferrous mining, NEPA, MEPA, and the implementing rules promulgated by the federal Council on Environmental Quality and the Minnesota Environmental Quality Board, the Co-Lead Agencies (DNR, USACE, and USFS) worked over the course of ten years to complete a comprehensive EIS for the Project. The FEIS, for which DNR issued an adequacy determination under MEPA on March 3, 2016, establishes a foundation for the related environmental permitting and regulatory approvals. Among other things, the FEIS considers:

- the Project as currently proposed by PolyMet, including its purpose and need (FEIS Section 1.3, page 1-11), facility configuration, construction plan, operating protocols, and specified mitigation measures (FEIS Section 3.2, starting on page 3-7)
- a range of alternatives to the Project (FEIS Section 3.1, starting on page 3-5), as required by federal and state law (including other facility siting options, alternative technologies, changes in design/layout, and different scales of operations)
- existing environmental conditions relevant to the Project based on baseline data developed over extended periods of time (FEIS Chapter 4)
- potential impacts of the Project and the identified alternatives, including potential cumulative effects, to natural resources and the environmental, human health, and socioeconomic conditions (FEIS Chapters 5 and 6)
- mitigation measures to avoid or minimize potential adverse impacts (FEIS Chapter 3)
- the relevant permits and other authorizations necessary for construction and operation of the Project (FEIS Section 2.6, starting on page 2-11)
- financial assurance requirements that will be applicable to the Project (FEIS Section 3.2.2.4, starting on page 3-140)

The DNR, as the Responsible Governmental Unit under MEPA, completed its administrative process for the FEIS by issuing its determination on the adequacy of the FEIS under Minnesota law, which is included as Appendix 16.2.1. The DNR and the MPCA are now proceeding with the applicable permitting processes, which will allow them to determine whether, and on what conditions, to issue state permits for the Project. The USACE will use the analysis developed in the FEIS to prepare a Record of Decision (ROD) for the pending CWA Section 404 permit application. The USFS completed its administrative review process and issued a Final ROD for the proposed land exchange on January 9, 2017, which is included as Appendix 16.2.2.

Section 6.1.1 summarizes how the project was modified during the EIS process to minimize impacts. Section 6.1.2 summarizes the public process that culminated in the FEIS (Appendix 16.1). Section 6.1.3 provides a brief overview of certain FEIS outcomes that informed this Application.

6.1.1 Project Modifications in EIS Process

The FEIS addressed direct, indirect, and cumulative potential impacts that could result from the Project. The potentially significant issues relevant to the Project were determined by the Co-Lead Agencies during the scoping process prior to the preparation of the EIS. Potentially significant issues that could trigger the need for mitigation measures identified during the scoping process included physical impacts on groundwater and surface waters, water appropriations, surface water runoff, wastewater, solid waste, vegetation cover types, fish and wildlife resources, threatened and endangered species, erosion and sedimentation, air emissions, amphibole mineral fibers, noise, cultural resources and tribal access to lands within the 1854 Ceded Territory, visibility, compatibility with plans and land use regulations, and infrastructure.

Throughout the environmental review process, the Project was modified in order to reduce the potential for impacts. A summary of the potential impacts from the proposed Project, by issue, is provided in Section 6 of the DNR's final ROD (Appendix 16.2.1). Key components of the Project which are intended to reduce the potential for impacts, as listed in Section 7 of the DNR's final ROD (Mitigation Measures), are summarized below by media type, as relevant to activities that will be regulated by the PTM (in addition to other permits) and reviewed as part of the PTM process.

6.1.1.1 Water Resources

- Stormwater control – mine perimeter and pit rim ditches and sedimentation basins have been designed to separate and control stormwater and process water (now called mine water).
- Temporary storage – geomembrane liners, underdrain systems (if necessary), sumps, and overflow ponds will be used for temporary storage of Category 2/3 and Category 4 waste rock, and Ore Surge Pile rock and associated drainage collection for further conveyance for treatment.
- Water seepage – the Category 1 Stockpile Groundwater Containment System and the FTB seepage capture systems will be used to collect surface and groundwater seepage from the Category 1 Waste Rock Stockpile and the Tailings Basin, respectively.
- Reuse of water – mine water from the Mine Site and seepage from the Tailings Basin will be captured and reused as process water to minimize the need for make-up water from off-site sources (i.e., Colby Lake).
- Reduction of water and oxygen intrusion – bentonite-amended tailings basin beaches and bottom (during reclamation) and embankment face (during operations) will be employed to reduce water and oxygen intrusion into the tailings during reclamation, closure, and postclosure maintenance.

- Control of hydrometallurgical residue – the double-lined HRF will be used to collect, control, and store hydrometallurgical residue, and for reuse and recycling of process water. The HRF will include a double geomembrane liner with a leakage collection system to return leachate to the HRF Pond.
- Control of water flows – stream augmentation will occur at the Plant Site to maintain flows in downstream waters plus or minus 20 percent of existing flows to offset potential impacts due to the collection of seepage from the Tailings Basin.
- Adaptive engineering controls – adaptive engineering controls will be implemented as needed and could include:
    - maintenance and modifications to the WWTS
    - adaptive management strategies for total mercury
    - adaptive mitigation measures to protect surface and groundwater (i.e., monitoring, evaluation, and management)
    - modifications to the Category 1 Stockpile Cover System to mitigate issues discovered through construction
    - adaptations in construction phases and in operating conditions of the WWTS
    - changes to the FTB Pond bottom cover
- Contingency mitigation – contingency mitigation measures will serve as options to undertake in the event that fixed or adaptive engineering controls are not able to ensure water quality standards are being met. Potential issues and contingency mitigation measures have been identified for:
    - additional capacity constructed if overflows of mine water occurs
    - construction and cleanup of catchment areas if material is spilled from rail cars from the Mine Site to the Plant Site
    - interception wells for groundwater downgradient of lined infrastructure if concentrations in groundwater are rising due to the Project
    - treatment of West Pit water if water quality is not as expected
    - a grout curtain if the mine pit groundwater inflows are greater than expected due to bedrock faults
    - expansion of seepage management systems if new surface seepage locations emerge around the Tailings Basin
    - improve FTB Pond water quality if needed

- improve groundwater and/or surface water quality if concentrations are rising downgradient of the Tailings Basin
- Prevention of a northward flow of pit water from the proposed NorthMet pits to the Northshore Mine pits after NorthMet pits are flooded

6.1.1.2 Wetlands

- Wetlands mitigation strategy – the overall wetland mitigation strategy is to compensate for unavoidable wetland impacts in-place and in-kind where possible, and in advance of impacts, when feasible, in order to replace lost wetland functions. Indirect wetland impacts will also be monitored for and mitigated per permit requirements.
- Off-site wetland mitigation – to complete the requirements for compensatory mitigation, off-site wetland mitigation will occur.
- Establishment of wetlands – new wetlands will be established on-site during reclamation.

6.1.1.3 Vegetation

- Reclamation – impacts to vegetation will be mitigated through site reclamation. A self-sustaining plant community where potential impacts to the community are minimized will be established. The reclaimed vegetation will be comprised of native species where effective and will provide wildlife habitat.

6.1.1.4 Geotechnical Stability

- Design – the preliminary designs of the waste rock stockpiles, FTB, and HRF were developed through an iterative design and modeling process, and the slope stability and liner integrity will be monitored through all Project phases, allowing for identification of a need to implement adaptive mitigation measures (e.g., slope modification, additional rock buttressing, and/or improving water management performance) should the facilities perform differently from their design.
- Waste rock stockpiles – the waste rock stockpile design includes the following measures to address geotechnical stability:
  - a surface water and groundwater containment system will encompass the permanent Category 1 Waste Rock Stockpile to capture groundwater and surface water flows from the stockpile
  - an engineered geomembrane cover system will be added progressively during operations for the permanent Category 1 Waste Rock Stockpile
  - a composite geomembrane liner system (with a foundation underdrain system if necessary, an impermeable composite liner barrier, and an overliner drainage layer) for the temporary stockpiles of Category 4 waste rock, combined Category 2/3 waste rock, and the Ore Surge Pile
  - Backfilling the East and Central Pits with Category 2, 3, and 4 waste rock from their temporary stockpiles and from the West Pit following Mine Year 11 of the Project;

Category 1 waste rock mined after Mine Year 14 will also be backfilled into the East and Central Pits.
    - monitoring and maintenance of the stockpiles for geotechnical stability
    - adaptive waste management
- Tailings Basin – measures to address tailings basin geotechnical stability include rock buttressing, repairing eroded surfaces, and repair and/or replacement of damaged monitoring and operational infrastructure, modifications where necessary, a Contingency Action Plan, long-term maintenance, and mitigation measures in all Project phases
- HRF – measures to address HRF include considerations for stability during design, installation of a liner and collection system, monitoring, maintenance, and specific reclamation considerations for the cover systems

6.1.2 Public Involvement in EIS Process

Consistent with NEPA and MEPA requirements, the process for developing the FEIS included multiple opportunities for involvement by federal and state agencies, interested Minnesota Tribal Nations (herein referred to as the "Bands"), local governments, and members of the public. Some of these stakeholders, including the federal U.S. Environmental Protection Agency (USEPA) and three Bands, served as Cooperating Agencies during the EIS process. Others, like MPCA, assisted in the preparation of the EIS at appropriate points.

To provide a full and fair opportunity for meaningful public participation, the Co-Lead Agencies undertook the following actions, among others, during the EIS process:

- Completed scoping: The Co-Lead Agencies followed statutory scoping procedures to identify potentially significant issues and the potential impacts, alternatives, and mitigation measures to be analyzed during the environmental review process. The agencies obtained public input on the NorthMet Mining Project during scoping for the Draft EIS (DEIS) in 2005 and on the Land Exchange during scoping for the Supplemental Draft EIS (SDEIS) in 2010.

- Identified permits and other regulatory authorizations: Section 2.6 of the FEIS (starting on page 2-11) identified federal and state permitting requirements, federal land exchange procedures, local land-use protocols, and other regulatory authorizations.

- Implemented consultation: The federal Co-Lead Agencies consulted with:

    - the Bands, agencies and other interested parties on matters of cultural, archaeological, and historical significance pursuant to the National Historic Preservation Act

    - the USFWS and other agencies with expertise with respect to endangered and threatened species, wildlife, plant, and aquatic resources pursuant to the federal ESA and similar state laws

- Provided opportunities for public review and comment: The Co-Lead Agencies conducted public meetings and other procedures to obtain extensive public input on the Project and the environmental review documents (including scoping documentation, the DEIS, and the SDEIS) that preceded the FEIS. In addition, under MEPA, members of the public had an additional opportunity to comment on the FEIS before the DNR issued its adequacy determination.

- Incorporated substantive input from the USEPA: The USEPA provided substantive input as a Cooperating Agency during the EIS process, in addition to submitting comments on the DEIS, the SDEIS, and the FEIS. USEPA will continue to collaborate with the appropriate federal and state agencies during permitting on specific issues for which the USEPA has authority (e.g., air and water permits). The Co-Lead Agencies worked closely with USEPA to address USEPA's comments and views regarding the analyses set forth in the FEIS.

- Responded to public comments: After considering comments on the DEIS from USEPA and other agencies, the Bands, local governmental authorities, the public, and PolyMet, the Co-Lead Agencies completed and released the SDEIS. Subsequently, the Co-Lead Agencies considered all comments on the SDEIS and developed specific responses to satisfy the requirements of NEPA and MEPA. The public process of responding to comments was completed with issuance of the FEIS.

For additional information, Section 1.2 of the FEIS (starting on page 1-9) details the roles and responsibilities of the Co-Lead Agencies, the Cooperating Agencies (the Bands, supported by the Great Lakes Indian Fish & Wildlife Commission and the 1854 Treaty Authority, and USEPA), and other agencies (USFWS, MPCA, and Minnesota Department of Health [MDH]) in the EIS process. Section 2.0 of the FEIS (starting on page 2-1) summarizes the multiple opportunities for public participation (including public meetings and formal notice and comment procedures) that were available over the multiple EIS stages.

This public involvement process not only resulted in revisions to the environmental review documents, but also contributed to the refinement of the Project as presented in this Application.

6.1.3 Environmental Review Outcomes

During the course of the environmental review process, the Co-Lead Agencies considered numerous alternatives and mitigation measures (including those relating to siting, technology, modifications to designs and layouts, among others) to avoid, minimize, and mitigate potential adverse impacts. In conjunction with this process, PolyMet made numerous refinements to incorporate benefits and avoidance or mitigation measures that will produce substantial environmental benefits and other advantages to the Project. The full alternatives analysis discussion is located in Section 3.2.3 of the FEIS (starting on page 3-143). Project refinements made in connection with the 2013 SDEIS process include, among other things, the following:

- inclusion of a semi-autonomous grinding mill at the Plant Site for more efficient grinding and reduced air emissions

- removal of the existing LTVSMC Coal Ash Landfill from within the FTB footprint prior to inundation

- additions to the seepage capture systems for the Tailings Basin

- modification to the stream augmentation plan such that only treated mine water will be discharged to three streams downstream from the Tailings Basin
- refurbishment of existing rail cars to reduce potential for ore spillage
- stability enhancements to strengthen the existing LTVSMC tailings basin dams

In sum, the Project configuration as analyzed in the FEIS will both minimize potential environmental impacts and facilitate permit compliance. By complying with the various permits and authorizations summarized in the following sections, together with the Permit to Mine, PolyMet will meet Minnesota's statutory goals for nonferrous mining.

6.2 Federal Land Exchange

In addition to providing information concerning potential environmental effects relevant to the Application and related environmental permits and approvals, the FEIS and subsequent DNR ROD (Appendix 16.2.1) and USFS ROD (Appendix 16.2.2) incorporates an analysis of the proposed federal land exchange. The proposed land exchange between PolyMet and the United States, acting through the USFS, is an assembled land exchange in which PolyMet will convey rights to several non-contiguous parcels of land to the United States.

When discussing the land exchange, areas are described using GLO acreages. GLO surveys are the official record of the boundaries and contents of public lands and may be different from areas determined using GIS data. In this Application, unless noted as GLO acres, all areas provided are calculated in GIS.

As described in its Draft ROD, the USFS is proposing to convey to PolyMet approximately 6,495 acres (6,650 acres GLO) of Superior National Forest lands encompassing the ore deposit and the adjacent land. In exchange, PolyMet will convey to the USFS approximately 7,075 acres (6,690 acres GLO) of private land within the Superior National Forest. The proposed land exchange facilitates PolyMet's use of the surface overlying its mineral rights and allows PolyMet to own these surface lands in fee title.

As described in the USFS's January 2017 Final ROD (Appendix 16.2.2), the land exchange will also advance USFS objectives consistent with agency guidance. The land exchange meets the USFS's stated purpose and need by meeting desired conditions in the Superior National Forest Land and Resource Management Plan, including by eliminating potential conflicts over land use. The land exchange also meets the purpose and need by facilitating production of mineral resources in an environmentally sound manner contributing to economic growth and national defense. In addition, the land exchange results in a 40-acre (GLO) net gain in National Forest System (NFS) lands, improves the spatial arrangement of NFS lands by reducing the length of ownership boundaries to be managed by 33 miles; improves management effectiveness by acquiring lands with public overland access; and saves money by eliminating two easements and their associated administrative costs.

6.3 Other Permits

PolyMet will need to obtain, in addition to the Permit to Mine, a number of other environmental permits that will guide PolyMet's construction, operations, reclamation, closure, and postclosure maintenance activities. These other permits are, in some instances, subject to the jurisdiction of other agencies. Regulatory oversight for areas such as air and water quality, wetland protection, water appropriations, and dam safety may, in some instances, result in conditions for these related permits that are more stringent than the Permit to Mine requirements or are not related to DNR's PTM Regulations.

Thus, while issuance of the Permit to Mine is not dependent on these other permitting programs, refinement of the Project and imposition of permit conditions by the appropriate agencies on separate permits (e.g., performance criteria, monitoring obligations, reporting duties) will further demonstrate that the Project meets the requirements of Minnesota's PTM Regulations. The following sections provide a high-level summary of general scope and process for the other primary environmental permits.

6.3.1 Wetlands

Wetlands in Minnesota are regulated under an overlapping set of federal and state statutes and rules, including Section 404 of the CWA and the Minnesota Wetland Conservation Act (WCA) of 1991. The USACE, DNR, MPCA, and local governmental authorities in Minnesota typically coordinate their permitting processes.

As summarized in Section 12.0, the Project will impact wetlands directly and indirectly. Before constructing and operating the Project, PolyMet will need to obtain both a CWA Section 404 permit from the USACE and DNR approval of a wetland replacement plan under WCA and the PTM Regulations.

Under WCA (including both the applicable statutes and regulations) and the PTM statutes and regulations, DNR is responsible for approving PolyMet's wetland mitigation plan, which PolyMet is submitting as part of this Application. PolyMet will continue to coordinate with DNR, USACE, and MPCA on wetland permitting both in relation to WCA, the PTM Regulations, and under the separate CWA Section 404 process. Section 12.0 discusses the wetland mitigation plan, which is included in Appendix 18.1.

In addition to USACE and DNR permits and approvals, some aspects of wetland permitting will involve coordination with MPCA, USFWS, MnHPO, and USEPA. Under CWA Section 401, MPCA must certify that dredge and fill activities to be conducted under the CWA Section 404 permit will comply with applicable state water quality standards. Under Section 106 of the National Historic Preservation Act of 1966, as amended, the USACE coordinated with MnHPO, which issued an effect determination for the Project. The USACE will also coordinate with the USEPA regarding the Project under the CWA Section 404 process.

6.3.2 Threatened and Endangered Species

PolyMet conducted database searches and field surveys to evaluate the presence of federal or state-protected wildlife and plant species in the vicinity of the Project. Under Section 7 of the Endangered

Species Act (ESA), the USACE conducted a formal consultation with the USFWS, which issued a Biological Opinion regarding effects on federally-listed threatened and endangered species (Appendix 18.2).

Surveys were conducted across the Project areas as described in Appendix 18.1. During these surveys, 13 populations of one state-endangered plant species was documented within the vicinity of the Project areas. Project impacts are unavoidable in one location that currently supports a state-endangered species population. For this reason, PolyMet submitted a takings permit application to the DNR (Reference (26)). A takings permit, including approved mitigation, will be required from the DNR for direct impacts to this state-endangered plant species. An appropriate mitigation proposal will be discussed with DNR and provided as part of the takings permit.

6.3.3 Water Quality

Minnesota has numerous programs to protect water resources. The terms and conditions for discharges of industrial waste water to waters of the state are established through Minnesota's joint NPDES/SDS permit program. The NPDES portion of this program is grounded in the federal CWA (Section 402) and is administered by the MPCA under delegation from the USEPA and authority established under Minnesota Statutes, section 115. The SDS portion of this program is also established under Minnesota Statutes, section 115.

The NPDES program regulates industrial waste water and stormwater discharges from point sources into surface waters such as lakes, streams, and wetlands. The SDS program applies to the construction and operation of waste water disposal systems discharging to surface waters and/or groundwater. Under Minnesota law, these programs protect waters for uses such as drinking water, aquatic life, and recreation. MPCA has established water quality standards that protect these uses by limiting the amount of certain pollutants that may be discharged into receiving waters. Water quality standards and use classifications are specified in Minnesota Rules, Chapters 7050 and 7052. As part of its permitting process, MPCA may develop effluent limitations and monitoring requirements based on applicable Minnesota water quality standards and applicable federal categorical standards (as established under 40 CFR Part 440 for point source discharges from ore mining and dressing facilities). Such effluent limitations and monitoring requirements will be incorporated into a NPDES permit or SDS permit (or a combined NPDES/SDS permit) to require that applicable water quality standards are met.

As discussed in Section 11.0, PolyMet has designed the Project to meet applicable state and federal water-protection requirements. PolyMet anticipates that NPDES and/or SDS permitting requirements will apply to, among other things, discharges from mining and processing operations, mine dewatering, waste water management, stormwater control, and storage of Flotation Tailings and Residue. Through compliance with the performance-based water quality standards under the NPDES and SDS programs, the Project will control possible adverse environmental effects to water resources as required under the PTM Regulations.

6.3.4 Water Appropriation

To preserve state water resources, a water appropriation permit is required for withdrawals of waters of the state for any use of more than 10,000 gallons per day or 1 million gallons per year (Minnesota Rules, part 6115.0620). State law encourages conservation and recycling of water resources, and imposes various restrictions on water appropriations. Among other things, state statutes limit appropriations from certain sources and areas of the state and allow for suspension of surface water appropriations during low-flow periods. DNR rules also prioritize the use of water sources for mining-related appropriations; for example, use of water from active mine pits is prioritized over use of water from natural basins. DNR imposes these regulatory requirements through its water appropriation permitting program.

As discussed in Section 11.0, PolyMet intends to withdraw groundwater for construction dewatering and mine pit dewatering. Groundwater withdrawn for dewatering will be used to meet water supply needs consistent with the priorities of Minnesota Rules, part 6115.0720, subpart 2B. To meet any additional water needs, PolyMet will also appropriate surface water from Colby Lake. Consistent with Minnesota law, PolyMet will obtain approvals for its water appropriations from the DNR. Through this permitting approach, PolyMet can minimize hydrologic impacts from its operations, and comply with both the water appropriation permitting requirements and those set forth in the PTM Regulations.

6.3.5 Air Quality

The federal Clean Air Act (CAA) and associated rules promulgated by USEPA and MPCA create numerous standards and requirements to protect air quality. MPCA is responsible for administering both the federal and state air quality programs under authority delegated by USEPA.

MPCA's air program standardizes the permitting process, and allows the issuance of either a single air emissions construction and operating permit or staged permits that separately authorize construction and operations. Permits typically include, among other things, federal and state performance standards and emissions limits, specific requirements for hazardous air pollutants, and monitoring and testing obligations. Under these permitting requirements, MPCA may, among other things, impose process or equipment controls, emission limits, and obligations for monitoring, reporting, and record keeping.

As discussed in Section 13.0, PolyMet anticipates that the Project will be permitted as a synthetic minor source under the federal/state program for New Source Review – Prevention of Significant Deterioration (PSD), a Part 70 permit, or a Title V permit. PolyMet has designed its planned activities to comply with these air permitting requirements, and, as a result, the Project will also meet the air quality goals articulated in the PTM Regulations.

6.3.6 Dam Safety

Minnesota law regulates the construction and operation of dams, including those used as tailings impoundments in mining operations. DNR administers the dam safety programs, and issues permits for construction of new dams, as well as for enlargement, repair, or alteration of existing dams.

To promote dam safety, DNR requires permit applicants to submit detailed construction information, including structural, geotechnical, geological, and topographical data. In the permitting process, DNR also reviews design, engineering, safety, maintenance, and operational information; contingency planning; and detailed plans and specifications. The dam safety program also includes comprehensive DNR inspections and company record keeping and reporting obligations.

PolyMet has filed two separate applications for dam safety permits: one for the FTB and one for the HRF. In support of these dam safety permit applications and this Application, PolyMet has conducted detailed technical analysis, including more than ten years of waste characterization and geotechnical studies, and has developed its dam designs with concurrent review by DNR. Based on this technical analysis and consistent with DNR's guidance, PolyMet has designed its dams to achieve long-term stability, to prevent overtopping, and to protect water and other environmental resources. Consequently, as discussed in Section 10.0 of this Application, PolyMet's dams will comply with the requirements of both the dam safety permit program and the applicable Permit to Mine Regulations.

6.3.7 Legacy Environmental Conditions

The Project incorporates, consistent with Minnesota policy, the refurbishment and reuse of existing ferrous mining facilities at the Plant Site. These existing ferrous mining facilities remain subject to several permits issued to Cliffs Erie, including a ferrous Permit to Mine for closure activities and two existing NPDES/SDS permits issued by MPCA for closure purposes. These existing permits generally are not applicable to the Project, and they include many facilities and locations that will not be used in the Project.

This Application focuses on the new nonferrous-related operations and anticipated environmental conditions. It does not cover the former LTVSMC areas that will not be under PolyMet's control within the Mining Area. Information on the portions of the legacy Cliffs Erie properties that will be under PolyMet's control are discussed in Section 8.0 (e.g., Process Plant, existing tailings basin, railroads, powerlines). There are areas within the former LTVSMC legacy properties that will not be used by the Project (e.g., Areas 2, 3, and 5, railroads, powerlines). Costs associated with reclaiming or closing legacy areas that will be under PolyMet's control within the Mining Area are included in PolyMet's Legacy Closure Plan as described in Section 16, and associated financial assurance calculations are provided in Appendix 15.1. Further, PolyMet understands that the state of Minnesota is evaluating how to manage the transition from the current ferrous financial assurance under the legacy permits held by Cliffs Erie, which is in the form of a corporate guarantee, to the financial assurance for the Project in areas subject to both legacy permits and the Permit to Mine for the Project. See Section 8.0 for further discussion regarding legacy area transition for construction and operations, Section 16.1 for contingency reclamation and financial assurance for existing ferrous conditions within the Project footprint, and Appendix 15.1 for financial assurance cost estimates associated with legacy areas within the Project footprint.

7.0 Mine Site and Mining Facilities

In coordination with a team of qualified technical experts who meet regulatory qualifications for the state of Minnesota, PolyMet has developed a Mining and Reclamation Plan that is tailored to the environmental setting in which the Project will operate. Qualifications of these technical experts are discussed in further detail in Section 10.0. The Mining and Reclamation Plan evolved substantially through the EIS process, and the resulting plan balances operational needs with advanced environmental controls to minimize adverse environmental impacts. In addition, it incorporates design elements that are responsive to input provided by the Co-Lead Agencies, Cooperating Agencies, Bands, and members of the public.

The DNR has had the opportunity to provide input on PolyMet's Mining and Reclamation Plan, through their role as a Co-Lead Agency for the FEIS as well as their participation in the pre-application conference associated with this Application. The resulting Mining and Reclamation Plan is based on a significant public process with substantial technical review, and is in accordance with the PTM Regulations and environmental permitting.

The Mining and Reclamation Plan described in Section 3.0, and set forth in more detail in Sections 7.0 through 10.0 and 15.0, along with related appendices, is designed to achieve the goals of the PTM Regulations by complying with each of the associated requirements, and to further Minnesota's policies on mineral development and the environment. The related environmental permits address, where applicable, specific performance standards for water quality, wetlands, air quality, and other environmental media. Specific information related to the Mining and Reclamation Plan is provided as follows:

- This Section 7.0 describes the Mine Site facilities and operations.
- Section 8.0 describes the Plant Site facilities and operations.
- Section 9.0 describes the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor, along with auxiliary facilities.
- Section 10.0 describes PolyMet's waste characterization program, mine waste materials, and the management and progressive reclamation of these materials during Project operations.
- Section 11.0 describes the design and operation of water management facilities during Project operations.
- Section 15.0 provides an overview of the reclamation, closure, and postclosure maintenance phases.

The associated appendices included in this Application provide specifics regarding the engineering and technical design elements for construction along with the management and operational plans at the Mine Site and Plant Site. Construction appendices provide permit application support drawings for construction and development activities at the Mine Site, such as earthwork design, stockpile design, Category 1

Stockpile Groundwater Containment System design, mine water infrastructure design, and stormwater infrastructure design. Specific construction appendices for Mine Site and Plant Site facilities are as follows:

- Appendix 3 Mine Site and Dunka Road Earthwork Permit Application Support Drawings
- Appendix 4 Categories 1, 2/3, and 4 Stockpiles and Ore Surge Pile Design and Category 1 Stockpile Groundwater Containment System Permit Application Support Drawings
- Appendix 5 Mine Site Stormwater Permit Application Support Drawings
- Appendix 6 Flotation Tailings Basin and FTB Seepage Containment and Stream Augmentation Systems Permit Application Support Drawings
- Appendix 7 Hydrometallurgical Residue Facility Permit Application Support Drawings
- Appendix 8 Mechanical Infrastructure Permit Application Support Drawings
- Appendix 9 Sewage Treatment System Permit Application Support Drawings
- Appendix 10 Plant Site Stormwater Permit Application Support Drawings

Management Plans provide information on how the facility will be operated and managed over the LOM) and include descriptions of the basis of design for various permit level designs. In addition to the Management Plans, other plans have also been developed for the Project. Managment Plans and other plans include:

- Appendix 11 Management Plans Updated for Permit to Mine
    - Appendix 11.1 Rock and Overburden Management Plan
    - Appendix 11.2 Water Management Plan – Mine Site
    - Appendix 11.3 Water Management Plan – Plant Site
    - Appendix 11.4 Adaptive Water Management Plan
    - Appendix 11.5 Flotation Tailings Management Plan
    - Appendix 11.6 Residue Management Plan
- Appendix 12 Fugitive Emission Control and Blasting Plans
    - Appendix 12.1 Fugitive Emission Control Plan: Mine Site
    - Appendix 12.2 Fugitive Emission Control Plan: Plant Site
    - Appendix 12.3 Blasting Plan
- Appendix 13 Annual Report

- Appendix 13.1 Annual Report Template
- Appendix 13.2 Annual Report Year 1

- Appendix 14 Reclamation, Closure, and Postclosure Maintenance Plan

This Section 7.0 is structured as follows:

- Section 7.1 provides an overview of the location of the Mine Site and its compliance with applicable siting and buffer criteria
- Section 7.2 describes the NorthMet ore body
- Section 7.3 summarizes the LOM as well as the currently anticipated mining rate, amount, sequence, and schedule
- Section 7.4 describes the construction activities necessary before operations commence at the Mine Site
- Section 7.5 discusses the mining operations PolyMet expects to conduct at the Mine Site

7.1 Overview of Mine Site

The NorthMet Deposit, which drives the location of the Mine Site, is located in Sections 1, 2, 3, 4, 9, 10, 11, and 12 of Township 59N Range 13W (sections, township, and range are shown on Figure 1-5 and Figure 1-6). Figure 7-1 shows the Mine Site in Mine Year 1 and the surrounding lands, which include existing mining facilities and Superior National Forest lands.

The Mine Site is designed to meet the applicable siting and buffer requirements set forth in the PTM Regulations, specifically Minnesota Rules, parts 6132.2000 and 6132.2100. The design for the Mine Site minimizes adverse impacts on natural resources and the public and includes, as needed, setbacks or separations to comply with air, water, and noise pollution standards and other applicable requirements. The Mine Site will be compatible with surrounding non-mining uses and will maintain separations between the Project and adjacent conflicting land uses (which are minimal given the NorthMet Deposit's location in an area zoned for mineral mining, as shown on Figure 5-38). Specifically, the Mine Site is located within the Mesabi Iron Range, with numerous iron mining operations in the general area. Once the land exchange has occurred, the Superior National Forest will be located east and south of the Mine Site. The closest residential areas are Hoyt Lakes to the southwest and Babbitt to the northeast.

As described in Section 3.0, the Mining and Reclamation Plan contemplates that the specific details of the proposed mining operations may vary in a particular year based on operational considerations and market conditions; however, Figure 7-1 through Figure 7-4 show the proposed location of the mine pits, the surface facilities, and the infrastructure at the Mine Site in Mine Years 1, 11, and 20, and in postclosure maintenance, respectively. This Section 7.1 of the Application lists the facilities and infrastructure located at the Mine Site and, for those items not addressed in detail in a separate section, describes how each facility or infrastructure complies with the applicable general siting and buffer requirements. Mining and surface disturbances will not occur in excluded or prohibited areas, and mining operations will comply with the additional restrictions applicable to mining per Minnesota Rules, part 6132.2000, as described in detail in Section 5.11.

While the location of the pits for accessing the ore body drove much of the design, where PolyMet has flexibility in site selections, it analyzed alternative locations for siting as part of the EIS process and ultimately sited facilities, to the extent practicable, in accordance with the general siting criteria established in Minnesota Rules, part 6132.2000, subpart 5, so that:

> A. *impacts on the public and natural resources due to wind erosion, noise, and air emissions are minimized*
>
> B. *potential injury to life due to floods, caving, or slope failure is minimized*
>
> C. *potential damage to property and natural resources due to floods, caving, or slope failure is minimized*
>
> D. *major modification of watersheds, including diversions of surface water and alterations of groundwater levels, are minimized*
>
> E. *runoff and seepage can be managed to minimize water impacts on surface water and groundwater*
>
> F. *conflicts with natural and historical heritage sites, identified during the environmental review, are minimized*
>
> G. *former mining areas are used in preference to areas undisturbed by mining*

This Section 7.1 describes, among other things, how the siting of facilities is in accordance with the criteria listed above. The following list of Mine Site major infrastructure summarizes PolyMet's current expectations regarding how the siting and management of these facilities is consistent with the general siting criteria, listed above. Project conformance with siting criteria regarding excluded, prohibited, and restricted areas is discussed further in Section 5.11. Buffer criteria, listed in Minnesota Rules, part 6132.2100, will be met by incorporating each of the features listed below into the overall Mine Site to minimize impacts to the surrounding non-mining uses.

- Three mine pits: the East Pit, Central Pit, and West Pit. Given the location of the ore body, PolyMet does not have flexibility in the siting of the three pits. Nonetheless, where practicable, siting considerations were incorporated into the design of each of the pits. Impacts to the public will be minimal due to the pits' remote location. Pit slope design will meet criteria specified in Minnesota Rules, part 6132.2300, to be structurally sound and promote progressive reclamation. Water collected in the pits will be managed to minimize impacts on surface water and groundwater: it will be pumped to the WWTS for treatment, then routed to the FTB Pond for reuse as process water. To meet the buffer criteria specified in Minnesota Rules, part 6132.2100, the pits will be stripped and the perimeter dikes constructed, revegetated, and maintained to safely accommodate mining and diminish impacts of the mining activities.

- The Categories 1, 2/3, and 4 Waste Rock Stockpiles, OSP, and OSLA. These features, which Sections 10.4.4.210.4.3 through 10.4.6 describe in detail, will be constructed and maintained to conform to applicable siting criteria listed in Minnesota Rules, part 6132.2000. Water that contacts these stockpiles and the OSLA will be managed as mine water, as described in Section 11.3.2. Water management will also minimize potential damage to property and natural resources due to floods. Air emissions of fugitive dust from these areas will be managed using effective dust suppression techniques as discussed in Section 13.2.1.2.

- The RTH, consisting of a raised structure that facilitates transfer of ore from trucks to rail cars. Surface water runoff from the RTH area will be collected and managed on-site during operations to minimize impacts on surface water and groundwater. Water that contacts the top surface of the RTH where haul trucks drive and at the rail car loading area will be collected and managed as mine water. Water that does not contact the top surface or the rail car loading area will be managed as industrial stormwater. Water management will also minimize potential damage to property and natural resources due to floods. Operations will minimize air emissions of fugitive dust by using effective dust suppression techniques as discussed in Section 13.2.1.2. The RTH is discussed in more detail in Section 7.4.2.1.

- The new Railroad Spur and loadout area connecting the RTH and the OSP to the existing mainline railroad. Use of the existing private rail line will minimize additional impacts to areas undisturbed by mining. Surface water runoff from the Railroad Spur area will be collected and managed as industrial stormwater, except where the Railroad Spur and loadout area will drain onto the OSP where it will be managed as mine water. This will minimize potential impacts on surface water and the reduction in stormwater flow will minimize potential damage to property and natural resources due to floods.

- Mine water sumps and ponds. This infrastructure will help manage runoff to minimize potential impacts on surface water and groundwater. Mine water infrastructure is discussed in more detail in Section 11.3.2.

- Equalization Basin Area. The Construction Mine Water Basin and the lined equalization basins will store mine water at the Mine Site. The Construction Mine Water Pumping Station will pump construction mine water and OSLA runoff to the FTB Pond for reuse as process water or to the East and Central Pits to aid in pit flooding after mining is completed in each pit. The CPS will pump mine water from the equalization basins to the Plant Site for treatment and reuse as process water. As part of the overall mine water management system, these features will provide for beneficial re-use of this excess water and help minimize impacts on surface water and groundwater. The Equalization Basin Area is described in further detail in Section 11.3.2.4.

- Mine Site Fueling and Maintenance Facility (MSFMF). The MSFMF will incorporate secondary containment and spill and leak collection structures into the design. Use of spill and containment systems will minimize potential impacts on surface water and groundwater. As required by the MPCA, the facility will be operated in accordance with a Spill Prevention, Control, and Countermeasure (SPCC) Plan that will be developed prior to the threshold for need being met. The MSFMF is discussed in more detail in 7.4.2.2.

- Stormwater ponds located and sized to manage non-contact stormwater, construction stormwater, and industrial stormwater. Stormwater will be managed in accordance with the permitting requirements of the MPCA, and associated agency-approved Stormwater Pollution Prevention Plan (SWPPP). Stormwater ponds will be located as shown on Figure 7-1 through Figure 7-4. They are sited to minimize major modification of watersheds, including the diversion of stormwater, and provide appropriate retention for settling of total suspended solids (TSS) to minimize impacts on surface water. The design allows for stormwater management up to the 100-year, 24-hour storm event. The ponds are designed with primary outlets to provide flood attenuation capacity up to the 10-year, 24-hour storm event, and emergency outlets to pass runoff from larger storms up to and in excess of the 100-year, 24-hour storm event. This will minimize the potential for injury to life or damage to property and natural resources due to flooding. Section 11.3.4.3 provides additional details on the design of the Mine Site stormwater ponds.

- Existing electric power transmission lines and proposed electric power transmission lines. Existing electric power transmission lines will be used where possible, and new power lines, where necessary, will be installed along existing corridors when possible. New power lines will connect existing lines to portions of the Mine Site that will require power. This approach will minimize disturbance of areas undisturbed by mining.

7.2 Description of Ore Body

The NorthMet Deposit contains an ore body that is depicted on Figure 7-5. This ore body will support the full operating life of the mine as described in Section 7.5.

The ore body is located in portions of Sections 2, 3, 9, and 10 of Township 59N Range 13W. The extent and shape of the mine pits are constrained by the contact between the Duluth Complex, which hosts the mineral deposit, and the underlying, un-mineralized Virginia Formation. The mineralization is generally parallel to this contact and dips southeast at about 25°.

The overall mine pit design takes into account the existing rock conditions, safety, and efficiency of mining. The pit configuration and mining plan are based on a numerical Block Model, a computer model based in part on exploration drilling information and assay data. Ongoing data collected from drilling conducted before the start of mining and during mining operations will provide additional information that will inform revisions to the Block Model and, subsequently, the mine schedule. Section 7.5 describes the East, West, and Central Pits.

7.3 Operating Life of Mine and Mine Rate, Amount, Sequence, and Schedule

The Project contemplates a 20-year LOM. This Mining and Reclamation Plan (Section 7.0 through 11.011.0 and 15.0 of this Application along with related appendices) presents the anticipated mine rate, the estimated volume of ore to be mined during the LOM, the planned sequence of mining operations, and the mining schedule. Over time, prices of metals, energy, labor, and other factors may present opportunities to make adjustments and optimize economic and environmental performance. If such opportunities arise, PolyMet will present potential refinements as part of the Annual Report. Depending on the circumstance and the specific changes, these adjustments and refinements may result in the need for an amendment of the Permit to Mine, per Minnesota Rules, part 6132.4200; PolyMet will provide the relevant information to the DNR for their determination on if an amendment is required.

The Mining and Reclamation Plan is designed to provide a steady and reliable supply of ore to the Beneficiation Plant and methods to dispose of mine waste (rock and overburden) to comply with safety and environmental regulations. During operations, PolyMet expects to mine approximately 533 million tons of rock over 20 years, which includes approximately 225 million tons of ore and about 308 million tons of waste rock. After the initial ramp-up period, the anticipated annual average ore production rate will be 32,000 tons per day. Table 7-1 describes the estimated annual production rates of ore and waste rock.

Mining is planned in the East Pit from Mine Years 1 through 11, in the Central Pit from Mine Years 11 through 16, and in the West Pit from Mine Years 2 through 20 (Table 7-2). As mining of the Central Pit commences in Mine Year 11, it will extend into the East Pit, thereby joining the pits. The combined pit (after Mine Year 13) will be referred to as the East Pit.

Waste rock and overburden will be stored in stockpiles located on the surface of the Mine Site. PolyMet plans to segregate waste rock into three stockpiles, based on sulfur content, placing the more potentially reactive waste rock and saturated mineral overburden in temporary stockpiles (Categories 2/3 and 4 Waste Rock Stockpiles), and the least potentially reactive waste rock in a permanent stockpile (Category 1 Waste Rock Stockpile). Unsaturated mineral overburden and peat not used for construction will be stored at the OSLA. Section 10.4 provides more detail regarding waste rock characterization and stockpile design, construction, operation and management, and progressive reclamation. Section 10.4.2 provides more detail regarding overburden separation and storage and disposal.

As part of its progressive reclamation practices, PolyMet will begin backfilling waste rock into the East Pit after mining in that pit is finished. The East Pit will be allowed to flood with water during backfilling, and water levels in this pit will be managed to allow safe backfill and mining in the Central Pit. The backfilling of material and the water level management was included in the GoldSim water modeling completed for the FEIS, as described in Section 6.1.2.2 of the Water Modeling Data Package – Mine Site (Appendix 16.19). PolyMet anticipates that it will relocate material from the temporary Category 4 Waste Rock Stockpile to the East Pit in approximately Mine Year 11. The material located in the Category 2/3

Waste Rock Stockpile will be relocated to the East Pit after backfilling with the Category 4 Waste Rock Stockpile is complete.

During the first two years of backfilling of material into the East Pit, the model estimates that the rock placed in the East Pit from the temporary stockpiles and from continued mining will be submerged within one month of being placed. Material from continued mining will include Categories 1, 2, 3 and 4 waste rock. Category 1 waste rock will continue to be placed in the Category 1 Waste Rock Stockpile until approximately Mine Year 14 to minimize uncertainty of pit capacity for Categories 2, 3, and 4 waste rock and stockpile materials. After approximately two years (approximately the middle of Mine Year 13), the water level in the East Pit must be maintained near the bottom elevation of the Central Pit to allow for continued mining of the Central Pit. This water level will be maintained until the Central Pit mining is completed (in approximately Mine Year 16), and during this time material will continue to be placed in the East Pit from the Category 2/3 Waste Rock Stockpile and from continued mining in the West and Central Pits. After mining in the Central Pit is complete, the water level in the East Pit will be allowed to rise again as backfilling continues. The water level is expected to be near the backfilled rock surface again in approximately the middle of Mine Year 17. These model estimates show that material backfilled into these pits will be submerged shortly after placement. Actual backfilling operations will be dependent on a number of factors, including, first and foremost, the safety of the operators and operations within the pits, but also based on the rate of material backfilling, rate of rise of groundwater, and rate of mining within the Central Pit.

Figure 7-6 and Figure 7-7 present mine pit cross-sections for the following time periods: Mine Years 1, 11, 20. Figure 7-1 through Figure 7-4 also show the status of the mine pits, stockpiles, and OSP during these intervals as well as in postclosure maintenance. Mine Year 1 shows the end of the first year of mining. Mine Year 11 is when the stockpiles and pits are expected to have their largest footprints. Mine Year 20 represents the end of mining. After Mine Year 20, PolyMet will conduct reclamation, closure, and postclosure maintenance as described in Section 15.0. Section 15.3 discusses the reclamation of the mine pits.

7.4 Construction of Mine Site Infrastructure

This Section 7.4 presents an overview of activities that PolyMet will undertake at the Mine Site before mining commences as well as the infrastructure and facilities required to conduct mining. PolyMet will excavate, manage, and store unconsolidated materials to expose the ore body and prepare the site for construction of new facilities. These unconsolidated materials are classified as overburden. Overburden at the Mine Site is further classified as peat or unsaturated or saturated mineral overburden, depending on whether it is situated above or below the water table.

Due to the shallow depth of the ore deposit, the Project will use open pit mining methods. No underground mining or construction to support underground mining will take place at the Mine Site. There is minimal potential for subsidence as contemplated in Minnesota Rules, part 6132.3000, associated with open pit mining because subsidence is typically associated with underground mining. In the unlikely event that PolyMet identifies a former underground mine shaft or other infrastructure that would cause potential for subsidence, PolyMet will implement mining techniques to maintain safe operating conditions for employees, minimize hazardous conditions, and otherwise comply with the applicable rule.

Before mining operations begin, PolyMet will strip the pit area and construct infrastructure and facilities. Initial activities will consist of clearing, grubbing, and harvesting marketable biomass and timber. Construction and stripping of overburden will not be conducted outside of the Mining Area. Blasting will occur during the construction phase where necessary to modify bedrock outcrops that impinge on design of Mine Site infrastructure (e.g., stockpile foundations, mine water ponds, ditches). Blasting for construction of Mine Site infrastructure will be carried out using contractors and methods normally employed for construction blasting of rock, with the resulting blast rock utilized or managed as proposed for the Project (Figure 3-11 and Section 10.4.4).

Stripping work will remove the overburden, consisting of mineral overburden and peat, where necessary. PolyMet will stockpile excavated peat and unsaturated mineral overburden, including topsoil, in the OSLA until it can be reused for construction or on-site reclamation. The peat may potentially be used for off-site wetland mitigation activities, if needed in the future. Table 7-3 provides the estimated excavated overburden volumes by type and location. Section 7.5 provides additional information about development of the mine pits as operations commence.

As designed, the overburden portion of the pit walls will be structurally sound during stripping, operations, and reclamation, and will meet the applicable slope requirements as set forth in Minnesota Rules, part 6132.2300. Overburden stripping will expose an area of the underlying rock that is large enough to safely accommodate mining as well as provide adequate area to conform to reclamation rules. Figure 7-8 depicts the stripping limits for each of the proposed pits. The progression of the pits is shown on Figure 7-1 through Figure 7-4. A typical stripping cross section is shown on Figure 7-9.

The toe of the overburden will be set back about 30 feet (and in no event less than 20 feet) from the crest of the blasted pit wall (Figure 7-9). This setback will allow the ditches installed along the toe of the overburden slope to intercept and direct runoff water to stormwater control structures.

PolyMet will grade final overburden bank slopes at a horizontal (H) to vertical (V) slope not steeper than 2.5H:1V. Available borehole data indicates that the overburden thickness along the perimeter of the open pits ranges from 5 feet to 29 feet; therefore, this thickness would allow lift heights to be less than 60 feet, as required with Minnesota Rules, part 6132.2300. PolyMet will select lift heights based on the following regulatory considerations:

- public safety considerations
- the location of the pit wall in relation to surrounding land uses
- the soil types and their erosion characteristics
- the variability of overburden thickness, and the potential use

After final grading of the overburden bank slopes, PolyMet will vegetate the slopes to prevent erosion and promote progressive reclamation. Pit reclamation is discussed further in Section 15.3.1.3 and Section 2.1.3 of Appendix 14. Figure 7-8 shows a plan view of the pit stripping boundaries.

7.4.1 Mine Site Infrastructure

Figure 7-1 through Figure 7-3 depict the Mine Site infrastructure during operations. The subsequent sections provide details regarding the construction of this infrastructure.

7.4.1.1 Site Access and Mine Site Roads

The main access to the Mine Site will be from Dunka Road, which originates at the Plant Site and extends through the Dunka Road and Utility Corridor. PolyMet will be transporting ore to the Plant Site on the existing mainline railroad, which generally parallels the Dunka Road from the Plant Site to the Mine Site.

PolyMet will construct haul roads at the Mine Site to transport ore, waste rock, and overburden between the mine pits, stockpiles, RTH, OSP, and OSLA. Source and destination of material moved between these facilities will depend on the current mine plan and production schedule. Drawings EW-005 through EW-007 in Appendix 3 show haul road design details on the permit application support drawings for the Mine Site earthwork. These drawings show a plan view and typical cross-sections of the haul roads and Mine Site access road.

The design for the Mine Site haul roads will support the largest mobile equipment planned for use at the site. The Mine Site access road will have a typical road width of 40 feet, and the haul roads will have a typical road width of 85 feet. On-site and/or off-site construction materials for these features are described in more detail in Section 2.0 of Appendix 11.1. PolyMet will construct Mine Site haul roads with berms as required by applicable Mine Safety and Health Administration (MSHA) regulations. The roadway will be sloped, and berms will have breaks to allow runoff to flow into constructed mine water ditches running parallel to the roadway. Mine water in the haul road ditches will flow to one of four haul road mine water ponds, then be pumped to the Equalization Basin Area prior to further conveyance through the Mine to Plant Pipelines to the WWTS for treatment. PolyMet will manage the haul roads to control dust during both construction and operations, as discussed in Section 13.2.1.2. There will be additional small vehicle access roads within and around the Mine Site to access environmental monitoring equipment (e.g., wells, piezometers, stream gages) and monitoring sites.

7.4.1.2 Miscellaneous Utilities

Propane suppliers will provide the heating fuel required by Mine Site facilities (CPS, RTH, and MSFMF) and railroad switch heaters. PolyMet does not anticipate the use of natural gas service or the use of heating oil storage tanks at the Mine Site. Section 9.1.2 discusses the transmission lines that will provide electrical power to the Mine Site facilities.

Potable drinking water will be supplied by a bottled water supplier. None of the existing wells on-site are potable water wells, and no Potable Water Treatment Facilities are planned at the Mine Site. If other uses of potable water are needed, they will be supplied by portable services. Portable sanitary services will be provided by a qualified vendor.

7.4.2 Mine Site Facilities

This Section 7.4.2 describes the Mine Site support facilities. Section 11.3 provides details regarding Mine Site water management features including the Equalization Basin Area, CPS, mine water management infrastructure, and stormwater management infrastructure.

7.4.2.1 Rail Transfer Hopper and Ore Surge Pile

The purpose of the RTH and ore loadout area is to transfer ore from the Mine Site to rail cars for delivery to the Coarse Crusher Building at the Plant Site.

The RTH will consist of a raised platform from which haul trucks dump into a hopper over a pan feeder. The pan feeder will pass through an opening in a retaining wall and load rail cars positioned under the feeder outlet. The pan feeder and the control gate will be hydraulically powered. The locomotive operator will control both the pan feeder and the control gate using controls located in the RTH operator's cab and will also control the locomotive using remote controls. Similar to the haul roads, the RTH platform will be constructed using on-site and/or off-site construction materials, with the primary material source being Duluth Complex construction rock (Section 10.4.5.5). Construction materials are described in more detail in Section 2 of Appendix 11.1. Berms will be constructed around the RTH platform as required by applicable MSHA regulations.

Water that contacts the surface where haul trucks drive and the rail car loading area will be collected and managed as mine water. Water at the RTH that that does not contact those surfaces, but rather runs off the side slopes, will be managed as industrial stormwater. Material spills will be cleaned up and placed back with the ore, either directly in a rail car or back in the RTH. The loading area in front of the RTH will be a concrete pad in order to contain spilled material, facilitate cleanup, and direct mine water to the mine water pond. Permit application support drawings of the RTH include Drawings G-100-B, G-101-B, and G-101-C in Appendix 3.

The RTH will be located to the south of the mine pits and will be connected to the existing mainline railroad by the new Railroad Spur, as shown on Figure 7-1 though Figure 7-3.

The OSP (Figure 10-22) will be constructed near the RTH to facilitate delivery of a consistent flow and a uniform grade of ore to the Beneficiation Plant. PolyMet may place ore on the OSP if the mining rate exceeds the loadout rate at the RTH. Ore will flow into and out of this pile during operations as needed to meet mine and plant operating conditions. The alignment of the Railroad Spur to the RTH and the OSP will allow direct loading of rail cars by a front-end loader at the OSP. Direct loading could occur if the RTH is unavailable due to maintenance and repairs, if the storage volume of the RTH is full, if disabled equipment at the RTH prevents trucks from dumping, if there are problems with the rail system, and if there are problems at the Beneficiation Plant. Additionally, the RTH will not be constructed until Mine Year 1; prior to the availability of the RTH, ore will be directly loaded in rail cars by a front end loader from the OSP.

Ore will be hauled to the OSP from the haul road to the north. Material will be removed from the OSP by loading into rail cars along the south face of the OSP or, on a rare occasion if the pits are inaccessible (e.g., flooding), hauled by truck to the RTH while also loading at the south face of the OSP. Operation of this surge pile will not necessarily be first in-first out; previously stockpiled ore may be covered by subsequent truckloads of ore. Regardless of the length of time in the OSP, the material will be processed through the Beneficiation Plant, and drainage from the OSP will be captured and managed as part of the mine water system. The current design of the OSP has a capacity of 2.5 million tons in one 40-foot lift with side slopes at the angle of repose. Additional lifts can be constructed to increase storage capacity as necessary.

Because the ore will have a sulfur content similar to Category 4 waste rock, the OSP will have a lined foundation. The liner system is the same as the Category 4 Waste Rock Stockpile liner specifications, as shown on Figure 10-28. Drainage from the OSP will be collected on the liner and routed to a sump for pumping to the Equalization Basin Area. At the completion of mining activities, PolyMet will remove the ore from the OSP, and the footprint will be reclaimed. Section 10.4 provides more details regarding the OSP.

7.4.2.2 Mine Site Fueling and Maintenance Facility

Equipment fueling and minor service and repair work will occur at the MSFMF, which will be located north of the RTH, as shown on Figure 7-1 though Figure 7-3. This facility will consist of two buildings: one for fueling mobile equipment (Fueling Station), and the second for mobile equipment maintenance (Maintenance Building). The design of the MSFMF is in progress, and engineering drawings of this facility can be submitted as part of final design.

Minor mobile equipment maintenance will take place at the maintenance building. These maintenance activities will include oil changes, filter changes, maintenance of fluid levels, tire changes, lamp changes, haul truck box welding, and other short duration maintenance that can be done without the need of a large overhead crane.

PolyMet will perform major scheduled maintenance and repair work on mobile equipment such as haul trucks, front end loaders, rubber tired dozers, and motor graders in the refurbished and reactivated former LTVSMC Area 1 Shops, located about one mile west of the Beneficiation Plant. Because of the size and weight of the primary excavators and blast hole drill rigs, as well as the distance to the Area 1 Shops, most of their maintenance and repair work will be done at the Mine Site.

Storage, handling, and use of oil and related products at the MSFMF will be included in the Project's SPCC Plan, which will be developed prior to aboveground oil storage of greater than 1,320 gallons.

7.4.2.3 Overburden Storage and Laydown Area

PolyMet will construct the OSLA to the west of the RTH and will grade it to provide a well-drained site. This area will serve to screen, sort, and temporarily store peat and unsaturated mineral overburden that may be used for future construction or reclamation purposes. Grading of the site will direct drainage to an unlined pond in the southwest corner of the OSLA. Section 10.4.3 and Sections 2.2.2 through 2.2.4 of the

Rock and Overburden Management Plan in Appendix 11.1 provide additional detail on the design and operation of the OSLA. Grading of the OSLA is shown on Drawing EW-009 in Appendix 3. Water quality monitoring of internal waste streams, including the water quality in the OSLA pond, is discussed in Section 14.3.1.4, which explains that the details of the OSLA water quality monitoring will be determined in the NPDES/SDS Permit.

7.4.2.4 Environmental Controls

Environmental controls will be in place to minimize environmental impact during construction activities. Mine Site environmental controls will include measures to minimize fugitive dust from Mine Site development as described in Section 13.1. Storage, handling, and use of oil and related products will be consistent with the PolyMet's SPCC Plan(s) that will be developed prior to aboveground oil storage of greater than 1,320 gallons. Once required, the SPCC Plan will address storage and containment of petroleum based products on site in capacities of 55 gallons or more, including mobile equipment. Measures to protect against contamination of stormwater from oil and related product storage and handling are further provided in the Construction SWPPPs to meet the requirements of the Construction General Stormwater Permit. The Construction SWPPPs will include Best Management Practices (BMPs) to reduce the potential for erosion to impact stormwater. Stormwater and sediment control features that will prevent sedimentation and minimize transport of sediment in stormwater runoff to adjacent land will be constructed during initial site clearing work. This will include installing erosion and sediment controls, and constructing berms, ditches, and sedimentation ponds. Stabilization of stormwater and sediment control features will be initiated immediately after construction and completed in accordance with MPCA's Construction Stormwater General Permit requirements. Appendix 5 provides design details on the permit application support drawings of the Mine Site stormwater features. After the construction phase, measures to protect against contamination and transporting sedimentation to adjacent lands will be implemented through the Industrial SWPPP.

7.4.2.5 Equalization Basin Area

Before operations begin, the Equalization Basin Area will be constructed to pump mine water to the WWTS and construction mine water and OSLA runoff to the FTB. Additional information on the Equalization Basin Area is provided in Section 11.3.2.4. It will consist of the CPS, High and Low Concentration Equalization Basins, a Construction Mine Water Basin, and a Construction Mine Water Pumping Station. Mine water from the Equalization Basin Area will be pumped through the MPP to the WWTS or FTB for use at the Plant Site or used in the flooding of the East and Central Pits. Additional information on the WWTS is provided in Section 11.4.8.

7.5 Mining Operational Activities

The Project will use open pit mining methods similar to those currently in use at ferrous metallic mining operations on the Iron Range. The Project will transition from construction to operations when production blasting commences to access ore at the Mine Site. PolyMet will haul ore to the RTH and the OSP, and waste rock and overburden to the appropriate stockpile based on the waste characterization and classification completed for the Project. This Section 7.5 provides details on open pit mining methods, drilling and blasting, excavation and hauling, and auxiliary equipment.

7.5.1 Open Pit Mining

The Project will include three separate open pits known as the East, Central, and West Pits. For approximately the first half of operations, mining will take place in the East and West Pits simultaneously.

The Beneficiation Plant feed rate will progressively increase as plant operations ramp up in the first year of production. PolyMet will schedule ore production to match the Beneficiation Plant feed rate to provide an adequate supply of ore and a continuous supply of plant feed. PolyMet will progressively refine the pit configuration, mine schedule, and stockpile layout throughout the projected 20-year life of the mine, staying within the permitted maximum footprints and heights of the stockpiles and maximum footprints and depths of the pits. Changes to the stockpile maximum footprints or heights and/or pit maximum footprints or depths may require an amendment to the Permit to Mine, per Minnesota Rules, part 6132.4200. PolyMet anticipates that the sequence of mining will proceed as described in Section 7.3, and its annual report will detail the anticipated mining sequence for the upcoming year and the work completed the past year. A template of the annual report is included in Appendix 13.1. Figure 7-1 to Figure 7-3 and Figure 7-6 and Figure 7-7 show the progression of pit development and the anticipated final pit configuration, before backfilling the East Pit with waste rock. At its ultimate size, each pit is projected to have the approximate footprint area and depth listed in Table 7-4 and shown on Figure 7-6 and Figure 7-7. The progressive development of stockpiles over the 20-year LOM is also depicted on Figure 7-1 through Figure 7-3. Figure 7-10 through Figure 7-13 show cross-sections of the stockpiles and OSP.

7.5.2 Open Pit Rock Slope Design

PolyMet retained Golder to develop an open pit rock slope design (Reference (8)). This Section 7.5.2 summarizes the development of the open pit rock slope design. Appendix 16.22 contains a more complete discussion of the investigation and findings of the open pit rock slope design.

7.5.2.1 Geotechnical Investigation

Golder collected rock cores and discontinuity data from 16 geotechnical drill holes in the proposed West Pit and East Pit areas. All drill holes were inclined. Golder logged all 16 geotechnical holes for recovery, RQD, and fractures per run. Recovery was very close to 100% and RQD is excellent, typically exceeding 95% in all rock units. In addition, the cores were logged for the Roughness Parameter and Joint Alteration Index in accordance to Barton's Q-System (Reference (27)).

The following field and laboratory data are included in Reference (8):

- geotechnical profiles of the drill holes, rock core photographs, and geotechnical and intact rock mass properties
- plots of discontinuity data (stereonets - abbreviations used for various discontinuity types are listed in Table 7-5)
- kinematic assessment based on oriented core data

Before commencing operations, PolyMet anticipates performing additional geotechnical work to inform final designs.

7.5.2.2 Kinematics Assessments and Slope Design Recommendations

Golder also provided kinematics assessments and pit slope recommendations (Reference (8)). Based on the results of kinematic assessments, the West Pit and East Pit ultimate slope design recommendations are summarized in Table 7-6 and Table 7-7, respectively and detailed in Reference (8).

Table 7-6 and Table 7-7 list calculated inter-ramp angle recommendations for the West and East Pits, respectively, on the basis of 30-meter (m) vertical bench separation (98-feet) and 10-m berm widths (33-feet) for bench face angles of 65° and 70°. To date, pit design has been based on a 51° inter-ramp angle in both pits. Therefore, based on current design, adequate berms (10-m or 33-feet) can be maintained.

7.5.2.3 Pit Slope Design During Operation

Consistent with industry standard practice, PolyMet will base final pit slope design on pit slope monitoring, geotechnical recommendations, ongoing mapping, and data collection. PolyMet will perform analysis from the commencement of mining operations. This analysis will allow PolyMet to refine the current preliminary design (based on core logging) to update and modify slope designs on the basis of "real-time" data and field measurements.

PolyMet will manage pit slopes on an ongoing basis through pit slope stability monitoring and analysis, which will evaluate pit slopes, rock types, and pit wall movement, as described in Section 14.2.1.

PolyMet will perform this ongoing sequence of mapping, data collection, and analysis during operations to maintain safe pit slopes, and to design mitigation procedures as necessary. Because the mine will deepen gradually, there will be adequate time before pit walls reach their ultimate position to modify slope angles and berm widths, if necessary.

PolyMet will maintain the stability of the pit slope over the LOM by modifying, as necessary, the pit slope design to account for groundwater inflow conditions. Once mining begins, PolyMet will evaluate the need for additional dewatering of pit slopes, based on field conditions. The NorthMet Pit: Conceptual Plan for Bedrock Groundwater Flow Mitigation, which includes grouting to be implemented if needed, is included in Appendix 17.3.

7.5.3 Drilling and Blasting

Blasting of waste rock and ore is described in the Blasting Plan included in Appendix 12.3. This includes a description of drilling before blasting, monitoring blasting activities, estimated quantities of annual blasted material, and continued refinement of the drilling and blasting designs to optimize methods. Section 14.2.1.2 discusses blast monitoring, which is also detailed in the Blasting Plan (Appendix 12.3).

7.5.4 Excavation and Haulage

After drilling and blasting, the ore and waste rock will be loaded by excavators into haul trucks that will transport the ore to the RTH or OSP and the waste rock to stockpiles, or after Mine Year 11, to the East Pit. Electric-hydraulic excavators will be the primary rock loading equipment in the mining fleet with a large diesel front-end loader available to provide operational flexibility and additional loading capacity. The haul truck fleet will initially consist of conventional diesel-powered rear dump trucks. Haul trucks may be re-assigned between excavators loading ore and waste rock.

7.5.5 Mine Auxiliary Equipment

Mine operations will also require auxiliary equipment. Table 7-8 lists the vehicles and equipment currently anticipated as the Project fleet. Once operations commence, PolyMet may adjust its fleet based on operational considerations.

7.5.6 Mine Site Progressive Reclamation

PolyMet will undertake progressive reclamation of various facilities, as practical, during the LOM. When areas are closed and no longer necessary for the operations, PolyMet will undertake progressive reclamation of those areas in accordance with Minnesota Rules, chapter 6132. PolyMet's Annual Report to DNR under the PTM Regulations will include the reporting of reclamation activities that take place during the prior year. A template for PolyMet’s Annual Report is included in Appendix 13.1 and requires reporting of the following:

- a description of the reclamation activities completed in the previous year
- the anticipated reclamation activities in the upcoming year, including methods, schedule, and research
- notification of intent to close any portions of the Mining Area in the upcoming year

Vegetative reference areas will be used to evaluate the effectiveness of the reclamation vegetation activities. Vegetative reference area locations for the Mine Site are shown on Figure 15-3 and Figure 15-4.

Progressive reclamation of the Mine Site during Project operations will include:

- relocation of the waste rock from the Categories 2/3 and 4 Waste Rock Stockpiles to the East Pit (Section 10.4.6.4 and Section 6.1.2.2 of the Water Modeling Data Package, Volume 1 (Appendix 16.19))
- removal of mine water management systems associated with the Categories 2/3 and 4 Waste Rock Stockpiles (Section 10.4.6.4)
- removal of select pit dewatering pumps and pipes in the East and Central Pits and East Pit flooding (Section 10.4.6.4)
- incremental installation of the Category 1 Waste Rock Stockpile Cover System (Section 10.4.5.4)

- reclamation of the pit rim overburden backslopes (Section 10.4.6.5)
- installation and vegetation of a pit exclusion dike (Section 10.4.6.5)
- removal of the Construction Mine Water Pumping Station and reclamation of the Construction Mine Water Basin, when no longer needed (Section 11.3.2.4)

Table 7-1 Estimated Annual Production Rates – Waste Rock and Ore

Mine Year	Ore (tons)	Category 1 (tons)	Category 2 (tons)	Category 3 (tons)	Category 4 (tons)	Total Waste Rock (tons)
1	4,285,400	18,707,500	4,674,400	564,300	1,489,200	25,435,500
2	11,680,000	15,016,700	3,821,800	611,100	762,500	20,212,000
3	11,680,000	16,139,000	3,739,800	557,300	1,127,700	21,563,900
4	11,680,000	12,796,600	3,275,700	379,900	827,500	17,279,700
5	11,680,000	11,741,300	2,384,800	30,300	441,900	14,598,200
6	11,680,000	16,842,200	3,914,200	434,800	665,600	21,856,800
7	11,680,000	10,405,000	2,382,800	183,200	549,000	13,520,100
8	11,680,000	16,939,800	3,883,900	448,300	110,600	21,382,700
9	11,680,000	12,556,200	4,147,800	512,400	133,500	17,349,800
10	11,680,000	12,974,200	3,589,900	480,600	76,800	17,121,600
11	11,680,000	10,180,400	3,717,400	286,500	22,400	14,206,700
12	11,680,000	10,773,100	4,253,100	531,600	50,100	15,607,800
13	11,680,000	8,133,600	5,050,000	662,900	36,300	13,882,700
14	11,680,000	8,474,200	3,258,300	378,200	66,900	12,177,700
15	11,680,000	6,166,000	4,288,500	401,300	94,100	10,949,900
16	11,680,000	4,444,100	2,875,900	912,900	866,300	9,099,300
17	11,680,000	4,022,300	1,841,900	563,100	528,200	6,955,500
18	11,680,000	5,592,500	2,628,000	321,000	300,200	8,841,600
19	11,680,000	6,944,600	4,296,300	483,000	220,300	11,944,200
20	10,754,600	7,845,300	5,303,900	711,400	267,400	14,128,000
Total	225,280,000	216,694,700	73,328,300	9,454,000	8,636,600	308,113,700

Estimates subject to change based on metal prices and other factors.
Source: *NorthMet Project - Mine Plan* (Appendix 16.22)

Table 7-2 Pit Activities Over Life of Mine – Mining and Waste Rock Placement

Mine Year	East Pit	Central Pit	West Pit
1	M		
2	M		M
3	M		M
4	M		M
5	M		M
6	M		M
7	M		M
8	M		M
9	M		M
10	M		M
11	M / WR	M	M
12	WR	M	M
13	WR	M	M
14	WR	M	M
15	WR	M	M
16	WR	M	M
17	WR	WR	M
18	WR	WR	M
19	WR	WR	M
20	WR	WR	M

M - Mining
WR - Waste rock placement
East and Central Pits merge in approximately Mine Year 14.

Table 7-3 Volume and Types of Overburden to be Excavated within Feature Footprints

Location	Area (acres)	Saturated Mineral Overburden (bcy)(1)	Unsaturated Mineral Overburden (bcy)(1)	Peat (bcy)(1)	Total Volume (bcy)(1)
Ore Surge Pile	31	21,000	202,000	4,000	227,000
Category 1 Waste Rock Stockpile(2)	526(2)	0	0	220,500(2)	220,500(2)
Category 2/3 Waste Rock Stockpile	180	27,000	274,000	462,000	763,000
Category 4 Waste Rock Stockpile(3)	57	3,000	53,000	43,000	99,000
West Pit	321	4,491,000	1,193,000	1,498,000	7,182,000
East/Central Pits(3)	207	1,047,000	1,450,000	227,000	2,724,000
TOTAL(3)	1,275(3)	5,589,000	3,172,000	2,454,500	11,215,500

Source: (Appendix 16.22)

(1) bcy - bank cubic yard. Bcy is the volume of material in-place. Excavation will generally increase the volume measurement of a material.
(2) The Category 1 Waste Rock Stockpile overburden excavation volumes include excavation of peat within 100 feet from the outer edge of the stockpile for stockpile stability.
(3) The Category 4 Waste Rock Stockpile footprint overlaps with the Central Pit footprint. The individual areas are greater than the total, which takes into account the overlap. The volumes listed for the East/Central Pits only include the volumes in excess of the stockpile.

Note:
Estimates subject to change based on metal prices and other factors.

Table 7-4 Maximum Pit Dimensions

Mine Pit	Area (acres)	Maximum Depth (feet below ground surface)
West	321	630
Central	52	356
East	155	696

Source: (Appendix 16.22)

Note:
Estimates subject to change based on metal prices and other factors.

Table 7-5 List of Abbreviations for Describing Discontinuities

Abbreviation	Definition
BD	bedding
CL	cleavage
CO	contact
FLT	fault
FO	foliation
FO IN HNF INCL IN	foliation in hornfels inclusion
JN	joint
JN/VN	joint or vein
SHR	shear
VN	vein

Table 7-6 West Pit Ultimate Slope Design Recommendations

Material	Sector and Wall Dip Directions	Maximum Vertical Bench Separation (m)	Bench Face Angle (°)	Bench Width (m)	Inter-Ramp Angle (°)
Unit 1 on Footwall, Unit 1 and overlying units on other walls	Sector I Footwall 090° to 160°	30	65(1)	10	51.4
	Sector II East Wall 170° to 260°	30	65	10	51.4(2)(3) *(53.8)*
	Sector IIIa Hanging Wall 260° to 020°	30	65	10	51.4(2) *(53.8)*
	IIIb West Wall/Footwall 020° to 090°	30	70	10	55.1

(1) On the Footwall, the Bench Face Angle is limited to 65° to control steep potential wedges. Flat sets (dip less than 35°) dipping out of the wall are also prevalent. While estimated friction angle on the joints of these sets is on the order of phi = 35° based on Jr and Ja logging, localized failures involving these features may still occur, in particular if adequate slope depressurization is not achieved and/or if joint surfaces are significantly altered.

(2) On West Pit Sectors II and IIIa, there is upside potential for slope steepening, if lack of adverse structure can be verified, by reducing the bench width to 8m or increasing the Bench Face Angle to 70° or better, provided that experience with initial slopes, confirmed by mapping, indicates that adverse wedges and planes with dips in the 47° to 51° range are not problematic. Reducing the bench width from 10m to 8m, with BFA=65° would provide IRA=53.8°.

(3) The East Wall of the proposed West Pit is significant enough in length and height for consideration of further drilling investigation at the detailed design stage. Drilling of a geotechnical borehole (oriented core) with NE azimuth would be the best way of justifying steeper slopes in advance of experience with initial benches. Geotechnical boreholes from the present study have azimuths parallel to the strike of this proposed wall.

Abbreviations:

m = meter

° = degree

Source: Adapted from Appendix 16.22

Table 7-7 East Pit Ultimate Slope Design Recommendations

Material	Sector and Wall Dip Directions	Maximum Vertical Bench Separation (m)	Bench Face Angle (°)	Bench Width (m)	Inter-Ramp Angle (°)
Unit 1 and Virginia on Footwall and East Wall, Unit 1 and overlying units on other walls	Sector I Footwall 200° to 115°	30	65	10	51.4[1] (47)
	Sectors II, III, and IV East[2] South (Hanging Wall[3] and West Walls 115° to 200°	30	65	10	51.4

(1) The East Pit Footwall Design of IRA=51° is considered aggressive because of kinematically possible wedges (plunges 47° to 51°) and also because of kinematically possible plane failures (dip 43° to 59°). This more adverse fabric arrangement appears to be related to steeper apparent dips of the Virginia and overlying Duluth Complex Units. If these features are problematic on initial benches, then the IRA should be reduced to 47° by decreasing the Bench Face Angle to 60°. Adequate dewatering is essential. Concerns are mitigated by the presence of ramps and step outs on the footwall, which will help to control any localized instabilities.

(2) Slope design on the East wall is controlled by the potential for steep wedges (plunge 60 to 66° and 41°) involving assumed potentially continuous structures. This interpretation is conservative. There is upside potential to steepen the East Pit East Wall from 51° to 53° by reducing the bench width from 10m to 8m, provided experience with initial benches confirms that the initial assumptions are conservative. Similarly, bench face angles could be steepened based on operational experience and good blasting. As an alternative, an oriented core hole with NE azimuth directed into the east wall could be considered at the detail design stage of the project.

(3) Oriented core drillholes in the East Pit Hanging Wall area consistently indicate the presence of a NW dipping set (dip 38° to 40°) that could be result in plane failures. This is interpreted to be a joint set roughly orthogonal to the apparent dip of the Duluth Complex layering. It does not appear to occur in the West Pit data. Kinematically possible wedges ranging from plunge 46° to 66° are indicated from stereographic projections. Both the planes and wedges are considered discontinuous features. While the recommended bench configuration (IRA = 51.4°) is intended to control most of these features, localized instabilities may still occur.

<u>Abbreviations:</u>
m = meter
° = degree

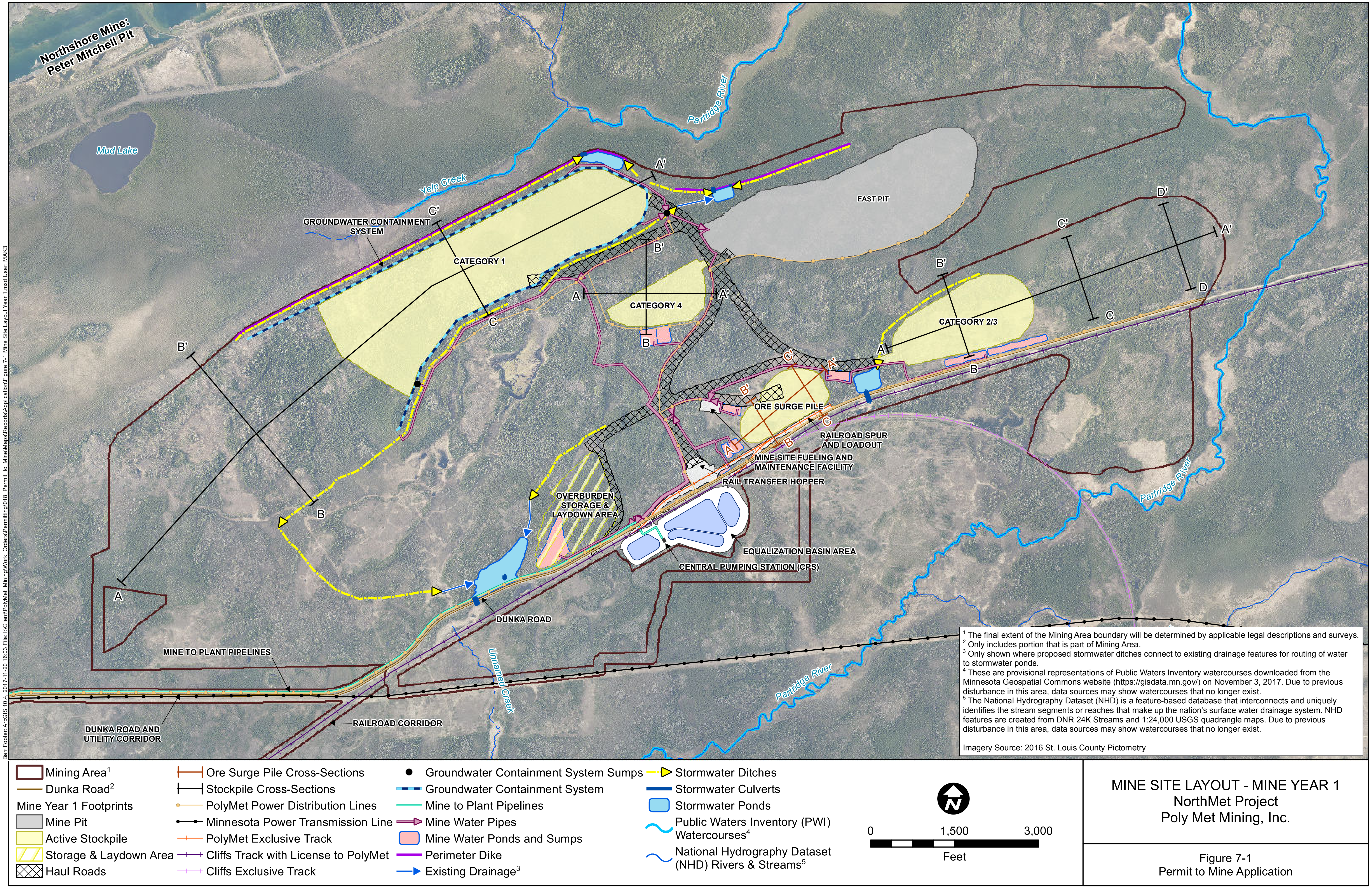
Source: Adapted from Appendix 16.22

Table 7-8 Mine Auxiliary Equipment

Typical Machine Type	Power[1]	Duties
Cat D10R tracked dozer or equivalent	582 hp	Stockpile maintenance, construction, stockpile reclamation
Cat 834G wheel dozer or equivalent	450 hp	Cleanup at the pit loading faces and the RTH
Cat 16H Grader or equivalent	275 hp	Haul road maintenance
Cat 777D Water Truck or equivalent	937 hp	Haul road maintenance, dust suppression, auxiliary firefighting duties
Cat 992G Wheel Loader or equivalent	800 hp	General purpose loading, site reclamation
Cat 446D Backhoe with Hammer or equivalent	110 hp	Secondary breakage
Cat IT62H Integrated Tool Carrier or equivalent	230 hp	Miscellaneous tasks (e.g., snow plowing, forklift, sweeper, etc.)
Field service trucks	114 hp	Field maintenance flatbed trucks fitted with hydraulic arm lift
Fuel truck	150 hp	Field fueling of mobile equipment and drills
Line truck	100 hp	Powerline maintenance, excavator, and RTH service
Off-road lowboy trailer and tractor	200 hp	Transporting equipment around mine and to service area/workshops
Drills	Electric and/or 1,600 hp	Blasthole drilling for waste rock and ore
Excavators	Electric	Excavation of ore and waste materials (waste rock and overburden)
Haul Trucks	2,500 hp	Haulage of ore and waste materials (waste rock and overburden)
Haul truck retriever	1,120 hp	Retrieving and transporting haul trucks unable to move under their own power
Light vehicles (pickups and SUVs)	150-250 hp	Supervisors' transport, general duties

(1) Equipment subject to change.
Abbreviations:
Cat = Caterpillar
hp = horsepower
RTH = Rail Transfer Hopper
SUV = sport utility vehicle

Source: (Appendix 16.22)

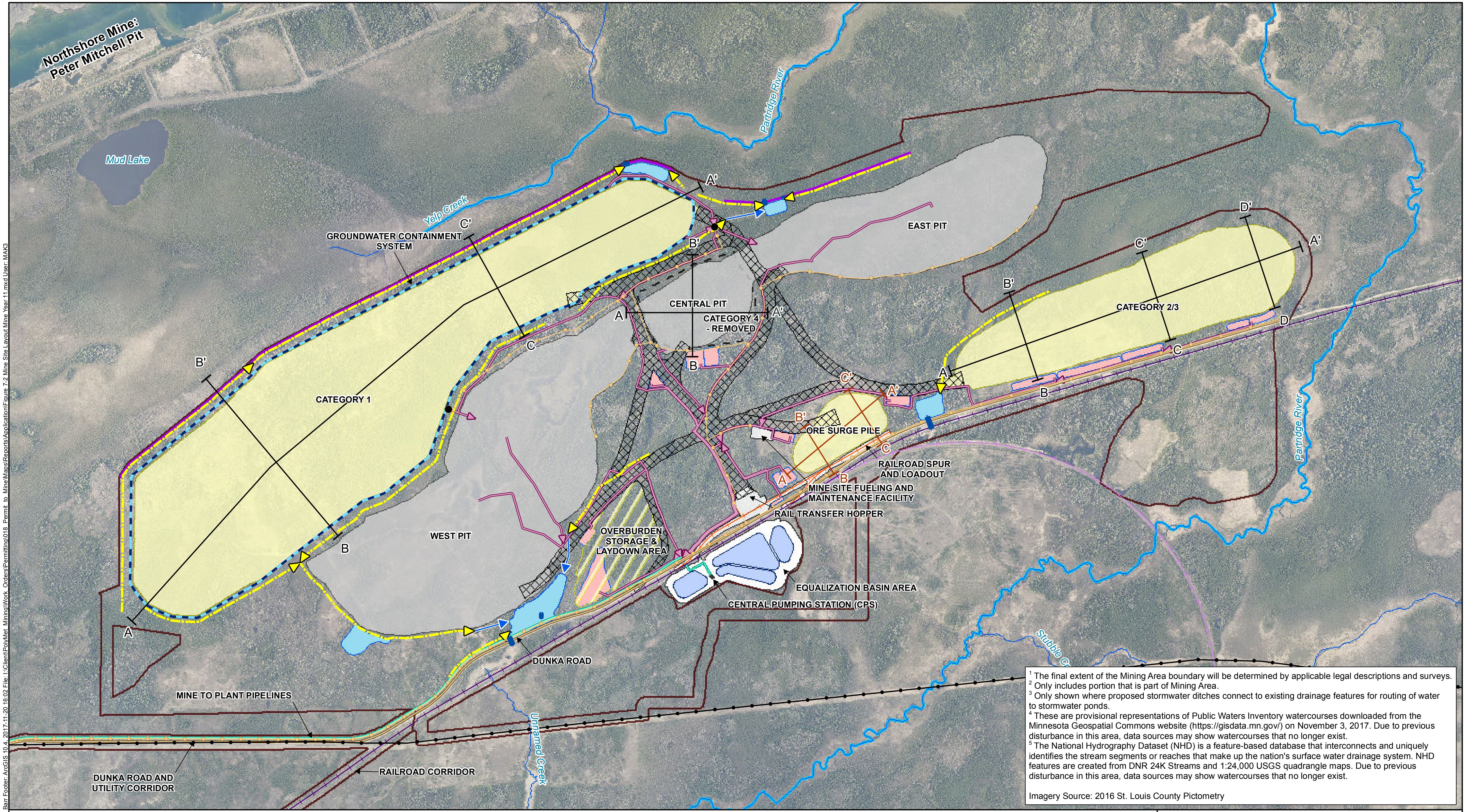


[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

MINE SITE LAYOUT - MINE YEAR 1
NorthMet Project
Poly Met Mining, Inc.

Figure 7-1
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

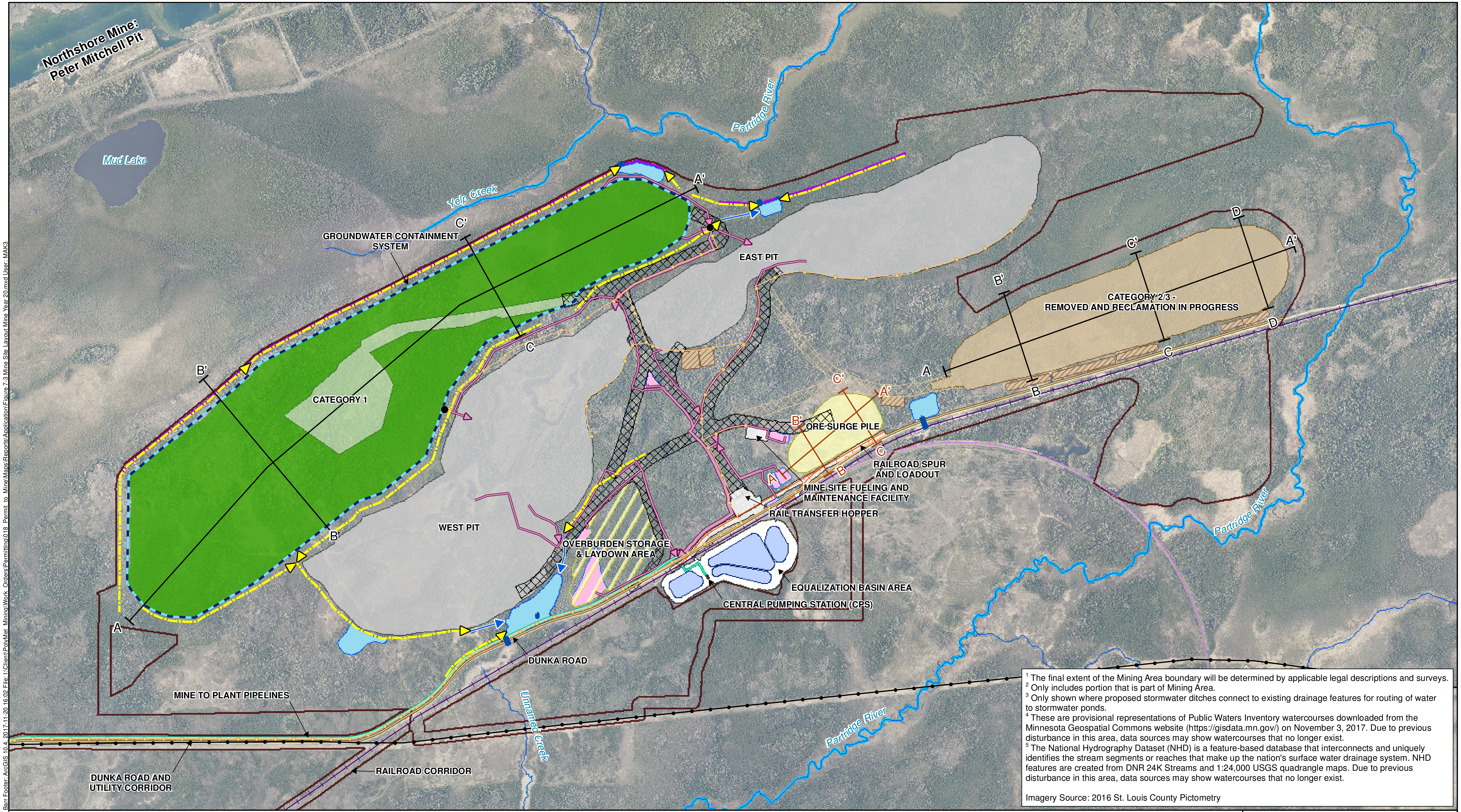
Mining Area[1]
Dunka Road[2]
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Haul Roads
Ore Surge Pile Cross-Sections
Stockpile Cross-Sections
PolyMet Power Distribution Lines
Minnesota Power Transmission Line
PolyMet Exclusive Track
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Groundwater Containment System Sumps
Groundwater Containment System
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps
Perimeter Dike
Existing Drainage[3]
Stormwater Culverts
Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE LAYOUT - MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 7-2
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 16:02 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 7-2 Mine Site Layout Mine Year 11.mxd User: MAK3



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

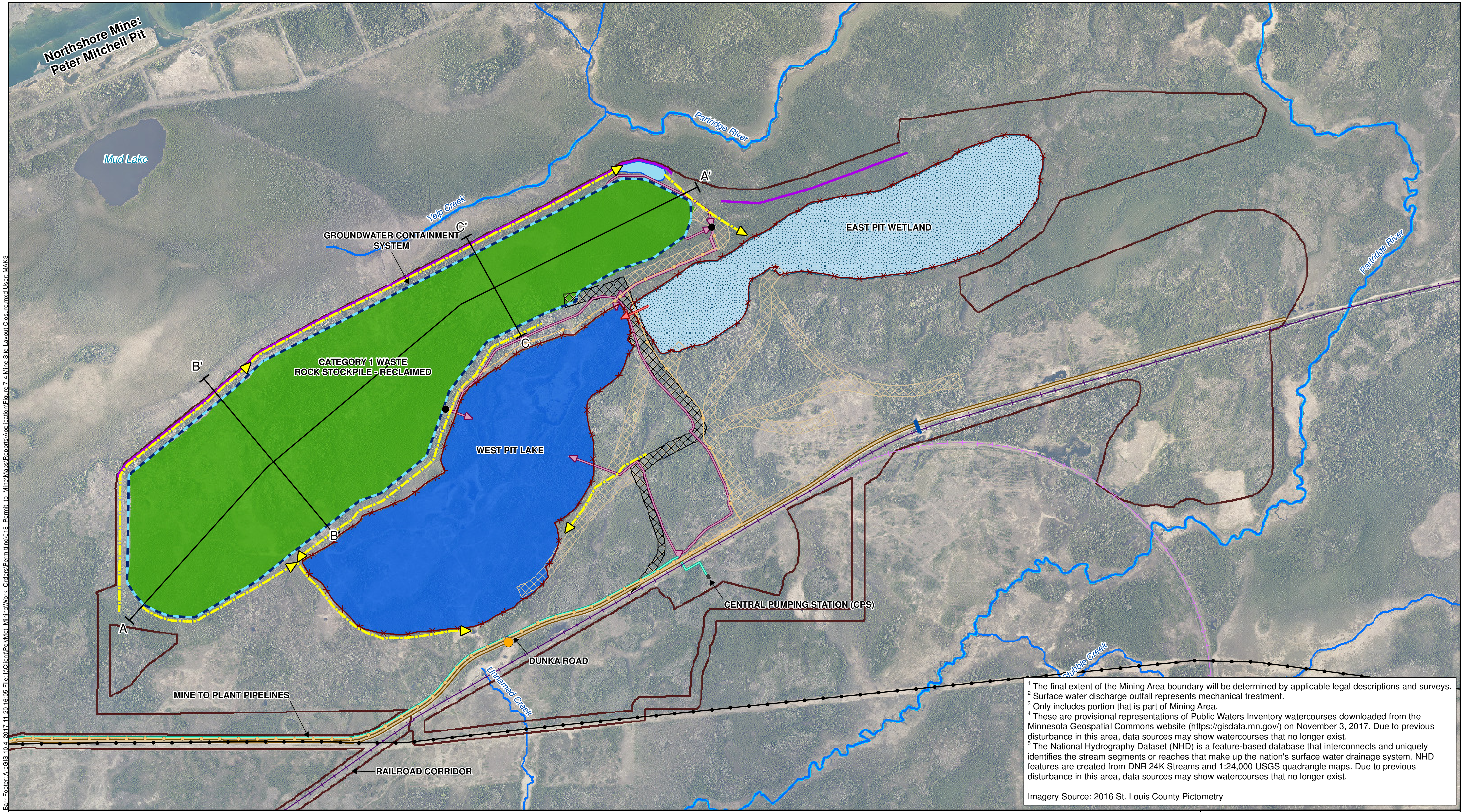
- Mining Area[1]
- Dunka Road[2]
- Mine Year 20 Footprints
  - Mine Year 20 Footprints
  - Open Stockpile
  - Covered Stockpile
  - Active Stockpile
- Storage & Laydown Area
- Removed and Reclaimed Stockpiles
- Haul Roads
- Reclaimed Haul Roads
- Ore Surge Pile Cross-Sections
- Stockpile Cross-Sections
- PolyMet Power Distribution Lines
- Minnesota Power Transmission Line
- PolyMet Exclusive Track
- Cliffs Track with License to PolyMet
- Cliffs Exclusive Track
- Groundwater Containment System Sumps
- Groundwater Containment System
- Mine to Plant Pipelines
- Mine Water Pipelines
- Reclaimed Mine Water Ponds and Sumps
- Mine Water Ponds and Sumps
- Perimeter Dike
- Existing Drainage[3]
- Stormwater Ditches
- Stormwater Culverts
- Stormwater Ponds
- Public Waters Inventory (PWI) Watercourses[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

0 750 1,500
Feet

MINE SITE LAYOUT - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 7-3
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 16:02 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\18_Permit_to_Mine\Maps\Reports\Application\Figure 7-3 Mine Site Layout Mine Year 20.mxd User: MAK3



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Surface water discharge outfall represents mechanical treatment.
[3] Only includes portion that is part of Mining Area.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

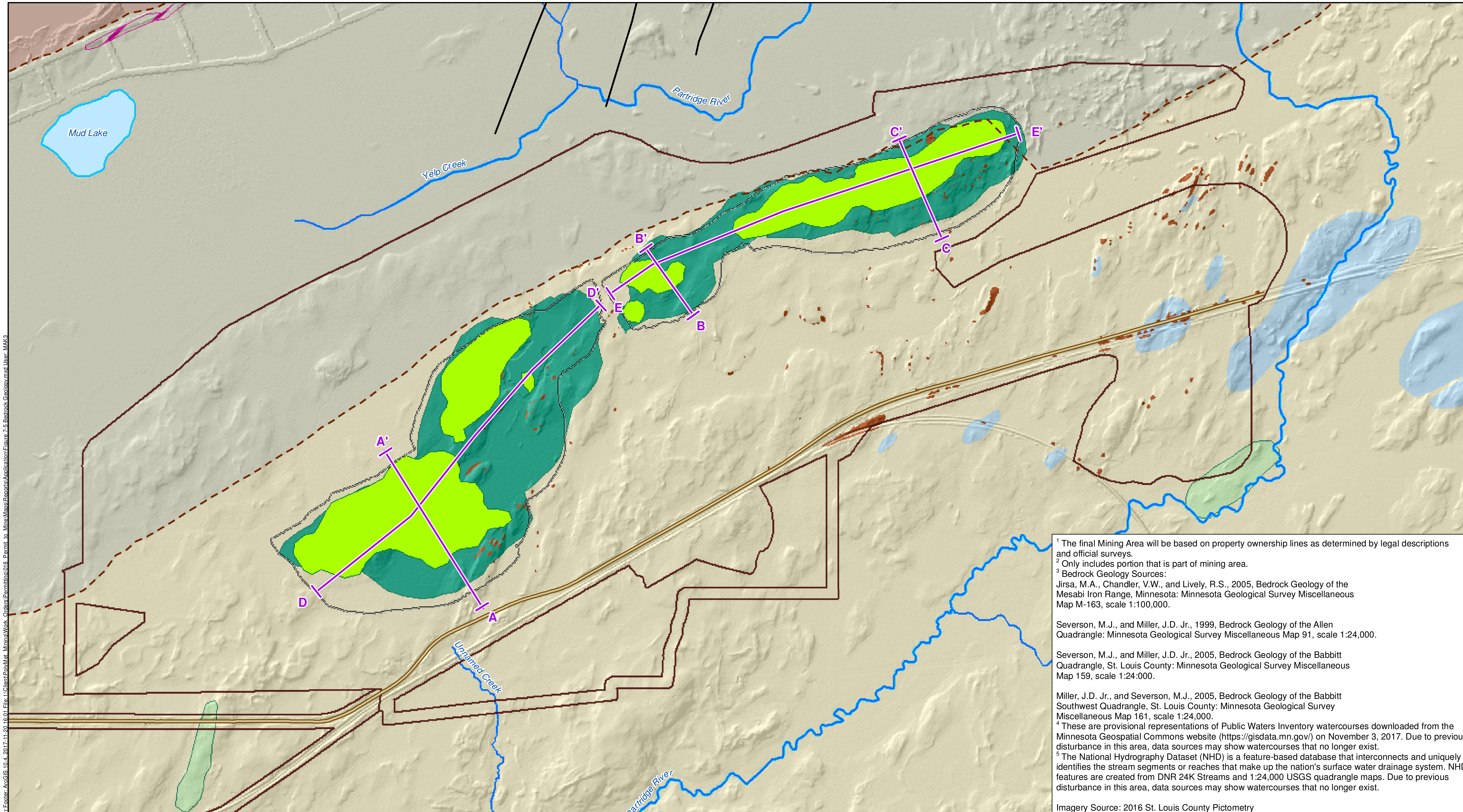
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Surface Water Discharge Outfall[2]
- Dunka Road[3]
- West Pit Lake
- East Pit Wetland
- Covered Stockpile
- Haul Roads
- Reclaimed Haul Roads and RTH
- Stockpile Cross-Sections
- PolyMet Power Distribution Lines
- Minnesota Power Transmission Line
- Cliffs Track with License to PolyMet
- Cliffs Exclusive Track
- Pit Perimeter Barrier System
- Mine to Plant Pipelines
- Mine Water Pipelines
- East Pit Overflow
- Groundwater Containment System Sumps
- Groundwater Containment System
- Perimeter Dike
- Stormwater Ditches
- Stormwater Culverts
- Stormwater Pond
- Public Waters Inventory (PWI) Watercourse[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE LAYOUT - POSTCLOSURE MAINTENANCE
NorthMet Project
Poly Met Mining, Inc.

Figure 7-4
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Bedrock Geology Sources:
Jirsa, M.A., Chandler, V.W., and Lively, R.S., 2005, Bedrock Geology of the Mesabi Iron Range, Minnesota: Minnesota Geological Survey Miscellaneous Map M-163, scale 1:100,000.

Severson, M.J., and Miller, J.D. Jr., 1999, Bedrock Geology of the Allen Quadrangle: Minnesota Geological Survey Miscellaneous Map 91, scale 1:24,000.

Severson, M.J., and Miller, J.D. Jr., 2005, Bedrock Geology of the Babbitt Quadrangle, St. Louis County: Minnesota Geological Survey Miscellaneous Map 159, scale 1:24:000.

Miller, J.D. Jr., and Severson, M.J., 2005, Bedrock Geology of the Babbitt Southwest Quadrangle, St. Louis County: Minnesota Geological Survey Miscellaneous Map 161, scale 1:24,000.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Dunka Road[2]
- Mine Pit - Mine Year 11
- Cross-Section Locations
- Mine Site Block Model Ore Body

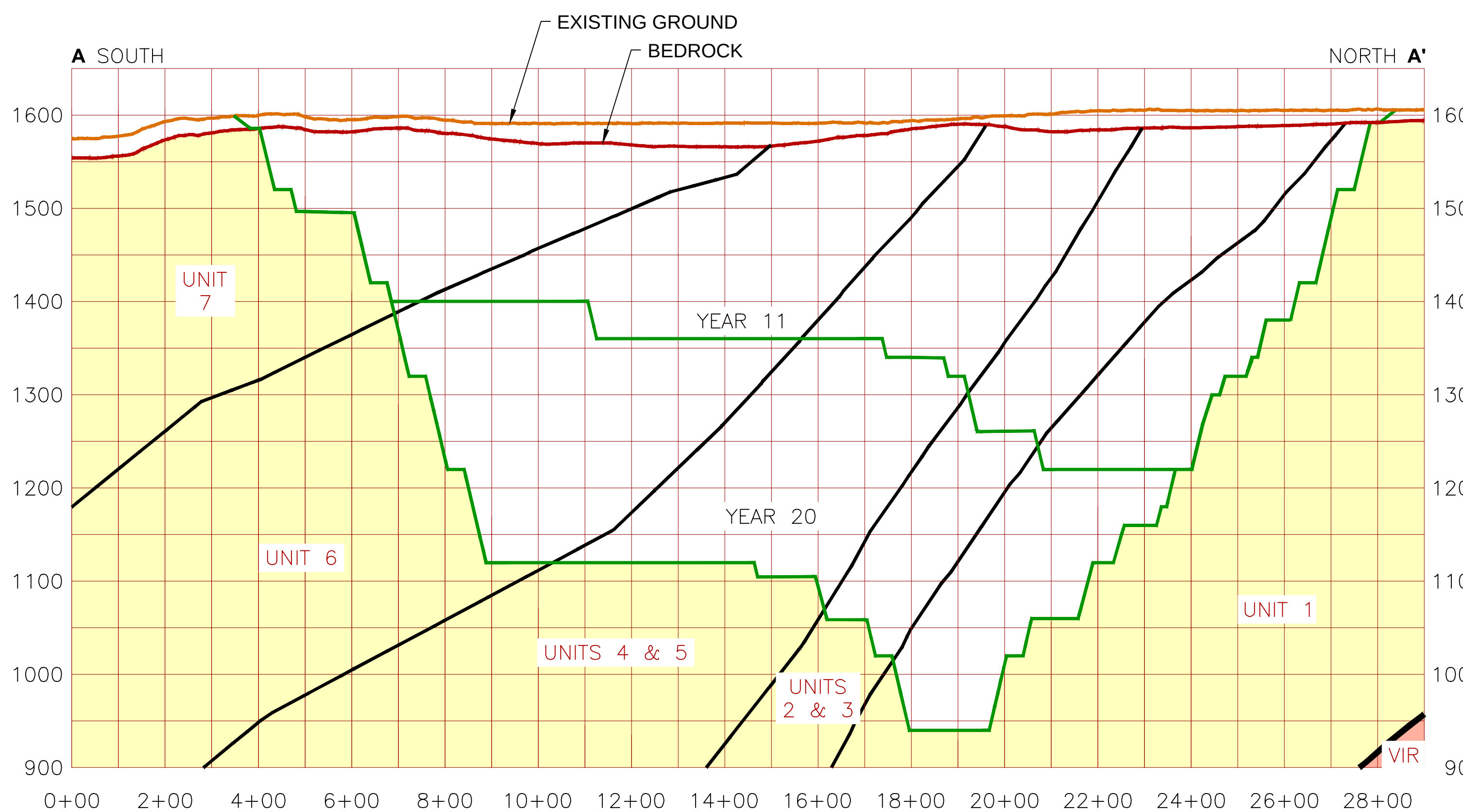
Bedrock Geology[3]
- Mnv - North Shore Volcanic Group
- Pab - Biwabik Iron Formation
- Mda - Anorthositic series subsuite of the Duluth Complex
- Partridge River instrusion
- Pav - Virginia Formation
- Mmi - Mafic intrusions
- Bedrock Outcrop
- Duluth Complex Deposits
- Geologic Contact (Approximately Located)

- Fault (Approximately Located)
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourse[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

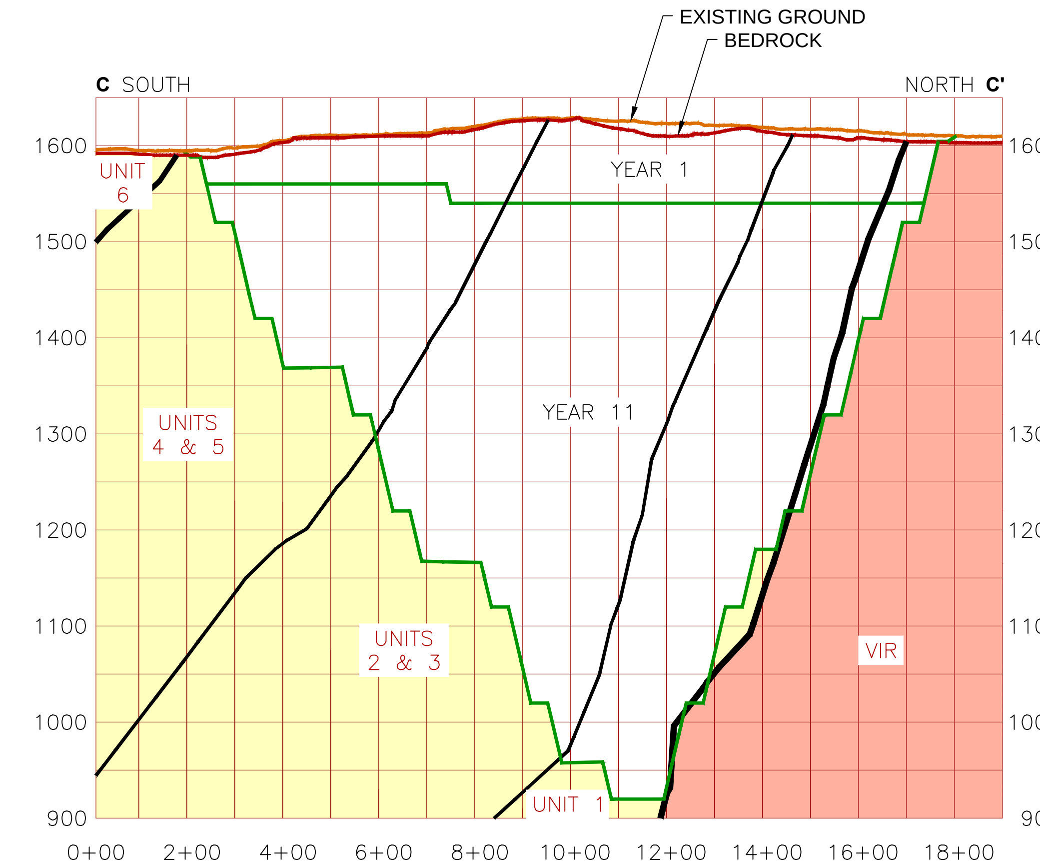
0 1,500 3,000
Feet

BEDROCK GEOLOGY
NorthMet Project
Poly Met Mining, Inc.

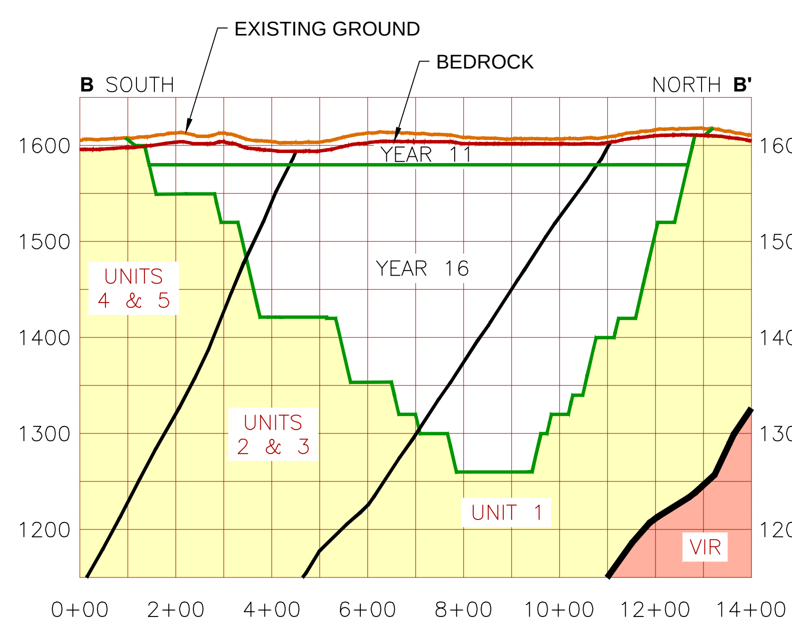
Figure 7-5
Permit to Mine Application



A – SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



C – SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION



B – SECTION: CENTRAL PIT
2:1 VERTICAL EXAGGERATION

LEGEND

- UNIT 1–7 — PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
- VIR — VIRGINIA FORMATION
- GEOLOGIC CONTACT

NOTES:

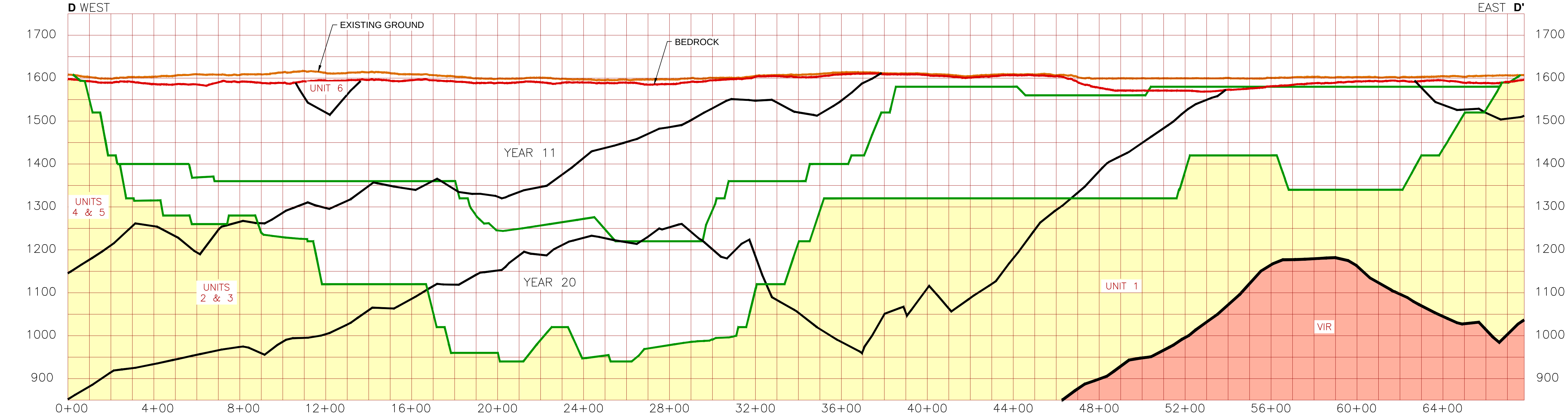
1. CROSS–SECTION LOCATIONS SHOWN ON FIGURE 7–5.
2. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.
3. CENTRAL PIT MINING WILL BE COMPLETED IN MINE YEAR 16, AT WHICH TIME, BACKFILLING WILL BEGIN.

Horizontal: 0 200 400 800 Feet

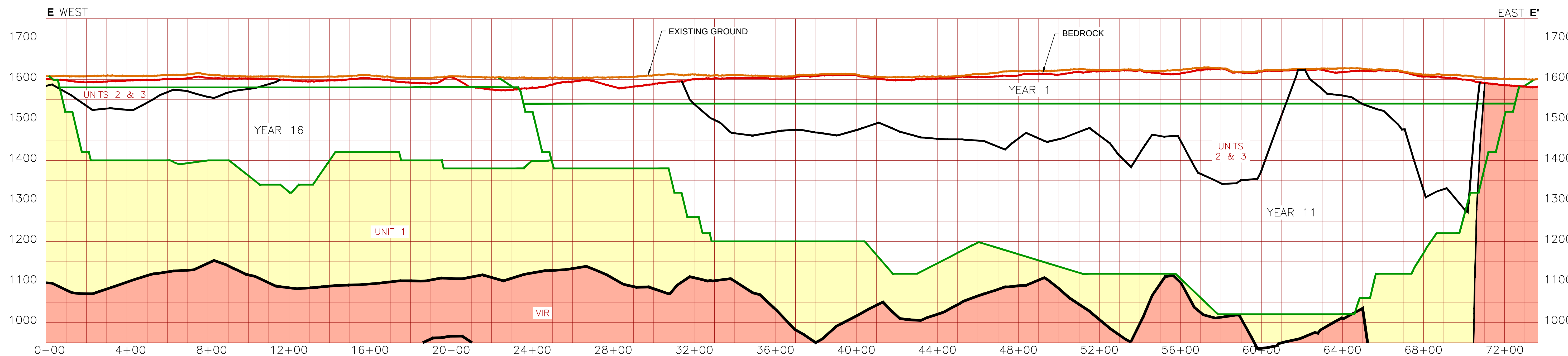
Vertical: 0 100 200 400 Feet

PIT CROSS-SECTIONS A, B, C
NorthMet Project
Poly Met Mining, Inc.

Figure 7-6
Permit to Mine Application



D SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



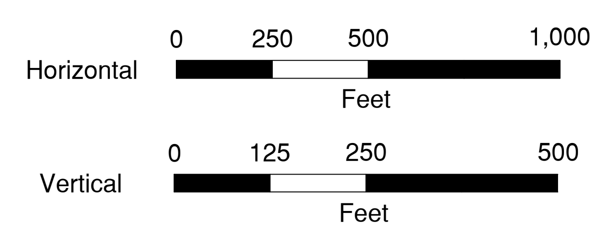
E SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION

LEGEND

- UNIT 1–7 — PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
- VIR — VIRGINIA FORMATION
- GEOLOGIC CONTACT

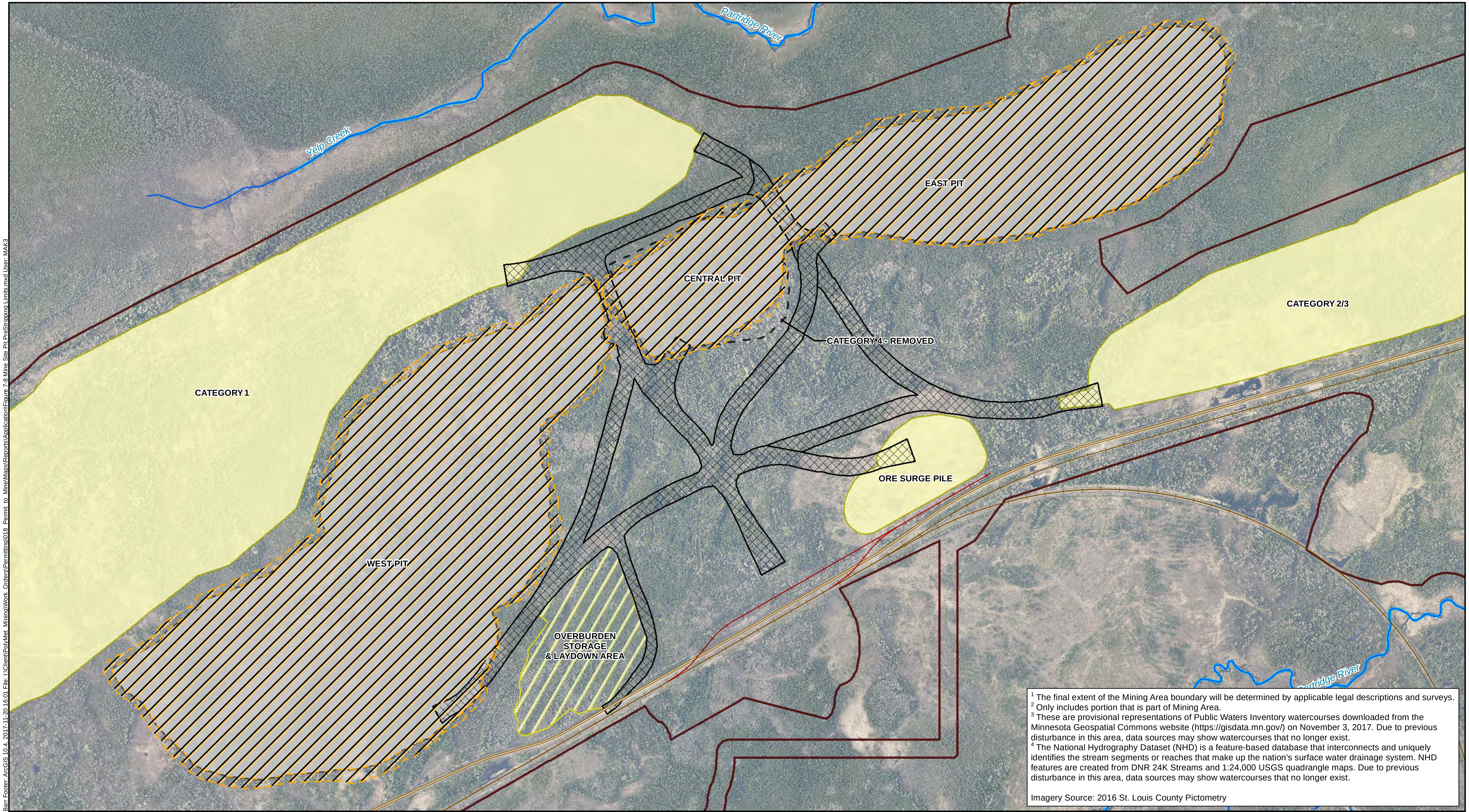
NOTES:

1. CROSS–SECTION LOCATIONS SHOWN ON FIGURE 7–5.
2. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.
3. CENTRAL PIT MINING WILL BE COMPLETED IN MINE YEAR 16, AT WHICH TIME, BACKFILLING WILL BEGIN.



PIT CROSS-SECTIONS D, E
NorthMet Project
Poly Met Mining, Inc.

Figure 7-7
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

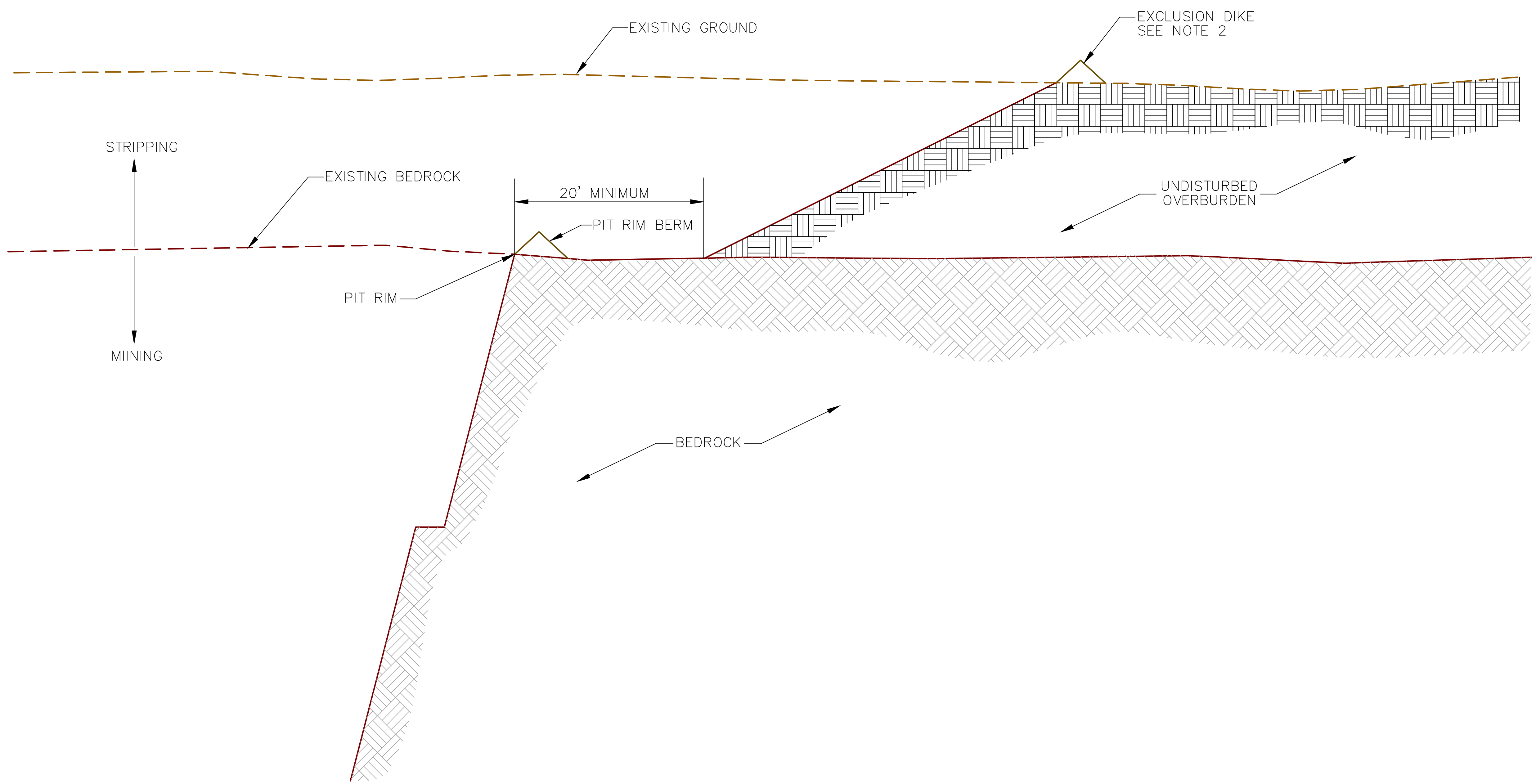
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Haul Roads
Stripping Limits
Existing Railroad
Proposed Railroad
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,000 2,000
Feet

MINE SITE PIT STRIPPING LIMITS
NorthMet Project
Poly Met Mining, Inc.

Figure 7-8
Permit to Mine Application

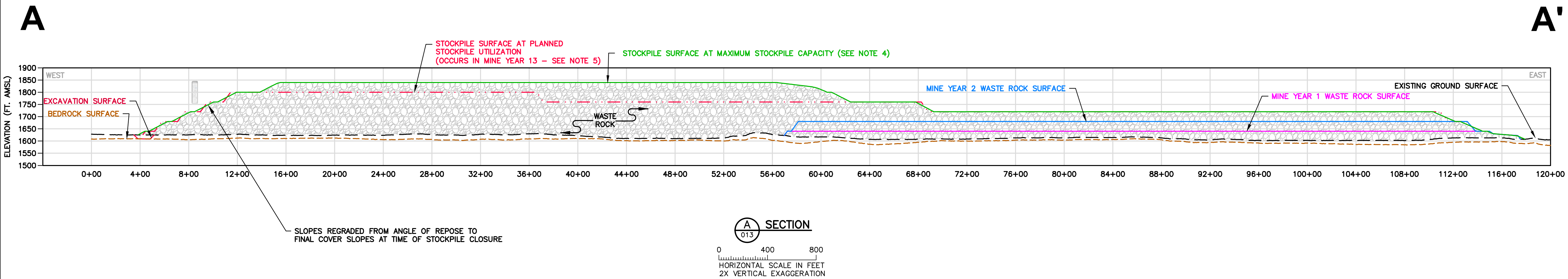


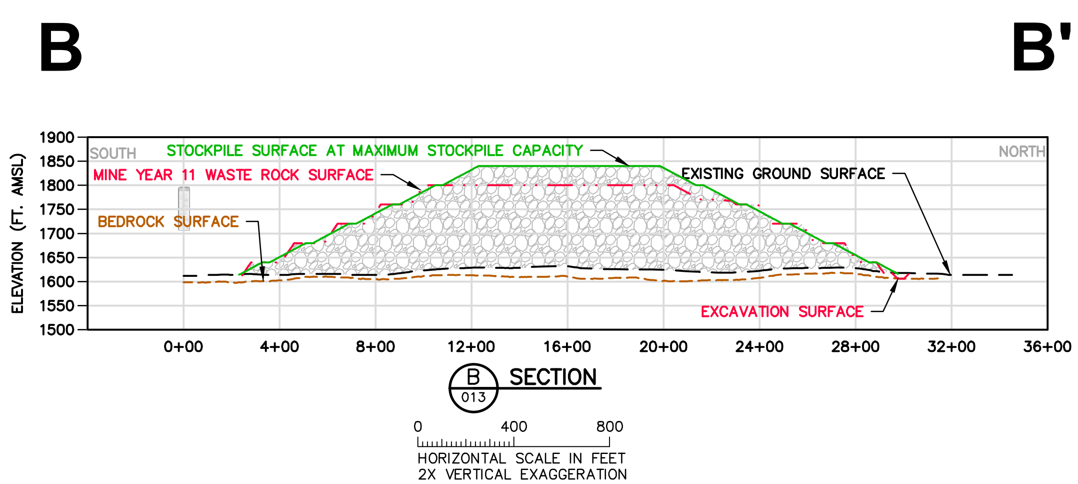
NOTES:

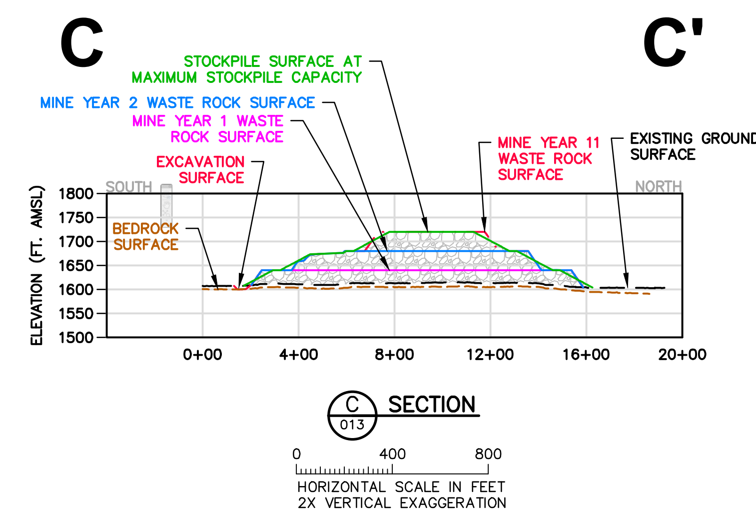
1. SOURCE: PERMIT APPLICATION SUPPORT DRAWINGS—MINE SITE AND DUNKA ROAD EARTHWORK, DRAWING NUMBER EW—008, INCLUDED IN APPENDIX 3 OF THE APPLICATION.
2. CONSTRUCT EXCLUSION DIKE AROUND PIT PERIMETER TO BLOCK SURFACE RUNOFF INTO PIT.

TYPICAL PIT STRIPPING
CROSS-SECTION
NorthMet Project
Poly Met Mining, Inc.

Figure 7-9
Permit to Mine Application







NOTE

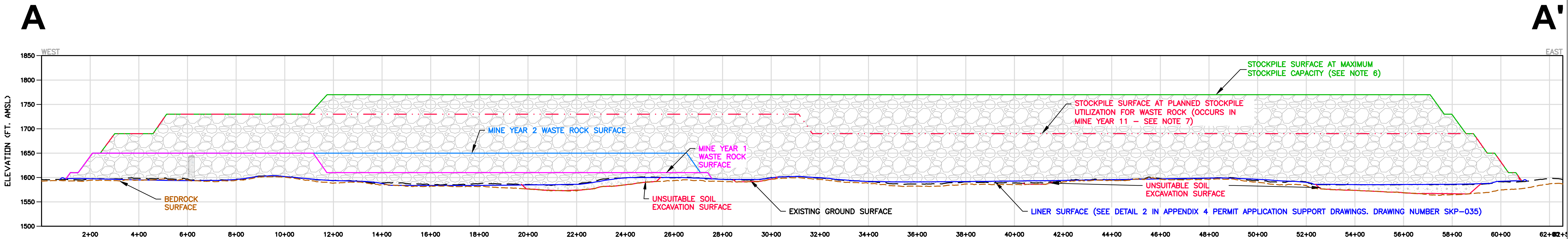
1. UNSUITABLE SOILS TO BE EXCAVATED WITHIN FIRST 100 FEET FROM THE ULTIMATE STOCKPILE BOUNDARIES. GEOTECHNICAL PROPERTIES OF THE FOUNDATION SOILS WILL BE CONFIRMED PRIOR TO FINAL DESIGN.
2. SEE CROSS–SECTION LOCATIONS ON FIGURES 7–1 THROUGH 7–4.
3. FROM GOLDER ASSOCIATES INC. DRAWING INCLUDED IN APPENDIX 4 PERMIT APPLICATION SUPPORT DRAWINGS: CATEGORIES 1, 2/3, 4 STOCKPILES AND ORE SURGE PILE DESIGN.
4. MAXIMUM STOCKPILE CAPACITY – THE TOTAL CAPACITY OF THE WASTE ROCK STOCKPILE IF FILLED TO THE MAXIMUM ELEVATIONS NOTED.
5. PLANNED STOCKPILE UTILIZATION – THE PORTION OF THE TOTAL STOCKPILE CAPACITY PLANNED TO BE UTILIZED FOR WASTE ROCK.
6. THESE FIGURES SHOW THE WASTE ROCK SURFACE AT PLANNED STOCKPILE UTILIZATION FOR WASTE ROCK. ADDITIONAL CAPACITY SHOWN UP TO THE MAXIMUM CAPACITY WILL ACCOUNT FOR POTENTIAL VARIATION IN WASTE ROCK QUANTITY AND/OR DENSITY.

LEGEND

- MINE YEAR 1 LIMITS
- MINE YEAR 2 LIMITS
- MINE YEAR 11 LIMITS
- MINE YEAR 21, ULTIMATE LIMITS
- EXISTING GROUND SURFACE
- BEDROCK SURFACE
- EXCAVATION SURFACE

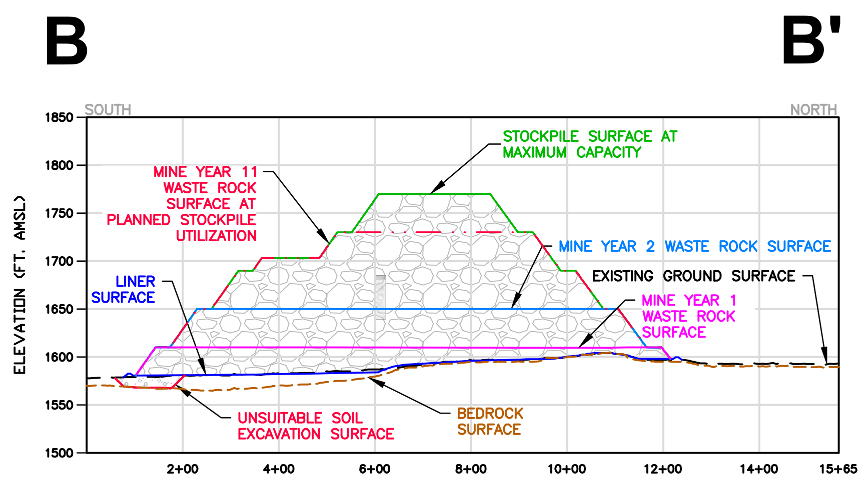
CATEGORY 1 WASTE ROCK STOCKPILE CROSS-SECTIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 7-10
Permit to Mine Application



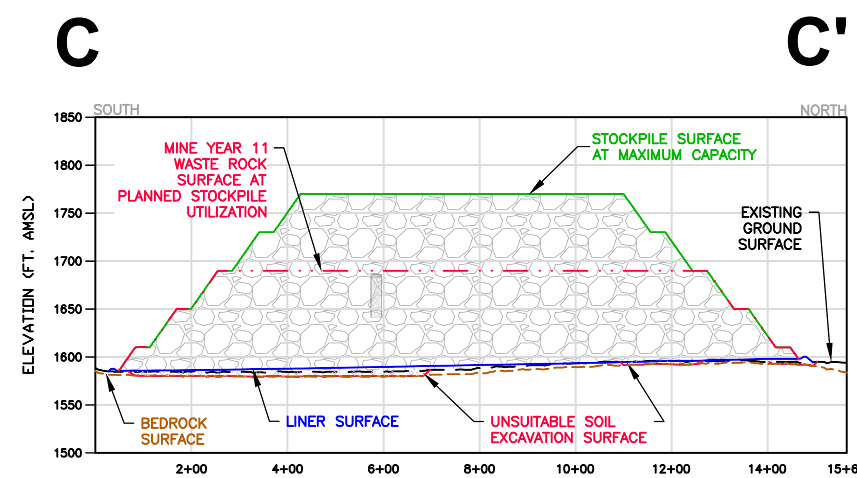
A SECTION 019

0 200 400
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



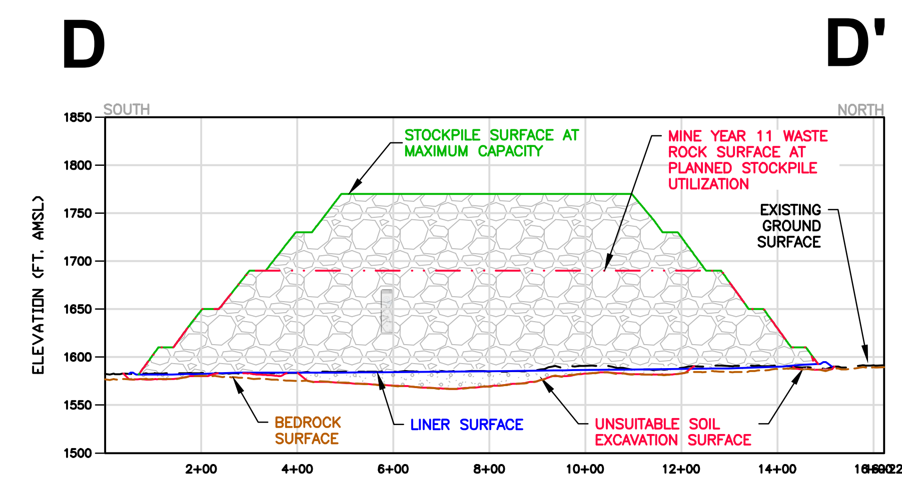
B SECTION 019

0 200 400
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



C SECTION 019

0 200 400
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



D SECTION 019

0 200 400
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION

NOTES

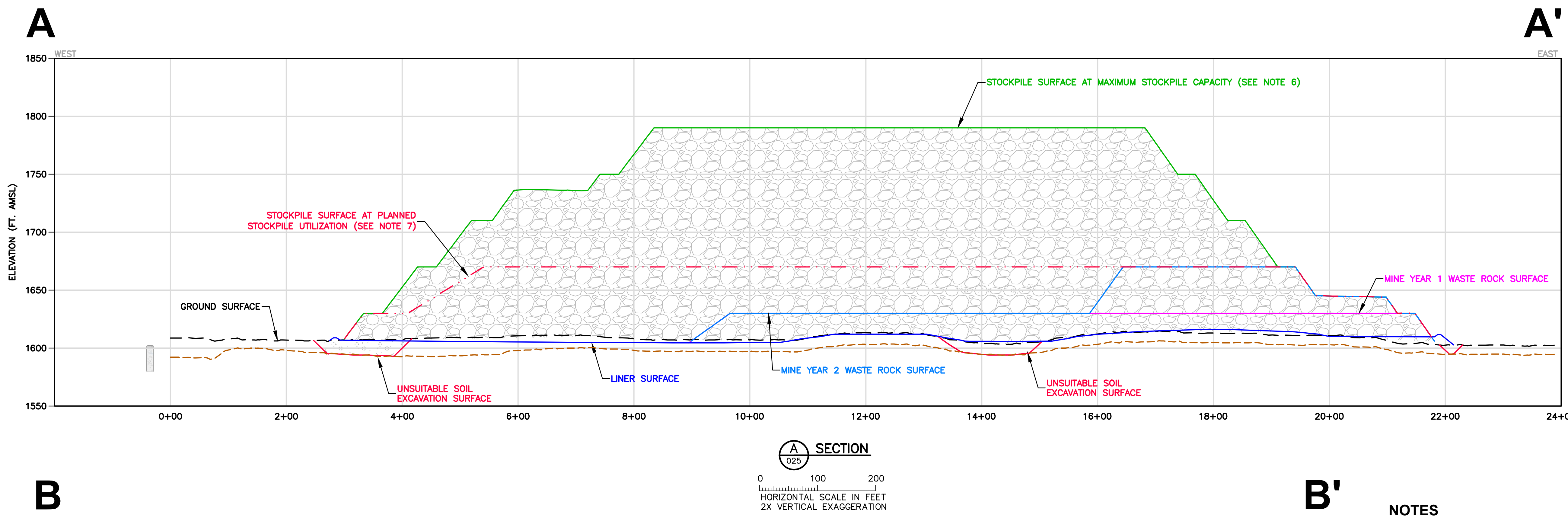
1. STOCKPILE INTERBENCH SLOPES AT ANGLE OF REPOSE.
2. THIS DESIGN CONSERVATIVELY ASSUMES THAT ALL LOWLAND/WETLAND SOILS ARE GEOTECHNICALLY UNSUITABLE AND WILL REQUIRE EXCAVATION AND REPLACEMENT WITH STRUCTURAL FILL TO THE DESIGN FOUNDATION BASE GRADE. GEOTECHNICAL PROPERTIES OF THE FOUNDATION SOILS WILL BE CONFIRMED PRIOR TO CONSTRUCTION.
3. MAXIMUM DEPTH OF UNSUITABLE MATERIAL SUBGRADE EXCAVATION LIMITED TO 20 FEET FOR THIS DESIGN. THE ACTUAL DEPTH OF UNSUITABLE SOIL EXCAVATION WILL BE CONFIRMED BY PHASE II GEOTECHNICAL INVESTIGATION.
4. SEE CROSS-SECTION LOCATIONS ON FIGURES 7-1 AND 7-2
5. FROM GOLDER ASSOCIATES INC. DRAWING INCLUDED IN APPENDIX 4 PERMIT APPLICATION SUPPORT DRAWINGS: CATEGORIES 1, 2/3, 4 STOCKPILES AND ORE SURGE PILE DESIGN.
6. MAXIMUM STOCKPILE CAPACITY – THE TOTAL CAPACITY OF THE WASTE ROCK STOCKPILE IF FILLED TO THE MAXIMUM ELEVATIONS NOTED.
7. PLANNED STOCKPILE UTILIZATION – THE PORTION OF THE TOTAL STOCKPILE CAPACITY PLANNED TO BE UTILIZED FOR WASTE ROCK.
8. THESE FIGURES SHOW THE WASTE ROCK SURFACE AT PLANNED STOCKPILE UTILIZATION FOR WASTE ROCK. ADDITIONAL CAPACITY SHOWN UP TO THE MAXIMUM CAPACITY WILL STORE SATURATED MINERAL OVERBURDEN AS NEEDED AND WILL ALSO ACCOUNT FOR POTENTIAL VARIATION IN WASTE ROCK QUANTITY AND/OR DENSITY.

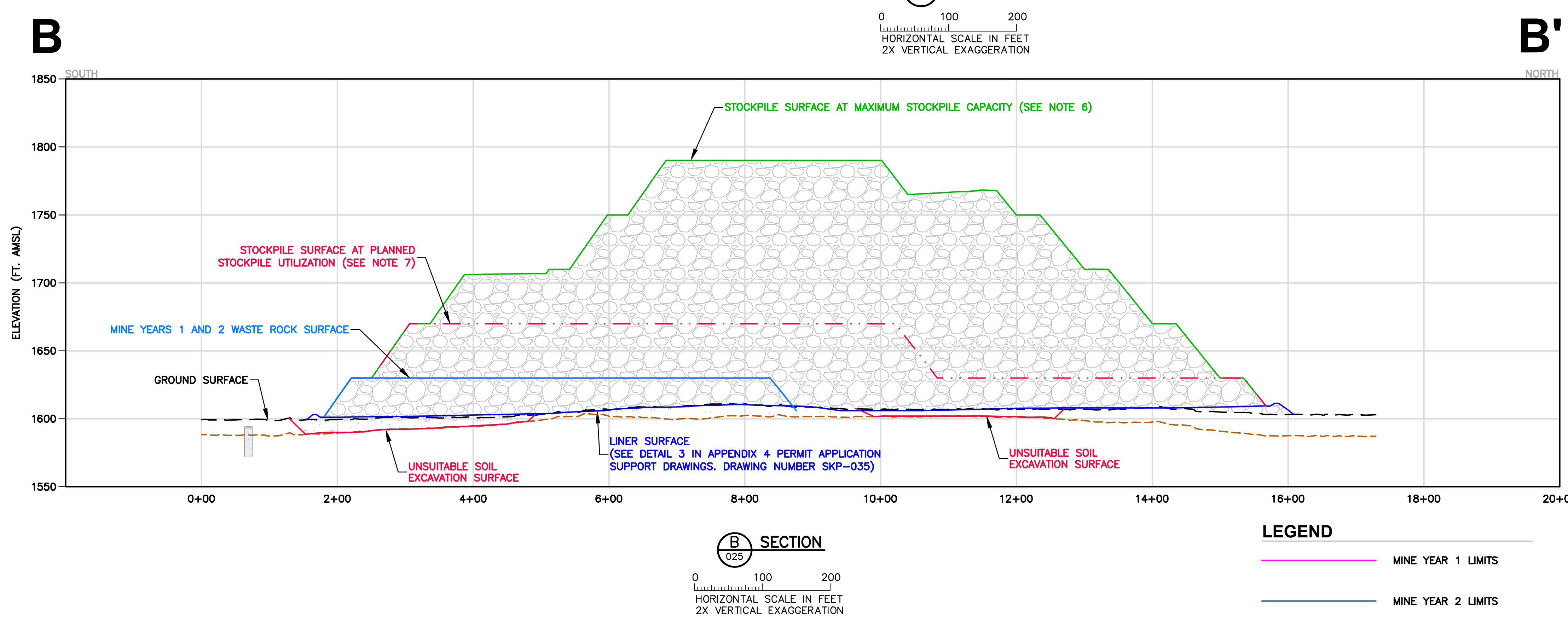
LEGEND

- MINE YEAR 1 LIMITS
- MINE YEAR 2 LIMITS
- MINE YEAR 11 LIMITS
- MAXIMUM CAPACITY
- LINER SURFACE
- EXISTING GROUND SURFACE
- UNSUITABLE SOIL EXCAVATION SURFACE
- BEDROCK SURFACE

CATEGORY 2/3 WASTE ROCK STOCKPILE CROSS-SECTIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 7-11
Permit to Mine Application





NOTES

1. STOCKPILE INTERBENCH SLOPES AT ANGLE OF REPOSE.
2. THIS DESIGN CONSERVATIVELY ASSUMES THAT ALL LOWLAND/WETLAND SOILS ARE GEOTECHNICALLY UNSUITABLE AND WILL REQUIRE EXCAVATION AND REPLACEMENT WITH STRUCTURAL FILL TO THE DESIGN FOUNDATION BASE GRADE. GEOTECHNICAL PROPERTIES OF THE FOUNDATION SOILS WILL BE CONFIRMED PRIOR TO FINAL DESIGN.
3. MAXIMUM DEPTH OF UNSUITABLE MATERIAL SUBGRADE EXCAVATION LIMITED TO 20 FEET FOR THIS DESIGN. THE ACTUAL DEPTH OF UNSUITABLE SOIL EXCAVATION WILL BE CONFIRMED BY PHASE II GEOTECHNICAL INVESTIGATION.
4. SEE CROSS-SECTION LOCATIONS ON FIGURES 7-1 AND 7-2.
5. FROM GOLDER ASSOCIATES INC. DRAWING INCLUDED IN APPENDIX 4 PERMIT APPLICATION SUPPORT DRAWINGS: CATEGORIES 1, 2/3, 4 STOCKPILES AND ORE SURGE PILE DESIGN.
6. MAXIMUM STOCKPILE CAPACITY – THE TOTAL CAPACITY OF THE WASTE ROCK STOCKPILE IF FILLED TO THE MAXIMUM ELEVATIONS NOTED.
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LEGEND

MINE YEAR 1 LIMITS

MINE YEAR 2 LIMITS

MINE YEAR 11 LIMITS

MAXIMUM CAPACITY

LINER SURFACE

EXISTING GROUND SURFACE

UNSUITABLE SOIL EXCAVATION SURFACE

BEDROCK SURFACE

CATEGORY 4 WASTE ROCK STOCKPILE CROSS-SECTIONS

NorthMet Project

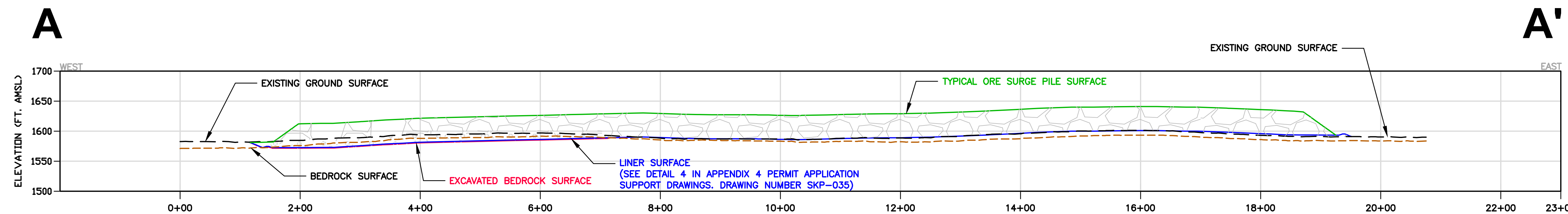
Poly Met Mining, Inc.

Figure 7-12

Permit to Mine Application

CADD USER: Kelly Matson FILE: K:\DESIGN\23690C29.99\PERMIT_PTM_FIGURE 7-12_CATEGORY 4 STOCKPILE CROSS SECTIONS.DWG PLOT SCALE: 1:2 PLOT DATE: 11/28/2017 3:56 PM

BAR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50



A SECTION 031

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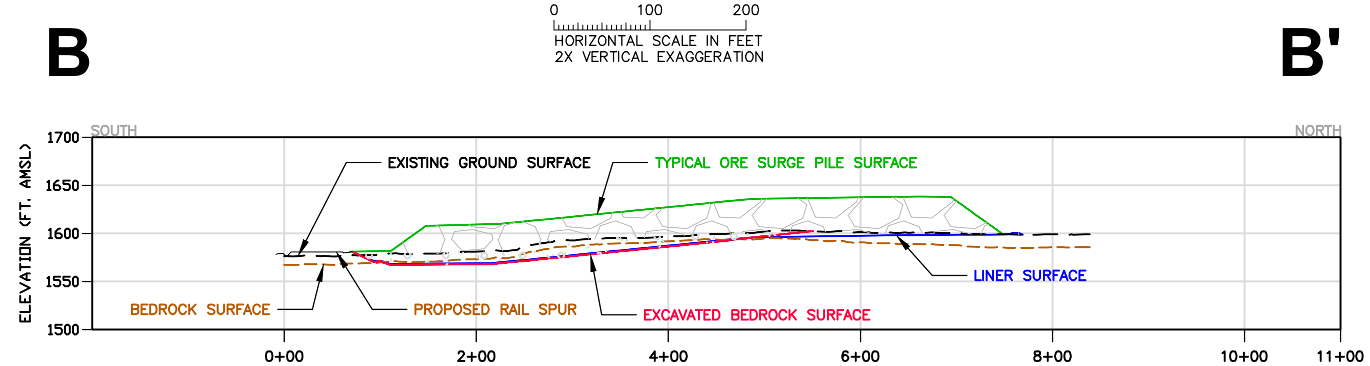
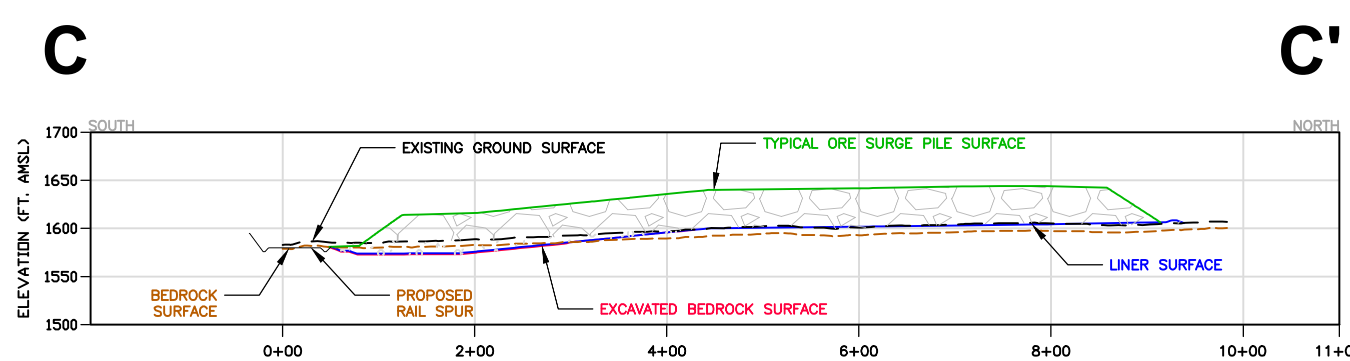
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



B SECTION 031

0 100 200
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



C SECTION 031

0 100 200
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION

LEGEND

- ORE LIMITS AT TYPICAL CAPACITY
- LINER SURFACE
- EXISTING GROUND SURFACE
- OVERBURDEN SOIL AND BEDROCK EXCAVATION SURFACE
- BEDROCK SURFACE

NOTES

1. STOCKPILE SIDE SLOPES AT ANGLE OF REPOSE.
2. SEE CROSS-SECTION LOCATIONS ON FIGURES 7-1 THROUGH 7-3.
3. FROM GOLDER ASSOCIATES INC. DRAWING INCLUDED IN APPENDIX 4 PERMIT APPLICATION SUPPORT DRAWINGS: CATEGORIES 1. 2/3, 4 STOCKPILES AND ORE SURGE PILE DESIGN

ORE SURGE PILE
CROSS-SECTIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 7-13
Permit to Mine Application

8.0 Plant Site and Ore Processing Facilities

This Section 8.0 of the Application provides the information relating to the ore beneficiating process that is required for the Mining and Reclamation Plan pursuant to Minnesota Rules, part 6132.1100, subpart 6(B2). The Mining and Reclamation Plan is comprised of Sections 7.0 through 11.0 and 15.0, along with related appendices. This Section 8.0 also provides information addressing the siting requirements of Minnesota Rules, parts 6132.2000-6132.3200 applicable to the Plant Site and ore processing facilities and operations, including related infrastructure and general plant facilities. The hydrometallurgical process is also described in this Section 8.0.

The location, construction, and operation of the Plant Site are designed to comply with the requirements set forth in nonferrous mining rules, including those requirements relating to siting and buffers. Specifically, no Plant Site operations or surface disturbance will occur in excluded or prohibited areas, and operations will comply with the additional restrictions applicable to mining sites. All facilities and operations will meet the design, construction, and maintenance requirements for buffers and vegetative cover of Minnesota Rules, parts 6132.2100 and 2700. Additionally, the design, construction, and maintenance of the Plant Site will be compatible with surrounding non-mining uses, and the existing terrain, vegetation, and/or revegetated buffers will reduce impacts from Plant Site activities. The private residences nearest the Plant Site are located approximately 0.8 miles to the north and 5 miles to the south, with agricultural lands located approximately 2.8 miles northwest of the facility. The location of residential dwellings relative to the Plant Site are shown on Figure 5-37. The existing terrain and vegetation at and around the Plant Site are compatible with non-mining areas.

The Plant Site design and layout will also facilitate compliance with specific operating requirements of Minnesota Rules, parts 6132.2200, 6132.2500, and 6132.2800, applicable to Plant Site operations, including, for example, waste management, dust suppression, FTB design and operation, and Beneficiation Plant operation.

As detailed in this Section 8.0, PolyMet's operations at the Plant Site will reuse the existing taconite processing infrastructure rather than undisturbed areas. PolyMet will refurbish buildings, equipment, and infrastructure to meet the mineral processing requirements of the ore. It is anticipated that the necessary upgrades such as re-wiring, new equipment, and/or structural refurbishments will occur within the existing LTVSMC plant buildings. Details on necessary refurbishments within the buildings will be determined in detailed design. The Plant Site layout is shown on Figure 3-5, and detailed views of the Process Plant area are shown on Figure 8-1 through Figure 8-4.

The Project will make use of several existing infrastructure within the Plant Site, and PolyMet will assume responsibility for reclaiming those infrastructure used, based on the ownership and agreements with the owners of the infrastructure, as well as for additional existing infrastructure at the Plant Site that will not be used by the Project but are part of the NorthMet legacy assets obtained by PolyMet. Existing structures the Project will and will not use are listed in Table 8-1 and shown on Figure 8-5. New buildings and structures to be constructed for the Project are shown on Figure 8-1. Existing legacy buildings and structures at the Plant Site that the Project will not use but are part of PolyMet's legacy assets within the

Mining Area will be removed by the end of Mine Year 1. Foundations above existing grade will be razed, and foundations and slabs at or below grade will be left in place. Foundations and slabs will be covered with a minimum of two feet of surface overburden, seeded, and mulched. Existing facilities and new facilities at the Plant Site that are part of PolyMet's legacy assets and are used by the Project will be demolished after operations. Reclamation activities are discussed in more detail in Section 15.0 and in the Reclamation, Closure, and Postclosure Maintenance Plan in Appendix 14.

The Plant Site includes several areas that previous owners of the property and the MPCA have identified as Areas of Concern (AOCs). AOCs at the Plant Site that PolyMet will manage are listed in Table 8-2 and shown on Figure 8-6. The MPCA is overseeing the resolution of the AOCs under its Voluntary Investigation and Cleanup (VIC) program, and several have already been resolved to the agency's satisfaction. The unresolved AOCs at the Plant Site that will not be used by the Project will be managed or remediated during Project operations. AOCs that will be used by the Project will be managed or remediated during reclamation, closure, and postclosure maintenance phases, as discussed in Appendix 14, and Section 3.1.2.

8.1 Plant Site Operations Overview

Key features of the Plant Site during operations will include:

- Beneficiation Plant. The plant will include a combination of new and existing buildings and equipment, as shown on Figure 8-1. Ore processing will include crushing, grinding, flotation, and concentrate dewatering, followed by product loadout. The beneficiation facilities and process are described in Section 8.3.

- Hydrometallurgical Plant. The hydrometallurgical process will provide additional on-site refining of the concentrate. The Hydrometallurgical Plant will consist of a new building for the plant and additional new buildings for support of this plant, as shown on Figure 8-1. The hydrometallurgical facilities and process are described in Section 8.4.

- WWTS. Waste water treatment will include a new building for treatment through chemical precipitation and RO or similar membrane separation technology and associated systems, including a lined pre-treatment basin.

- Maintenance and Repair Facilities. PolyMet will use the former LTVSMC maintenance facilities, including the General Shops, the Rebuild Shop, Area 1 Shop facilities, and Area 2 Shop facilities.

- Support Infrastructure. This infrastructure will consist of roads (Section 8.2.1.1), rail facilities (Section 8.2.1.2), electrical transmission and distribution lines and equipment (Section 8.2.1.3), a Sewage Treatment System (Section 8.2.2.1), and a Potable Water Treatment System (Section 8.2.2.2). Most of these facilities will require both upgrading the existing infrastructure and new construction. Support infrastructure are shown on Figure 8-1 through Figure 8-4. Refer to the additional sections referenced for specific information on each of these infrastructures.

Additional key features of the Plant Site not discussed further in Section 8.0, and a description of where further details are included, are as follows:

- Tailings Basin. PolyMet will construct the FTB on top of the former LTVSMC tailings basin. The FTB will contain Flotation Tailings produced by the Project. The Tailings Basin refers to the combined LTVSMC tailings basin and the FTB. Section 10.2 and the permit application support drawings included in Appendix 6 address the design of the FTB. Appendix 11.5 addresses management and monitoring plans for the FTB.

- FTB seepage capture systems. These systems include the FTB Seepage Containment System and the FTB South Seepage Management System, both of which will capture seepage from the Tailings Basin. The FTB seepage capture systems are described in Section 10.2.3.4, and permit application support drawings for these systems are included in Appendix 6.

- Hydrometallurgical Residue Facility. The hydrometallurgical process will provide additional refining of the concentrate on-site, and the HRF will be constructed to contain the waste from this process. Section 10.3 and permit application support drawings in Appendix 7 address the design of the HRF. Appendix 11.6 addresses management and monitoring plans for the HRF.

The following sections of the Application and appendices contain additional information relating to Plant Site operations:

- Sections 10.2.3.1 and 10.3 address management of coal ash contained in the Coal Ash Landfill, which is located along the southeast side of the Tailings Basin.
- Section 11.2 addresses the Project water balance.
- Section 11.4 and Appendix 10 address Plant Site stormwater management.
- Section 11.4 addresses Plant Site water management and infrastructure.
- Section 12.0 addresses wetland delineation, impacts, and mitigation, and Appendix 18.1 presents the wetland permit application, including mitigation plans.
- Section 13.2.2 addresses air quality management at the Plant Site, with dust suppression specifically discussed in Section 13.2.2.2.
- Section 14.0 summarizes the overall Project monitoring programs.

8.2 Plant Design and Layout

As summarized above, the Plant design and layout is intended to facilitate compliance with specific operating requirements necessary for the reclamation plan applicable to the ore beneficiating process, including, among other things, requirements relating to dust suppression, utilization of vegetative cover to prevent excessive erosion, and appropriate tailings storage.

Blasting will occur during the construction phase where necessary to modify bedrock outcrops that impinge on design of Plant Site infrastructure and facilities (e.g., Hydrometallurgical Residue Facility, Sewage Treatment System, rail track, ditches). Blasting for construction of Plant Site infrastructure and facilities will be carried out using contractors and methods normally employed for construction blasting of rock, with the resulting blast rock utilized or managed as proposed for the Plant Site (Figure 3-12).

8.2.1 Plant Site Infrastructure

Plant Site infrastructure includes the following: roads, rail track, and electrical distribution lines and related equipment.

8.2.1.1 Roads

Access to the Plant Site is through the Main Gate located at the north end of County Road 666 or from State Highway 135 (Figure 9-1). The Administration Building is located south of the Main Gate on County Road 666 and can be accessed without passing through the Main Gate security. The rest of the Plant Site can only be accessed after passing through security at the Main Gate. The Plant Site contains a network of existing two-lane roads that PolyMet will use. PolyMet will repair and resurface existing roadways as necessary to support vehicle traffic around the Plant Site facilities. Other modifications to the existing roads are not planned at this time. New two-lane roads will be constructed to provide access to the WWTS and the Sewage Treatment System ponds.

8.2.1.2 Railroad

The Plant Site includes existing railroad tracks owned by PolyMet, Cliffs Erie, and Canadian National (CN) Railroad. The ownership of the existing railroad tracks is depicted on Figure 8-3. PolyMet has agreements to use portions of the tracks around the Plant Site that are owned by Cliffs Erie. With the exception of the CN tracks, PolyMet will refurbish the existing railroad network at the Plant Site as necessary, which would include replacing ballast, ties, and rails where needed. Existing private rail owned by Cliffs Erie that is licensed to PolyMet will be used to transport ore from the Mine Site to the Coarse Crusher at the Plant Site and to move rail cars to and from maintenance facilities. PolyMet will realign certain parts of the existing tracks at the Plant Site and construct new track between the concentrate loadout and the existing CN interchange point to accommodate train traffic during loading. Consumables will be received at, and concentrates will be shipped from the future interchange point (located south of the Beneficiation Plant). PolyMet will use the existing General Shops and Area 2 Shop facilities for re-fueling, routine inspection, and maintenance on ore cars and locomotives.

8.2.1.3 Electric Transmission and Distribution Lines and Equipment

Two Minnesota Power Company 138 kilovolt transmission lines serve the Plant Site. Minnesota Power will extend new distribution lines to existing buildings as they are refurbished and to new buildings when they are constructed. Minnesota Power will own the transmission lines up to the substation at the Plant Site. PolyMet will own the distribution lines from the substation at the Plant Site. Electrical distribution lines will require refurbishment (repairs or replacement of poles, ties, or lines) along existing routes and new electrical service connections to serve upgraded and new structures. Power distribution is depicted on Figure 8-3.

8.2.2 General Plant Site Facilities

This Section 8.2.2 describes the general Plant Site facilities and services, including the Sewage Treatment System, Potable Water Treatment System, WWTS, stream augmentation, Area 1 and Area 2 Shops, and related services.

8.2.2.1 Sewage Treatment System

PolyMet will demolish the existing sewage treatment plant, and replace or repair the associated sewage collection piping, add new sewage collection piping to service new buildings, and construct new stabilization ponds to meet current MPCA design standards. Pond location is shown on Figure 8-2. PolyMet will size the treatment system to meet the anticipated treatment demand. At the Area 1 and Area 2 Shops, PolyMet will evaluate and upgrade, if necessary, the existing septic systems. Section 11.4.2 contains additional details of sewage management and facilities at the Plant Site, and permit application support drawings of the system are included in Appendix 9. Section 2.4 of Appendix 11.3 includes additional details on the Sewage Treatment System.

8.2.2.2 Potable Water Treatment System

The Potable Water Treatment System will require refurbishing to provide potable water to the Plant Site. Potable water will be used for showers and sinks, and it will be treated (chlorinated) to be drinkable. Water from Colby Lake will be pumped to the Plant Reservoir, which will supply water to the Potable Water Treatment System. PolyMet will either refurbish the existing Potable Water Treatment System, which would include upgrading the mechanical systems within the building, or demolish the existing plant to construct a new plant in the same location; this decision will be made in detailed design. The distribution system within the Plant Site will be evaluated in detailed design to determine if additional work is needed on the system. New distribution piping will be added to service new buildings. The existing Potable Water Treatment System is located west of the Plant Site Reservoir, as shown on Figure 8-1.

8.2.2.3 Waste Water Treatment System

PolyMet will construct the WWTS north of the Beneficiation Plant (Figure 8-1), adjacent to the existing LTVSMC tailings basin. The WWTS will treat mine water for reuse to support the water demands of ore processing operations and treat Tailings Basin seepage as required by the MPCA NPDES/SDS Permit. Section 11.4.8 and Figure 11-20, along with PolyMet's NPDES/SDS Permit Application to the MPCA provide further descriptions of the WWTS design and operations, including treatment methods.

8.2.2.4 Stream Augmentation System

The FTB seepage capture systems will significantly reduce the amount of seepage leaving the Tailings Basin relative to existing conditions, thereby reducing the amount of stream flow available to four downstream creeks: Unnamed Creek, Trimble Creek, Unnamed (Mud Lake) Creek, and Second Creek. These creeks are shown on Figure 5-5 and Figure 5-6. PolyMet will augment flow to the watershed of three of these creeks (Unnamed Creek, Trimble Creek, and Second Creek) through discharge of treated water from the WWTS to offset the seepage reductions. The discharge quality will meet the requirements of the MPCA NPDES/SDS Permit, and discharge quantity will be managed to meet the zero discharge requirements of the NSPS (40 C.F.R., section 440.104) as required by the MPCA NPDES/SDS Permit as well as to minimize ecologic and hydrologic impacts to the receiving waters as required by the Water Appropriation Permits. Unnamed (Mud Lake) Creek will be augmented by diverting runoff that currently flows into the LTVSMC tailings basin, so that it flows to the Unnamed (Mud Lake) Creek watershed via a drainage swale. Section 11.4.8 provides additional discussion on stream augmentation.

8.2.2.5 Area 1 Shops

The Area 1 Shops (Figure 8-1) include a fully enclosed maintenance facility built by previous operators specifically to handle maintenance and repair of mobile equipment. PolyMet will use a heavy-duty low bed transporter and tractor to transport some equipment (e.g., dozers and front-end loaders) to the Area 1 Shops from the Mine Site. PolyMet will drive or tow haul trucks to the Area 1 Shops for major repair and maintenance. A haul truck retriever (large-scale tow truck) will tow haul trucks that are unable to move on their own. PolyMet anticipates performing major repairs approximately twice per year on each haul truck. To access the Area 1 Shops, mine vehicles will use existing roads from the Mine Site to the Plant Site.

PolyMet will collect and store used oils, used antifreeze/coolant, and residue from steam cleaning equipment at the Area 1 Shop. PolyMet will use a third-party contractor to manage recyclable materials. PolyMet will collect and store non-recyclable used filters, oily rags, and other oil products at the Area 1 Shop for subsequent off-site disposal in suitably licensed disposal facilities. PolyMet will manage petroleum and oil products collected in the Area 1 Shop in accordance with its SPCC Plan, which will be developed prior to the threshold for the need being met per 40 CFR part 112 and Minnesota Rules, chapter 7151.

8.2.2.6 Area 2 Shops

PolyMet will renovate the former LTVSMC Area 2 Shops facilities, located approximately one mile east of the Plant Site (Figure 8-1), to provide office space for mining and railroad operations, supervision, and management. The Area 2 Shops will include change-house facilities, toilets, lunchrooms, first aid facility, emergency response center, and training and meeting rooms for mining and railroad crews. The Area 2 Shops facilities will also include a Locomotive Fueling Station, Locomotive Service Building, and Mine Reporting Building. The Locomotive Fueling Station, where locomotives will be fueled and lubricated, has a roof and sides but is open at the ends to facilitate access and egress. The concrete floor, equipped with drip trays, will collect spilled fuel and route it to a collection sump for proper disposal. It will also have a new 15,000-gallon aboveground diesel storage tank with containment systems. PolyMet will collect, store, and handle petroleum and other oil products at the Area 2 Shops in the same manner as described above for the Area 1 Shop, including managing the materials in accordance with an approved SPCC Plan.

8.2.2.7 Plant Site Support Services

Operations at the Plant Site will require various support services such as compressed air, steam, fuel storage, fire protection, and an oxygen plant. These services are summarized in Table 8-3.

Locomotives needing major repair will be repaired in the renovated and recommissioned General Shops or sent off-site to be repaired by a contractor. The ore cars will be maintained at the General Shops. General Shops will provide other maintenance capabilities and expertise to support Plant Site and Mine Site operations.

8.3 Beneficiation Facilities

The beneficiation process will produce saleable copper and nickel concentrates (flotation concentrates). PolyMet will sell and ship copper concentrate to customers. Nickel concentrates of various grades will be sold and shipped to customers, used as a feedstock to the hydrometallurgical process, or divided for both uses.

Throughout operations, PolyMet will use the Plant Site (Figure 8-4 and Figure 8-5) to produce flotation concentrates through a beneficiation process.Figure 8-7 shows a simplified process flow diagram for the beneficiation process. In a future phase, PolyMet anticipates adding hydrometallurgical processing facilities, which are discussed in Section 8.4.

Beneficiation (Figure 8-7) includes ore crushing, grinding, flotation, and dewatering. These processes will occur within the existing Coarse Crusher, Fine Crusher, and Concentrator Buildings as well as within the new Flotation, Reagent, Concentrate Dewatering, Concentrate Storage, and Concentrate Loadout Buildings. Drive House 1 is also associated with this process, housing the drive systems for the conveyors running between the Coarse Crusher and the Fine Crusher Buildings. PolyMet will perform crushing and grinding in the existing Coarse Crusher and Concentrator Buildings, respectively. Ore will be conveyed from the secondary, also referred to as second stage, crusher in the Coarse Crusher Building to a semi-autogenous grinding (SAG) mill and ball mill in the Concentrator Building. Flotation will take place in a new Flotation Building located immediately to the west of the Concentrator Building. The consumables associated with the flotation process are described in Table 8-4 and the hydrometallurgical processing facility consumables are described in Table 8-5. PolyMet will construct and operate a new Concentrate Dewatering, Storage, and Load-out facility to prepare concentrate for shipping to off-site refiners. Section 11.4 includes additional details regarding water management and infrastructure relating to the beneficiation process and the FTB at the Plant Site.

8.3.1 Ore Crushing

PolyMet will move ore pieces as large as approximately 48 inches in diameter by rail from the Mine Site to the Coarse Crusher Building. Rail cars of ore will dump into the primary crusher at an average feed rate of 1,667 tons per hour. From the primary crusher, ore will move by gravity to four secondary crushers. From the secondary crushers, a conveyor system will move the ore, approximately 80% of which will be smaller than 4.25 inches, to the ore storage bins located in the Concentrator Building. Conveyor systems for ore crushing are enclosed, in buildings, or underground to contain material spills and fugitive dust, including dust collection equipment. Existing sumps in the Coarse Crusher, Drive House 1, and Fine Crusher buildings will be used to manage water within these buildings and the Drive House 2 building. Spills of large material pieces will be manually placed back into the system for processing. Spills of fine materials within these buildings will be washed into the respective sumps, with the exception of within the Fine

Crusher that will use dry clean-up methods via shovel, broom, or vacuum. Water from sumps will be periodically pumped back into the process at select points in the circuit.

8.3.2 Ore Grinding

The crushed ore will be conveyed into a new SAG mill and ball mill installed in the existing Concentrator Building to reduce the ore particle size such that 80% will be less than 120 microns (4.7 x 10^{-3} inches). The SAG mill output slurry will feed the ball mill via cyclone feed pumps. The ground ore will re-circulate through the milling circuit until the particle size is the proper size for the flotation process.

PolyMet will repair or replace the existing dust collection systems in the Concentrator Building to meet the applicable requirements of the MPCA Air Quality Permit. To reduce space-heating requirements, PolyMet will recycle a portion of the emission control system exhaust to the process buildings. The material collected by the emission control system exhaust would be mixed with water and added to the milling circuit. This means that the solids removed from the air stream would be recycled back into the process; therefore, no solid waste management will be required. This operating system will not require particulate emission control systems downstream of the feed to the SAG mill because water will be added to the mill lines and the beneficiation process will be wet from that point forward. Section 13.2.2 and PolyMet's Air Permit application to MPCA provide further information on dust collection control systems and management.

In the event of a power failure, PolyMet will contain process fluids in the Concentrator building within the process piping, tanks, sumps, and vaults below the building and will then recycle the fluids back into the system when power is restored. The same containment system will be used during maintenance and plant shutdown periods. The Concentrator building has an existing system of large concrete vaults and sumps below the floor to collect process fluids, material spills, and water from floor washing. The vaults are partitioned off into smaller sumps to contain the different types of process fluids separately so that when power is restored or maintenance is complete, the sumps can be pumped back into the system for continued processing. These vaults extend below the existing tailings thickeners, where they continue as large tunnels out to the Emergency Basin. For the Project, the tailings thickeners will be removed for construction of the Flotation Building and Reagent Building, and the tunnels to the Emergency Basin will be sealed shut and used as part of the Process Plant Area containment.

8.3.3 Flotation

The ground ore will be processed in flotation cells to recover the base and precious metal minerals. Figure 8-7 depicts the various stages of the flotation process. PolyMet will construct a new Flotation Building in which the copper and nickel concentrates are produced.

In flotation, PolyMet will separate the target minerals using a collector/frother combination. Air will be injected into each flotation cell, and the cell will be mechanically agitated to create air bubbles that will pass upward through the slurry in the cell. The frother (methyl isobutyl carbinol [MIBC] and MIBC/DF250) strengthens the bubbles, and the collector (potassium amyl xanthate) causes the sulfide minerals to attach to the air bubbles. The material attached to the bubbles is concentrate and the material remaining in the slurry is tailings. Table 8-4 contains additional information on consumables used in this process.

Stages of the flotation process, as depicted in Figure 8-7, include Rougher Flotation, Scavenger Flotation, Cleaner Flotation, and Separation Flotation. Concentrates and tailings will be transported as slurry through this process by pumping or gravity flow. The Rougher Flotation Tailings will go to Scavenger Flotation where collector and frother will be added, along with copper sulfate as a flotation activator. The activator will promote recovery of the particles that would be difficult to float (i.e., contain minor amounts of sulfide) in the concentrate, which reduces the total sulfur content of the tailings. The Scavenger Flotation concentrate will go through Scavenger Regrind to Cleaner 2 Flotation. Cleaner 2 Flotation Tailings will go back to Scavenger Flotation feed, while the nickel rich Cleaner 2 flotation concentrate will be sent through Fine Grinding 2 to the Hydrometallurgical Plant or directly to Concentrate Dewatering. The Flotation Tailings from Scavenger Flotation will be sent to the FTB. Rougher Flotation concentrate will be fed through Rougher Regrind to Cleaner 1 Flotation. Cleaner 1 Flotation Tailings will go back to Rougher Flotation feed, while the concentrate will be sent through Fine Grinding 1 to Separation Flotation. Separation Flotation will produce a copper concentrate and two nickel concentrates. The copper concentrate will go to Concentrate Dewatering. The nickel concentrates will go to Concentrate Dewatering or to the Hydrometallurgical Plant. A pH Modifier (hydrated lime) will be added in Separation Flotation which will result in a highly basic process water stream. Because this stream will be combined with other process water streams and make-up water, buildup of basicity is not expected. If there is a buildup of basicity, the highly basic process water stream can be neutralized before it is combined with other process water streams.

The waste material from the Scavenger Flotation, the Scavenger Flotation Tailings, will be pumped to the FTB where the solids will settle and be permanently contained. The decanted water will be re-circulated to the mill process water system.

Spills and cleanup of process fluids from flotation will be contained within vaults and tunnels below the Flotation Building and recycled back into the process. The containment system below the Flotation Building is described in Section 8.3.2. A plan for cleanup of potential spills from the Flotation Tailings pipeline between the plant and the FTB will be developed prior to the start of operations; this plan is integral to the detailed design of the site and should therefore be deferred to final design.

8.3.4 Concentrate Dewatering, Storage, and Loadout Facility

PolyMet will utilize Concentrate Dewatering, Storage, and Loadout Facilities to dewater and store copper and nickel concentrates and to load those concentrates into covered rail cars. PolyMet will dewater and store concentrate in the new Concentrate Dewatering/Storage Building. The copper and nickel concentrates will each be delivered to separate dewatering lines equipped with filters that will reduce concentrate moisture content to approximately 8% to 10%. The process will return the water removed by the filters to the Beneficiation Plant.

The operations will convey each filtered concentrate to separate stockpiles within the enclosed 10,000-ton Concentrate Storage Building for loading into covered rail cars. The storage facility will store about 15 days of production during the periods when both flotation concentrates are directed to Concentrate Dewatering/Storage and about 32 days of production during the periods when only copper flotation concentrate is directed to Concentrate Dewatering/Storage. The storage facility will prevent concentrates from being tracked out of the facility by having a concrete floor and operational systems to wash wheeled equipment prior to exiting the building.

In the event of a leak or power failure, PolyMet will contain process fluids within the process piping, pipe galleries, tanks, and sumps, and will then recycle the fluids back into the processing system when operation is resumed. The Concentrate Dewatering/Storage building is designed over the existing Heating Plant, which will be demolished for construction of the Concentrate Dewatering/Storage building. This new building will utilize the existing sump system below the Heating Plant for containment in a similar manner as the Concentrator Building (Section 8.3.2).

8.3.5 Processing Parameters for the Beneficiation Process

Table 8-6 shows estimates for daily production rates and size reduction through the processing steps in the beneficiation process. These rates and sizes represent the design basis values for the Beneficiation Plant piping and equipment.

Water needed for the grinding and flotation circuits will primarily be return water from the FTB Pond. Water in the FTB Pond will include process water from the Beneficiation Plant, treated mine water from the WWTS, captured Tailings Basin seepage, and precipitation. PolyMet will use water from the Plant Reservoir, which is drawn from Colby Lake using an existing pump station and pipeline, to make up any shortfall in water requirements. The average annual make-up water drawn from Colby Lake will vary throughout operations between 260 and 1,760 gallons per minute (gpm), with an average annual demand of 760 gpm. This amount represents total potential raw water demand from both the Beneficiation Plant and the Hydrometallurgical Plant. Section 11.4 presents additional discussion on water demand for the beneficiation process and use of Colby Lake water.

8.4 Hydrometallurgical Plant Facility

The second phase of mineral processing at the Plant Site will involve construction and operation of the Hydrometallurgical Plant. PolyMet will base its decisions on the timing for construction of the plant on equipment delivery schedules, customer requirements, and overall Project economics. Figure 8-8 presents a simplified process flow diagram for the hydrometallurgical process.

PolyMet will use hydrometallurgical technology to process the nickel concentrates. This process involves pressure and temperature autoclave leaching followed by solution purification to extract and isolate platinum group metals, precious metals, and base metals. PolyMet will locate the hydrometallurgical-process equipment in a newly-constructed Hydrometallurgical Plant, which will be located where the former LTVSMC pellet plant once stood. Should spillage of process fluids occur, PolyMet will contain the fluids within the Hydrometallurgical Plant through a system of spill containment vaults that are still in place from the LTVSMC pellet plant, although they are currently backfilled with overburden. Spill containment in the Hydrometallurgical Plant will be similar to the existing Concentrator Building design, as described in Section 8.3.2. Collected spills will be returned to the appropriate process streams. Once the Hydrometallurgical Plant becomes operational, PolyMet will utilize some of the concentrates produced in the Beneficiation Plant as feedstock to the hydrometallurgical process. The feedstock will be a combination of the separate nickel concentrates produced by the Beneficiation Plant. PolyMet will decide whether to ship or process concentrates based on customer requirements and overall Project economics.

In addition to the Hydrometallurgical Plant, an Oxygen Plant, Hydrometallurgical Reagent Building, and Limestone Preparation Building will also be constructed to support the hydrometallurgical process.

Section 11.4.7 contains additional information regarding water management associated with the hydrometallurgical process and facilities. The HRF permit application support drawings in Appendix 7 and the Residue Management Plan in Appendix 11.6 provide further details concerning the HRF design. A plan for cleanup of potential spills from the Hydrometallurgical Residue pipeline between the plant and the HRF will be developed prior to the start of hydrometallurgical operations; this plan is integral to the detailed design of the site and should therefore be deferred to final design of the Hydrometallurgical Plant and HRF.

8.4.1 Autoclave

An Autoclave is a mineral processing pressure vessel used for conducting chemical reactions such as sulfide mineral oxidation and leaching of metals. Before feeding the nickel concentrate into the Autoclave, PolyMet will add WWTS filtered sludge and hydrochloric acid to the nickel concentrate. The sludge has recoverable metals. Filtered sludge handling prior to construction of the Autoclave is discussed in Section 11.4.8. The hydrochloric acid is added to maintain the chloride concentration in the solution to enable leaching of the gold and platinum group metals. The system requires oxygen gas to be injected into the Autoclave at a rate that will be controlled to completely oxidize the sulfur in the concentrate. PolyMet will construct an Oxygen Plant to supply the oxygen for the Autoclave.

The Autoclave process oxidizes and dissolves the sulfide minerals in the concentrate to produce a metal-rich slurry and an insoluble solid residue. Gold and platinum group metals in the nickel concentrate will dissolve as soluble chloride salts. The system will route the slurry discharging from the Autoclave to the Leach Residue Thickener where solids will be settled with the aid of a flocculant. The Leach Residue Thickener underflow will be filtered to produce a filter cake, which will be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the HRF. The Leach Residue Thickener overflow will be routed to gold and platinum group metals (Au/PGM) recovery.

8.4.2 Gold and Platinum Group Metals

Gold and Platinum Group Metals Recovery will create a marketable product (a filter cake) consisting of a mixed gold and platinum group metals precipitate. The operation will route the remaining solution, which contains copper, to Copper Cementation. PolyMet will package the gold and PGM filter cake in either bulk bags or drums for sale to a third-party refinery.

8.4.3 Copper Cementation

Copper concentrate from dry concentrate storage would be re-pulped, and the solution from Au/PGE recovery would be combined with the re-pulped copper concentrate. Copper would precipitate mostly in the form of copper sulfide. The enriched copper concentrate would be filtered and placed back into dry concentrate storage. The remaining solution would then go to Solution Neutralization. Figure 8-8 shows how materials flow through the process.

8.4.4 Solution Neutralization

The process next routes the solution from Copper Cementation to Solution Neutralization, a process that neutralizes acids formed as a result of the upstream process. Calcium in the form of either limestone or lime will be added. The result of the calcium addition will be the formation of gypsum that will be filtered to produce a gypsum filter cake. The process will wash and re-pulp this filter cake, combine it with other hydrometallurgical residues, and then pump the combined Residue to the HRF. The solution remaining after neutralization will be directed to Iron and Aluminum Removal.

The effluent from the Solution Neutralization process will feed Iron and Aluminum Removal. The process adds limestone, steam, and air to precipitate the aluminum and iron. The precipitated metals will be filtered to produce a filter cake, which will be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the HRF. The remaining solution will be sent to Mixed Hydroxide Product Recovery.

8.4.5 Nickel Cobalt Hydroxide Precipitate

The solution from Iron and Aluminum Removal is mixed with magnesium hydroxide. The reaction will produce a nickel and cobalt precipitate. The precipitated metals will be filtered to produce a filter cake. The final mixed hydroxide product (MHP) will have an approximate composition of 97% nickel and cobalt hydroxides with the remainder as magnesium hydroxide. PolyMet will package this high quality mixed hydroxide filter cake for sale and shipment to a third-party refiner. The process will direct the remaining solution to Magnesium Removal.

8.4.6 Mixed Hydroxide Product Recovery

The process adds lime slurry to the solution from MHP Recovery to facilitate magnesium precipitation. The resulting slurry will be pumped to the HRF along with other residues. The solids will settle in the HRF for storage, while the clear water will be reclaimed continuously in the Hydrometallurgical Plant process water system.

8.4.7 Magnesium Removal

Lime slurry would be added to the solution from MHP Recovery to facilitate magnesium precipitation. The resulting slurry would be pumped to the HRF along with other residues. The solids would settle in the HRF to be stored permanently while the clear water would be reclaimed continuously to the Hydrometallurgical Plant process water system.

8.4.8 Process Water System

The Hydrometallurgical Plant operating system requires a separate process water distribution system due to the different nature of the process solutions involved in the hydrometallurgical and beneficiation processes. Hydrometallurgical process water will contain significant levels of chloride relative to the Beneficiation Plant process water. The Hydrometallurgical Plant process water system will distribute water to various water addition points throughout the Hydrometallurgical Plant. The main water source for the process water system is the HRF, although it will also receive water contained in the concentrates. As described in Section 8.4.3, the copper concentrate comes from dry storage, so most of the moisture from the concentrates is from the nickel concentrate. Raw water from the Plant Reservoir will provide the additional make-up water for the Hydrometallurgical Plant, as needed.

8.5 Consumable Materials

Both the beneficiation and hydrometallurgical processes will require the addition and consumption of raw materials. These consumables are summarized below, along with details regarding transportation and handling of those materials.

8.5.1 Beneficiation Process Consumables

Table 8-4 identifies the reagents that will be consumed in the beneficiation process. The table provides information regarding anticipated quantities, delivery methods, and storage details. The information in the table is provided in accordance with Minnesota Rules, part 6132.1100, subpart 6, item B. Section 3.2.2.3.4 of Appendix 16.1 includes a more detailed discussion of the beneficiation process and use of these consumables. The quantities and storage of Beneficiation Plant consumables have been further refined in this and other environmental permit applications, as listed in Table 8-4.

8.5.2 Hydrometallurgical Process Consumables

Table 8-5 identifies the reagents that will be consumed in the hydrometallurgical process. The table provides information regarding quantities, delivery methods, and storage details. The information in the table is provided in accordance with Minnesota Rules, part 6132.1100, subpart 6, item B. Section 3.2.2.3.6 of Appendix 16.1 includes a more detailed discussion of the hydrometallurgical process and use of these consumables. The quantities and storage of Hydrometallurgical Plant consumables have been further refined in this and other environmental permit applications, as listed in Table 8-5.

8.6 Transportation and Handling of Consumables and Products

PolyMet will utilize a switching locomotive to transfer loaded and empty cars carrying process consumables and concentrates.

Copper and nickel concentrates will be shipped in solid bottom (gondola) rail cars with weather tight covers. PolyMet will inspect these rail cars for structural integrity before loading. Concentrates will be loaded into the rail cars via a conveyor system in a new building that will be located to the south of the Concentrate Building. PolyMet will inspect car exteriors before they leave the buildings, and any significant residual concentrate on the car exterior will be recovered and returned to storage. Methods for recovery may include dry cleanup (e.g., vacuuming, sweeping) or wet cleanup methods (e.g., washing the cars with water) to attain full recovery of these saleable products. PolyMet anticipates the concentrate will have an 8% to 10% moisture content and will not generate fugitive dust during loading. PolyMet will ship Phase 2 products nickel/cobalt hydroxide and precious metal precipitate to customers in sealed bulk bags or sealed containers.

8.7 Plant Site Progressive Reclamation

When areas are closed and no longer necessary for the operations, PolyMet will undertake progressive reclamation of those areas in accordance with Minnesota Rules, chapter 6132. At the Plant Site, PolyMet's progressive reclamation during Project LOM will include:

- incremental dam-slope restoration at the FTB (Section 10.2.5)
- incremental dam-slope restoration at the HRF (Section 10.3.3.2)
- restoration of areas of construction, including borrow areas
- remediation and reclamation of AOCs (Table 8-2 and Section 3.1.2 of Appendix 14)

Vegetative reference areas will be used to evaluate the effectiveness of the reclamation vegetation activities. Vegetative reference area locations for the Plant Site are shown on Figure 15-3 and 15-4.

Table 8-1 Plant Site Facilities

Existing Facilities Not Used by the Project			
To be Demolished by the End of Mine Year 1	• Additive Building & Heating Plant • Area 2 Sample House • Bentonite Silos • Colby Lake Pipeline Valve House	• Sewage Treatment Plant • Tailings Basin Foreman's Office • Tailings Basin Lube House • Tailings Basin Lube Oil Storage	• Tailings Basin Reporting • Tailings Basin Utility Building • Thickener
To be Demolished in Operations	• Emergency Basin Ancillary Building • Emergency Basin Pump House • Fuel Oil Tank		
Existing Facilities Used by the Project			
To be Demolished during Reclamation	• Acetylene Building • Administration Building • A-Lab • Ambulance Garage • Area 1 Boiler House • Area 1 Fire Pump House • Area 1 Heavy Duty Storage Garage • Area 1 Locomotive Fueling Facility • Area 1 Lube Oil Storage • Area 1 Reporting Building • Area 1 Truck/Tractor Shop • Area 1 Water Tank • Area 2 Cold Storage Building • Area 2 Hose House • Area 2 Locomotive Fueling Facility • Area 2 Locomotive Service Shop • Area 2 Maintenance Service Shop • Area 2 Reporting Building	• Area 2 Truck Storage Garage • Booster Pump House • Carpenter's Shop • Coarse Crusher • Concentrator • Conveyor • Covered Staircase near Coarse Crusher • Drive House 1 • Drive House 2 • Fine Crusher • Gasoline Tank • General Shops • H5 Main Reclaim Conveying System • Lube House • Main Gate Guard House • Pipe Gallery • Plant Reservoir • Plant Site Water Tower	• Portable Building • Potable Water Treatment System[1] • Potable Water Treatment Storage Tanks • Radio Transmitter Building • Rebuild Shop • Reservoir Inlet Building • Reservoir Outlet Building • Return Water Barge • Rubber Shop • Stockpile Conveyor • Storage Building • Storage Yard Shed • Thickener • Truck Scale • Warehouse 49 • Warehouse Electrical • Water Tower - Area 2
To be Demolished After Closure by Others	• Town Station Natural Gas Pipeline Control Station		
To be Demolished During Postclosure Maintenance	• Substation		
To Remain in Place	• Colby Lake Pumphouse		
New Facilities			
To be Demolished during Reclamation	• Concentrate Dewatering • Concentrate Loadout • Concentrate Storage • Flotation Building	• Hydrometallurgical Plant • Limestone Preparation • Oxygen Plant	• Reagent Building • Reagent Storage • Sewage Treatment System
To be Demolished During Postclosure Maintenance	• Waste Water Treatment System (WWTS)		

(1) PolyMet plans to either re-use the Potable Water Treatment System building or to demolish and build in same location. To be determined during detailed design.

Table 8-2 Plant Site Areas of Concern (AOCs) Management Schedule

Areas of Concern (AOCs) accepted by PolyMet that are resolved	Areas of Concern (AOCs) not to be used by Project and managed/remediated during Operations	Areas of Concern (AOCs) to be used by Project and managed/remediated during Reclamation, Closure, and/or Postclosure Maintenance
Mill Rejects Area (AOC 12)	Oily Waste Disposal Area (AOC 6)	Area 1 Shops (AOC 1)
Private Landfill (AOC 8)	Bull Gear Disposal (AOC 7)	Area 2 Shops (AOC 38)
Coal Ash Landfill (AOC 36)	Railroad Panel Yard (AOC 9)	Administration Building (AOC 43)
Pellet Plant PCB Ditch Investigation (AOC 61)	Airport (AOC 10)	Main Gate Vehicle Fueling Area (AOC 44)
	Stoker Coal Ash Disposal (AOC 11)	Plant Site and General Shops (AOC 46)
	2001 Storage Area (AOC 13)	Tailings Basin Reporting (AOC 47)
	Sandblasting and Large Equipment Painting Area (AOC 14)	Booster Pump House with Transformer (AOC 48)
	Dunka Water Treatment Plant Sludge (AOC 35)	Tailings Basin Salvage and Scrap Areas (AOC 51)
	Line 9 Petroleum Contaminated Soil (AOC 37)(1)	Colby Lake Pumping Station (AOC 59)
	Heavy Duty Garage (AOC 40)	
	Bunker C Tank Farm (AOC 42)	
	Coarse Crusher Petroleum Contaminated Soil (AOC 49)	
	Emergency Basin (AOC 50)(2)	
	Cell 2W Salvage Area (AOC 52)	
	Hornfels Burial (AOC 53)	
	General Shops Transformer (AOC 63)(3)	
	Pellet Plant (AOC 64)	

(1) This AOC included a petroleum contaminated soil landfarm. The landfarm has been released by MPCA; however, a desktop study is still required to close out the AOC.

(2) This AOC has not received a "No Further Action" letter from the MPCA; however, the sampling and analysis plan and investigation was completed. The final report is pending, which recommends to the MPCA that no further action is needed.

(3) This AOC included clean up of soil and confirmation sampling related to a transformer leak. Further reporting may be required to formally close this site.

Table 8-3 Plant Site Support Services

Service	Source	Location	Needed for
Compressed Air	Duty/standby arrangement of rotary screw type compressors	General Shops	Provide air at a pressure of 100 pounds per square inch gauge (PSIG) for plant services
Instrument Air	Receiver/accumulation/filter package	General Shops	Compressed purified and dried air provided for instruments (e.g., control valves)
Steam	Natural gas-fired boiler	Hydrometallurgical Plant	Generates heat needed for startup of the autoclave
Diesel Fuel Storage	Existing Locomotive Fuel Oil facility	Area 2 Shop	Diesel for locomotives
Gasoline Storage	Existing storage facility – two 6,000 gallon tanks	Main Gate	Gasoline for vehicles
Make-up Water	Water from Colby Lake via an existing pumping station and pipeline	Stored in the Plant Reservoir	Plant fire protection systems, water for Potable Water Treatment System, make-up water for grinding and flotation process water, Hydrometallurgical Plant process water, and stream flow augmentation, if required
Potable Water Treatment	Existing Potable Water Treatment System would be refurbished and reactivated or demolished and reconstructed	Near the Plant Reservoir	Water distribution system
Fire Protection	Existing fire protection system will be refurbished, reactivated	Plant Reservoir	Area 1 Shop and Area 2 Shop have independent fire protection systems
Oxygen	770 tons per day via Oxygen Plant. Plant process takes in ambient air, compresses it, and separates the oxygen from nitrogen and other trace atmospheric gases. Liquid will be pumped to plant processes and nitrogen and trace gases will be returned to the atmosphere or used in the Hydrometallurgical Plant.	Adjacent to Concentrator	Plant processes including oxidation of sulfide sulfur in the autoclave

Source: Adapted from Table 4-11 of Appendix 16.3

Table 8-4 Beneficiation Plant Consumables

Beneficiation Plant Consumables													
Chemical	**Purpose**	**Location of chemical addition in process**	**Amount/ duration/ frequency of addition[(1)]**	**Average rate of use**	**Maximum rate of use**	**Mode of Delivery**	**Storage Location**	**Storage Capacity**	**Tank Description**	**Secondary Containment**	**Fate and Transport**	**Properties**	**Potential effect on dissolution[(2)]**
SIPX (Sodium isopropyl xanthate	Collector: Used to selectively adsorb minerals based on hydrophobicity of the collector and mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Circuits	Continuous	2.74 tons per day (1,000 tons per year)	4.79 tons per day (1,750 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	Bulk (< 20 ton, 100% SIPX), AST (0.5% concentration in water)	Storage Tank: 25,000 gal AST	Building containment	Sodium will be transported to the WWTS and be discharged to the receiving water body. The alcohol component of SIPX will be biodegraded within the Flotation Tailings Basin (FTB). Xanthate primarily will be oxidized to sulfate and be removed by the WWTS. Some xanthate may be included within the concentrate. Decomposes to carbon disulfide, trithiocarbinate, isopropyl alcohol.	pH 13 at 10%-H_2O, SG 1.263, salts of carbonic acids dithio esters, soluble in water, hydrophobic	Unlikely to have significant effect on mineral dissolution in the FTB due to low proposed concentration and rapid degradation of xanthates.
PAX (Potassium Amyl Xanthate)	Collector: Used to selectively adsorb minerals based on hydrophobicity of the collector and mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.74 tons per day (1,000 tons per year)	4.79 tons per day (1,750 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	Bulk (< 20 ton, 100% PAX), AST (0.5% concentration in water)	Storage Tank: 25,000 gal AST	Building containment	Potassium will be transported to the WWTS and be discharged to the receiving water body. The alcohol component of SIPX will be biodegraded within the FTB. Xanthate primarily will be oxidized to sulfate and be removed by the WWTS. Some xanthate may be included within the concentrate. Decomposes to carbon disulfide. Absorbs to concentrate particles and not the tailing.	pH 10.5 at 10%-H_2O, salts of carbonic acids dithio esters, soluble in water, hydrophobic	Unlikely to have significant effect on mineral dissolution in the FTB due to low proposed concentration and rapid degradation of xanthates.
MIBC (Methyl isobutyl carbinol, 100% solution)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is composed of alcohols, which will be biodegraded within the FTB. Decomposes to carbon monoxide and carbon dioxide.	pH 10.5, SG 0.85, aliphatic alcohols, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Frother (F-160-05)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon monoxide, carbon dioxide, aldehydes, ketones, organic acids.	pH 10 at 5%-H_2O, SG 0.96, polyglycol ethers, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.

Beneficiation Plant Consumables													
Chemical	**Purpose**	**Location of chemical addition in process**	**Amount/ duration/ frequency of addition(1)**	**Average rate of use**	**Maximum rate of use**	**Mode of Delivery**	**Storage Location**	**Storage Capacity**	**Tank Description**	**Secondary Containment**	**Fate and Transport**	**Properties**	**Potential effect on dissolution(2)**
Frother (F-160-13)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon monoxide, carbon dioxide, aldehydes, ketones, organic acids.	pH 10 at 5%-H_2O, SG 0.98-1.05, mixed glycol ethers, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Frother (DVS4U038)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Truck (2-3 trucks per month)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. This chemical additive is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon oxides.	SG 0.85, alcohols, aldehydes, esters, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Copper sulphate ($CuSO_4$)	Activator: Used to increase the available adsorption sites on the mineral to allow for adsorption by the Collector	Flotation Circuit, specifically the Scavenger Cells	Continuous	1.71 tons per day (625 tons per year)	2.05 tons per day (750 tons per year)	Truck (1-2 trucks per month)	Flotation Reagents Building	Bulk: (< 30 ton pentahydrate crystals); AST (< 10% concentration in water)	Storage Tank: 17,000 gal AST	Building containment	The copper component of this chemical additive will precipitate with iron oxide or as an oxide. The sulfate will be precipitated as gypsum. These precipitates will be included in the sludge that will initially be transported to an appropriately permitted disposal facility. Following start-up of the Hydrometallurgical Plant, the sludge will be transported to the Hydrometallurgical Residue Facility (HRF) or appropriately permitted disposal facility.	SG 2.284 solid, soluble in water, acidic in solution	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly be removed to a solid phase in flotation process rather than report to the FTB.
Flocculant (Magnafloc 10)	Flocculant: Used to promote flocculation of suspended particles in liquors	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.082 tons per day (30 tons per year)	0.14 tons per day (50 tons per year)	Truck (1 truck per 2 months)	Flotation Reagents Building	Bulk (< 5 ton, 100% M10), AST (< 1% concentration in water)	Storage Tank: 15,000 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. Recovered water from these thickeners is reused in	pH 4-9 at 5g/l, polyacrylamide, anionic,	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation

Beneficiation Plant Consumables													
Chemical	**Purpose**	**Location of chemical addition in process**	**Amount/ duration/ frequency of addition[(1)]**	**Average rate of use**	**Maximum rate of use**	**Mode of Delivery**	**Storage Location**	**Storage Capacity**	**Tank Description**	**Secondary Containment**	**Fate and Transport**	**Properties**	**Potential effect on dissolution[(2)]**
											the process facility. This product is biodegradable within the process.		within the process facility.
Flocculant (Magnafloc 455)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for Magnafloc 10)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Truck (1 truck per 2 months)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentrati on in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. Recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	polyacrylamide, anionic	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
Flocculant (Neo NS 6655)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 10/455)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Truck (1 truck per 2 months)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentrati on in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. Recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 4 - 9 at 5 g/L, completely miscible in water	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
Flocculant (NALCO: 83949)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 10/455)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Truck (1 truck per 2 months)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentrati on in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. Recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 7.4 at 0.3 %, soluble in water	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
Flocculant (NALCO: 9877 Pulv)	Flocculant: Used to promote flocculation of suspended	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Truck (1 truck per 2 months)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1%	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and	pH 5.5 - 7.5 at 1%, insoluble in water	Unlikely to have significant effect on mineral dissolution in

Beneficiation Plant Consumables													
Chemical	**Purpose**	**Location of chemical addition in process**	**Amount/ duration/ frequency of addition(1)**	**Average rate of use**	**Maximum rate of use**	**Mode of Delivery**	**Storage Location**	**Storage Capacity**	**Tank Description**	**Secondary Containment**	**Fate and Transport**	**Properties**	**Potential effect on dissolution(2)**
	particles in liquors (Potential substitute for MagnaFloc 10/455)							concentration in water)			hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. Recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.		FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
CMC (Carboxyl methyl cellulose)	Depressant: Used to depress gangue minerals in flotation cells to improve selectivity towards Cu Ni minerals	Flotation Circuit, specifically Rougher and Pyrhotite Cleaner Flotation Cells	Continuous	3.29 tons per day (1,200 tons per year)	4.79 tons per day (1,750 tons year)	Truck (2-3 trucks per month)	Flotation Reagents Building	Bulk (< 25 ton, 100% CMC), AST (< 1% concentration in water)	Storage Tank: 70,000 gal AST	Building containment	This chemical additive is an organic compound, which will be broken down within the FTB. It is an anionoic water soluble polymer derived from cellulose and is mainly used for silicate gangue inhibitors.	pH 6-12, SG 0.6-0.9, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB due to its low concentration.
Lime slurry	pH Modifier: Used to regulate pH in the flotation circuit	Flotation Circuit, specifically the Separation Cleaner Flotation Cells	Continuous	28.15 tons per day as hydrated lime (10,274 tons per year as hydrated lime)	41.10 t/day as hydrated lime (15,000 tons per year as hydrated lime)	Tank Truck (1-2 trucks per day)	Flotation Reagents Building	Bulk (< 400 ton, 100% Hydrated Lime), AST (< 15% solution in water)	Storage Tank: 80,000 gal AST	Building containment	The calcium within this chemical additive will either be precipitated or neutralized. The calcium will be precipitated as gypsum and included in the sludge that will initially be transported to an appropriately permitted disposal facility. Following start-up of the Hydrometallurgical Plant, the sludge will be transported to the HRF or an appropriately permitted disposal facility.	pH 12.45 at saturation, SG 2.3-2.4, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will precipitate or be neutralized within the process rather than report to the FTB.

(1) The amount of chemicals used will be optimized for the production, so that added chemicals will be consumed. The fate and transport and the effect on dissolution are intended to describe the effects of the minor amounts (if any) of chemicals that are not consumed in the process.

(2) Screening criteria for potential mineral dissolution impacts looked for reagents that (1) are oxidizers, (2) would substantially raise or lower net pH upon discharge to the Flotation Tailings Basin (FTB), (3) have been demonstrated at other sites, at the concentration discharged to the FTB, to impact microbial communities with respect to their ability to enhance mineral dissolution, and/or (4) have been demonstrated at other sites, at the concentration discharged to the FTB, to enhance dissolution rates through complexation or surface modification.

Adapted from: Large Table 1 of Reference (28)

Table 8-5 Hydrometallurgical Plant Consumables

Hydrometallurgical Plant Consumables												
Chemical	Purpose	Location of chemical addition in process	Amount / duration / frequency of addition(1)	Average rate of use	Maximum rate of use	Mode of Delivery	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Sodium hydrosulfide (30% solution)	Cementation of copper from solution as CuS	Hydromet, specifically copper cementation	Continuous	3.17 tons per day (1,160 tons per year)	4.10 tons per day (1,750 tons per year)	Truck (2-3 trucks per month)	Hydromet Reagents Area	AST (30% concentration in water)	25,000-gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Caustic soda (Sodium hydroxide, 50% solution)	Increase pH of off-gases by removing traces of H_2S and SO_2 in vent scrubbers	Hydromet, specifically the plant scrubber	Continuous	57.53 gallons per day (21,000 gallons per year)	82.19 gallons per day (30,000 gallons per year)	Truck (1 truck per month)	Hydromet Reagents Area	AST (50% concentration in water)	7,000-gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Sulfuric acid (93% solution)	Used as wash water for leach residue filter	Hydromet, specifically the residue filter wash water	Continuous	0.47 tons per day (170 tons per year)	0.68 tons per day (250 tons per year)	Truck (2 trucks per month)	Hydromet Reagents Area	AST (93% concentration in water)	12,500-gal AST	Yes, and building containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Hydrochloric acid (32% solution)	Addition of chloride used to promote mineral leaching	Hydromet, specifically the autoclave	Continuous	13.70 tons per day (5,000 tons per year)	20.55 tons per day (7,500 tons per year)	Truck (3 trucks per month)	Hydromet Reagents Area	AST (32% concentration in water)	60,000-gal AST	Yes, and building containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 342)	Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.06 tons per day (21 tons per year)	0.11 tons per day (40 tons per year)	Truck (1 truck per 2 months)	Hydromet Reagents Area	Bulk (<5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (NALCO 9877 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 342)	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Truck (1 truck per month)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 155)	Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Truck (1 truck per month)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (Neo NS 6670)	Promote flocculation of suspended	Hydromet, specifically mixed	Continuous	0.11 tons per day	0.21 tons per day	Truck (1 truck per month)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1%	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or

Hydrometallurgical Plant Consumables												
Chemical	Purpose	Location of chemical addition in process	Amount / duration / frequency of addition(1)	Average rate of use	Maximum rate of use	Mode of Delivery	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
	particles in liquors (Potential substitute for MagnaFloc 342 or 155)	hydroxide precipitation		(40 tons per year)	(75 tons per year)			concentration in water)			flocculant will attach to the solids and end up in the concentrates.	on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (NALCO 8173 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 342 or 155)	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Truck (1 truck per month)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 351)	Promote flocculation of suspended particles in liquors	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.27 tons per day (100 tons per year)	0.41 tons per day (150 tons per year)	Truck (2 trucks per month)	Hydromet Reagents Area	Bulk (< 10 ton, 100% M351), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (Neo NS 6500)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 351)	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.41 tons per day (150 tons per year)	0.55 tons per day (200 tons per year)	Truck (4 trucks per month)	Hydromet Reagents Area	Bulk (< 10 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (NALCO 9876 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 351)	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.41 tons per day (150 tons per year)	0.68 tons per day (250 tons per year)	Truck (4 trucks per month)	Hydromet Reagents Area	Bulk (< 10 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Sulfur dioxide (liquid)	Reduce ferric ions to ferrous ions	Hydromet, specifically iron reduction and PGM precipitation	Continuous	4.14 tons per day (1,510 tons per year)	6.16 tons per day (2,250 tons per year)	Truck (2 trucks per month)	Hydromet Reagents Area - outside	AST	AST: 17,500 gal	Yes	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Limestone (lump)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons per day (101,000 tons per year)	410.96 tons per day (150,000 tons per year)	Rail (one 100-car train/ week from April to October)	Outdoor Stockpile near Concentrate Loadout	Stockpile (50,000 st); silo: (500 st); AST (37.5% concentration)	AST: 150,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

Hydrometallurgical Plant Consumables												
Chemical	Purpose	Location of chemical addition in process	Amount / duration / frequency of addition(1)	Average rate of use	Maximum rate of use	Mode of Delivery	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Limestone (ground)	Promote precipitation of Fe and Al (Potential substitute for lump limestone)	Hydromet, specifically in iron removal	Continuous	276.71 tons per day (101,000 tons per year)	410.96 tons per day (150,000 tons per year)	Rail (one 100-car train per week from April to October)	Outdoor Stockpile near Concentrate Loadout	Stockpile (50,000 st); silo: (500 st); AST (37.5% concentration)	AST: 150,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Lime (dry)	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	10.55 tons per day as CaO) (3,850 tons per year as CaO)	16.44 tons per day as CaO (6,000 tons per year as CaO)	Truck (75 trucks per month)	Hydromet Reagents Area	Bulk (< 40 ton - CaO, 100%), AST (22% concentration in water)	AST: 20,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Magnesium hydroxide (60% slurry)	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons per day (6,000 tons per year)	24.66 tons per day (9,000 tons per year)	Truck (7 trucks per month)	Hydromet Reagents Area	AST: Received as 60-65% slurry; diluted to 30%	AST: 85,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Magnesium hydroxide (dry)	Used to promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate) (Potential substitute for magnesium hydroxide (60% slurry))	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons per day (6,000 tons per year)	24.66 tons per day (9,000 tons per year)	Truck (7 trucks per month)	Hydromet Reagents Area	Received dry bulk, diluted to 30%	AST: 85,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

(1) The amount of chemicals used will be optimized for the production, so that added chemicals will be consumed. The fate and transport and the effect on dissolution are intended to describe the effects of the minor amounts (if any) of chemicals that are not consumed in the process.

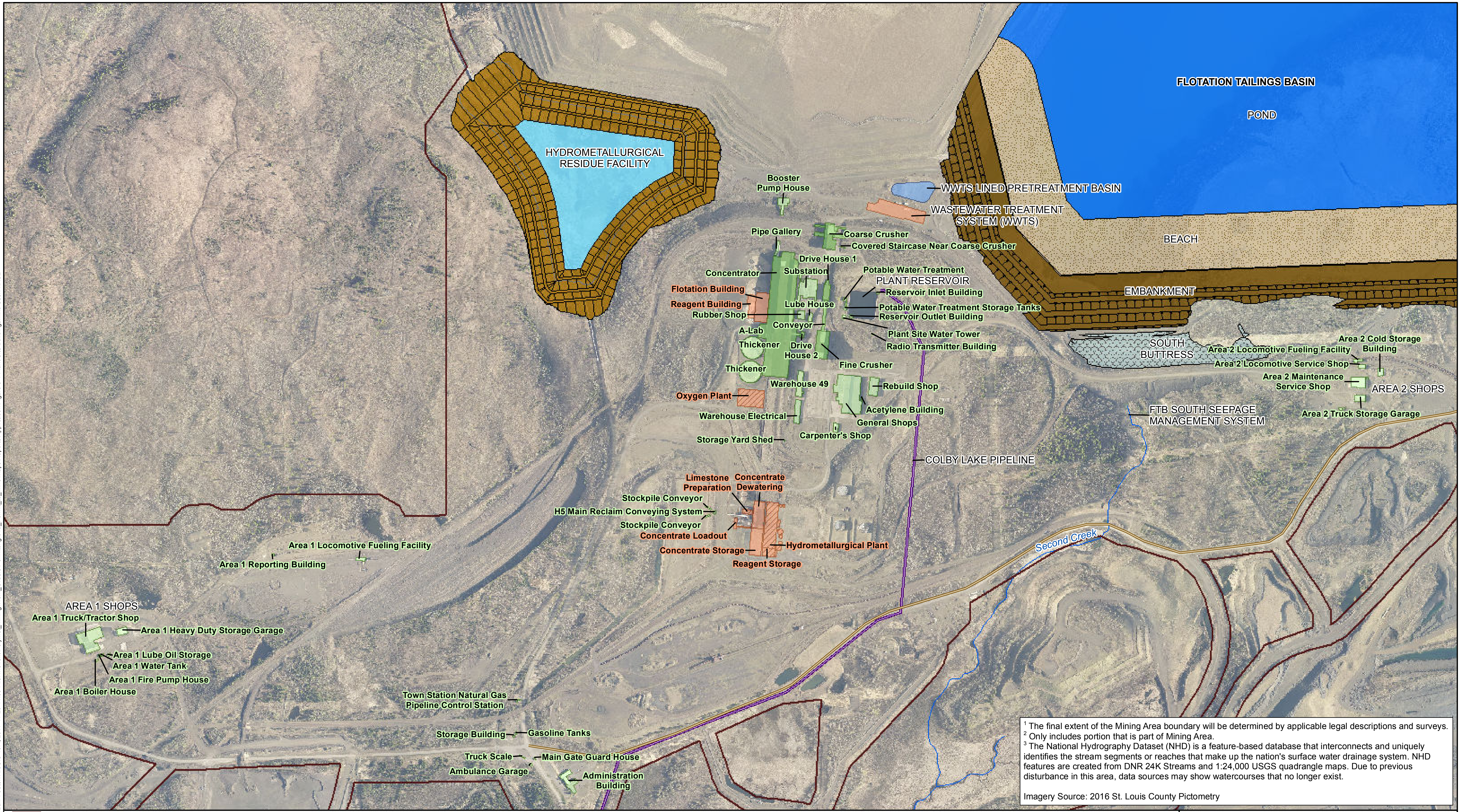
Source: Large Table 1 of Reference (29)

Table 8-6 Design Processing Parameters

Process	Input			Output		
	Material	Rate (tons per day)	Size (inches)	Material	Rate (tons per day)	Size (inches)
Ore Crushing	Ore	32,000	48	Ore	32,000	4
Ore Grinding	Ore	32,000	4	Ore	32,000	4.7×10^{-3}
Flotation	Ore	32,000	4.7×10^{-3}	Concentrate	374 to Hydrometallurgical Plant and 286 to Concentrate Dewatering; or 660 to Concentrate Dewatering	Varies depending on concentrate stream and next process step
				Flotation Tailings	31,340	4.7×10^{-3}
Concentrate Dewatering	Concentrate	660	Varies depending on concentrate stream(1)	Dried nickel and copper concentrate	286 copper and 374 nickel	Same as input(1)

(1) Flotation step has two fine grinding stages that produce a defined size. One nickel concentrate stream to Concentrate Dewatering does not pass through a fine grinding stage, but all concentrates to the Hydrometallurgical Plant pass through a fine grinding stage. Therefore, the average output for Flotation does not coincide with the average input for Concentrate Dewatering.

Source: Adapted from Table 4-8 of Appendix 16.3

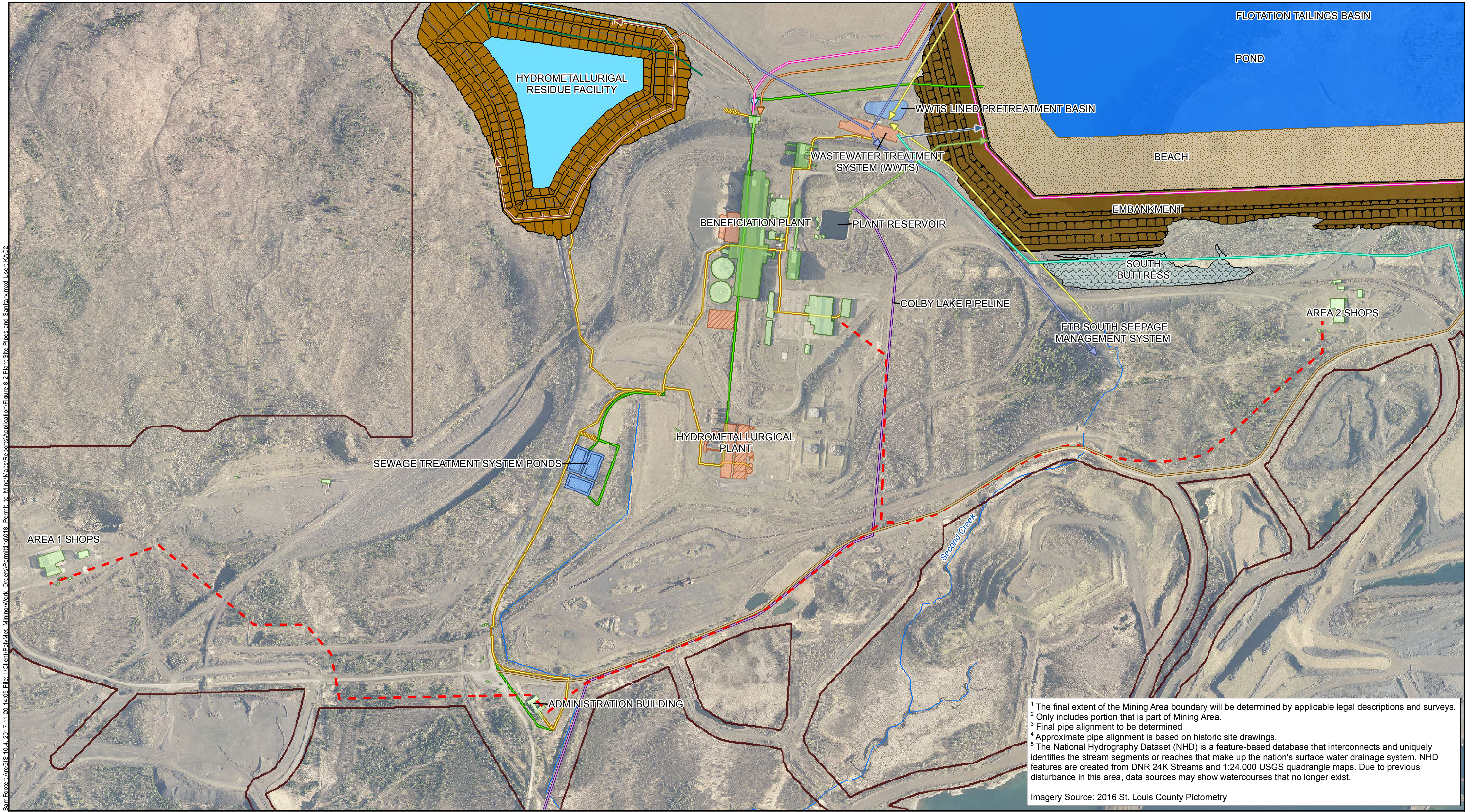


Mining Area [1]
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Dunka Road[2]
Hydrometallurgical Residue Facility Pond
Hydrometallurgical Residue Facility Dam
Flotation Tailings Basin
Dam
Beach
Pond
South Buttress
National Hydrography Dataset (NHD) Rivers & Streams [3]

0 500 1,000 2,000
Feet

PROCESS PLANT AREA BUILDINGS-
MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 8-1
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Final pipe alignment to be determined
[4] Approximate pipe alignment is based on historic site drawings.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

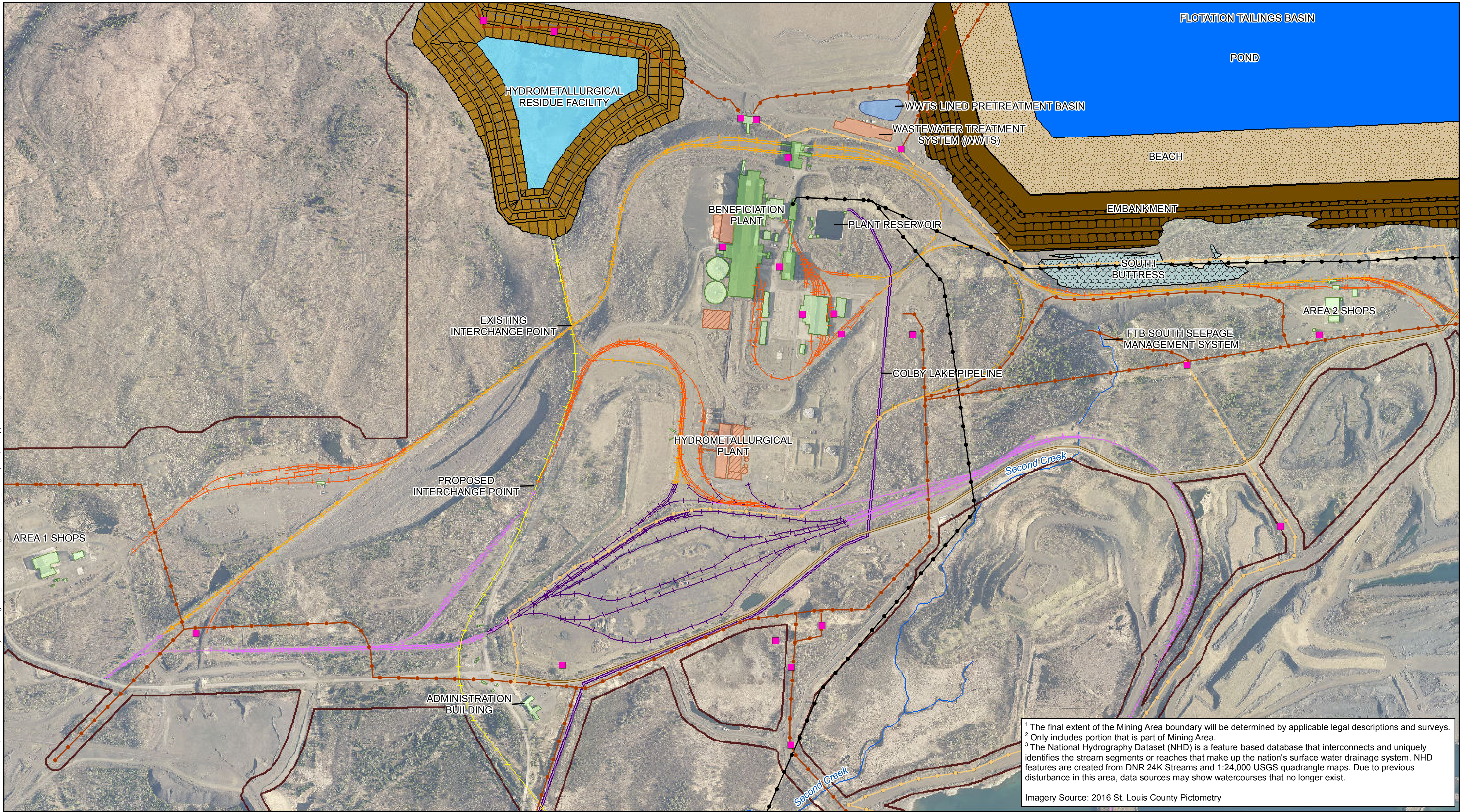
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area [1]
- Dunka Road[2]
- Colby Lake Pipeline
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- HRF Pond
- HRF Dam
- Flotation Tailings Basin
  - Dam
  - Beach
  - Pond
  - South Buttress
- Proposed Sewer Pipe[3]
- Existing Sewer Pipe[4]
- Potable Water Pipeline (Underground)
- Mine to Plant Pipelines
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe
- FTB Water Return Pipe
- FTB Tailings Discharge Pipe
- Tailings Basin Seepage Collection Pipe
- Plant Reservoir Overflow
- Treated Water Pipe
- Treated Mine Water Ppe
- National Hydrography Dataset (NHD) Rivers & Streams [5]

0 1,000
Feet

PROCESS PLANT AREA
PIPES AND SANITARY SYSTEM -
MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 8-2
Permit to Mine Application



Mining Area [1]
Dunka Road[2]
Colby Lake Pipeline
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building

HRF Pond
HRF Dam
Flotation Tailings Basin
Dam
Beach
Pond
South Buttress

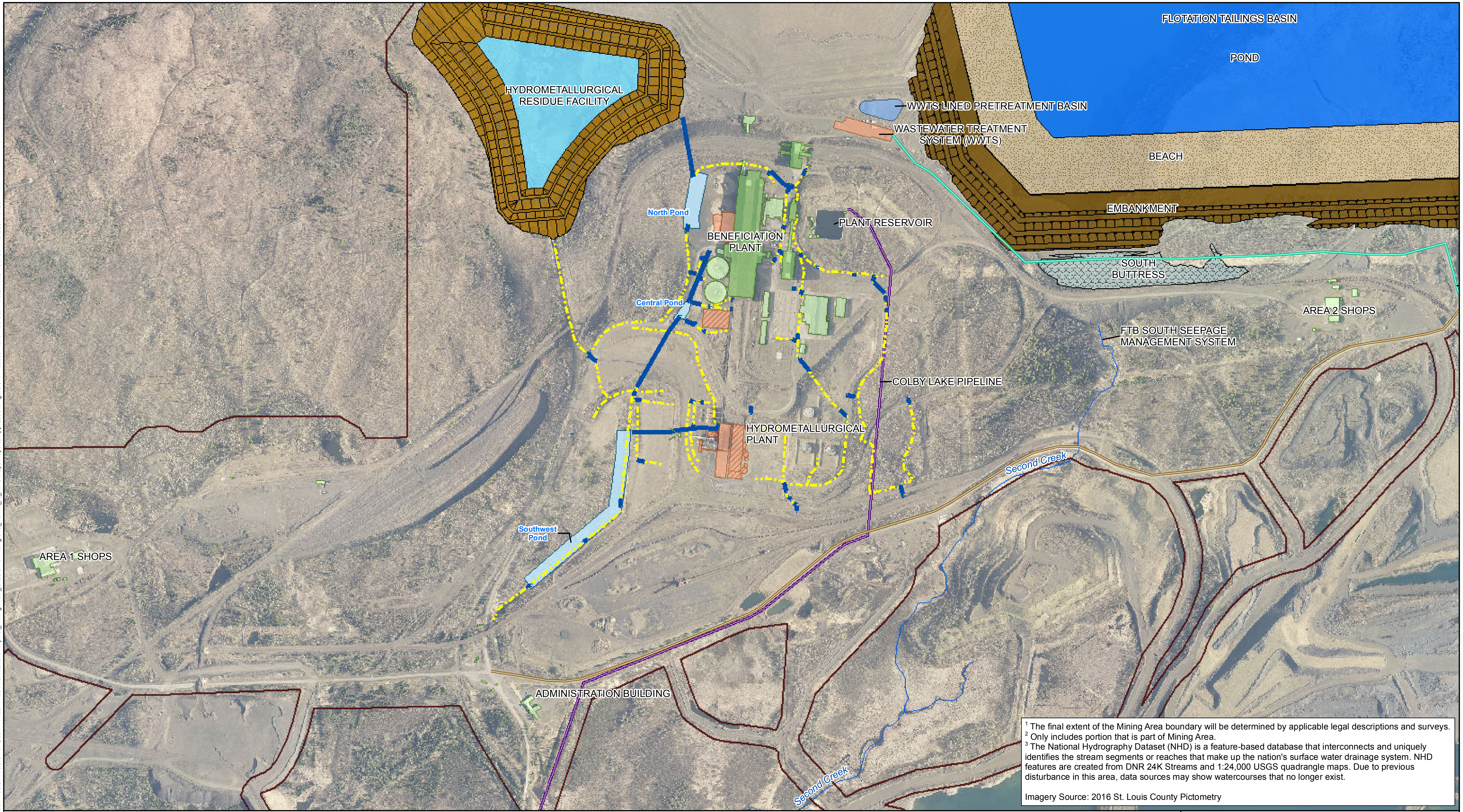
PolyMet Exclusive Track
PolyMet Track with License to Cliffs
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Canadian National Track

PolyMet Substations
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Lines
National Hydrography Dataset (NHD) Rivers & Streams [3]

0 500 1,000
Feet

PROCESS PLANT AREA
POWER DISTRIBUTION AND RAILROADS-
MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 8-3
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

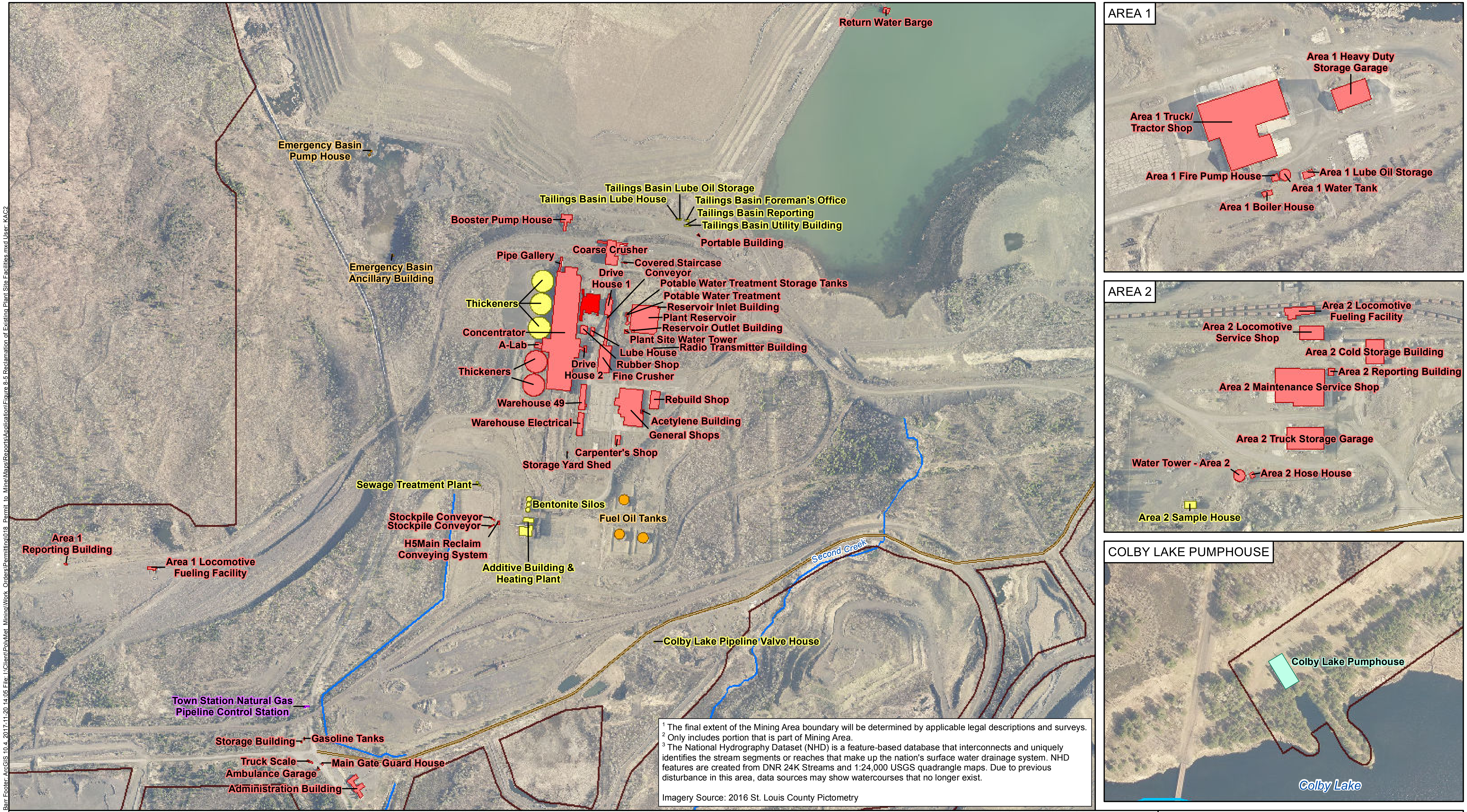
Imagery Source: 2016 St. Louis County Pictometry

Mining Area [1]
Dunka Road[2]
Colby Lake Pipeline
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Hydrometallurgical Residue Facility Pond
Hydrometallurgical Residue Facility Dam
Flotation Tailings Basin
Dam
Beach
Pond
South Buttress
Stormwater Ponds
Stormwater Culvert/Pipe
Stormwater Ditch
Mine to Plant Pipelines
National Hydrography Dataset (NHD) Rivers & Streams [3]

0 500 1,000 2,000
Feet

PROCESS PLANT AREA
STORMWATER - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 8-4
Permit to Mine Application



- Mining Area [1]
- Existing Facility Used by Project to be Demolished During Reclamation
- Existing Facility Used by Project to be Demolished After Closure by Northern Natural Gas
- Existing Facility Used by Project to be Demolished During Postclosure Maintenance
- Existing Facility Used by Project to Remain In-place
- Existing Facility Not Used by Project to be Demolished by End of Mine Year 1
- Existing Facility Not Used by Project to be Demolished During Operations
- Dunka Road[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

0 500 1,000 2,000
Feet

RECLAMATION OF EXISTING PLANT SITE FACILITIES
NorthMet Project
Poly Met Mining, Inc.

Figure 8-5
Permit to Mine Application

[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

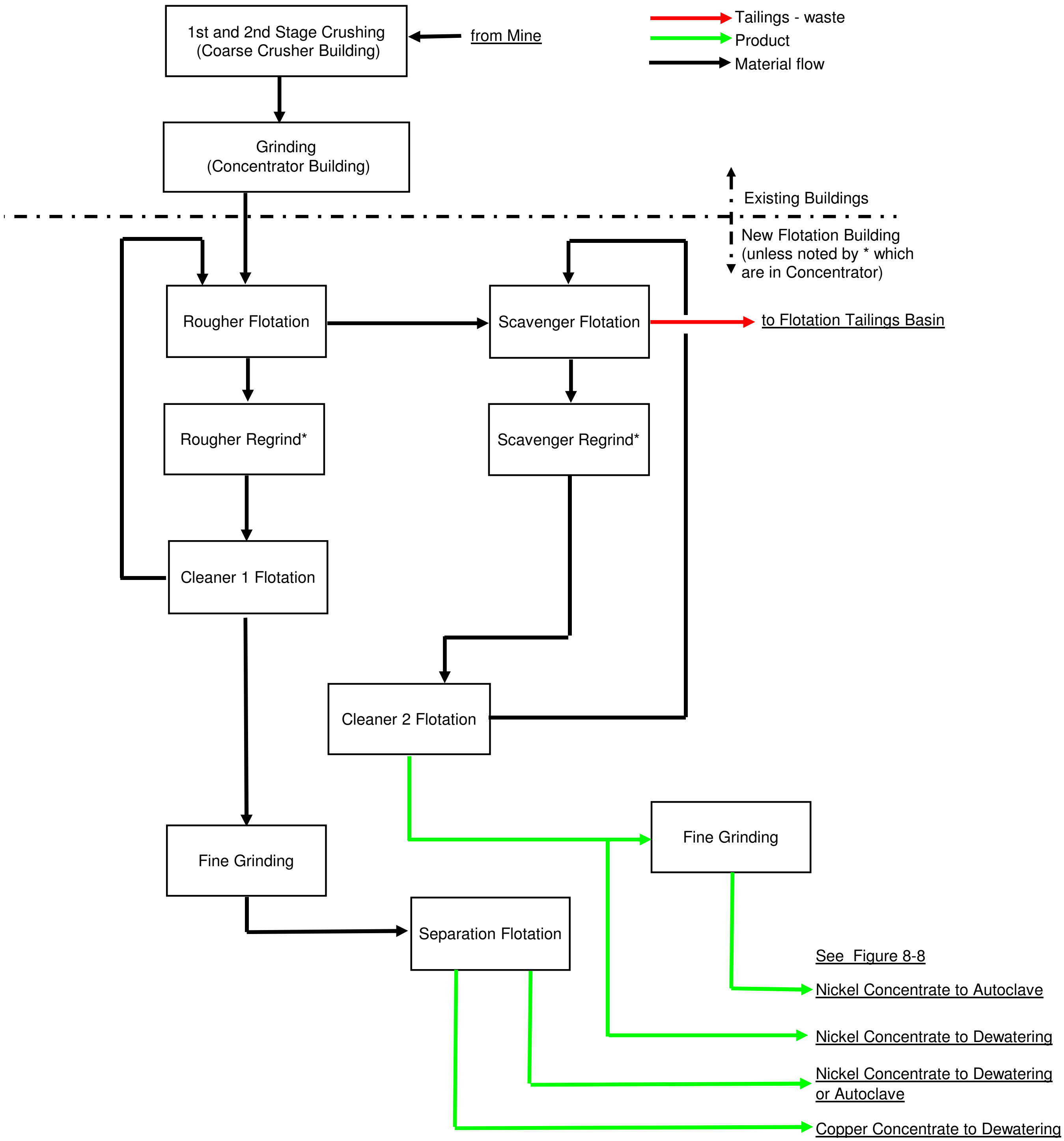
Mining Area[1]
Surface Ownership Boundary
Plant Site Areas of Concern
Resolved
Managed During Operations
Managed During Reclamation, Closure, and/or Postclosure Maintenance (or Managed after Operations)

Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 1,000 2,000 4,000
Feet

PLANT SITE AREAS OF CONCERN
NorthMet Project
Poly Met Mining, Inc.

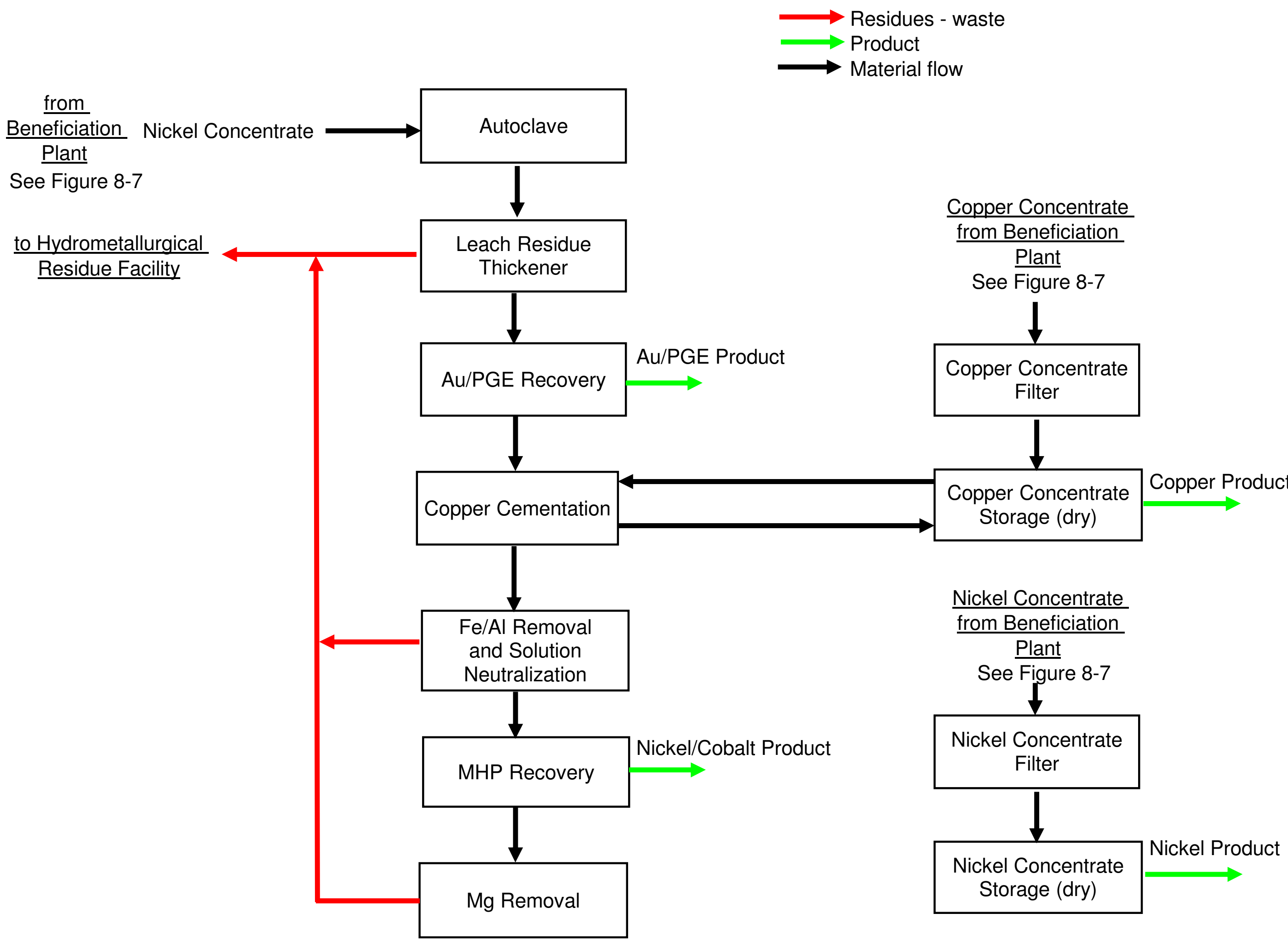
Figure 8-6
Permit to Mine Application



BENEFICIATION PLANT PROCESS FLOW DIAGRAM
Northmet Project
Poly Met Mining, Inc.

Figure 8-7
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\8 Plant Site\Figures\Figures\FIGURE 8-7_BENEFICATION PLANT PROCESS FLOW DIAGRAM-tcr.xls



HYDROMETALLURGICAL PLANT PROCESS FLOW DIAGRAM
NorthMet Project
Poly Met Mining, Inc.

Figure 8-8
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\8 Plant Site\Figures\Figures\FIGURE 8-8_HYDROMETALLURGICAL PLANT PROCESS FLOW DIAGRAM-tcr.xls

9.0 Transportation and Utility Corridors and Colby Lake Pipeline Corridor

In addition to the Mine and Plant Sites, the Mining Area also includes the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor. Figure 9-1 shows the location of these corridors and provides an overview of the areas covered in more detail on Figure 9-2 through Figure 9-5. The Transportation and Utility Corridors span approximately 8 miles, and include Dunka Road, the existing mainline railroad, the new Connection Track, new transmission lines that will be constructed along a portion of Dunka Road, and the new Mine to Plant Pipelines (MPP). The existing Colby Lake Pipeline will supply water to the Plant Site as needed by pumping water drawn from Colby Lake, approximately four miles south of the Plant Site.

The location, construction, and operation of the Transportation and Utility Corridors and Colby Lake Pipeline Corridor are designed to comply with the requirements set forth in Minnesota Rules, chapter 6132, including those requirements relating to siting and buffers, as listed in Minnesota Rules, part 6132.2000 and 6132.2100. Specifically, no mining or surface disturbance will occur in excluded or prohibited areas, and mining operations will comply with the additional siting restrictions applicable to mining sites. Additionally, the design, construction, and maintenance of the corridors will be compatible with surrounding non-mining uses, and the existing terrain, vegetation, and/or revegetated berms will diminish impacts from mining activities.

The Project will repurpose and reuse the existing taconite mining infrastructure for its operations in preference to using areas undisturbed by mining. In this way, it is designed to advance the policies and requirements of Minnesota law, including Minnesota Statues chapter 93 and various DNR rules, that encourage the preservation, repurposing, and reuse of existing mining facilities. Figure 9-2 through Figure 9-5 show the past mining infrastructure, including pipelines, railroads, and powerlines, as well as the proposed infrastructure PolyMet will use within its corridors.

9.1 Transportation and Utility Corridors Components

Blasting will occur during the construction phase where necessary to modify bedrock outcrops that impinge on design of components within the Transportation and Utility Corridors (e.g., Connection Track, Connection Track ditches). Blasting for construction along the Transportation and Utility Corridors is only anticipated to be needed along the Connection Track and will be carried out using contractors and methods normally employed for construction-related rock removal. Due to the proximity to the Plant Site, the resulting blast rock from the Connection Track will be utilized or managed as proposed for the Plant Site (Figure 3-12). As shown on Figure 5-1, the majority of the rock excavated for the Connection Track will be from the BIF with a very short segment from the Virginia Formation. Excavated rock from the BIF will be used for construction material pending State of Minnesota (mineral owner) approval. Excavated rock from the Virginia Formation will be routed to the Category 4 Waste Rock Stockpile for disposal.

9.1.1 Dunka Road

Dunka Road is a private existing gravel road, a portion of which connects the Mine Site to the Plant Site. PolyMet will upgrade the portion of the Dunka Road that will be used as part of the Project to accommodate the anticipated traffic associated with the Project. PolyMet will widen the driving surface to a 40-foot width with 60-foot-wide passing bays and construct safety berms as shown on Drawings EW-001 through EW-004 in Appendix 3. The finished road surface will be similar to the existing road profile. The road will follow the existing alignment with modifications to straighten the road slightly (typically 5- to 10-foot adjustments) in approximately 15 locations and increase the radius of one curve, as shown on Drawings MPP-003 through MPP-009 in Appendix 8. As required by applicable MSHA regulations, PolyMet will construct safety berms along the road to accommodate the travel of the largest piece of mobile equipment that will be using the road. PolyMet will extend existing culverts to accommodate the road widening and will construct passing bays at selected locations to allow for the haul trucks used for mine development traveling in opposite directions to pass each other. Both Wyman Creek and Longnose Creek are listed public waters; however, there will be no culvert extensions associated with these two creeks. One culvert extension located in a tributary to Wyman Creek will require a Public Waters Work Permit, and PolyMet will work with DNR separately on that permit process. Drawings EW-001 through EW-004 in Appendix 3 and Drawings MPP-001 through MPP-009 in Appendix 8 include additional details on the Dunka Road upgrade including typical cross-sections.

9.1.2 Power Distribution

Electrical service will be provided to the Mine Site along the Transportation and Utility Corridors from the Plant Site. Figure 9-2 through Figure 9-5 show the location of this power distribution system along this corridor.

The new power distribution line will be installed along the northern side of Dunka Road, following the MPP alignment, from the Plant Site substation to the Mine Site. This aboveground power distribution line will be located in the same corridor as the MPP on the north side of Dunka Road for ease of access for maintenance from Dunka Road.

9.1.3 Mine to Plant Pipelines

The MPP will be constructed along Dunka Road within the Transportation and Utility Corridors (Figure 9-2 through Figure 9-4 and Drawings MPP-001 through MPP-012 in Appendix 8) to move mine water from the Mine Site to the WWTS and the FTB and to move treated water back to the Mine Site during pit flooding in the later years of the operations. PolyMet will operate the MPP as part of daily operations. The MPP will be used continuously throughout the year and will be designed and constructed to prevent freezing in the winter by covering the pipelines with a berm or burying and insulating them at access crossings. Additional information on the water conveyed through the MPP is described in Section 11.3.2.4.

Monitoring of the MPP will be by flow meters on each end of each pipeline, which would be monitored in the control room at the WWTS. Having the flow meters on each end of each pipe will allow for continuous monitoring of flow differentials; if a differential suggests that a leak might have occurred, an alarm will be triggered and the pumps will automatically stop as described in Section 4.1.3 of Appendix 11.2 (further details on flow differentials to be determined during final engineering design). Additionally, visual inspections of the MPP manhole locations will be completed daily to identify and prevent any potential leaks and spills. Also, monthly visual inspections will occur along the entire MPP alignment (berms, in most cases). Once final design and construction of the MPP is completed, PolyMet will include its monitoring and inspection protocols in a monitoring plan, and its spill response procedures in a spill response plan. Section 11.5 describes the management of stormwater along the Transportation and Utility Corridor, including along the MPP alignment. The route along Dunka Road provides easy access for maintenance and regular inspection.

9.1.4 Railroad and Rail Cars

PolyMet will refurbish the existing mainline railroad that connects the Mine Site to the Plant Site between mileposts 3.9 and 8.4. PolyMet plans to build the new Connection Track, to connect the mainline railroad to the existing track that serves the Coarse Crusher Building at the Beneficiation Plant. Figure 9-1 through Figure 9-4 show the location of the mainline railroad and Connection Track.

Trains will move ore from the Mine Site to the Coarse Crusher Building at the Beneficiation Plant along this private railroad system. Each train will consist of 16 to 20 side-dumping ore cars and one locomotive. PolyMet will refurbish and reuse the side-dumping ore cars that were used in the previous LTVSMC operation. These cars have hinged sides that drop down when the cars are tipped at the Coarse Crusher for unloading as shown in Figure 9-6. To minimize and prevent ore spillage, rail cars will be refurbished to minimize gaps along the hinges and joint areas by replacing and tightening worn linkages, pins, and bushings. PolyMet will inspect the refurbished ore cars for structural integrity prior to use and daily thereafter, and will replace worn linkages, pins, and bushings as needed during operations.

LTVSMC's ore was loaded using a RTH. While there is anecdotal evidence of large pieces of ore along the track that may have fallen off the top of the loaded car because of their size, there is no anecdotal evidence of a trail of fines/small pieces of ore that could have spilled out through the joints between the movable side doors and stationary car body. Collectively, this supports the premise that the car design and loading method proposed for the Project, which is similar to the LTVSMC method, would result in minimal potential for spillage of ore fines and resultant potential for soil and water body contamination.

As was done by LTVSMC, the rail cars will be loaded along the centerline at the RTH such that the ore is naturally classified by size, with the larger ore pieces at the edge of the car trapping fines at the center, away from the door hinges as shown in Figure 9-6. To minimize the potential for large pieces of ore to spill, a rubber-tired dozer or a front-end loader would push any large ore pieces extending out of a car into or off of the car near the RTH. In the event that a large piece of ore would fall over the top edge of the cars during transit, it would be recovered during routine track maintenance.

Planned monitoring and management activities, including dust suppression, are discussed in Section 14.2.6. The Fugitive Emissions Control Plan associated with the Mine Site and Transportation and Utility Corridors, which is included in Appendix 12.1, discusses the triggers for determining when dust suppression should occur. Fugitive dust control along the Transportation and Utility Corridors is discussed further in Section 13.2.1.

The railroad infrastructure around the Project, as shown on Figure 9-1 through Figure 9-5, has been grouped into six ownership categories:

- "PolyMet Exclusive Track" is railroad that PolyMet controls (or will control after the track is constructed) and on which PolyMet will be the sole entity operating.
- "PolyMet Track with License to Cliffs" is railroad that PolyMet controls and will operate. Cliffs Erie, under a license with PolyMet, may also operate on this track.
- "Cliffs Track with License to PolyMet" is railroad that Cliffs Erie owns on which PolyMet has a license to operate.
- "Cliffs Exclusive Track" is railroad that Cliffs Erie has ownership and exclusive operating rights PolyMet will not operate on these tracks.
- "Canadian National Track" is railroad owned by the common carrier Canadian National. PolyMet may enter into arrangements with Canadian National to operate on this track.
- "Other Track" is railroad infrastructure that is located around the Project area that PolyMet does not own and on which it will not be operating. Ownership of railroad further away from the Project is classified as "Other Track" when ownership and license agreements do not involve PolyMet.

The railroad tracks within the Mining Area include the tracks that PolyMet controls and is responsible for maintaining and reclaiming, as well as tracks that are owned by other parties as indicated on Figure 9-1 through Figure 9-5 and described in the bullet list above. PolyMet's railroad arrangments with Cliffs, including use and ownership rights, are included among the agreements between the two companies that are more fully described in Section 4.0. The tracks owned by other parties, though in the Mining Area, are only the responsibility of PolyMet in accordance with the agreements held by PolyMet and the owner (Section 4.0).

9.2 Colby Lake Pipeline Corridor Components

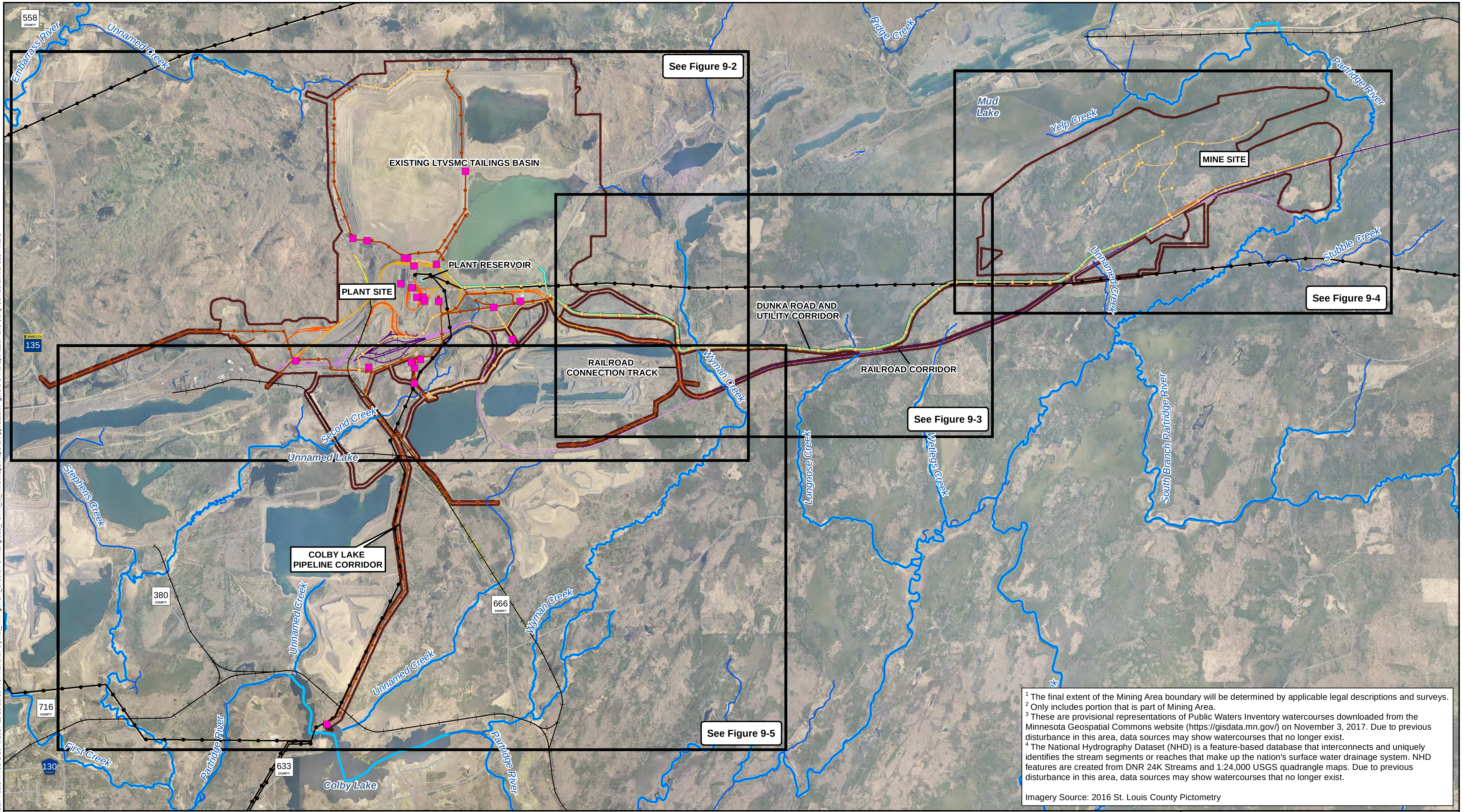
9.2.1 Colby Lake Pipeline and Pumphouse

The existing Colby Lake Pipeline and Pumphouse will deliver water from Colby Lake, located approximately four miles south of the Plant Site, to the Plant Site. Figure 9-5 shows the Colby Lake Pipeline alignment and the location of the Colby Lake Pumphouse. LTVSMC constructed Whitewater Reservoir and the Colby Lake Pipeline and Pumphouse in the early 1950s to provide make-up water to the Beneficiation Plant. The Colby Lake Pipeline is three feet in diameter, and is buried between 7 and 25 feet below ground along its alignment. PolyMet will inspect the pumphouse and pipeline and will refurbish these infrastructures, as necessary, before putting this system back in service prior to the start of operations. The pipeline crosses Second Creek, which is a DNR-mapped public water, and, therefore, if the pipeline requires refurbishment across this water crossing, a DNR Work in Public Waters Permit would be required prior to the commencement of any work below the ordinary high water of that waterway. The nature and extent of the refurbishment of the Colby Lake Pipeline will be dependent on the results of the inspection, which will be completed by televising the pipeline.

Colby Lake water will be stored in the existing Plant Reservoir, which will provide an on-site water source for make-up water for the Beneficiation Plant and Hydrometallurgical Plant, the Potable Water Treatment System, fire protection systems, dust control, air emission control scrubber system water, gland seal water, water supply to the Area 1 Shops and the Area 2 Shops, as well as other miscellaneous Project water needs for construction and operation, including filling the tailings basin prior to startup of operations. Sections 11.4.3 (Potable Water), 11.4.5 (Beneficiation Plant), and 11.4.7 (Hydrometallurgical Plant) describe these specific uses of Colby Lake water. Water appropriation from Colby Lake and water management details are also covered in the applications for the Water Appropriation Permit (DNR) and the NPDES/SDS Permit (MPCA), respectively, and the Water Management Plan – Plant (Appendix 11.3) also discusses the use of Colby Lake water for operations.

9.2.2 Power Distribution

Electrical service is provided to the Colby Lake Pumphouse along the Colby Lake Pipeline Corridor. Figure 9-5 shows the location of the existing power distribution system along this corridor.



¹ The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
² Only includes portion that is part of Mining Area.
³ These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
⁴ The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

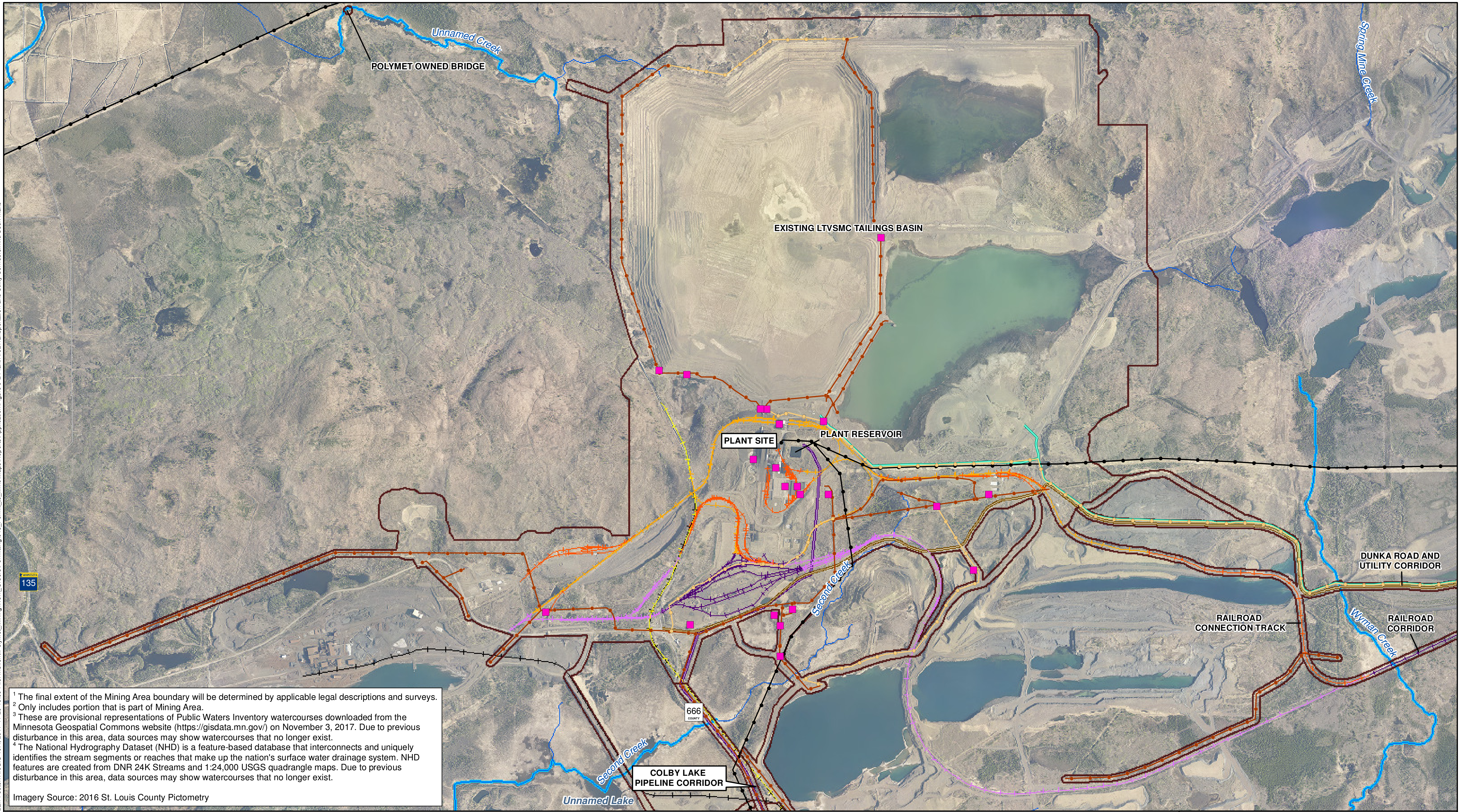
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
PolyMet Exclusive Track
PolyMet Track with License to Cliffs
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Canadian National Track
Other Track - This track is not owned or operated on by PolyMet.
Dunka Road[2]
Roads
PolyMet Substation
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Lines
Mine to Plant Pipelines
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 0.5 1 2
Miles

TRANSPORTATION AND UTILITY CORRIDORS
NorthMet Project
Poly Met Mining, Inc.

Figure 9-1
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

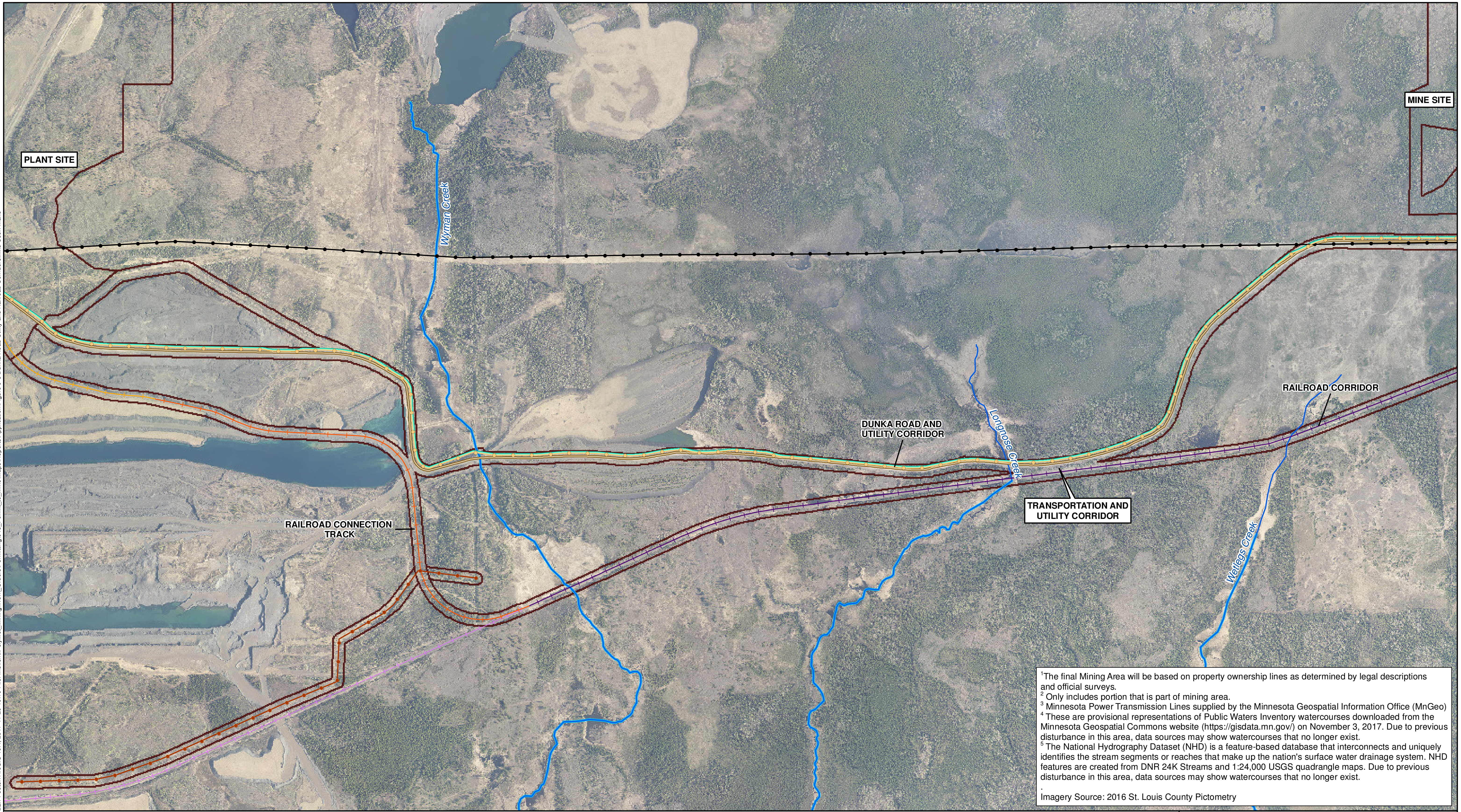
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
PolyMet Exclusive Track
PolyMet Track with License to Cliffs
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Canadian National Track
Other Track - This track is not owned or operated on by PolyMet.
Dunka Road[2]
Roads
PolyMet Substation
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Lines
Mine to Plant Pipelines
Colby Lake Pipeline
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,250 2,500 5,000
Feet

PLANT AREA - TRANSPORTATION AND UTILITY CORRIDORS
NorthMet Project
Poly Met Mining, Inc.

Figure 9-2
Permit to Mine Application



[1]The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Minnesota Power Transmission Lines supplied by the Minnesota Geospatial Information Office (MnGeo)
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
.
Imagery Source: 2016 St. Louis County Pictometry

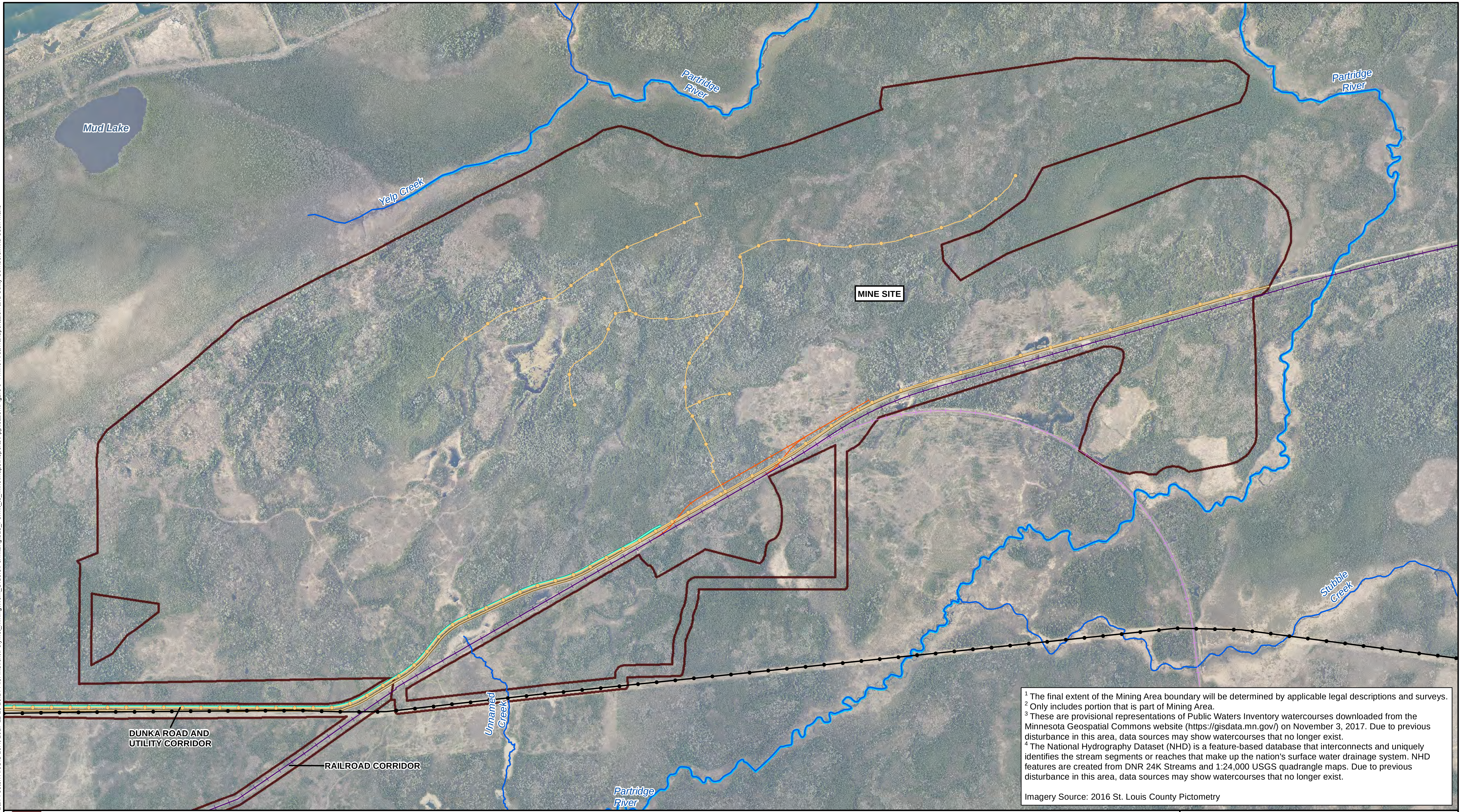
Mining Area[1]
PolyMet Exclusive Track
PolyMet Track with License to Cliffs
Cliffs Track with License to PolyMet
Cliffs Exclusive Track
Dunka Road[2]
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Lines[3]
Mine to Plant Pipelines
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 750 1,500 3,000
Feet

DUNKA ROAD, UTILITY AND RAILROAD CORRIDORS
NorthMet Project
Poly Met Mining, Inc.

Figure 9-3
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 10:16 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 9-3 Dunka Road Utility and Railroad Corridors.mxd User: mak3



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

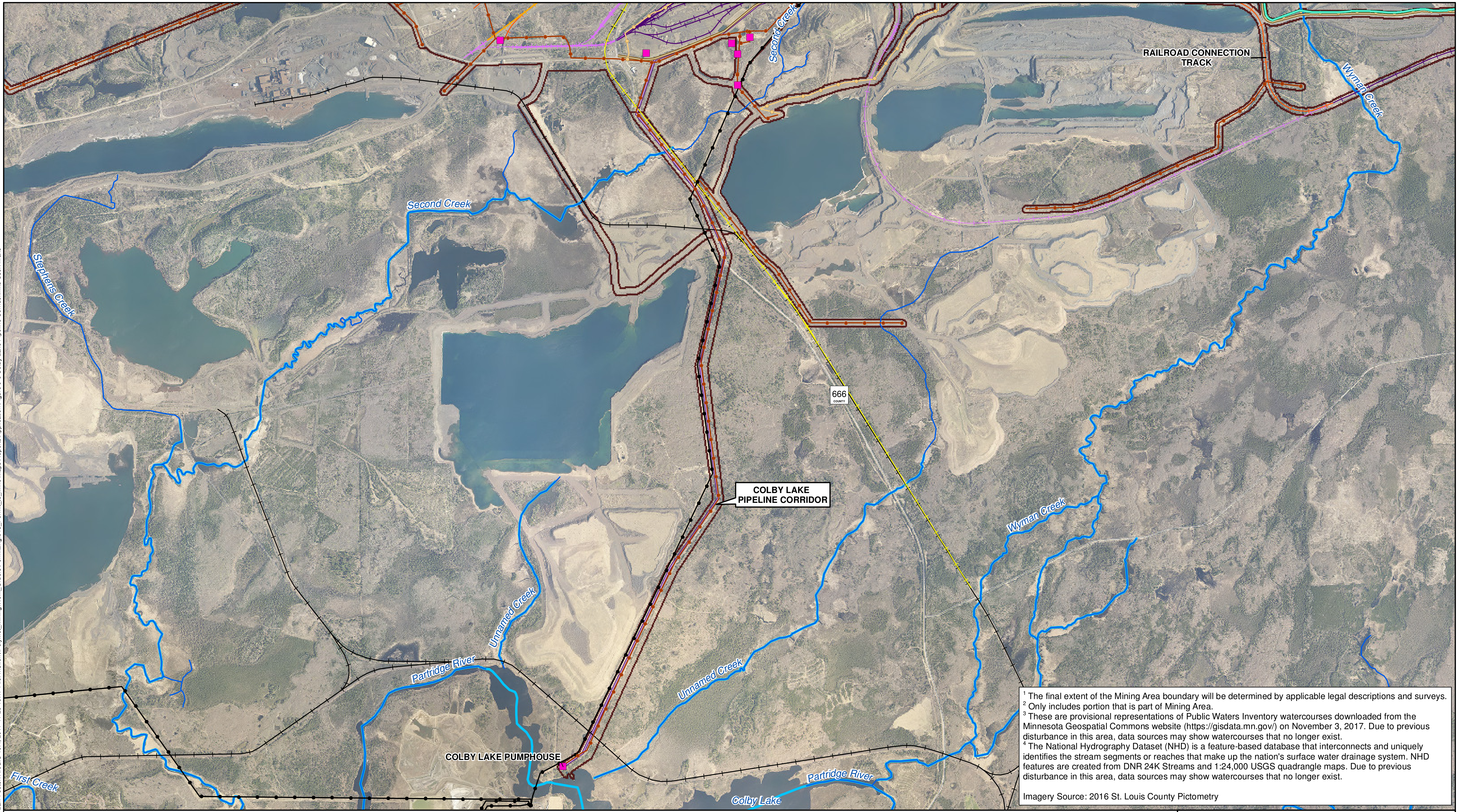
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- PolyMet Exclusive Track
- Cliffs Track with License to PolyMet
- Cliffs Exclusive Track
- Dunka Road[2]
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Lines
- Mine to Plant Pipelines
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE AREA - TRANSPORTATION AND UTILITY CORRIDORS
NorthMet Project
Poly Met Mining, Inc.

Figure 9-4
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

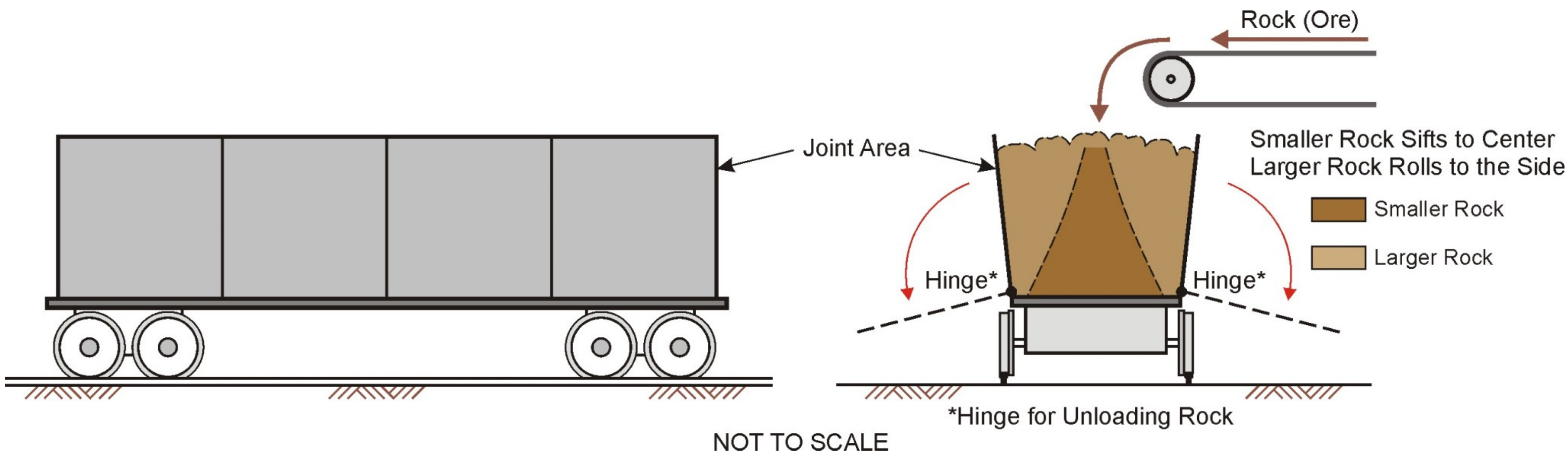
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- PolyMet Exclusive Track
- PolyMet Track with License to Cliffs
- Cliffs Track with License to PolyMet
- Cliffs Exclusive Track
- Canadian National Track
- Other Track - This track is not owned or operated on by PolyMet.
- Dunka Road[2]
- Roads
- PolyMet Substation
- PolyMet Power Distribution Lines - Existing
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Lines
- Mine to Plant Pipelines
- Colby Lake Pipeline
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,250 2,500 5,000
Feet

COLBY LAKE
PIPELINE CORRIDOR
NorthMet Project
Poly Met Mining, Inc.

Figure 9-5
Permit to Mine Application



LTVSMC RAIL ORE CAR
NorthMet Project
Poly Met Mining, Inc.

Figure 9-6
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\9 Utility Corridor\Figures\Native Files\Figure 9-6 LTVSCM Rail Ore Car.pptx

10.0 Characterization and Management of Mine Waste

PolyMet has designed the Project so that mine waste generated from its mining and processing operations will be appropriately managed, in accordance with applicable federal and state laws, to minimize potential environmental impacts. Based on approximately 10 years of mine waste characterization testing, PolyMet has designed the Project such that reactive and non-reactive rock will be mined, stored, contained, and reclaimed so as to prevent the release of substances that may result in adverse impacts to natural resources. The proposed design, construction, operation, and reclamation of the Project stockpiles, FTB, and HRF will, consistent with the PTM Regulations, be structurally sound, minimize hydrologic impacts, control air emissions, enhance the survival and propagation of vegetation, control erosion, promote progressive reclamation, and preserve access to and avoid encumbering remaining mineral resources.

For over 10 years, PolyMet has conducted a mine waste characterization program and worked with the Co-Lead Agencies to develop an FEIS that analyzed the alternatives for managing this waste. During this period, and in close collaboration with DNR, PolyMet worked with a team of qualified technical experts, including professional engineers, geochemists, and hydrogeologists, to conduct this technical analysis, which included, among other things, an evaluation of:

- the geochemical and geotechnical properties of the Mine Site overburden, Mine Site waste rock, ore, Flotation Tailings, and Residue
- the geochemical and geotechnical properties of the existing LTVSMC tailings
- the existing environmental setting, including climate, precipitation, topography, drainage, subsurface conditions, hydrogeology, and seismology
- potential storage methods for different categories of mine waste
- various alternatives for design and construction of dams and storage piles
- the application of industry standard engineering and environmental practices to the specific context of the Project
- the use of ongoing monitoring, maintenance, and management practices

PolyMet and its engineering team used the results of these studies and analyses to design facilities that, through proposed management practices, can be constructed, operated, and reclaimed so as to be structurally sound and minimize environmental impacts. As detailed in this Section 10.0, PolyMet's mine waste management is configured to achieve multiple objectives, including:

- safe permanent disposal and storage of mine waste produced over the 20-year LOM
- efficient and effective management of process water, mine water, and stormwater

- successful reclamation, closure, and postclosure maintenance
- compliance with statutory and regulatory criteria for structural stability during operations and after closure
- minimization of environmental impacts

This Section 10.0, which is part of PolyMet's Mining and Reclamation Plan for the Project, summarizes the technical analyses developed through the mine waste characterization, FEIS, and related processes to demonstrate how the Project will conform to the applicable regulatory standards. Because the specific characteristics of the mine waste informs the design and construction of the facilities used to manage it, this Section 10.0 first discusses the characterization of the mine waste and then explains how that characterization informed the proposed design, construction, operations, reclamation, closure, and postclosure maintenance activities. Accordingly, this Section 10.0 is structured as follows:

- Section 10.1 describes PolyMet's mine waste characterization program, including the technical professionals responsible for performing the work, the process for developing the program, the materials analyzed, the methods of analysis, the results, and the application of the results for Project design and review.
- Section 10.2 summarizes the management and disposal of the Flotation Tailings at the FTB located at the Plant Site, including the FTB's design, relevant construction and operational activities, and reclamation.
- Section 10.3 explains the management and disposal of Residue, generated by the Hydrometallurgical Plant, at the HRF located at the Plant Site, including the HRF's design, relevant construction and operational activities, and reclamation.
- Section 10.4 discusses the management and disposition of overburden, waste rock, and ore at the Mine Site, including methods for identifying and segregating different classes of waste rock and overburden; the design and management of the OSLA, waste rock stockpiles, and OSP; the potential use of overburden and waste rock in construction activities; and the backfilling of the East and Central Pits in Mine Year 11 through 20.

Appendix 2 includes additional information regarding the mine waste characterization program and the results of that program. Appendix 3 through Appendix 7 include permit application support drawings for the earthwork, the waste rock stockpiles and OSP, the FTB, and the HRF, respectively. The management plans and data packages developed during the EIS process are included in Appendix 16.3 through Appendix 16.22. PolyMet has updated several of the management plans related to mine waste and water management for this Application and other permitting related documents (i.e., Flotation Tailings Management Plan, Residue Management Plan, Rock and Overburden Management Plan, Adaptive Water Management Plan, Water Management Plan – Mine, and Water Management Plan-Plant). The six updated management plans included in Appendix 11 entirely supersede the earlier versions, and the references to management plans in this Section 10.0 refer to the updated versions.

10.1 Mine Waste Characterization

Minnesota Rules, parts 6132.1000 and 6132.2200 require geochemical characterization of "mine wastes" from nonferrous mining projects to support the Application process. Mine waste is defined broadly by Minnesota Rules, part 6132.0100, subpart 16 to mean a "material, such as surface overburden, rock, lean ore, leached ore, or tailings that in the process of mining and beneficiation has been exposed or removed from the earth." Given this broad regulatory definition, PolyMet has characterized ore in addition to the different types of mine waste. If the mine waste characterization program shows that certain mine wastes will "release substances that adversely impact natural resources", then the regulations define such waste to qualify as "reactive mine waste" and impose specific requirements on the management of those wastes per Minnesota Rules, part 6132.0100, subpart 28; and part 6132.2200.

The PTM Regulations impose requirements relating to the development of the mine waste characterization program and specify the analyses that an applicant must perform. In addition, the regulations require that the applicant use the results of the mine waste characterization to develop the Mining and Reclamation Plan and describe the mine waste characterization program as part of the Mining and Reclamation Plan (Minnesota Rules, part 6132.1100, subpart 6). This Section 10.1 describes PolyMet's mine waste characterization program in accordance with this requirement, and Appendix 2 provides more detailed information regarding the characterization program and results, as required by the regulations.

10.1.1 Development of the Mine Waste Characterization Program

Minnesota law requires that an applicant for a nonferrous Permit to Mine meet with DNR "to outline chemical and mineralogical analyses and laboratory tests to be conducted for mine waste characterization," which DNR will then use in "evaluation of the applicant's mining and reclamation plan" (Minnesota Rules, part 6132.1000, subpart 1). In addition, "mine waste characterization shall be conducted by persons with demonstrated proficiency in such analysis and approved by the commissioner" (Minnesota Rules, part 6132.1000, subpart 2).

In accordance with these regulatory requirements, in 2004, PolyMet initiated a series of characterization conferences and other exchanges with the Lands and Minerals Division of DNR to develop a mine waste characterization program for the Project. These interactions included PolyMet's primary mine waste characterization consultant, SRK Consulting (SRK), with demonstrated proficiency in conducting mine waste characterization,[1] As documented in Appendix 1.10 in this Application.

Over this series of conferences and exchanges, which continued into 2010, DNR provided PolyMet guidance and direction in developing the primary documents outlining the parameters of the waste characterization program for the Project including the Mine Site waste rock and lean ore geochemical characterization work, the Flotation Tailings and the Hydrometallurgical Residue geochemical characterization work, the Mine Site overburden geochemical characterization work, and other targeted

[1] PolyMet first notified DNR of its intent to utilize SRK to work with DNR to develop the mine waste characterization program at a meeting in late 2004.

studies and analyses to support the waste characterization program (collectively, characterization work). The characterization work included chemical, physical, and mineralogical analyses and laboratory procedures to test the weathering and dissolved solids release from Project materials defined as mine waste, which are described in further detail in Section 2.2 of Appendix 2. Specific references for this additional information are provided according to material type in Sections 10.1.3.1 through 10.1.3.6.

As indicated by this characterization work, developed in consultation with DNR, SRK was responsible for the design and oversight of the characterization programs on PolyMet's behalf. The laboratories that were selected to conduct the required analyses were also identified in the characterization work and have demonstrated proficiency in conducting mine waste characterization.

Development of the characterization work was an iterative process with DNR in which DNR reviewed the characterization plans and evaluated results of preliminary sampling and testing, requested that PolyMet provide supplemental information in certain instances, provided PolyMet with comments and requested revisions to the characterization work, and provided PolyMet with further direction and input on sampling and test work. Appendix 2 contains additional information and materials relating to the work of PolyMet with respect to development of the mine waste characterization program. Specific references for this additional information are provided according to material type in Sections 10.1.3.1 through 10.1.3.6.

10.1.2 Contents of the Mine Waste Characterization Program

Consistent with the regulatory requirements, PolyMet's mine waste characterization program is "based on chemical, physical, and mineralogical analyses and laboratory tests of material generated by exploration, preproduction sampling, and process testing." (Minnesota Rules, part 6132.1000, subpart 2). The mine waste characterization program includes: (1) chemical analysis of mine waste; (2) mineralogical and petrological analysis of mine waste; and (3) laboratory tests describing acid generation potential and dissolved solids released from mine waste. In addition, PolyMet's mine waste characterization program provides information regarding the reagents associated with Flotation Tailings and Residue, including their chemical composition, mass to be used, and where applicable, the degradation and transport characteristics as well as the effects on mineral dissolution.

10.1.3 Mine Waste Characterization Program Implementation and Results

PolyMet began the analyses and studies that comprise the mine waste characterization program in 2005. DNR provided input to the mine waste characterization conducted to date as well as the characterization work that remains ongoing.

PolyMet submitted the results of its mine waste characterization program to DNR, MPCA, and USEPA as part of the EIS process. As required by Minnesota Rules, part 6132.1000, subpart 3, PolyMet is resubmitting these results as part of the Mining and Reclamation Plan in this Application. PolyMet's Annual Report will contain additional information on the mine waste characterization work that is ongoing, including the results of any additional test work that was done the prior year. Plans for new mine waste characterization tests will be submitted to the DNR for approval, prior to the outcomes being included in the Annual Report.

Sections 10.1.3.1 through 10.1.3.6 present details of the characterization programs for each type of mine waste, as well as combinations of these various wastes, including:

- Mine Site overburden
- Mine Site waste rock and ore
- Flotation Tailings
- LTVSMC tailings
- Residue
- Reagents associated with Flotation Tailings and Residue

A type of mine waste termed "lean ore" is defined in Minnesota Rules, part 6132.1000, subpart 14, as "rock containing metallic mineralization that is not profitable to process using technologies that exist at the mining operation." PolyMet's 2007 waste rock and lean ore geochemical characterization work and associated reporting, included "lean ore" among the categories of materials characterized; however, the current Mining and Reclamation Plan does not separate out a category of rock that would be considered lean ore. Therefore, PolyMet has reclassified the samples originally identified as lean ore in the early characterization program reports as waste rock samples, for the purpose of interpreting waste rock geochemical characteristics, and has included them in the waste rock analysis and results in Section 10.1.3.2.

PolyMet has used the results of the mine waste characterization tests to design its Mining and Reclamation Plan, including those facilities and engineering controls needed to store, contain, and manage the wastes so as to minimize environmental impacts.

10.1.3.1 Overburden

PolyMet has analyzed the overburden at the Mine Site that the Project will excavate to determine its chemical and physical properties and to develop an overburden management plan. Overburden (referred to as "surface overburden" in Minnesota Rules, part 6132.0100, subpart 16) is the unconsolidated earth material overlying bedrock. PolyMet's mine waste characterization program included geochemical and leach testing of the three types of overburden that will be generated by the Project at the Mine Site: unsaturated mineral overburden, saturated mineral overburden, and peat (organic soils). Peat and the two types of mineral overburden exhibit different physical and geochemical properties, which necessitate different management approaches. Table 10-1 briefly summarizes overburden types, properties, and management approaches. Details on sampling and analysis plans for overburden characterization are provided in Section 5 of Reference (30); Section 3 of Reference (31), Reference (32), and Reference (33). Full results from this program are provided in Sections 2.3 and 3.3 of Reference (34).

PolyMet focused waste characterization on the overburden materials at the Mine Site due to the underlying Duluth Complex deposits, and the characterization work was designed to assess the degree to which the overburden materials reflected the potential presence of sulfide minerals and/or metal enrichment of this underlying rock. As shown on Figure 5-1, the Plant Site overburden materials primarily overlay quartz and schist geologic materials, which have been heavily disturbed as a result of past mining activities without record of environmental or water quality issues as a result of the overburden usage. With regard to the Transportation and Utility Corridor, the overburden materials directly overlay, from west to east, the Giants Range batholith, the BIF, the Virginia Formation, and the Partridge River intrusion of the Duluth Complex (Figure 5-1). Background information on overburden in the area, compiled as part of the characterization work (Section 2.1 of Reference (30)), indicated that overburden in the region is primarily a result of glacial deposition and associated processes from the Rainy Lobe of the Laurentian Ice Sheet. The Rainy Lobe advanced locally in a direction subparallel to the strike of the contact between the Duluth Complex and the country rocks (Section 2.1.1 of Reference (30)). Therefore, overburden at the Plant Site and the western half of the Transportation and Utility Corridors are unlikely to be impacted by rock from the Duluth Complex. In addition, with the exception of initial construction activities, disturbance of the overburden materials at the Plant Site and along the Transportation and Utility Corridors will be minimal. If disturbance of the saturated mineral overburden in the Transportation and Utility Corridors is necessary, PolyMet will complete waste characterization of the saturated mineral overburden to determine the appropriate handling and disposal of the material, in accordance with Mine Site saturated mineral overburden handling procedures (Section 3.3.6.1) or, if not representative of the Duluth Complex, handled as unsaturated mineral overburden (Section 3.3.6.2).

Overburden geochemical characterization was conducted through two separate, complementary, investigations. The first consisted of an overburden drilling program with field and laboratory-based analyses. Samples used for characterization of overburden were collected from 15 completed drill holes distributed across the Project site, representing a total of 225 feet of drilling. Visual observations, as well as measurements of oxidation reduction potential, pH, specific conductivity, and hydrochloric acid reactivity were conducted in the field. In addition, PolyMet conducted the following chemical, physical, and mineralogical analyses and laboratory tests on size-segregated overburden samples:

- acid-base accounting: total carbon, CO_2, total sulfur, sulfate, neutralization potential, and maximum potential acidity on -74 µm and -2 mm+74 µm size fractions
- bulk chemical composition: ICP analyses of 33 elements following four-acid digestion, ICP analyses of 51 elements following aqua regia digestion on -74 µm and -2 mm+74 µm size fractions
- pebble counts on the size fraction greater than 4 mm
- meteoric water mobility procedure on splits of whole samples

Following this initial program, PolyMet conducted additional overburden characterization when developing sumps as part of a bedrock drilling program. As part of this program, 13 additional overburden samples were collected from nine locations. These samples were subjected to the following chemical, physical, and mineralogical analyses and laboratory tests:

- measurement of particle size distribution

- acid-base accounting: paste pH, CO_2, total sulfur, sulfate, acid potential, neutralization potential, and fizz test
- bulk chemical composition: ICP analyses of 44 elements following four-acid digestion, ICP analyses of 51 elements following aqua regia digestion, ICP analysis of 24 elements following 1N nitric acid digestion
- meteoric water mobility procedure on splits of whole samples

The results of these two overburden characterization investigations indicated that unsaturated and saturated mineral overburden are geochemically distinct. The saturated mineral overburden samples contained higher sulfur and metal concentrations and more reduced chemical species than the unsaturated mineral overburden. The saturated mineral overburden, therefore, has a greater potential for leaching chemical constituents following oxidation under atmospheric conditions.

Section 10.4.2.1 addresses the geotechnical properties of the Mine Site overburden, including the additional testing that was performed.

10.1.3.2 Mine Site Waste Rock and Ore

PolyMet has characterized the waste rock and ore that the Project will generate at the Mine Site to determine their chemical and physical properties and to develop waste rock and ore management plans. As described in the Waste Characterization Data Package provided in Section 8.1.2.3 of Appendix 16.18, the waste rock and ore characterization incorporates total sulfur analyses from approximately 18,800 drill core samples. These analyses provide the basis for sulfur distribution in the Project Block Model which is used to estimate the sulfur content of waste rock piles and the mine pit walls. In addition, PolyMet has conducted detailed characterization of 82 waste rock samples, which were selected to represent the waste rock that will be generated by the Project. The selection process for these samples is described in Section 1 of Reference (35). Details on characterization are provided in Section 4 of Reference (36). The waste rock and ore samples were subjected to the following chemical, physical, and mineralogical analyses and laboratory tests:

- optical mineralogical and petrological characterization: reporting includes mineral identification, mineral abundance, grain sizes, and petrologic determination
- sub-optical mineral characterization: trace element content of major minerals via electron microprobe analysis
- acid-base accounting: total sulfur content, total carbon content, and paste pH
- bulk chemical composition of whole rock samples: ICP analyses of 27 elements following four-acid digestion, ICP analyses of 34 elements following aqua regia digestion; whole rock oxides
- bulk chemical composition of size-fractionated samples: total sulfur and ICP analyses of 27 elements following four acid digestion

- specific gravity (G_s) and particle size distribution
- in-laboratory weathering tests (kinetic testing): whole rock samples were subjected to humidity cell testing (American Society for Testing and Materials [ASTM] Procedure D 5744); size-fractionated portions of splits from five of the whole rock samples were also tested using a laboratory test method developed by DNR (DNR Reactor tests); a subset of these kinetic tests is still ongoing; results from ongoing tests will be provided to the DNR in the PTM Annual Report

Based on data from the test program and DNR guidance, PolyMet has classified waste rock by sulfur content as shown in Table 10-2.

Consistent with the regulatory requirement to characterize material generated by, among other things, process testing, PolyMet subjected three ore composites prepared for pilot-plant testing to static and whole sample chemical characterization and kinetic testing. The characterized ore samples represent blended ore composite samples, similar to the mixed ore material that will be in the OSP. Kinetic testing results indicate this material will generate acid and release metals.

Summary results of this characterization work are provided in Section 2.3 of Appendix 2. Detailed results of the waste rock and ore characterization program are provided in Section 3.2 of Reference (37), Section 8 of Appendix 16.18, and Section 5 of Reference (38). Trend analysis of effluent from the Project kinetic tests depicts behavior of copper, nickel, other trace metals, pH, and sulfate within the various waste rock categories and ore. The trend graphs visually display the potential for the generation of acidic leachate and/or the release of metals over time. Section 10.1.4 describes the application of these waste characterization results in Project design and review of potential environmental impacts.

Based on these characterization results, PolyMet will, during Project operations, segregate waste rock at the Mine Site based on the results of characterization testing and will manage the rock as follows:

- *Category 1 waste rock* – This rock has a sulfur content of less than or equal to 0.12%. Characterization testing indicates this material will not produce acidic leachate, but may release metals. Some of this waste rock may be used for construction purposes, as discussed in Section 10.4.5.5. PolyMet will transport Category 1 waste rock not used for construction to one of two destinations: the Category 1 Waste Rock Stockpile in early MineYears and the East Pit once backfilling commences. The Category 1 Waste Rock Stockpile will have a groundwater containment system that will capture mine water draining through the stockpiled waste rock and route it to the WWTS. PolyMet will allow the East Pit to flood after disposal of backfilled waste rock (subaqueous disposal), which will limit oxidation and metals release. Flooding of the pit will be aided by pumping treated water from the WWTS and from the OSLA to the pit. Timing of East Pit flooding will be coordinated with Central Pit mining activities so as to maintain appropriate water levels in the Central Pit during mining. See additional details of East Pit flooding in Section 10.4.6.4.
- *Category 2/3 waste rock* – This rock has a sulfur content greater than 0.12% and less than or equal to 0.60%. Characterization testing indicates this material may produce acidic leachate if allowed to

weather for several years, and is likely to release metals to a greater degree than Category 1 waste rock. Due to their similar levels of reactivity, PolyMet will manage Category 2 and Category 3 waste rock together. The Project will store Category 2/3 waste rock in the temporary Category 2/3 Waste Rock Stockpile, which will include a liner system that allows PolyMet to collect and treat stockpile drainage. This waste rock will ultimately be relocated to the East Pit for subaqueous disposal to minimize oxidation of sulfide minerals and release of metals.

- *Category 4 waste rock* – This category of rock includes rock with a sulfur content of greater than 0.60%. In addition, all rock from the Virginia Formation will be managed as Category 4 waste rock. Characterization testing indicates this material will produce acidic leachate and will release metals. Due to expected reactivity, PolyMet will temporarily store Category 4 waste rock in the Category 4 Waste Rock Stockpile with a liner system that allows for collection and treatment of stockpile drainage. This waste rock will ultimately be relocated to the East Pit for subaqueous disposal to limit oxidation of sulfide minerals and release of metals.
- *Ore* – Characterization of the ore indicates that it has potential to generate leachate that is acidic with elevated metal content. PolyMet may temporarily store ore in the OSP before processing. The OSP includes a geomembrane liner system. PolyMet will capture and treat water that contacts the OSP.

Section 10.4 provides additional information regarding the stockpiles and East Pit backfilling used to manage this waste rock, including geotechnical information, and the design and operations of these facilities. Reclamation of these facilities is discussed in Section 15.3.1.2.

10.1.3.3 Flotation Tailings

At the Plant Site, the froth flotation process will produce Flotation Tailings throughout the LOM. PolyMet has characterized the Project's Flotation Tailings to determine their chemical and physical properties. PolyMet used these characterization results to design the FTB and to develop management practices that minimize environmental impacts and comply with applicable standards, as described in Section 10.1.4.

PolyMet conducted pilot-plant processing of Project bulk ore samples at the SGS Lakefield facility in Lakefield, Ontario to produce Flotation Tailings for characterization. PolyMet's team collected samples of the Flotation Tailings from pilot-tests run in 2005, 2006, 2008, and 2009 for laboratory testing to determine geochemical and geotechnical characteristics. The 2005 pilot-test represented the beneficiation process flowsheet proposed for the Project. The flowsheet of the flotation process has not fundamentally changed since 2005. However, the initial trials during the 2005 pilot-test did not include copper sulfate to activate the pyrrhotite, while all subsequent trials utilized copper sulfate. PolyMet completed additional flotation process optimization tests with the 2006 pilot-test and collected additional tailings samples. The 2008 pilot-test represented a refinement that increased grinding in the flotation area. The 2009 pilot-test represented a refinement that increased grinding in the flotation area and had a cleaner flotation process for the scavenger flotation step. PolyMet conducted characterization testing on a total of 33 tailings samples from all of these pilot-plant runs. The pilot-plant Flotation Tailings samples are representative of the Flotation Tailings expected from the Beneficiation Plant. Details on sample selection and characterization methods are provided in Section 1 of Reference (39) and Sections 3 and 4 of Reference (40). Flotation Tailings samples were subjected to the following chemical, physical, and mineralogical analyses and laboratory tests:

- density determinations and size fraction analysis
- mineralogical characterization via optical analyses of tailings thin sections
- acid-base accounting: total sulfur and sulfur speciation, paste pH, neutralization potential, and total carbon
- bulk chemical composition of samples: ICP analyses of 50 elements following aqua regia digestion; whole rock oxides
- in-laboratory weathering tests (kinetic testing): tailings samples were subjected to humidity cell testing (ASTM Procedure D 5744); in addition, splits from samples were also tested using a laboratory test method developed by DNR (DNR Reactor experiments); a subset of these kinetic tests are still ongoing; results from ongoing tests will be provided to the DNR in the PTM Annual Report

Summary results of the Flotation Tailings characterization program are provided in Section 2.3 of Appendix 2. Detailed results and analyses are located in Section 5.2.1 of Reference (41) and Section 4 of Reference (37).

PolyMet integrated the results of the geochemical testing, which included the long-term kinetic testing of Flotation Tailings, to develop an overall understanding of the tailings as follows:

- Flotation Tailings will not generate acid
- Flotation Tailings will have the potential to release certain metals and other parameters of concern

PolyMet will manage Flotation Tailings to account for both of these characteristics by processing ore using a bulk sulfide flotation process to minimize the amount of sulfides deposited with the Flotation Tailings. The Project specifies management of the Flotation Tailings in the FTB to allow collection and treatment of water contacting the tailings. During operations and reclamation, PolyMet will add a bentonite amendment to the FTB side slopes, final pond bottom, and final beaches to limit oxidation of sulfide minerals and release of metals. Section 10.2 provides additional information regarding the FTB and the management practices for the Flotation Tailings, including geotechnical information, and the design, construction, and operations of the Tailings Basin. Reclamation of the Tailings Basin is discussed in Section 15.4.1.2.

10.1.3.4 LTVSMC Tailings

PolyMet obtained representative samples of LTVSMC tailings from the existing tailings basin and characterized these samples to determine their chemical and physical properties alone, as well as in combination with Flotation Tailings. Results from the characterization of the LTVSMC tailings were used to design the FTB to meet environmental objectives for the Project.

PolyMet initiated geochemical kinetic testing of LTVSMC tailings samples in 2010, using the same testing methods as for the Flotation Tailings samples. Kinetic testing of LTVSMC tailings show stable leachate with a pH above 7.3, stable alkalinity, and very low metal leaching. Results from the kinetic test program, included in Section 4.2.2 of Reference (37), were used to define constituent release rates under unsaturated conditions and oxygen consumption rates under saturated conditions. These values were used as inputs to the Project water model utilized in the environmental review and NPDES/SDS permitting processes, as described in Section 10.1.4.

Summary results from the characterization work on LTVSMC tailings is presented in Section 2.3 of Appendix 2. Section 4.2.2 of (Reference (37)) provides kinetic tests results, Section 5 of (Reference (41)) contains detailed analysis of the geochemical properties of the LTVSMC tailings, and Section 10.2 presents the geotechnical analysis of the LTVSMC tailings.

10.1.3.5 Hydrometallurgical Residue

PolyMet characterized the Residue to be generated by the Hydrometallurgical Plant. PolyMet used these characterization results to design the HRF and to develop management practices that minimize environmental impacts and comply with applicable standards.

Consistent with the regulatory requirements, PolyMet undertook pilot-plant testing at SGS Lakefield Research Laboratories in Lakefield, Ontario to produce hydrometallurgical residue for testing. The hydrometallurgical process will generate five individual types of residue:

- leach residue
- gypsum residue
- iron/aluminum residue
- magnesium residue
- raffinate neutralization residue

This pilot-plant testing program generated samples of all five types of hydrometallurgical residue for testing. PolyMet characterized discrete samples of each of the hydrometallurgical residues, a sample of all residues combined, and a sample of all residues combined without the gypsum residue to allow for possible marketing of the gypsum. Accordingly, the samples produced by the pilot-plant testing for characterization are representative of the hydrometallurgical residues anticipated to result from the Project operations. Details on sample selection, characterization methods, and results are provided in Section 2 of Reference (39), Section 3 of Reference (40), and Section 2 of Reference (42).

Consistent with the regulatory requirements, PolyMet subjected these hydrometallurgical residues to the following chemical, physical, and mineralogical analyses and laboratory tests:

- mineralogical characterization via quantitative X-ray diffraction to identify major and minor crystalline phases and estimate relative abundance of each
- acid-base accounting: total sulfur and sulfur speciation, paste pH, neutralization potential, and total carbon
- bulk chemical composition of samples: ICP analyses of 50 elements following aqua regia digestion; whole rock oxides
- leachate characterization: chemistry of leachate measured after samples are subjected to Toxicity Characteristic Leaching Procedure (TCLP), SPLP, and a sequential shake flask leach procedure
- in-laboratory weathering tests (kinetic testing): samples were subjected to humidity cell testing (ASTM Procedure D 5744); in addition, splits from samples were also tested using a laboratory test method based on the DNR Reactor experiments; a subset of these kinetic tests is still ongoing; results from ongoing tests will be provided to the DNR in the PTM Annual Report

Summary results from the characterization work on hydrometallurgical residues is presented in Section 2.3 of Appendix 2. Section 5 and 6 of Reference (43) provides the detailed results and analyses. PolyMet conducted leachate extraction testing of the individual residues and the combined Residue using the TCLP test to determine if they had leaching characteristics that were above the Resource Conservation and Recovery Act (RCRA) hazardous waste thresholds. TCLP testing indicated that concentrations of metals were below RCRA hazardous waste thresholds and, therefore, the individual residues and the combined Residue are not classified as hazardous waste (TCLP results in Appendix B of Reference (43)).

The characterization results show that the combined Residue (both with and without gypsum residue) is nonacidic and dominated by gypsum. Characterization testing results further indicate the combined Residue will release elevated levels of sulfate and could eventually produce acidic leachate if the neutralizing capacity is exceeded in the long term. The discrete magnesium residue is not acidic. It contains mostly gypsum (77%) but also 22% brucite, which is a source of alkalinity. The nonacidic nature of the combined Residue is due to the alkalinity that is contributed by the magnesium residue. The remaining four of the five discrete residues (leach residue, gypsum residue, iron/aluminum residue, and raffinate neutralization residue) are acidic. The leach residue consists primarily of natrojarosite and hematite along with gypsum and residual plagioclase. The gypsum residue, iron/aluminum residue, and raffinate neutralization residue consist mainly of gypsum (96 to 99.8%).

These characterization results inform PolyMet's proposed management practices and design for the HRF. As Section 10.3 discusses in more detail, because there is the potential for acid generation to exceed neutralizing capacity in the long term, PolyMet will blend lime or limestone with the Residue before disposal in the lined HRF. In addition, PolyMet will place the Residue in a double-lined facility for collection and treatment of water contacting the Hydrometallurgical Residue. Due to the design of the HRF, there is effectively no potential for leakage through the liner system. Therefore, water quality of the leakage from the HRF was not included in the water model, as described in Section 10.1.4, and the water model does not use input parameters derived from these characterization data.

10.1.3.6 Reagents

PolyMet's mine waste characterization program provides information regarding the reagents associated with the Flotation Tailings and Residue, in accordance with Minnesota Rules, part 6132.1000, subpart 2. The lists of reagents associated with the hydrometallurgical and beneficiation processes are provided in Table 8-4 and Table 8-5. Only one of these reagents, copper sulfate, is expected to contribute to metal and sulfate concentrations. Process testwork showed that sulfur concentration in the Flotation Tailings can be expected to vary in response to changes in process conditions, and that the use of copper sulfate can be expected to lower the sulfur concentration in Flotation Tailings. Leachate from tailings generated both with and without the use of copper sulfate were tested for evaluation of the effects of copper sulfate. The results of this testing are provided in Section 5 of Reference (41) and Section 2.3 of Reference (44).

PolyMet also evaluated the potential to use a number of different reagents on waste rock stockpiles to minimize or eliminate the need to treat stockpile drainage for metals (primarily cobalt, nickel, copper, and zinc). These efforts concluded that chemical modifications had not been demonstrated at scale such that water treatment for metals could be eliminated, and no chemical modifications were recommended for inclusion in the environmental review process or for this Application. Several chemical modifications technologies were identified, however, as potential measures to be evaluated during operations to reduce future treatment costs. PolyMet intends to track advances in mine water and rock management to identify opportunities to further limit reactivity of waste rock and reduce the potential for metal release. For example, approaches could include the addition of reagents, pH modification, and/or application of a bactericide; which have all been well-studied or have shown to be effective at other operations. PolyMet will develop a work plan for review and approval by DNR prior to the implementation of any proposed pilot- or full-scale study.

Additional information regarding the evaluation of reagents as part of the mine waste characterization program is provided in Attachment 2-1 of Appendix 2.

10.1.4 Application of Waste Characterization Results to Project Design and Review

The results of PolyMet's waste characterization program were used for multiple purposes in support of the design, environmental review, and permitting of the Project. The characterization data on mineralogy, petrology, chemistry (including dissolved solids release), acid-base accounting, and static leach tests on Project materials were used to identify the minerals with potential to release metals or acidity during weathering, and the Project-specific mechanisms that are expected to consume acidity. Results from the waste characterization program were used to identify the sulfur criteria thresholds used to classify waste rock as part of the Project's waste rock management program.

Custom test work on tailings deposition, conducted by Saint Anthony Falls Laboratory, University of Minnesota, informed decisions on management of the Flotation Tailings. In the case of residue, waste characterization results were used to compare leachate chemistry with criteria values for classification of hazardous waste.

In addition to the testing listed above, results from the waste characterization program were used to define input parameters for PolyMet's probabilistic water models developed to predict water quantity and quality at the Mine Site and the Plant Site used for environmental review and permitting. Input parameters from PolyMet's waste characterization program included constituent release rates, concentration caps, constituent flushing loads, time lag to formation of acidic conditions, and parameters that are used to model residual saturation of Flotation Tailings. The methods used to develop waste characterization program input parameters and input parameter distributions are summarized in Section 2.4 of Appendix 2, and described in Section 7 (for overburden), Section 8 (for waste rock), and Section 10 (for tailings) of Appendix 16.18. Water modeling methods are described in Section 5 of the Water Modeling Data Package – Mine (Appendix 16.19) and Section 5 of the Water Modeling Data Package – Plant (Appendix 16.20). As described in Appendix E of Reference (4), assessment of the performance of the probabilistic water models relative to observed conditions has been proposed to be conducted annually.

10.2 Flotation Tailings Basin

Consistent with the preferences in Minnesota law to reuse existing mining facilities, PolyMet will construct the FTB atop the existing LTVSMC tailings basin. PolyMet's FTB design is intended to achieve multiple objectives, including the following:

- safe permanent disposal of Flotation Tailings produced over the 20-year LOM
- efficient and effective process water management
- assurance of dam and slope stability during operations and after closure
- minimization of environmental impacts
- successful final closure at the end of the Project
- compliance with applicable regulatory requirements

With respect to regulatory compliance, the FTB is designed to minimize adverse impacts to natural resources and to comply with the siting requirements of DNR nonferrous mining rules. In particular, PolyMet has located and designed the FTB to minimize noise, dust, and air emissions, to avoid major modifications to watersheds, and to protect water resources. The FTB also will meet the applicable buffer and vegetation requirements established in the PTM Regulations.

PolyMet designed the FTB, and will construct, operate, and reclaim it to be structurally sound, control air emissions, minimize hydrologic impacts, enhance the survival and propagation of vegetation, preserve access to mineral resources, and promote progressive reclamation, in accordance with the requirements of Minnesota Rules, part 6132.2500. Also, PolyMet has designed and proposes to construct, operate, and reclaim the FTB to minimize the potential for a release of reactive mine waste that would adversely impact natural resources in accordance with Minnesota Rules, part 6132.2200.

This Section 10.2 describes the subsurface conditions of the Tailings Basin, including overburden, depth to bedrock, and the existing LTVSMC tailings basin, and the geotechnical properties of the Flotation Tailings. It then discusses how this information as well as other design criteria inform the FTB design and provides a summary of that design, including the type of dam, the form of tailings storage, and the FTB seepage capture systems. Finally, this Section 10.2 describes the operation of the FTB, focusing on the deposition of tailings and control of tailings basin water. Stormwater management, monitoring, and reclamation associated with the FTB are discussed in Sections 11.4.6, 14.3.1, and 15.4.1.2, respectively. Together this information is intended to demonstrate the FTB's compliance with the requirements of Minnesota Rules, chapter 6132.

10.2.1 Subsurface Conditions at the Tailings Basin

The subsurface in the Tailings Basin area is composed of overburden, bedrock, and the existing LTVSMC tailings basin.

10.2.1.1 Overburden

PolyMet conducted multiple field and laboratory testing programs to determine general geotechnical properties, hydraulic conductivities, and shear strength parameters of the overburden at the Tailings Basin. Reference (45) includes the results of the investigations. Figure 10-1 shows the investigation locations.

The overburden in the Tailings Basin area generally consists of native, unconsolidated, surficial deposits of dense silty sand and glacial till. The 2014 geotechnical investigation for the FTB Seepage Containment System identified the following generalized subsurface conditions along the northern and western toe of the existing LTVSMC tailings basin dams:

- isolated areas of peat up to 20 feet thick
- isolated areas of tailings up to 17 feet thick
- silty sand with clay up to 6 feet thick
- glacial till 5 to 37 feet thick interspersed with cobbles and boulders
- depth to bedrock ranging from 2 to 47 feet below existing ground surface

Location-specific layer thicknesses are presented in Reference (45). Table 10-3 provides the shear strength and hydraulic conductivity parameters of the peat and glacial till used in stability analysis.

10.2.1.2 Existing Tailings Basin and LTVSMC Tailings

The FTB will be constructed on the existing LTVSMC tailings basin, and the LTVSMC coarse tailings will be a source of dam construction material. LTVSMC ceased its tailings basin operations in January 2001. Cliffs Erie, which acquired various LTVSMC properties in 2001, is currently responsible for ongoing reclamation and remediation activities under an NPDES/SDS Permit and Consent Decree with the MPCA, a DNR-approved Closure Plan under the Cliffs Erie ferrous Permit to Mine, and a DNR-approved Dam Safety Permit.

The existing tailings basin was constructed in stages beginning in the 1950s. It was configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E, and Cell 2W. Construction began with perimeter starter dams followed by placement of tailings from the iron-ore process directly on native material. Perimeter dams, which were unlined, were initially constructed from rock, and subsequent perimeter dams were constructed of coarse tailings using upstream construction methods. Thus, the existing tailings basin dams consist of a shell of LTVSMC coarse tailings above a rock, sand, and gravel starter dam, with intermingling fingers of LTVSMC fine tailings and slimes. The interior of the cells consists primarily of LTVSMC fine tailings and slimes.

Historic and recent geotechnical explorations have been performed at the LTVSMC tailings basin, and multiple in-laboratory material tests have been conducted on LTVSMC tailings samples to determine their general geotechnical properties, hydraulic conductivities, and shear strength parameters. In developing its plans for construction of the new FTB dams, PolyMet used this data to aid understanding of how the materials in the FTB will transmit water and perform under load.

There are three main types of LTVSMC tailings as described below. Index properties (including percent fines, unit weight, Atterberg limits, and specific gravity) for the three main types of tailings are contained in Table 10-4. Index properties are unique to each tailings type and provide an overall indication of the geotechnical characteristics of a material (e.g., overall percent of silt and/or clay size particles from percent fines which gives some indication of expected hydraulic conductivity, relative degree of cohesiveness and plasticity from Atterberg limits, and general unit weight expectations from specific gravity).

- LTVSMC coarse tailings – existing material typically located in the shell of the LTVSMC tailings basin, comprised of larger particles of tailings that settled out closer to the dam crest during hydraulic deposition, the outer/upper zone of which was reworked to form subsequent lifts for the LTVSMC dams.
- LTVSMC fine tailings – existing material typically located downstream of the coarse tailings, comprised of mid-size particles that commonly settled out in between the slimes and coarse tailings.
- LTVSMC slimes – existing material typically located in the center of the LTVSMC tailings basin, comprised of finer tailings particles.

Those three types of LTVSMC tailings are combined in the tailings basin (in-situ) to create two additional composite types that are discussed in this document:

- LTVSMC fine tailings/slimes – existing material, referring to tailings zones within the central portion of the LTVSMC tailings basin where fine tailings and slimes are so thoroughly interbedded they cannot be individually distinguished.

- LTVSMC bulk tailings – material typically located within and near the shell of the LTVSMC tailings basin, comprised of existing LTVSMC coarse tailings having occasional inclusions of finer tailings, to be used with LTVSMC coarse tailings to construct the proposed FTB dams.

Table 10-3 and Table 10-4 contain laboratory test results concerning the general geotechnical properties and hydraulic conductivities of the three main types of LTVSMC tailings and of the two composite types of tailings. The shear strength parameters of the LTVSMC tailings were evaluated through review of historic data, testing on undisturbed samples, and in-situ field testing. The shear strength was determined for drained conditions, undrained conditions, and liquefied conditions.

Table 10-3 identifies the shear strength parameters used in the slope seepage and slope stability analysis for the design of the FTB dams. The Geotechnical Data Package (Reference (45)) includes additional discussion of the geotechnical explorations and material testing performed as the basis for the permeability and shear strength of materials used in the seepage and stability evaluation for the FTB.

10.2.2 Properties of the Flotation Tailings

PolyMet's analysis of the geotechnical properties of the Flotations Tailings is based on its study of the Flotation Tailings generated during the pilot-plant processing of Project ore samples. The pilot-plant Flotation Tailings samples are considered representative of the tailings expected from the Beneficiation Plant. PolyMet arranged for laboratory testing of the tailings samples to determine geochemical and geotechnical parameters for use in water quality estimates, FTB planning, slope stability analyses, and staged-construction evaluations.

PolyMet utilized pilot-testing at the Lakefield facility to test two different grinds. The first grind was obtained in 2005, and the second grind was obtained in 2009. The 2009 grind is slightly finer than the 2005 grind. Nonetheless, the grinds are relatively similar and the differences between the two are within the anticipated range of gradations that are expected from the PolyMet Beneficiation Plant. Therefore, PolyMet performed geotechnical testing on both samples, and evaluated the data for general geotechnical properties, hydraulic conductivities, and shear strength parameters required for FTB design.

Several tests were conducted on samples of pilot-plant Flotation Tailings in the laboratory to determine the material's index properties. The index properties describe the physical characteristics of the tailings and their state property (liquid state, plastic state and solid state). Index properties are unique to a material. Table 10-5 summarizes the test results. Additional details on the Flotation Tailings properties are provided in Reference (45). Section 14.2.5 summarizes testing that will be performed for verification of lab-scale test data with the Flotation Tailings deposited within the FTB.

10.2.2.1 Hydraulic Conductivity of Flotation Tailings

The hydraulic conductivity of a material is a measure of its ability to transmit water when submitted to a hydraulic gradient. The hydraulic conductivities of the Flotation Tailings are used for estimating seepage through the tailings.

The hydraulic conductivity of the Flotation Tailings will depend on depositional conditions. St. Anthony Falls Laboratory conducted a physical model study provided in Attachment B to Appendix 11.5. The study showed that, while there is some segregation of Flotation Tailings particles by grain size associated with hydraulic deposition, some fine particles are captured within the tailings matrix near the deposition point. Further, the Project deposition points will include multiple spigot locations around the FTB perimeter as well as deposition in the interior portions of the basin. Deposition of tailings within the interior of the FTB will differ from the more routine perimeter spigotting of tailings. PolyMet's proposed method of deposition is expected to minimize the hydraulic segregation of Flotation Tailings. While some segregation will occur during subaerial flow from the spigots, significant amounts of fines will be captured within the material matrix. Therefore, the Flotation Tailings were treated as a single material in modeling, rather than defining parameters for coarser and finer portions of the tailings.

Table 10-6 provides the results of the laboratory testing for hydraulic conductivity of the Flotation Tailings. Three different values for hydraulic conductivity were used in seepage modeling, based on the different expected hydraulic conductivity values at depth.

10.2.2.2 Shear Strength of Flotation Tailings

Appendix 16.15 describes the testing of the shear strength of the Flotation Tailings, which was evaluated through testing on bulk samples. Shear strength parameters were determined by performing triaxial compression tests on the samples under drained and undrained conditions. The data collected through triaxial testing were processed and used in selection of shear strength parameters. It was conservatively assumed that all Flotation Tailings are contractive and thus, liquefiable. The strength estimates are conservative because it is possible that some portion of the Flotation Tailings deposit will not be contractive, and thus, would not liquefy and would mobilize higher strengths.

Table 10-3 provides a summary of the geotechnical parameters used in seepage and slope stability analysis.

10.2.3 Design of the Flotation Tailings Basin

The FTB location and design are driven by multiple factors, including the geochemical and geotechnical properties of the Flotation Tailings and LTVSMC tailings, the existing site surface and subsurface conditions, the environmental setting of the Tailings Basin, FTB capacity requirements, in-basin hydrology, seepage water quality, and regulatory requirements.

Project-specific design and operating objectives include:

- siting the FTB within the existing footprint of the LTVSMC tailings basin to minimize land disturbance and wetland impacts
- using existing coarse LTVSMC tailings for FTB dam construction to minimize borrow source development

- minimizing ongoing seepage to the environment from the LTVSMC tailings basin and the potential for future seepage from the FTB by installing seepage capture systems
- maximizing subaqueous disposal of tailings to minimize oxidation and potential water quality impacts from the Tailings Basin

To design the FTB and the FTB dams, PolyMet engaged independent professional engineers from Barr, registered in the state of Minnesota who are proficient in the design, construction, operation, and reclamation of tailings basins, dams, and reactive mine waste disposal facilities. Independent professional engineers Dr. Scott Olson and Mr. Richard Davidson, proficient in the applicable subject matter, also assisted in portions of FTB dam design. Appendix 1.10 contains documentation demonstrating the experience of these engineers in this regard. The FTB design process evaluated alternative dam construction and tailing-disposal methods. The selected dam design uses the upstream construction method with existing LTVSMC coarse tailings forming the exterior shell of the dam. The LTVSMC tailings that will underlie the FTB are of suitable strength as a foundation for subsequent dam raises, and are sufficiently permeable to minimize phreatic water level increases within the dams.

The following sections provide an overview of the FTB design requirements and overall design plans.

10.2.3.1 Storage Volume

PolyMet will generate approximately 11.3 million short tons of Flotation Tailings annually (approximately 10.3 million in-place cubic yards annually) for an estimated cumulative total of 225 million short tons (approximately 207 million in-place cubic yards). Table 10-7 and Figure 10-2 present stage-storage calculations and relationships for the FTB design. Table 10-7 presents these relationships relative to the total dam raise increments of 20 feet for Lifts 1 through 7 and 10 feet for Lift 8. Table 10-2 presents a graph of cumulative FTB capacity versus tailings elevation. The permit application support drawing set contained in Appendix 6 contains the layout plan and design of the FTB.

10.2.3.2 Geotechnical Stability

PolyMet will construct and operate the FTB in a manner that is estimated to achieve desired slope stability factors of safety, and in turn, immediate and long-term stability. Achieving the desired factors of safety is an iterative design process wherein the geometry of the dam, the seepage conditions within the dam, and the material characteristics of the dam foundation, the dam, and the tailings are analyzed in concert to arrive at a dam configuration of adequate stability. The design of the FTB dams is based on seepage and slope stability analyses of:

- the existing LTVSMC tailings basin
- the Tailings Basin with the FTB dams at maximum height
- the Tailings Basin with the FTB dams during construction
- the Tailings Basin with the FTB dams subject to various potential liquefaction triggering events

- a flow liquefaction worst case scenario
- the Tailings Basin with the FTB dams during closure and postclosure maintenance

Data used in these analyses, the methods used for seepage and stability modeling, the approach for selection of material strength design parameters, and modeling outcomes are presented in Reference (45).

The stability modeling determined that PolyMet's proposed Tailings Basin design meets required factors of safety for all expected conditions:

- existing conditions at the LTVSMC tailings basin (before the FTB is constructed)
- interim conditions (while the FTB is under construction), with planned operating conditions
- maximum height, with planned operating conditions of the Tailings Basin
- maximum height, with planned closure and postclosure maintenance conditions of the Tailings Basin

PolyMet's modeling also determined that the proposed Tailings Basin design meets required factors of safety for a series of possible, but increasingly less likely, conditions:

- maximum height, with a plugged drain, a rapid load, or erosion
- maximum height, with an unknown triggering event causing all contractive materials to liquefy
- maximum height, with a seismic event

To assess how these results might be affected by uncertainty and variability in the soil strength values, a sensitivity analysis was conducted. Sensitivity analysis results show the following:

- the likelihood that the factor of safety (FOS) is less than the required value when the dam is at maximum height, under normal operating conditions, is 0%
- cumulative probability that the FOS is less than the required value when the dam is at maximum height, with an unknown triggering event causing all contractive materials to liquefy, is less than 2%
- it is orders of magnitude more probable that the required FOS will be above the required value than it is that a dam failure will occur

Slope stability analyses were carried out for critical dam cross-sections (F, G, and N) shown on Figure 10-3, Figure 10-4, and Figure 10-5, respectively, with stratigraphy or soil profiles interpreted from boring information. Table 10-8 provides a summary of slope stability safety factors computed for each component of the stability analysis.

PolyMet will configure the FTB dams to have a FOS equal to or greater than 1.3 for undrained shear strength stability analysis of yield ($USSA_{yield}$) conditions and equal to or greater than 1.5 for effective strength stability analysis (ESSA) conditions. The FTB dam designs have an overall FOS equal to or greater than 1.1 for the worst-case fully liquefied shear strength analysis of liquefaction ($USSA_{liq}$) baseline case (at end of operations). To achieve stability required for the worst-case $USSA_{liq}$ condition, PolyMet incorporated a toe-of-dam buttress, underdrain, and mid-slope setback into the dam design; these are all common design features used for modifying dam stability.

Finally, during construction of FTB dams, PolyMet will amend the exterior face of the dams with a bentonite layer. As shown on Drawing FTB-024 provided in Appendix 6, the bentonite layer will limit oxygen infiltration into the contained Flotation Tailings. The amendment will also reduce rainwater infiltration into the dams, which has a benefit in terms of increased slope stability safety factor. The QA/QC plan for bentonite layer construction will be prepared following completion of the work outlined in the Template for Pilot/Field Testing of Bentonite Amendment of Tailings, provided as Attachment I of Appendix 11.5, which was also part of the Dam Safety Permit Application.

10.2.3.3 Freeboard Requirements

The FTB design incorporates the freeboard required for the FTB to safely accommodate precipitation events without overtopping the dams. PolyMet conducted a hydrology study to determine the water (pond) level bounce (increase in stage due to flood flow or storm event) in the FTB Pond during the probable maximum precipitation (PMP), 1/3 PMP, and 2/3 PMP events. The hydrology study report is included as Attachment C of the Flotation Tailings Management Plan (Appendix 11.5). The elevation difference between the maximum pond elevation and planned dam elevation will yield freeboard ranging from 5.25 feet (for full PMP) to 26.5 feet (for 1/3 PMP) on the basis of the assumed starting water level elevations. PolyMet will manage the water level so that minimum freeboard, (i.e., 5.25 feet) will not be exceeded during operation. This would mean there would not be a need for an emergency overflow unless there was a rainfall greater than a 35-inch rainfall in 72 hours.

The probability of a PMP event occurring during Project operations and reclamation is low. The PMP utilized for analysis of FTB freeboard requirements, which represents approximately 35 to 38 inches of rainfall in a 72-hour event for the FTB over the 20-year mine life, does not have an assigned return period, but has been estimated to range from 100,000 to 1 billion years (Reference (46)). The 1/3 PMP event represents approximately 11.7 to 12.7 inches, and the 2/3 PMP event represents approximately 23.3 to 25.3 inches for the FTB over the 20-year mine life. These values are dependent on the location and area of land considered and are specific to the area covered by the FTB, which is why a range is provided for each rainfall event. Hence, despite the fact that pond elevations cannot be quickly adjusted in anticipation of a PMP event and elevations may vary from those used for the pond bounce computations, the probability of an emergency discharge occurring during the 20-year operating life of the FTB and prior to the cessation of WWTS operations is very low. However, an emergency overflow channel is incorporated into the dam design in the event that a partial to full PMP event does occur.

10.2.3.4 FTB Seepage Capture Systems

Water management is a key component of overall Flotation Tailings management. Within or surrounding a tailings basin, seepage containment or collection systems can serve several purposes, including water level control within the dams, and/or water collection for water quality purposes. For the FTB, seepage containment and collection is for water quality purposes, and for recycling water for process water needs, not for improvement of slope stability. The FTB seepage capture systems for this Project include both the FTB Seepage Containment System and the FTB South Seepage Management System, as described below.

The FTB Seepage Containment System will surround the western and northern sides of the Tailings Basin. A discontiguous segment will be built along a portion of the eastern side. Along the remaining portion of the eastern side of the Tailings Basin, high bedrock will prevent groundwater seepage. The FTB Seepage Containment System will collect tailings basin seepage via surface and shallow groundwater flow, as well as runoff from the exteriors of the north, west, and east dams and from the small area between the toes of the dams and the FTB Seepage Containment System.

The seepage containment system will consist of a cutoff wall (a low permeability hydraulic barrier) installed in the existing overburden down to bedrock, with a drainage collection system installed on the upgradient side. The drainage collection system will have a collection trench filled with granular drainage material and perforated drain pipe located near the bottom of the trench. Vertical risers extending above the ground surface from the drain pipe will collect surface seepage discharging upgradient of the cutoff wall. The seepage containment system will also include a series of subsurface gravity drain pipes, sumps, and lift stations installed between the cutoff wall and the toe of the Tailings Basin dam.

Construction QA/QC for the seepage containment systems will include criteria such as:

- confirmation/control of containment system cutoff wall thickness
- confirmation of cutoff wall hydraulic conductivity
- confirmation of cutoff wall depth

The seepage containment system construction QA/QC plan will be submitted for DNR review and approval prior to system construction. Proposed performance monitoring for the FTB Seepage Containment System is described in Appendix C of Reference (4). Groundwater and surface water monitoring proposed for the Project are described in Sections 3.2 and 3.3 of Reference (4). Performance monitoring and groundwater and surface water monitoring downstream of this system will be defined in the Project NPDES/SDS Permit, if one is issued.

Water collected in the FTB Seepage Containment System will be conveyed to the FTB Pond or the WWTS. The determination of when water is pumped to the FTB Pond or to the WWTS will be made by operations personnel considering factors such as the FTB pond level, WWTS treatment capacity availability, and stream augmentation requirements.

The FTB Seepage Containment System will draw down the water table on the Tailings Basin side of the cutoff wall, maintaining an inward gradient and mitigating the potential for tailings basin seepage to pass through the cutoff wall (i.e., any seepage through the cutoff wall would be inward into the FTB Seepage Containment System). PolyMet will extend the cutoff wall to bedrock in order to minimize the amount of water drawn inward.

Figure 10-6 shows a conceptual layout and cross-section of the FTB Seepage Containment System. In 2014 and 2017, PolyMet carried out geotechnical investigations along the alignment of the proposed FTB Seepage Containment System to address design requirements. The FTB Geotechnical Data Package contains the results of the 2014 investigation and is provided in Reference (45). Figure 10-1 identifies the boring locations for the 2014 investigations. Appendix 6 contains the FTB Seepage Containment System permit application support drawings. The results of the 2017 investigation are being evaluated and will be incorporated into the final design of the FTB Seepage Containment System.

The FTB South Seepage Management System will collect seepage from the south side of the Tailings Basin. Bedrock and surface topography create a narrow valley at the headwaters of Second Creek, along the southern side of the Tailings Basin. Due to this topography, seepage from the Tailings Basin emerges as surface seepage within a short distance of the embankment toe. An existing seepage management system, which is part of the Cliffs Erie Consent Decree, currently captures seepage leaving the LTVSMC tailings basin in this area. This existing system consists of a cutoff berm and trench placed approximately 200 to 250 feet downstream of the seepage face. A seepage collection sump, pump, and pipe system is being used to route this seepage back into the LTVSMC tailings basin pond.

PolyMet is working with Cliffs Erie and MPCA to evaluate possible improvements to this system, which will be called the FTB South Seepage Management System for the Project. During operations, PolyMet will pump seepage collected by the FTB South Seepage Management System to the FTB Pond or to the WWTS. A geotechnical investigation is required to determine if additional improvements are needed and to develop a design for these improvements, if deemed necessary. If improvements are necessary, design drawings will be submitted to the DNR for approval and potentially a permit amendment, as determined by the DNR, prior to the initiation of construction.

10.2.4 Dam Construction

The overall configuration of the FTB is based on multiple factors. These factors include the mining plan, the initial and long-term stability of the existing and proposed dams, materials available for dam construction, phased development of the dams to aid in maintaining stability, water management requirements, and reclamation requirements. The permit application support drawings contained in Appendix 6 depict the sequential development of the FTB. Table 10-7 summarizes the FTB capacity and the staged construction design elevations along with the constructed dam material volumes and FTB capacity. Figure 10-7 through Figure 10-11 shows the overall FTB development from existing conditions through Mine Year 20. This includes the FTB staged dam crest elevations and the tailings elevation in relation to the LOM.

Construction of the FTB dams will occur in increments over the 20-year operating life of the mine. PolyMet will construct the dams, via the upstream construction method, using routine earthwork techniques consisting of borrowing nearby LTVSMC coarse tailings, and placing the tailings in lifts with compaction to specified density to yield the desired dam lift height, geometry and strength. A bentonite amended oxygen barrier layer (at a depth of 30 inches from the surface of the dams) will be added on exterior sides of dams as part of construction. PolyMet will construct the dams in eight lifts (stages), with an approximate final crest elevation of 1,732 feet above mean sea level (amsl), nearly matching the current elevation (1,740 feet above mean sea level) of the existing western portion (Cell 2W) of the existing Tailings Basin. Each lift of the FTB dams will consist of a 200-foot wide base with 4.5H:1V slopes on the outside of the FTB and 2H:1V slopes on the inside. The dams will be constructed of individual lifts 20 feet high, which will be further subdivided into shorter lifts for construction in any single construction season. The dams will require approximately 18 million cubic yards of construction material to build the dams to the crest elevations required to contain Flotation Tailings generated during the LOM. Appendix 6 contains the FTB permit application support drawings.

The historic and recent testing of the LTVSMC tailings, discussed above, demonstrates that these materials are suitable for construction of the FTB dams in compliance with applicable regulatory requirements, including both dam safety permitting and PTM Regulations. Stage-volume calculations also demonstrate that the volume of LTVSMC coarse tailings readily available can meet this anticipated construction demand - there are roughly 20 million cubic yards of LTVSMC coarse tailings available. Drawing FTB-003 in Appendix 6 identifies the locations of the LTVSMC coarse tailings borrow. The tailings borrow will be mechanically placed and compacted. Once borrow is complete, these areas will be sloped and reclaimed according to Minnesota Rules, part 6132.2700. Seeding and mulching will be based on PolyMet's Reclamation Seeding and Mulching Procedure (Attachment 1 of Appendix 14).

10.2.5 FTB Exterior Dam-slope Progressive Reclamation

As FTB dams are constructed, exterior slopes will be stabilized and vegetated in order to minimize wind and water erosion. During construction of FTB dams, the exterior face of the dams will be amended with a bentonite layer to limit oxygen infiltration into the Flotation Tailings as indicated on Drawing FTB-024. The bentonite amendment will entail addition of granulated bentonite (approximately 3% by dry weight) to an 18-inch thick layer of the dam construction material, overlain by an additional 30-inch layer of dam construction material.

The exterior dam faces will be permanently vegetated by a qualified reclamation contractor according to Minnesota Rules, part 6132.2700. Seeding and mulching will be based on PolyMet's Reclamation Seeding and Mulching Procedure (Attachment 1 of Appendix 14). Inactive interior beach areas will be temporarily vegetated as necessary for fugitive dust control as required by the Fugitive Emissions Control Plan – Plant Site (Appendix 12.2).

10.2.6 Operation and Maintenance of the FTB

The operation of the FTB will begin when the Beneficiation Plant begins operation. The operational aspects include the control of processing through the various stages of the flotation process, the Flotation

Tailings transportation and deposition system, the return water system, general maintenance, and winter operation. The Flotation Tailings Management Plan, which describes these operational aspects in more detail, is included in Appendix 11.5 and is summarized below.

Flotation Tailings deposition is expected to begin in Cell 2E and last for approximately seven years, after which the Cell 2E elevation will reach the elevation of Cell 1E and the two cells will merge. From Mine Year 7 through the remainder of operations, PolyMet will deposit Flotation Tailings in the merged cell, Cell 1/2E.

PolyMet will deposit the Flotation Tailings in slurry form through a system of pumps and moveable pipelines. Flotation Tailings will be deposited by gravity flow over beaches when necessary and otherwise subaqueously via movable diffusers throughout the FTB Pond. The Flotation Tailings will settle out of the slurry, and the decanted water will be returned to the beneficiation process by a barge pumpback system. PolyMet will move the return water pipelines as dams are raised to keep the pipelines at or near the top of the dam. Figure 10-11 shows stages of the development of the FTB.

10.2.6.1 Dam Classification

Under Minnesota Rules, part 6115.0340, dams are regulated by DNR based on specified hazard classifications. DNR has defined the hazard classification for the existing LTVSMC tailings basin dams as a Class II hazard and will establish the hazard classification for the FTB dams. As provided by Minnesota Rules, part 6115.0340, the classification is used to partially define FTB dam permitting, inspection, and reporting requirements applicable to the Project. PolyMet has applied for a DNR-administered Dam Safety Permits for the FTB that contain information regarding the hazard classifications applicable to the FTB.

10.2.6.2 Dam Safety Inspections

PolyMet's geotechnical monitoring activities will include regular dam safety inspections. Appendix 11.5 includes an FTB Dam Safety Inspection Plan to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item C(3) and 6132.2500, subpart 2, item B(7).

10.2.6.3 Contingency Action Plan

PolyMet has prepared a Contingency Action Plan (CAP) to provide initial guidance to on-site personnel and emergency responders in the case of unplanned occurrences, such as the threat of dam failure at the FTB. The CAP, which was developed for the Dam Safety Permit Application, is included in Attachment F of Appendix 11.5 identifies and specifies initial actions in response to a variety of occurrences representing differing levels of severity and complexity.

10.3 Hydrometallurgical Residue Facility

PolyMet will use hydrometallurgical processing to recover metals from concentrate, and the combined Residue will be placed in the HRF. The HRF will be a single cell constructed with a double liner system consisting of geomembrane and geosynthetic clay liners. The Residue will settle out within the HRF and the decanted process water will be pumped back to the Hydrometallurgical Plant. The HRF is designed to be a closed-loop system with water lost only to evaporation from the cell surface and entrapment within the Residue's pore space.

PolyMet will construct the HRF on top of the historic LTVSMC Emergency Basin located to the northwest of the Plant Site ore processing facilities and near the southwest corner of the Tailings Basin. Figure 10-12 shows the location of the HRF. The permit application support drawings contained in Appendix 7 provide detailed information on the design of the HRF.

Depending on a variety of factors, including market demand, the Hydrometallurgical Plant will begin operation several years after mining commences. Once this operation begins, PolyMet will generate approximately 313,000 tons of Residue annually. The Residue will be a slurry of fine sand, silt, and clay-size particles, with individual particle diameter on the order of 0.5 mm or less. The HRF may also accept solids from water treatment and coal combustion residuals (coal ash) from an existing coal ash landfill near LTVSMC Tailings Basin Cell 1E. These materials will be characterized to confirm compatibility with the HRF design prior to disposal. Characterization and permitting will determine if they will be disposed of in the HRF or an appropriately permitted disposal facility.

The HRF is designed to minimize adverse impacts to natural resources and otherwise comply with the siting requirements of the PTM Regulations. In particular, PolyMet has located and designed the HRF to minimize noise, dust, and air emissions, and to avoid major modifications to watersheds and otherwise protect water resources.

PolyMet designed, and will construct, operate, and reclaim the HRF to be structurally sound, control air emissions, minimize hydrologic impacts, promote progressive reclamation, and enhance the survival and propagation of vegetation, in accordance with the requirements of Minnesota Rules, part 6132.2500. Further, the HRF is designed and will be constructed, operated, and reclaimed to prevent, to the maximum extent practicable, the release of constituents of concern that would have adverse impacts on natural resources, in accordance with Minnesota Rules, part 6132.2200.

This Section 10.3 provides an overview of Residue management and describes the design of the various components of the HRF such as foundation preparation, dams, and liner. Water monitoring for the HRF is discussed in Section 14.0, and reclamation and closure of the facility is discussed in Section 15.0. Together this information demonstrates that the HRF will be constructed and operated in accordance with the requirements of Minnesota Rules, chapter 6132.

10.3.1 Subsurface Conditions at the HRF

PolyMet advanced several borings in the vicinity of the proposed HRF to characterize the HRF foundation soils. The Geotechnical Data Package provided in Appendix 16.16 includes the results of the investigation. Figure 10-1 identifies the investigation locations. In general, subsurface conditions are similar to those described for the FTB in Section 10.2.1. As discussed further in Section 10.3.3.6, the former Emergency Basin will be preloaded to consolidate the HRF foundation soils and achieve adequate strength for construction.

10.3.2 Properties of Hydrometallurgical Residue

Geotechnical testing of the Hydrometallurgical Residue included grain-size and hydrometer analysis, Atterberg Limits determination, hydraulic conductivity tests, determination of specific gravities of various residue components, and a consolidation test on a sample of the combined Residue. Section 10.1.3.5 summarizes the geochemical characterization of the Hydrometallurgical Residue.

Table 10-9 summarizes the recommended geotechnical design parameters for the Hydrometallurgical Residue Facility, and includes the test results of the in-place dry density of the Residue. Table 10-10 presents the weighted average specific gravity of the combined Residue.

10.3.3 Design of Hydrometallurgical Residue Facility

To design the HRF, including its dams, PolyMet engaged independent professional engineers from Barr registered in the state of Minnesota who are proficient in the design, construction, operation, and reclamation of tailings basins, dams, and facilities for storage of reactive mine waste. Appendix 1.10 contains documentation demonstrating the experience of these engineers in this regard. The design of the HRF is based on a number of factors including Residue properties, HRF capacity requirements, the environmental setting and site conditions, hydrology, geotechnical considerations (slope stability, strain in liner system, and leakage), HRF operating plans, and applicable regulatory requirements, including Minnesota Rules, parts 6132.2200 and 6132.2500 requirements.

Based on a review of historical data, a study of the Residue properties, and geotechnical evaluations, it is feasible to construct the HRF on the historic LTVSMC Emergency Basin site. Consistent with Minnesota Rules, part 6132.2000, subpart 5, item G, which establishes a preference for use of former mining areas, PolyMet will construct the HRF on mostly disturbed ground previously used by LTVSMC, and will take advantage of existing topographic features to reduce the material needed for dam construction.

To manage water resource impacts, the HRF will have a double liner system with a Leakage Collection System between liners, and an additional drainage collection system on top of the double liner system. The HRF will also have a cover system at closure. These systems are designed to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item B(2) regarding the prevention of water moving through reactive mine waste and collection and disposal of residual waters draining from reactive mine waste. Under the HRF design, leakage is considered water that leaks through the upper layer of the double liner system, but to the extent there is such leakage, virtually all of it will be captured by the Leakage Collection System and the lower layer of the double liner system. The HRF will also have a drainage collection system that will be used during reclamation to speed Residue dewatering. Drainage is considered water that flows through the Residue and is collected above the upper layer of the liner system. The following sections provide an additional overview of the HRF design. Additional details including permit application support drawings for the HRF are provided in Appendix 7.

10.3.3.1 Dam Design

PolyMet will construct the HRF dams using downstream construction methods wherein the interior segments of each dam are constructed first, and then the dam is raised upward and outward from the crest of the dam as additional HRF capacity is needed. The permit application support drawings contained in Appendix 7 show the dam development in plan view and cross-section.

The maximum height of each of the proposed dams is approximately 85 feet with a crest elevation of 1,650 feet amsl. PolyMet will construct the dams using soil borrow and possibly quarried rock from the hills adjoining the HRF to the southeast and southwest. PolyMet may also use LTVSMC coarse tailings if needed to supplement the other borrow sources. Any material sources utilized will need to meet the requirements of PolyMet's Standard Operating Procedures – Environmental Characterization of Construction Material for the Project, which is included in Attachment F of the Rock and Overburden Management Plan (Appendix 11.1). Southeast and southwest segments of the HRF dam will abut existing high ground. The northern HRF dam will abut Tailings Basin Cell 2W. The construction material will be placed in thin lifts approximately 12 to 18 inches in loose lift thickness and compacted to a minimum of 95% of their standard Proctor maximum dry density (ASTM D698).

PolyMet will raise the HRF dams and extend the liner in stages to allow for Residue deposition for the life of the cell. Exterior dam slopes will be 3H:1V to achieve adequate slope stability and to facilitate long-term maintenance. Interior dam slopes will be 4H:1V to facilitate cell liner construction and to achieve adequate liner stability. PolyMet will raise the dams in three primary construction phases as presented in Table 10-11. Thirty-foot horizontal benches will be provided at elevation 1,600 and 1,630 feet amsl. This design will accommodate phased liner installation. Because the dams for the HRF will be constructed in major increments before and during operations, PolyMet will relocate Residue spigot points into the cell as frequently as needed to utilize the full capacity of the cell, thereby extending the time between dam rises.

10.3.3.2 HRF Exterior Dam-slope Progressive Reclamation

As HRF dams are constructed, exterior slopes will be stabilized and vegetated in order to minimize wind and water erosion. Progressive reclamation will be conducted by a qualified reclamation contractor according to Minnesota Rules, part 6132.2700. Seeding and mulching will be based on PolyMet's Reclamation Seeding and Mulching Procedure (Attachment 1 of Appendix 14).

10.3.3.3 Geotechnical Stability

PolyMet carried out slope stability analyses for HRF dam design in accordance with the DNR-approved Geotechnical Modeling Work Plan, provided in Appendix 16.16. The HRF perimeter dams were designed to meet a minimum FOS of 1.5 for ESSA. PolyMet used substantially the same analytical processes and relevant data discussed above regarding slope stability analyses for the FTB.

Stability analyses were carried out for the most critical section of the HRF southern dam and northern dam. In particular, the intermediate lifts of the HRF development and the end of operations configuration of the HRF were analyzed for all dam sections. Table 10-12 summarizes the results of slope stability analysis. The detailed analysis is provided in Appendix 16.16. In summary, the analysis demonstrates that the HRF dams will be stable during all lifts. In view of these results, further analysis such as pseudostatic slope stability analyses were determined to be unnecessary.

Material in the constructed dams will be well compacted and the HRF liner system will preclude leakage through the dams. Therefore, PolyMet, with the concurrence of DNR, did not perform undrained strength stability analysis (USSA) and liquefaction strength stability analyses. Appendix 16.16 discusses the basis for these conclusions in detail.

10.3.3.4 Double Liner System

The HRF will include a double liner system, which will consist of two barrier layers separated by a leakage collection layer. The liner cross-section, shown on Figure 10-13, will consist of:

- Drainage collection layer – granular drainage layer and geocomposite drainage net (geocomposite)
- Upper liner – 80-one thousandth of an inch (mil) linear low density polyethylene (LLDPE) geomembrane
- leakage collection layer – geocomposite drainage net (geocomposite)
- Lower liner – 60-mil LLDPE or high density polyethylene (HDPE) above a geosynthetic clay liner (GCL). The lower liner, with two barrier layer components (geomembrane liner and GCL) is commonly referred to as a composite liner.

The double liner system provides built-in redundancy and improved performance compared to that of a single liner or composite liner, and will be installed under an approved quality control plan to minimize installation defects. A Construction Quality Assurance Manual Template is provided as Attachment H to Appendix 11.6. The following sections describe the function of each component of this double liner system; additional details are provided in Appendix 11.6.

Drainage Collection System

PolyMet will install the Drainage Collection System during the HRF construction. It will not be activated, however, until reclamation. Its purpose will be to accelerate dewatering. The Drainage Collection System is discussed in more detail in Section 15.4.1.3.

Upper Liner

The upper liner serves as the primary barrier to leakage from the HRF. Its thickness was selected for durability and to resist ice impacts in the event of a temporary shutdown of the hydrometallurgical process in winter months.

Leakage Collection System

The Leakage Collection System consists of a geocomposite drainage net placed between the upper and lower liners. PolyMet designed the Leakage Collection System to intercept and recover substantially all of the leakage from the upper liner so that it will not reach the environment.

Lower Liner

The lower composite liner provides a virtually leak-free barrier to prevent leakage that may pass through the upper liner from leaving the HRF. Leakage retained above the lower liner will be collected by the Leakage Collection System.

The Leakage Collection System will discharge to a sump and pump system on the northwest side of the cell. PolyMet will install the Leakage Collection System during construction of the HRF and activate it at the time HRF operation commences. Figure 10-13 illustrates the Leakage Collection System, which is further detailed in the permit application support drawings contained in Appendix 7.

During the time the HRF is in operation, the Leakage Collection System will recycle leakage back into the HRF Pond. During reclamation, closure, and postclosure maintenance, the Leakage Collection System will continue to operate, and any leakage will be routed to the WWTS for treatment, although leakage will decrease after installation of the HRF final cover system during closure (Figure 10-14). The HRF final cover is described in Section 15.4.1.3.

10.3.3.5 Performance of GCL Liner

The selection of the GCL component of the HRF liner system will take into account the chemical properties of the Residue. PolyMet conducted a series of tests to evaluate the adequacy of performance of a GCL permeated by leachate from the Residue. Details of the tests are discussed in the Residue Management Plan that is provided in Appendix 11.6. The test results indicate that the GCL performed well, with long-term hydraulic conductivities at or below approximately 1.5 x 10^{-9} centimeters per second (cm/sec).

PolyMet further conducted another series of tests to demonstrate adequacy of performance of a GCL permeated by leachate (Appendix 16.16). The test results indicate that the GCL performed well, with long-term hydraulic conductivities at or below approximately 1.5 x 10^{-9} cm/sec.

10.3.3.6 Liner System Strain Management

Adequate long-term performance of the HRF liner system will depend in part on its ability to tolerate the strain that it will undergo during the life of the facility. Strain, expressed as a percentage, is a measure of the change in length of a segment of liner relative to its original length.

The majority of strain on the liner system will be due to settlement of the foundation materials. To minimize strain due to settlement, PolyMet will place a preload to consolidate sediments in the historic LTVSMC Emergency Basin before constructing the HRF liner system and the dams. Before placement of the preload, a seepage collection drain will be installed in the footprint of the HRF. If the construction schedule does not allow timely consolidation of the sediments, a system of wick drains can be installed to accelerate the process. The purpose of the seepage collection drain and wick drains is to dissipate excess pore water pressure to consolidate sediments during preloading, and to dissipate future excess pore-water pressures in the HRF foundation for stability. Water displaced from the foundation will drain to the FTB Seepage Containment System, which will begin northwest of the HRF footprint. Material sources utilized for the preload will meet the requirements of PolyMet's Standard Operating Procedure – Environmental Characterization of Construction Material for the Project, which is included in Attachment F of the Rock and Overburden Management Plan (Appendix 11.1). Material used for the preload will likely be subsequently reused for perimeter embankment construction of the HRF.

Appendix 16.16 includes the HRF Geotechnical Data Package. This document includes information related to the design and modeling of the preload for the HRF. PolyMet will remove the preload once materials in the basin have been adequately consolidated. The estimated maximum settlement of the foundation material is 3.9 feet in response to preloading and in advance of HRF construction. The estimated further settlement of the foundation materials at the end of operation of the HRF is 1.4 feet.

During the preloading operation, a professional engineer registered in the state of Minnesota will monitor the settlements and confirm the removal of the preload fill per the requirements of Minnesota Rules, part 6132.2400, subpart 2, item A(1).

The maximum strain in the liner system is estimated to be 0.20% (Appendix 11.6), which is well below tolerable limits of most geosynthetics. Table 10-13 and the permit application support drawings contained in Appendix 7 include information related to this strain analysis.

10.3.3.7 HRF Cover System

The HRF cover system will be constructed in two stages: a temporary cover and a final cover. After cessation of residue discharge into the HRF, and after dewatering the HRF Pond and activating the HRF Drainage Collection System, the temporary cover will be constructed to preclude further infiltration of precipitation into the Residue. After consolidation and settlement of the Residue resulting from dewatering with the HRF Drainage Collection System has stabilized, the final cover will be constructed on top of the temporary cover. The HRF final cover system will be configured to preclude further infiltration of precipitation and to shed surface water runoff from the closed facility in a controlled manner. The HRF cover system is described in more detail in Section 15.4.1.3 and Section 15.4.2.

10.3.4 Operation and Maintenance of the HRF

Residue deposition in the HRF will commence when the Hydrometallurgical Plant begins operation. The residue will be transported in slurry form via pipeline from the Plant to the HRF. The HRF will function as a large-scale sedimentation basin. A pond will be maintained within the cell in which the solid fraction of the slurry (the Residue) settles out, while the majority of the liquid fraction is recovered and returned to the Hydrometallurgical Plant for reuse. The levels of both the solids and liquid within the cell will increase incrementally over time.

10.3.4.1 Dam Classification

Under Minnesota Rules, part 6115.0340, dams are regulated by DNR based on specified hazard classifications. DNR will establish the hazard classification for the HRF dams, and, as provided by Minnesota Rules, part 6115.0340, the classification is used to partially define HRF dam permitting, inspection, and reporting requirements applicable to the Project. PolyMet has applied for a DNR-administered Dam Safety Permits for the HRF that contains information regarding the classification of the HRF.

10.3.4.2 Dam Safety Inspections

PolyMet's geotechnical monitoring activities will include regular dam safety inspections. Appendix 11.6 includes an HRF Dam Safety Inspection Plan to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item C(3) and 6132.2500, subpart 2, item B(7).

PolyMet has prepared a CAP to provide initial guidance to on-site personnel and emergency responders in the case of unplanned occurrences, such as the threat of dam failure at the HRF. The CAP contained in Appendix 11.6 identifies and specifies initial actions in response to a variety of occurrences representing differing levels of severity and complexity.

10.3.4.3 Contingency Action Plan

PolyMet has prepared a Contingency Action Plan (CAP) to provide initial guidance to on-site personnel and emergency responders in the case of unplanned occurrences, such as the threat of dam failure at the HRF. The CAP, which was developed for the Dam Safety Permit Application, is included in Attachment K of Appendix 11.6 and identifies and specifies initial actions in response to a variety of occurrences representing differing levels of severity and complexity.

10.4 Management of Mine Site Overburden, Waste Rock, and Ore

PolyMet will manage Mine Site overburden, waste rock, and ore to provide stable and safe storage of the Project's excavated materials in a manner that results in compliance with safety, mining, and environmental regulations. Figure 10-15 through Figure 10-18 show the layout and development of the overburden and waste rock stockpiles for Mine Year 1, Mine Year 11, Mine Year 20, and in the postclosure maintenance phase. Mine Year 11 reflects the year when the mine's footprint is expected to be at its largest extent. By that period, PolyMet expects to have completed mining in the East Pit, commenced mining in the Central Pit, backfilled the Category 4 Waste Rock Stockpile into the East Pit, and established the maximum footprints of the Categories 1 and 2/3 Waste Rock Stockpiles and the West Pit. Mine Year 20 represents the end of mining. At the end of the LOM, PolyMet will have established the ultimate depths and extents of the West Pit and maximum height of the permanent Category 1 Waste Rock Stockpile, and will have relocated the temporary Categories 2/3 and 4 Waste Rock Stockpiles to the East Pit. Table 10-14 shows the waste rock production and placement schedule based on the mine plan described in Section 7.0. Table 10-15 provides estimates of the approximate area, height, and elevation of each stockpile at its maximum size. This Section 10.4 provides an overview of the stockpile designs and material management practices to be employed at the Project.

PolyMet will stockpile overburden, waste rock, and ore in storage facilities as shown on Figure 10-15 through Figure 10-19. These proposed stockpiles include the following:

- OSLA unsaturated mineral overburden and peat stockpiles
- Category 1 Waste Rock Stockpile

- Category 2/3 Waste Rock Stockpile
- Category 4 Waste Rock Stockpile
- OSP (although not a stockpile, the OSP is discussed with the stockpiles due to similar design features)

The stockpile designs address specific requirements for the materials being stored as follows:

- The OSLA will have one or more temporary stockpiles of unsaturated mineral overburden and peat that may be suitable for a variety of uses during the LOM. These stockpile designs are consistent with that of typical stockpiles used for construction materials and are unlined.
- The Category 1 Waste Rock Stockpile has provisions for a groundwater containment system appropriate for the material type (Category 1 waste rock) and for its permanent nature.
- The Categories 2/3 and 4 Waste Rock Stockpiles are temporary structures that will store potentially acid-generating material (Categories 2, 3, and 4 waste rock and saturated mineral overburden) and are designed with composite liners and drainage collection systems.
- The OSP, a temporary surge pile, provides ore storage capacity to assist in a steady and reliable supply of ore to the Beneficiation Plant. It will have a composite liner and drainage collection system.

The OSLA will be located southeast of the West Pit. The Category 1 Waste Rock Stockpile, which will remain after closure, will be located to the north of the West Pit. The Categories 2/3 and 4 Waste Rock Stockpiles are temporary stockpiles that PolyMet will remove before mine closure. The Category 2/3 Waste Rock Stockpile will be located in the eastern portion of the Mine Site, south of the East Pit. The Category 4 Waste Rock Stockpile will be located between the East Pit and West Pit. The OSP will be located between the Category 2/3 Waste Rock Stockpile and the RTH, and will be removed upon mine closure.

10.4.1 Regulatory Summary

PolyMet prepared its plans to manage overburden, waste rock, and ore in accordance with the requirements of Minnesota Rules, part 6132.2200 and part 6132.2400. As such, PolyMet retained independent professional engineers from Golder Associates Inc. and Barr, registered in the state of Minnesota, and proficient in the design, construction, operation, and reclamation of mining facilities for the storage of reactive mine wastes and on stockpile design with unsuitable geotechnical conditions, as applicable. Appendix 1.10 contains documentation demonstrating the experience of these engineers.

The stockpile location and design are driven by multiple factors, including the environmental setting and site conditions, engineering and other technical criteria, the mining plan, and regulatory requirements. With respect to such regulatory matters, the stockpiles for the Project are designed to minimize adverse impacts to natural resources and otherwise comply with the siting requirements of the nonferrous mining rules. In particular, PolyMet has located and designed the stockpiles to minimize noise, dust, and air emissions, and to avoid major modifications to watersheds and otherwise protect water resources. The stockpiles are designed to meet the applicable buffer and vegetation requirements established in the PTM Regulations.

PolyMet has designed, and will construct, operate, and reclaim the stockpiles to minimize hydrologic impacts, enhance the survival and propagation of vegetation, be structurally sound, control erosion, and preserve access to mineral resources, and for permanent stockpiles, to promote progressive reclamation, in accordance with the requirements of Minnesota Rules, part 6132.2400. Also, because PolyMet's management of ore, waste rock, and overburden includes management of reactive mine waste, PolyMet's stockpiles have been designed and will be constructed, operated, and reclaimed to prevent, to the maximum extent practicable, the release of constituents of concern that would have adverse impacts on natural resources, in accordance with Minnesota Rules, part 6132.2200.

The remainder of this Section 10.4.2 through Section 10.4.6 provides additional information as to how PolyMet will comply with specific requirements of Minnesota Rules, chapter 6132 relating to management of overburden, waste rock, and ore. This discussion includes information relating to the use of overburden and waste rock, and their management, storage, and disposal in stockpiles and elsewhere at the Mine Site. Appendix 4 provides the permit application support drawings for the Categories 1, 2/3, and 4 Waste Rock Stockpiles, Ore Surge Pile, and Category 1 Stockpile Groundwater Containment System.

10.4.2 Mine Site Overburden Management

As described in Section 10.1.3.1, the Project will generate three general types of overburden material at the Mine Site: unsaturated mineral overburden, saturated mineral overburden, and peat. Each type of overburden will be managed according to its characteristics.

Maximizing the use of overburden for construction and operation activities is typically beneficial. Appendix 11.1 outlines plans for segregating, using, and storing overburden materials. Unsaturated mineral overburden is unconsolidated earth material that has been above the water table. PolyMet's waste characterization results show that unsaturated mineral overburden has been oxidized so that metals have already been released and this material is suitable for general construction purposes. PolyMet will generally store unsaturated mineral overburden that exceeds immediate construction and reclamation needs in the OSLA. This storage will be similar to a typical stockpile on a construction site.

Saturated mineral overburden is the material that has remained below the water table. It has not been exposed to air and is unoxidized, and therefore, will be used for more limited and specific on-site construction applications. PolyMet will place the saturated mineral overburden that is not used for construction into the lined Categories 2/3 and 4 Waste Rock Stockpiles or directly into the East and Central Pit once mining in those pits have ceased.

PolyMet will use peat removed during Project construction or operation for reclamation activities. Peat will be segregated from the mineral overburden and stored in the OSLA or locations near planned reclamation sites.

10.4.2.1 Geotechnical Properties of Overburden

PolyMet performed a series of geotechnical investigations at the Mine Site. Figure 10-20 identifies these investigation locations. Investigation results and design details for the stockpiles are provided in Reference (47). The overburden generally will consist of native, unconsolidated, surficial deposits of dense silty sand and glacial till. In low lying areas, the till is overlain by up to 15 feet of peat. The bedrock surface within the open pit footprints occurs at depths ranging from 8 feet to over 28 feet below the existing ground surface with an isolated area within the West Pit footprint having a bedrock depth of greater than 40 feet.

Based on the available boring information, the following overburden materials are expected to be encountered at the Mine Site:

Peat or Organic Clay

Peat or organic sandy clay, which is classified as peat for overburden management, is present in the lowland areas and ranges in thickness from 1 foot to 15 feet.

Silty Sand/Sand Silt

Silty sand and sandy silt comprise the majority of the overburden and are subcategories of saturated or unsaturated mineral overburden, depending on their location in regard to the water table. Gravel and cobbles are also present within these soils. The grain size distribution of the silty sand and sandy silt are:

- Percent fines (-#200 sieve): minimum 19%; maximum 55%; average 30%
- Percent gravel (>#10 sieve): minimum 27%; maximum 52%; average 35%

In conjunction with construction, PolyMet will initiate a supplemental Mine Site geotechnical investigation to gather additional data on overburden and to confirm its suitability for construction uses. A Geotechnical Investigation Work Plan has been developed and was provided to the DNR as part of version 1 of this Application (Appendix 17.1); this document has since been removed from the Application, and the work begun at the Plant Site. Agency review (DNR and MPCA) of this work plan was on a different timeline than this Application.

10.4.2.2 Construction and Operations Uses of Overburden

Based on the geochemical analysis to date, the three categories of overburden can be used as described below. Operational overburden management is discussed further in Appendix 11.1.

Unsaturated Mineral Overburden

PolyMet will utilize unsaturated mineral overburden as a general construction material. In order to meet the specifications for certain construction specifications, PolyMet may screen unsaturated mineral overburden prior to use and compact it during construction. The need for screening, if any, will depend on the use of the material and Project specifications relative to the overburden gradation, which will be determined in final design and at the time of construction. Crushing of boulders from the unsaturated mineral overburden will not be performed with the exception of granite boulders, which PolyMet may use as haul road cover and railroad ballast, as described in Section 2.2.3.2 of the Rock and Overburden Management Plan (Appendix 11.1). PolyMet will store excess unsaturated mineral overburden in the OSLA, Category 1 Waste Rock Stockpile, or in some instances, near locations for future planned use. Any additional temporary storage areas will be built in upland areas within the Mining Area and will comply with the design and siting requirements of Minnesota Rules, part 6132.2400, subpart 2(C), which specifically governs overburden stockpiles. Proposals for any additional temporary storage areas will be discussed with the DNR, and DNR approval and permit amendments will be obtained as needed prior to implementation of any additional temporary storage areas.

In locations where unsaturated mineral overburden depths are very thin, it may not be practical to excavate the unsaturated mineral overburden separately from saturated mineral overburden. In these cases, PolyMet will treat the excavated mixed soils as saturated mineral overburden.

Saturated Mineral Overburden

Saturated mineral overburden from the Mine Site is only usable for specific on-site construction applications. These applications include uses where contact water can be collected, where the material is placed in saturated conditions (i.e., under the water table), and where applicable surface and groundwater standards can be maintained. Figure 10-21 shows potential uses of saturated mineral overburden. Table 10-16 shows the estimated quantities required for the proposed construction uses of saturated mineral overburden. Requirements for runoff control from construction areas where saturated mineral overburden is encountered are described in Section 2.0 of Appendix 11.2. PolyMet will store saturated mineral overburden not used in these construction applications in the lined Categories 2/3 and 4 Waste Rock Stockpiles, which are discussed below, or place this material directly into the East or Central Pit when mining in those pits has ceased.

Peat

PolyMet will use peat for restoration and reclamation activities or in wetland reclamation activities. This use may include the development of wetlands in the East Pit and within the reclaimed temporary stockpile footprints. Peat may also be mixed with unsaturated mineral overburden to increase the organic content for reclamation uses, including the cover for the Category 1 Waste Rock Stockpile.

10.4.2.3 Long-Term Storage and Disposal of Overburden

PolyMet anticipates that it will not be able to use all of the excavated overburden for construction and operations. Excess and unusable material will require storage and disposal.

Unsaturated Mineral Overburden

As discussed in Section 10.4.2, PolyMet will typically stage unsaturated mineral overburden in the OSLA for use in construction and operations. In some circumstances, PolyMet may place unsaturated mineral overburden in the Category 1 Waste Rock Stockpile, and in the temporary waste rock stockpiles, discussed below, for ultimate disposal in the East or Central Pits.

Saturated Mineral Overburden

PolyMet will commingle the saturated mineral overburden from the Mine Site that is not used for construction with waste rock in the lined Categories 2/3 and 4 Waste Rock Stockpiles, which are discussed below, or place this material directly into the East or Central Pits. Saturated mineral overburden in the stockpile subgrade could be used as wetland substrate if permanently saturated.

Peat

PolyMet will stockpile peat in the OSLA, in the Category 1 Waste Rock Stockpile, or in areas near its ultimate reclamation use. If permanent peat stockpiles outside of the OSLA become necessary, they will be built in upland areas with mine water collection similar to that planned for the OSLA and will comply with the design and siting requirements of Minnesota Rules, part 6132.2400, subpart 2(C), which specifically governs overburden stockpiles. PolyMet will obtain DNR approval and secure any permit amendments required prior to establishment of any new permanent stockpiles.

10.4.3 Overburden Storage and Laydown Area

With the exception of saturated mineral overburden from the Mine Site, PolyMet will generally manage the overburden removed during Project activities at the OSLA, which will be developed southeast of the West Pit as shown on Figure 10-15. PolyMet will use the OSLA as a temporary staging area to screen, sort, and temporarily store peat and unsaturated mineral overburden for later use.

10.4.3.1 Subsurface Conditions at the OSLA

PolyMet performed geotechnical testing in the vicinity of the OSLA to characterize the foundation soils. Reference (47) includes the results of the investigation, which are summarized here. Figure 10-20 shows the investigation locations. The subsurface conditions in the vicinity of the OSLA can be inferred to consist of native, unconsolidated, surficial deposits of dense silty sand and glacial till underlain by bedrock.

10.4.3.2 Design of Overburden Storage and Laydown Area

PolyMet will grade the OSLA to facilitate drainage around storage and processing areas as shown on Figure 10-22. Grading will direct surface runoff and drainage to an unlined mine water pond in the southeast of the OSLA. PolyMet will pump the collected water to the FTB Pond via the Construction Mine Water Basin. The OSLA will be unlined, but will be compacted sufficiently to support equipment operation, maximize runoff, and minimize infiltration.

The OSLA Pond was designed to allow for storage of peat within the pond to limit oxidation of the peat and maintain the wetland characteristics of the peat for future reclamation.

Temporary stockpiles within the OSLA will be constructed with a slope not steeper than the angle of repose of the material.

If permanent stockpiles become necessary, PolyMet will configure the stockpile(s) in accordance to Minnesota Rules, part 6132.2400, subpart 2, item C(2) (i.e., no lifts shall exceed 40 feet in height; no bench shall be less than 30 feet wide; interbench slope shall not be steeper than 2.5H:1V; and runoff water shall be temporarily stored on benches or removed by drainage control structures). Once the need for any permanent stockpiles in the OSLA is identified, PolyMet will work with the DNR to determine if any additional permitting is necessary.

10.4.4 Waste Rock Management

This Section 10.4.4 provides an overview of PolyMet's plans for managing, storing, and disposing of waste rock. It includes a review of regulatory requirements for both the permanent Category 1 Waste Rock Stockpile, the temporary Categories 2/3 and 4 Waste Rock Stockpiles, and the temporary OSP. All stockpiles were designed to store a greater capacity of waste rock than the capacity that is currently estimated to be mined during the LOM to account for refinements to the mine plan that may occur as more information is gathered during mining. The maximum capacity of the waste rock storage areas was analyzed in the FEIS (Section 3.2.2.1.7 starting on page 3-44). Information relevant to the specific types of stockpiles are included in Sections 10.4.5 and 10.4.6.

10.4.4.1 Properties of Waste Rock

The waste rock to be generated by the Project consists of blasted bedrock. Blasted rock typically consists of well graded angular rock made up of rock fragments ranging from silt and sand-sized particles to boulders. Figure 10-23 shows a simulated blast curve which estimates the particle size distribution of the waste rock. Section 10.1.3.2 provides information concerning the physical and geochemical properties of the waste rock. Appendix 11.1 provides additional detail on waste rock properties.

10.4.4.2 Determining Ore/Waste Rock and Waste Category

Proper identification and separation of the ore from the waste rock, and classification and separation of waste rock are important to the operation of the mine. Further rock sampling will be conducted during mining to periodically confirm the location of the ore and waste rock as well as define the waste rock category. The Block Model, which predicts the location of ore and different types of waste rock, will be periodically updated as new information is available to confirm the boundaries between ore and the different waste rock categories. New information will be incorporated from additional drill coring, blasthole drill cutting analysis, blast rock sampling data, and geologist observations. This Block Model will be used by the mining engineers to refine mining activities on an ongoing basis. The Block Model will also be used in the GPS Mine Dispatch System to guide excavation of the material in the pit and track each truck load of ore to the RTH or OSP and waste rock to its storage or disposal location. Additional details of the operating plan for management of waste rock are included in Section 4.1 of Appendix 11.1.

10.4.4.3 Waste Rock Stockpile Design

PolyMet designed the temporary waste rock stockpiles and the OSP in accordance with Minnesota Rules, part 6132.2400 to minimize hydrologic impacts, be structurally sound, control erosion, and enhance the survival and propagation of vegetation. The permanent Category 1 Waste Rock Stockpile will also be designed to comply with Minnesota Rules, part 6132.2400, subpart 2, item B requirements for final slopes, benches, and lifts, including having a maximum lift of 40 feet, final bench width of 30 feet, and slopes between benches at or flatter than the angle of repose of the waste rock. The final reclamation slopes for the permanent Category 1 Waste Rock Stockpile are discussed in Section 15.3.1, and depicted in Appendix 4.

As part of its operations, PolyMet will implement a program of routine inspection and surveying to monitor the waste rock stockpiles to evaluate compliance with PTM Regulations. As part of this monitoring, PolyMet will inspect for irregular surfaces that may be due to minor localized settlements in the stockpiles. PolyMet will address irregular surfaces that could impede surface drainage of the stockpile. In particular, the final grade of the Category 1 Waste Rock Stockpile surface will allow the installation of the cover system as designed. Section 14.2.2 provides details associated with the inspection and surveying of waste rock stockpiles.

PolyMet designed stormwater management and runoff control on active portions of the waste rock stockpiles and OSP to minimize erosion on the stockpile surface. The benches and top surfaces of each stockpile will be sloped away from the crests to minimize the potential for ponding and erosion due to breakout of ponded water. This type of design will facilitate erosion control on each stockpile. Drainage collection from active portions of the stockpiles is discussed below.

10.4.4.4 Geotechnical Stability of the Waste Rock Stockpiles and OSP

PolyMet performed slope stability analyses to develop a safe design for each of the waste rock stockpiles and the OSP. Slope stability is the resistance of the inclined stockpile surface to failure by sliding. The objective of the slope stability analysis was to confirm adequate slope stability FOS for global stability and acceptable foundation stability. The waste rock is a free draining material, and it is unlikely that a mounding phreatic surface within the stockpile will develop to undermine the slope stability.

PolyMet's stability analysis for the waste rock stockpiles and OSP was performed in accordance with the requirements of the NorthMet Geotechnical Modeling Work Plan (Appendix 16.17).

For each of the lined temporary waste rock stockpiles and the lined temporary OSP, the basic engineering design requires unsuitable foundation soils to be excavated and replaced with structural fill prior to the construction of the stockpile liner system. For stability considerations at the permanent Category 1 Waste Rock Stockpile, unsuitable foundation soils within the initial 100 feet inward from the groundwater containment system limits (i.e., within 100 feet of the stockpile perimeter) will be excavated and replaced with structural fill prior to the construction of the groundwater containment system.

In accordance with Minnesota Rules, part 6132.2400, subpart 2, item A(1), before construction commences, the foundation condition and the final design of each of the waste rock stockpiles and OSP will be examined by appropriate professional engineers “registered in this state and proficient in the design, construction, operation, and reclamation of facilities on unstable foundations.”

Slope stability analysis was conducted based on the conventional "Limit Equilibrium Analysis" method, which evaluates the equilibrium of the soil or rock mass tending to slide down under the influence of gravity or a combination of gravity and external loads such as surcharges and earthquake loading. The result of slope stability analysis is expressed as a FOS which is defined as the ratio of the force to resist movement to the force driving the movement. The slope must be designed to achieve a FOS that is greater than the minimum allowable FOS. Minimum allowable FOS for stockpile design varies between 1.0 and 1.5, depending on the type of stability analysis being performed and the type of slope being designed (e.g., temporary vs. permanent slope, seismic zone vs non-seismic zone, coarse grained non-cohesive material vs fine-grained cohesive material, drained vs undrained material strength condition).

Golder performed analyses to evaluate the stability of the waste rock stockpiles and the OSP. The stability was evaluated under static and pseudo-static (to simulate earthquake loading) conditions. The results of the stability analyses for the Category 1 Waste Rock Stockpile design satisfy the mining FOS criteria. Table 10-17 contains a summary of the analytical results, and the full results are presented in Appendix 16.17.

Another aspect of the design of the Category 1 Waste Rock Stockpile is the cover system, which will be installed incrementally, as described in Section 10.4.5.4. Golder, the designer of the Category 1 Waste Rock Stockpile, conducted a stability analysis for the cover system. The analysis concludes that adequate slope stability safety factor can be achieved using the geomembrane types and soil types proposed for the stockpile cover system. Appendix 16.17 provides this analytical report. Details of the cover system are depicted on Figure 10-24 and in the permit application support drawings contained in Appendix 4.

10.4.5 Category 1 Waste Rock Stockpile

The Category 1 Waste Rock Stockpile is the only permanent stockpile. It will be located to the north of the West Pit as shown on Figure 10-17. The design of the Category 1 Waste Rock Stockpile and permit application support drawings contained in Appendix 4 have been developed by professional engineers registered in Minnesota.

10.4.5.1 Subsurface Conditions at the Category 1 Waste Rock Stockpile

As of the date of this Application, PolyMet has excavated a series of three test trenches and advanced nine boreholes in the Category 1 Waste Rock Stockpile area. Figure 10-20 shows the investigation locations. The Geotechnical Data Package provided in Appendix 16.17 contains the investigation results. These results show that the location of the Category 1 Waste Rock Stockpile will provide the necessary foundational support for the stockpile and allow it to be constructed in a structurally sound manner.

Generally, the overburden in the high ground are glacial in origin and typically consist of sandy silts and silty sands with varying amounts of coarser material and occasional layers of sandy clays, all of which are subcategories of mineral overburden, with the distinction between saturated and unsaturated mineral overburden depending on the location of the water table. The low lying areas contain glacial, alluvial, and lacustrine deposits which are overlain by peat or organic clays and silts. PolyMet will conduct a supplemental geotechnical investigation at the Mine Site to gather additional data on subsurface conditions for use in final design of this stockpile and the associated groundwater containment system. Mine Site geotechnical work will begin once PolyMet has the necessary approvals to access the land.

10.4.5.2 Additional Design Considerations for the Category 1 Waste Rock Stockpile

Sections 10.4.4.2 and 10.4.4.4 provide general information regarding the configuration for the Category 1 Waste Rock Stockpile. Based on the subsurface investigation results noted above, peat and other unsuitable soils will be removed from the stockpile perimeter prior to placement of waste rock. During the construction and operations phases, the slopes between benches will be at the angle of repose of the waste rock. For final reclamation, the slopes between benches will be regraded to allow construction of a stockpile cover. Figure 10-25 shows the proposed final slope configuration of the Category 1 Waste Rock Stockpile. A typical section of the Category 1 Waste Rock Stockpile during operation and regraded for reclamation is shown on Figure 10-26 and on Drawing SKP-013 in Appendix 4.

10.4.5.3 Groundwater Containment System

The Category 1 Waste Rock Stockpile contains waste rock that may release metals. Minnesota Rules, part 6132.2200, subpart 2, item B(2) requires the collection of water that drains from mine waste and does not preclude the construction of a groundwater containment system rather than a liner system. PolyMet will construct a groundwater containment system in stages around the Category 1 Waste Rock Stockpile to collect drainage as the stockpile is constructed. The system will convey the drainage to the WWTS for treatment.

The Category 1 Stockpile Groundwater Containment System will include a cutoff wall consisting of a low hydraulic conductivity (less than $1x10^{-6}$ cm/sec) barrier. The barrier may be a compacted low hydraulic conductivity soil placed in an excavated trench or in-situ type of construction such as a slurry wall. Construction methods will be determined during final design based on geotechnical data and costs associated with each proposed method. Regardless of the construction method selected, the required performance of the groundwater containment system will be based on the hydraulic conductivity and thickness of the barrier, which will be included in the final design plans and specifications. At full buildout, the drainage collection system will completely encircle the stockpile near the stockpile toe, as shown on Figure 10-17.

Appendix 4 includes the permit application support drawings for the Category 1 Stockpile Groundwater Containment System. The design meets the applicable requirements of Minnesota Rules, part 6132.2200, subpart 2, item B(2).

During operations, stockpile drainage collected by horizontal drain pipes will flow by gravity to two low points; one located near the northeastern corner of the Category 1 Waste Rock Stockpile and one located in the southcentral portion of the stockpile. The water collected by the groundwater containment system will be treated at the WWTS and pumped to the FTB or to the East or Central Pit when needed to flood those pits. If treated water is needed to flood the East or Central Pit, it will be directed there; otherwise this water will be sent to the FTB. As the stockpile development progresses to the west, additional sections of the groundwater containment system will be added to collect and convey drainage to these two collection sumps by gravity where it will be pumped to the WWTS.

The groundwater containment system will collect stockpile drainage and draw down the water table on the stockpile side of the cutoff wall, thereby maintaining an inward gradient along the cutoff wall and eliminating the potential for stockpile drainage passing through the cutoff wall. Potential leakage through the cutoff wall, if it occurs, will be inward into the groundwater containment system. Figure 10-27 shows a schematic cross-section of the Category 1 Stockpile Groundwater Containment System.

10.4.5.4 Category 1 Waste Rock Stockpile Cover System

Category 1 waste rock will be placed on the Category 1 Waste Rock Stockpile through approximately Mine Year 13 (as noted in Table 10-14). Category 1 waste rock will be placed into the East and Central Pits thereafter. Progressive reclamation of the permanent Category 1 Waste Rock Stockpile will start in Mine Year 14, and the stockpile is expected to be fully reclaimed by the end of Mine Year 21. Progressive reclamation of the Category 1 Waste Rock Stockpile during Project operations is detailed in Section 3.0 of the Adaptive Water Management Plan (Appendix 11.4) and summarized here.

Progressive reclamation of the Category 1 Waste Rock Stockpile will consist of an engineered geomembrane cover system, which will minimize exposure of the waste rock to precipitation. The cover system will reduce the flow of water into the stockpile, thus reducing the load of constituents to the West Pit during reclamation, closure, and postclosure maintenance. Installation of the cover system will be implemented progressively starting in Mine Year 14 after material is no longer being placed in those portions of the stockpile. The cover system will be required to function until the release rates of constituents from the stockpile have decreased to the point where West Pit lake concentrations result in achieving water resource objectives (Section 3.5 of Reference (1)).

Progressive reclamation of the Category 1 Waste Rock Stockpile during Project operations will also enable PolyMet to promote vegetation growth, minimize erosion of the outer slopes, promote land use after Project operations, and minimize the need for active site care and maintenance during the closure and postclosure maintenance phases. Before constructing the cover system, PolyMet will grade the stockpile surfaces, including slopes and benches, to promote long-term stability, to enhance vegetation growth and erosion control, and to develop a surface drainage network over the stockpile. The structures that convey runoff at dominant flow paths will be designed to minimize erosion and will be stabilized through closure and Postclosure maintenance phases (as necessary). The proposed surface water conveyance structures are designed to transmit surface water runoff downslope without need for significant maintenance. Proposed conveyance structures, referred to as channels and downchutes, are shown on Drawing SKP-012 and detailed on SKP-032 and SKP-033 in Appendix 4. Additional details regarding the phased cover design are provided on Drawing SKP-034 in Appendix 4.

The proposed Category 1 Waste Rock Stockpile closure bench frequency and inter-bench slopes are in conformance with the requirements of Minnesota Rules, part 6132.2400, as well as meeting the requirements of Minnesota Rules, part 6132.2200.

After the geomembrane barrier layer and cover soils have been placed and vegetation is established, precipitation on the stockpile will runoff the surface and be managed as stormwater. Stormwater will be collected by the stormwater ditch surrounding the stockpile and routed through sedimentation ponds prior to off-site discharge or directed to the West Pit during flooding (from tributary areas).

The mine water ditch along the Category 1 Stockpile Groundwater Containment System will also be progressively reclaimed as the cover system is constructed. The ditch will be filled, as shown on the typical sections on Drawing GCS-011 in Appendix 4, and clean surface water runoff will be routed to the stormwater ditch. The containment system vertical pipe risers will be extended to finished cover grade to provide access for pipe cleanout as shown on the typical sections on Drawing GCS-011 in Appendix 4.

10.4.5.5 Construction Uses of Waste Rock

PolyMet plans to use the subset of the Category 1 waste rock with a maximum average sulfur concentration of 0.05% for general construction material (referred to for this Project as Duluth Complex construction rock). Based on long-term kinetic testing, bulk chemical composition, and water quality evidence from analog sites, water contacting Duluth Complex construction rock is expected to remain neutral in pH (as is the case for all Category 1 waste rock), and also contain sufficiently low dissolved metals as to meet stormwater benchmarks for the Project, as listed in Minnesota's NPDES/SDS Industrial Stormwater General Permit (Attachment F of Appendix 11.1).

In addition to the Duluth Complex construction rock and unsaturated mineral overburden (Section 10.4.2.2), rock from the BIF will also be used as general construction material (referred to for this Project. BIF construction rock is only needed at the Mine Site during the construction phase, before Duluth Complex construction rock is available. These criteria are described in Attachment F of Appendix 11.1 and are designed to select BIF construction rock that is not potentially acid generating and will result in contact water that meets stormwater benchmarks for the Project, as listed in Minnesota's NPDES/SDS Industrial Stormwater General Permit.

10.4.6 Temporary Categories 2/3 and 4 Waste Rock Stockpiles and OSP

The stockpiles storing Category 2/3 and Category 4 waste rock and the OSP are lined temporary stockpiles. PolyMet will move each of these stockpiles prior to closure to the East and Central Pits for ultimate disposal. The locations of the stockpiles, as shown on Figure 10-17, are as follows:

- the Category 2/3 Waste Rock Stockpile will be located southeast of the East Pit, near Dunka Road
- the Category 4 Waste Rock Stockpile will be located west of the East Pit, over the location of the Central Pit prior to its excavation
- the OSP will be located south of the East Pit along Dunka Road and east of the RTH

The temporary waste rock stockpiles will receive material from the mine pit development. After mining of the East Pit is complete, PolyMet will haul waste rock mined from the West Pit directly to the East Pit for disposal. PolyMet will also start relocating the temporary stockpiles to the East Pit, starting with the Category 4 Waste Rock Stockpile, once mining in the East pit is complete. After the Category 4 Waste Rock Stockpile is relocated to the East Pit, mining in the Central Pit will begin, and waste rock from the Central Pit will be hauled to the East Pit for disposal. PolyMet will also use waste rock to backfill the Central Pit, after mining ceases in that pit. Table 10-14 summarizes waste rock production and placement over the LOM.

Although in-pit stockpiling in the East and Central Pits may be done on a limited basis while still mining in the pits to minimize double handling of waste rock from the temporary stockpiles, in general it is not planned because of the limited area available in the bottom of these pits. The decision to perform in-pit stockpiling is an economic one that will be based upon factors such as the quality of the remaining ore above which in-pit stockpiling would occur, the pit configuration, the volume of waste rock, and the timing of pit backfilling.

The OSP will provide storage for ore until it can be processed. Use of the OSP will enhance the ability to manage a steady annual flow of a uniform grade of ore to the Plant Site ore processing facilities. PolyMet will transfer ore into and out of this pile to meet mine and plant operating needs. The OSP footprint is approximately 32 acres with capacity for 2.5 million tons for one 40-foot lift, and a maximum capacity of 4.4 million tons in three 40-foot lifts with side slopes at the angle of repose. PolyMet will remove the OSP at the completion of mining activities, with remaining ore processed at the Plant Site or placed in the East Pit for ultimate disposal. Appendix 11.1 provides additional details on the OSP.

10.4.6.1 Subsurface Conditions at the Temporary Stockpiles

PolyMet conducted an initial geotechnical investigation in the vicinity of areas of the planned temporary stockpiles. Figure 10-20 shows the investigation locations. The Geotechnical Data Package provided in Appendix 16.17 contains the investigation results. These results show that the locations of the temporary stockpiles can be adequately prepared to provide the necessary foundational support for the stockpile and allow it to be constructed in a structurally sound manner.

PolyMet will conduct supplemental geotechnical investigations at the Mine Site to gather additional data on subsurface conditions for use in final design of the temporary stockpiles. Mine Site geotechnical work will begin once PolyMet has the necessary approvals to access the land. Based on currently available data, the subsurface conditions of each of the temporary stockpile areas are described below.

Category 2/3 Waste Rock Stockpile

Borings advanced within the Mine Year 1 footprint of the Category 2/3 Waste Rock Stockpile indicate the mineral overburden are mainly silty sand with gravel and few cobbles. Bedrock underlies the mineral overburden at depths ranging from 3.5 feet to 14.5 feet below the existing ground surface.

Category 4 Waste Rock Stockpile

Borings advanced in the vicinity or within the footprint of the Category 4 Waste Rock Stockpile indicate bedrock depths between 5 and 22 feet below the ground surface. The Category 4 Waste Rock Stockpile is primarily situated upon highland mineral overburden, which typically consist of sands and gravels with varying amounts of silt, cobbles, and boulders. The silts are non-plastic to slightly plastic.

Ore Surge Pile

Borings advanced in the highland areas along the northern perimeter of the footprint of the OSP indicate bedrock depths ranging from 5 to 11 feet below the ground surface. Based on available boring information, the subsurface conditions at the OSP site are mineral overburden, which typically consist of silty sands with gravels with varying amounts of silt, cobbles, and boulders. The silts are non-plastic to slightly plastic.

10.4.6.2 Design of Temporary Stockpiles

The stockpile design includes the foundation, underdrain system, liner system, and overliner drainage system. In preparation for building the temporary stockpiles, the sites will be cleared and grubbed, and geotechnically unsuitable soils (mainly peat) will be excavated as needed to support a stable foundation. Structural fill will then be placed, as needed, to meet the foundation grades designed to provide gravity drainage of water collected on the stockpile liners. In areas where elevated groundwater is encountered at or near the liner grades, PolyMet will construct foundation underdrain systems as necessary to alleviate excess pore water pressure as load is placed during stockpile development. After the underdrain systems are installed, as needed, the liners will be constructed. In accordance with Minnesota Rules, part 6132.2400, subpart 2, item A(1), professional engineers registered in Minnesota will examine the foundation conditions and the final design of these temporary stockpiles. Appendix 4 includes the permit application support drawings for these temporary stockpiles.

10.4.6.3 Liner System

PolyMet will construct the Categories 2/3 and 4 Waste Rock Stockpiles and the OSP with liner systems to comply with Minnesota Rules, part 6132.2200, subpart 2, item B(2). Each liner system will be a composite liner consisting of an impermeable barrier (80 mil thick LLDPE geomembrane) underlain by a compacted soil liner (minimum 12 inches thick) which will limit the downward infiltration of water through the liner system. Details of the liner system are depicted on Figure 10-28 and in the permit application support drawings contained in Appendix 4.

PolyMet performed a series of liner load tests on the proposed 80 mil LLDPE geomembrane liner under the anticipated loading conditions of the waste rock stockpiles. The test results showed that the liner will meet design requirements. Appendix 16.17 provides the test results.

The compacted soil liner will be built to be commensurate with the level of environmental risk expected by the waste rock classification. The compacted soil liner will be composed of local materials, screened of oversized materials such as cobbles and boulders, then scarified, moisture-conditioned and compacted to meet the maximum hydraulic conductivity requirement of the stockpile type; not more than $1x10^{-5}$ cm/sec for Category 2/3 material and not more than $1x10^{-6}$ cm/sec for Category 4 material (waste rock and ore). If there are not sufficient quantities of suitable soils available for liner construction, PolyMet will admix the soils with bentonite to meet the design specification.

Before construction commences, PolyMet will provide the final construction plans and liner specifications to DNR for review. The supplemental geotechnical investigation at the Mine Site (Reference (48)), will provide additional information in support of the final design, construction plans, and liner specifications.

As noted previously an underdrain system may be necessary in order to provide foundation drainage to facilitate construction of the liner systems and to minimize the potential for development of excess foundation pore water pressures as the stockpiles are loaded. The purpose of the underdrain systems is to provide gravity drainage for foundation materials in areas where elevated groundwater is encountered after routine construction dewatering has ceased, and to prevent or minimize the potential for excess pore water pressures to develop as the stockpile foundation is loaded. The underdrain systems may not be necessary in areas where structural fill uses Category 1 waste rock material or in areas where granular moraine soils are present.

PolyMet anticipates that the foundation water collected by the underdrain system will be of suitable water quality for off-site discharge through the stormwater system. Nonetheless, PolyMet will configure the underdrains to accommodate water conveyance to the overliner sumps from where the water can be pumped to the WWTS. The design intent of the underdrain system is not for leakage collection; however, the potential exists that liner leakage, if it occurs, would be captured by the underdrains.

PolyMet will construct an overliner drainage layer above the impermeable barrier layer to promote gravity conveyance of water reaching the barrier layer to collection sumps. PolyMet will pump the sump contents to the WWTS for treatment.

10.4.6.4 Waste Rock and OSP Relocation and East Pit Flooding

Progressive reclamation of the Categories 2/3 and 4 Waste Rock Stockpiles will begin during Mine Year 11 when waste rock and overburden in the Categories 2/3 and 4 Waste Rock Stockpiles will be relocated to the East and Central Pit for final subaqueous storage. Starting in Mine Year 11, Category 2, 3 and 4 waste rock mined from the West and Central Pits will be hauled directly to the East Pit for disposal.

The movement of rock from the temporary stockpiles will be timed to allow complete relocation of the material (waste rock and overburden) from the Category 4 Waste Rock Stockpile first, followed by relocation of the material from the Category 2/3 Waste Rock Stockpile. The Category 4 material is expected to be relocated in approximately Mine Year 11. The Category 4 Waste Rock Stockpile will be completely removed and dismantled in Mine Year 11, with stripping of the Central Pit occurring in that same year. Once the liner system from the Category 4 Waste Rock Stockpile is removed, stripping for the Central Pit can begin. The Central Pit stripping area almost entirely encompasses the footprint of the Category 4 Waste Rock Stockpile. The Category 4 Waste Rock Stockpile footprint outside the Central Pit will be reclaimed by scarifying the surface, or by placing an overburden layer, and seeding.

The material located in the Category 2/3 Waste Rock Stockpile will be relocated to the East and Central Pit after backfilling with the Category 4 Waste Rock Stockpile is complete, starting in approximately Mine Year 12. The Category 2/3 Waste Rock Stockpile has a larger volume and is expected to be completely relocated by the end of Mine Year 19, followed by reclamation of the stockpile footprint that is expected to start during Project operations and extend into the reclamation phase.

The ore in the OSP will be removed by the end of Mine Year 20. Reclamation of the OSP will occur during the reclamation phase, as described in Section 15.3.1.2.

Table 10-18 shows the sequence of East Pit backfilling. Backfilling the East Pit will involve hauling approximately 140 million tons of waste rock, including material from the Categories 2/3 and 4 Waste

Rock Stockpiles, to the East Pit between Mine Years 11 and 20 along with the saturated mineral overburden that was stored in those temporary stockpiles. PolyMet will flood the backfilled East Pit in order to submerge the backfilled material, while facilitating continued backfill by maintaining a safe working surface that is at least five feet above the water elevation. Additional details regarding the timing and rate of flooding is discussed in Section 7.3 of this Application and in Section 6.1.2.2 of the Water Modeling Data Package, Volume 1 (Appendix 16.19).

As ultimate pit limits are reached, the overburden banks will be sloped and vegetated as per Minnesota Rules, parts 6132.2300 and 6132.2700, as noted in Section 3.4.1. The East Pit dewatering systems will be removed prior to East Pit flooding, with the exception of temporary pumps needed during pit backfilling.

Reclamation of the former temporary stockpile footprints will occur incrementally after the waste rock and overburden are completely relocated from the temporary stockpiles to the East and Central Pits. The entire footprint of the Category 2/3 Waste Rock Stockpile, as well as portions of the Category 4 Waste Rock Stockpile that are outside the extent of the Central Pit, and the OSP will be reclaimed. The stockpile foundations and associated water management systems, including the overliner drainage system, liner system, underdrain system (if required), piping, and pump systems associated with the stockpile foundations will be removed and properly recycled or disposed at a permitted solid waste facility. Excess material, rock, and earthen fill will be graded and/or disposed of in the East Pit. Once these systems have been removed, the footprint of the stockpiles, sumps, ponds, and associated disturbed areas will be reclaimed by covering with a growth medium, followed by seeding and planting. The area will be a mixture of upland and wetland areas, depending on the ultimate elevation of the remaining materials. Once reclamation in these areas is complete (or during the reclamation phase), the adjacent haul and access roads will also be scarified and seeded while still allowing access by small vehicles for long-term monitoring.

For the Category 2/3 Waste Rock Stockpile, wetlands will be restored where the hydrology and soil conditions exist to support their development. Approximately 60 acres of wetlands have been identified within the Category 2/3 Waste Rock Stockpile footprint. Wetlands could be developed in areas that were wetlands prior to the start of stockpile development, as well as in additional areas where the stockpile load has depressed the soils enough that wetland hydrology can be established from prior upland areas. The plan for development of wetlands within these areas will likely include grading, the addition of a growth medium, and wetland plant propagation. The ultimate goal in restoration and development of wetlands will be to restore the original flow patterns that existed prior to mining to the extent possible and to establish an area of wetlands equal to or greater than existed prior to mining. For portions of the footprint that cannot be converted to wetlands, the surface will be scarified or soil will be placed over the reclaimed foundation and seeded.

10.4.6.5 Overburden Layer of the Pit Walls

The toe of the overburden bank at the pit limits will be set back at least 20 feet from the crest of the pit. The overburden portions of the pit walls will be sloped and graded (refer to Drawing EW-008 in Appendix 3). The overburden portions of the pit walls will be progressively reclaimed by scarifying the surface and seeding. The sloped areas and other areas disturbed by subsequent pipe removal will be vegetated to conform to Minnesota Rules, part 6132.2700. An exclusion dike constructed atop the overburden portion of the pit wall to minimize stormwater flow into the pits will be vegetated to conform to Minnesota Rules, part 6132.2700.

Table 10-1 Summary of Overburden Types

Type of Overburden	Physical and Geochemical Properties	Management
Unsaturated Mineral Overburden	All non-peat unconsolidated material that has been above the water table; this material has been oxidized and has low potential for metal release.	Unsaturated mineral overburden will be used as general construction material and/or stored in unlined overburden stockpiles at the OSLA.
Saturated Mineral Overburden	All non-peat unconsolidated material that has remained below the water table, has not been fully oxidized, and has the potential to release metals when exposed to air and oxidized.	Saturated mineral overburden will be commingled and contained with Categories 2/3 and 4 waste rock, placed in the East or Central Pits, or used in limited construction applications.
Peat	Organic matter formed by the partial decomposition of plant material under saturated conditions that will not release metals associated with sulfide minerals but could potentially release mercury.	Peat will be stored at the OSLA and used in limited construction and reclamation applications.

Abbreviations:
OSLA = Overburden Storage and Laydown Area

Source: Adapted from Appendix 11.1

Table 10-2 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content	Potential to Generate Acid and/or Release Metals
Category 1	≤0.12%	Will not generate acid but may release metals
Category 2	>0.12% and ≤0.31%	May generate acid and release metals at higher rates than Category 1
Category 3	>0.31% and ≤0.60%	Will eventually generate acid and release metals at higher rates than Category 2
Category 4[(1)]	>0.60%	Will generate acid and release metals at higher rates than Category 3

Notes:
(1) Includes all Virginia Formation rock.

Source: Adapted from Appendix 11.1

Table 10-3 Summary of Hydraulic Conductivity and Shear Strength Parameters for FTB Materials

Material	Saturated Hydraulic Conductivity cm/s	Saturated Unit Weight pcf	Drained Conditions (ESSA) Cohesion c' psf	Drained Conditions (ESSA) Friction f' degrees	Undrained Conditions (USSA) Cohesion c_u psf	Undrained Conditions (USSA) Friction f_{cu} degrees	Undrained Conditions (USSA) $USSR_{yield}$ Strength Ratio, USSR s_u/s_{vo}	Undrained Conditions (USSA) $USSR_{liq}$ Strength Ratio, USSR $s_{u(liq)}/s_{vo}$
LTVSMC Coarse Tailings	2.4E-03	135	0	38.5	0	38.5	--	--
LTVSMC Fine Tailings (FT)	2.0E-05	130	0	33	--	--	0.25	0.1
LTVSMC Slimes	9.6E-07	120	0	33	--	--	0.22	0.1
LTVSMC FT/Slimes	3.1E-06	125	0	33	--	--	0.24	0.1
LTVSMC Bulk Tailings	8.0E-05	130	0	38.5	0	38.5	--	--
Glacial Till	1.6E-03	135	0	36.5	0	36.5	--	--
Virgin Peat	1.0E-03	70	0	27	--	---	0.23	--
Compressed Peat	3.6E-06	85	0	27	--	---	0.23	--
Rock Starter Dam	1.52	140	0	40	0	40	--	--
Flotation Tailings[1] - 0.45 psf	1.9E-04							
Flotation Tailings[1] - 1.35 psf	5.6E-05	125	0	33	--	--	0.26	0.12
Flotation Tailings[1] - 2.29 psf	2.0E-05							
Fractured Bedrock	7.2E-04	140	0	45.0	0	--	--	--
Bedrock	1.9E-05	Impenetrable						
Rail Grade	1.5E+00	140	0	45.0	0	45.0	--	--

Notes:
(1) Hydraulic conductivity of the Flotation Tailings was varied based on effective overburden pressures.
Abbreviations:
ESSA = effective shear strength analysis
S_u = undrained shear strength
ϕ = frictional angle
USSA = undrained shear strength analysis
$USSR_{liq}$ = undrained shear strength ratio liquefied
$USSR_{yield}$ = undrained shear strength ratio yield
σ_{vo} = initial overburden stress
$S_{u(liq)}$ = liquefied shear strength
psf = pounds per square foot
cm/s = centimeters per second
-- = value not determined and/or not needed

Source: Adapted from Reference (45)

Table 10-4 Summary of Index Properties for LTVSMC Tailings

Parameter	Minimum	Maximum	Average
Coarse Tailings			
% passing no. 200 sieve	3	19	13
Unit Weight $_{dry}$ (pcf)	104.2	125	116.1
Moisture Content (%)	2.2	17.5	7.1
Plastic Limit (PL, %)	NP	NP	NP
Liquid Limit (LL, %)	NP	NP	NP
Plasticity Index (PI, %)	NP	NP	NP
Specific Gravity (G_S)	2.69	2.93	2.80
Fine Tailings			
% passing no. 200 sieve	13.2	95.7	66.1
Unit Weight $_{dry}$ (pcf)	76.2	111.4	98.5
Moisture Content (%)	3.6	34.7	17.8
Plastic Limit (PL, %)	16.7	22.0	19.5
Liquid Limit (LL, %)	17.5	29.4	23.4
Plasticity Index (PI, %)	0.8	7.4	3.9
Specific Gravity (G_S)	2.62	3.03	2.94
Slimes			
% passing no. 200 sieve	90.4	99.9	97.7
Unit Weight $_{dry}$ (pcf)	77.9	111.5	91.6
Moisture Content (%)	11.0	58.2	32.6
Plastic Limit (PL, %)	16.5	27.6	21.0
Liquid Limit (LL, %)	18.6	37.9	26.9
Plasticity Index (PI, %)	2.1	10.3	5.9
Specific Gravity (G_S)	2.93	2.99	3.00

Abbreviations:
LTVSMC = LTV Steel Mining Company
NP = Non plastic per Atterberg Limits test methods and outcomes (Plastic Limit, Liquid Limit, Plasticity Index)
pcf = pounds per cubic foot

Source: Adapted from Reference (45)

Table 10-5 Summary of Index Properties of Flotation Tailings

Parameter	Minimum	Maximum	Average	Standard Deviation	No. of Tests
Percent Fine (minus No. 200 sieve)	52.0	68.2	60.3	6.07	8
Plastic Limit (PL) %	16.4	16.4	16.4	--	1
Liquid Limit (LL) %	17.5	17.5	17.5	--	1
Plasticity Index (PI) %	1.1	1.1	1.1	--	1
Specific Gravity (G_S)	2.97	3.03	3.00	0.02	6

Notes:
minus No. 200 sieve = passing a No. 200 US standard sieve
Tests performed by Soils Engineering Inc. on Flotation Tailings from 2005 and 2009 SGS Lakefield Pilot-Test Samples

Source: Adapted from Reference (45)

Table 10-6 Range of Hydraulic Conductivity for the Flotation Tailings

	K (cm/sec)	K (ft/sec)	K (ft/day)
Minimum$^{(1)}$	1.98E-05	6.50E-07	0.06
Maximum$^{(2)}$	4.82E-04	1.58E-05	1.37

Notes:
(1) Confining Stress at 7.0 tons per square feet
(2) Confining Stress at 0.25 tons per square feet
Tests performed by Soils Engineering Inc. on Flotation Tailings from 2005 and 2009 SGS Lakefield Pilot-Test Samples
Abbreviations:
cm/sec = centimeters per second
ft/day = feet per day
ft/sec = feet per second
K = hydraulic conductivity

Source: Adapted from Reference (45)

Table 10-7 FTB Stage Storage Relationship and Dam Volume

Mine Year (End of Year)	Area	Average Tailings Elevation (feet)	Cumulative Capacity (in-place cubic yards)	Staged Dam Crest Elevation (feet)	Cumulative Dam Volume (in-place cubic yards)
0	Cell 2E	1,570.0	--	--	--
1		1,585.0	21,600,000	1,602 (Lift 1)	2,480,000
3		1,609.0	38,100,000	1,622 (Lift 2)	4,180,000
5		1,633.0	54,650,000	1,642 (Lift 3)	5,840,000
7		1,658.0	71,450,000	1,662 (Lift 4)	7,440,000
7	Cell 1/2E	1,658.0	71,450,000	1,662 (Lift 4)	7,440,000
10		1,678.5	101,040,000	1,682 (Lift 5)	9,860,000
14		1,697.5	143,075,000	1,702 (Lift 6)	12,846,000
18		1,716.5	185,639,000	1,722 (Lift 7)	16,411,000
20		1,724.0	207,239,000	1,732 (Lift 8)	18,126,000

Abbreviations:
FTB = Flotation Tailings Basin

Source: Adapted from Appendix 11.5

Table 10-8 Summary of Slope Stability Analyses for FTB Dams

Cross-Section Location	Cross-Section F			Cross-Section G			Cross-Section N		
Case	USSA yield	ESSA	USSA liquefied	USSA yield	ESSA	USSA liquefied	USSA yield	ESSA	USSA liquefied
Target Factor of Safety	1.3	1.5	1.1	1.3	1.5	1.1	1.3	1.5	1.1
Design Scenario - Steady Stage Seepage									
Existing Conditions	--	1.83	--	--	2.21	--	--	3.11	--
Interim Lift 2	2.26	3.72	--	2.29	3.30	--	--	--	--
Interim Lift 4	1.96	3.72	--	1.95	3.29	--	--	--	--
Interim Lift 6	1.97	3.73	--	1.95	3.29	--	1.88	4.43	--
Lift 8 w/ Normal Pool	1.84	3.72	--	1.86	3.29	--	2.00	4.58	--
Lift 8 w/ PMP Event	1.82	3.67	--	1.85	3.29	--	1.91	4.34	--
Long-Term Stability - Steady State Seepage									
End of Operation	--	3.72	--	--	--	--	--	--	--
20 Years after Closure	--	3.89	--	--	--	--	--	--	--
200 Years after Closure	--	3.86	--	--	--	--	--	--	--
2000 Years after Closure	--	3.87	--	--	--	--	--	--	--
Liquefaction Triggering Analysis									
Baseline	2.13	--	--	--	--	--	--	--	--
Plugged Drain Lift 1	1.91	--	--	--	--	--	--	--	--
Lift 1 Rapid Loading	--	--	1.78	--	--	--	--	--	--
Erosion[1]	1.07	--	--	--	--	--	--	--	--
Plugged Drain Lift 8	2.12	--	--	--	--	--	--	--	--

Cross-Section Location	Cross-Section F			Cross-Section G			Cross-Section N		
Case	**USSA yield**	**ESSA**	**USSA liquefied**	**USSA yield**	**ESSA**	**USSA liquefied**	**USSA yield**	**ESSA**	**USSA liquefied**
Fully Liquefied with Unknown Trigger									
Operation Lift 8	--	--	1.10	--	--	1.10	--	--	1.16
20 Years after Closure	--	--	1.32	--	--	--	--	--	--
200 Years after Closure	--	--	1.68	--	--	--	--	--	--
2000 Years after Closure	--	--	1.74	--	--	--	--	--	--

Notes:
[1] Simplified analysis approach used in Geotechnical Data Package – Vol. 1 – Ver. 8; detailed analysis approach yields FOS >1.10.
Abbreviations:
ESSA = Effective Stress Stability Analysis
FTB = Flotation Tailings Basin
PMP = probable maximum precipitation
USSA = Undrained Strength Stability Analysis
Source: Adapted from Reference (45)

Table 10-9 Summary of Recommended Geotechnical Design Parameters for Hydrometallurgical Residue Facility

Characteristic	Residue as Tested	Recommended Design Values
Specific Gravity (G_S)	2.75	2.75
Natural Water Content (%)	17.5	---
Liquid Limit (LL, %)	40.7	---
Plastic Limit (PL, %)	38.4	---
Plasticity Index (PI, %)	2.3	---
Sand Content (% by weight)	15	---
Silt Content (% by weight)	84	---
Clay Content (% by weight)	1	---
Effective Shear Strength Friction Angle (degrees)	No Test(1)	30
In-place Dry Density vs. Confining Stress	58.1 pcf at 0.01 tsf 61.5 pcf at 0.1 tsf 71.0 pcf at 1.0 tsf 76.5 pcf at 2.0 tsf 77.1 pcf at 3.0 tsf(2)	Design Values for Liner Strain and/or Slope Stability Analysis: Dry Unit Wt. = 80 pcf Saturated Unit Wt. = 115 pcf Design Values for Initial Cell Sizing: Dry Unit Wt. = 73 pcf

Notes:

(1) Residual shear strength parameters were not tested due to their limited role in determining dam safety but were selected based on the relation between liquid limit and friction angle.

(2) In-Place density at 3.0 tsf is estimated from projection of Void Ratio vs. Log of Pressure Curve to 3.0 tsf.

Abbreviations:

HRF = Hydrometallurgical Residue Facility

tsf = tons per square foot

pcf = pounds per cubic foot

Wt = weight

Source: Adapted from Reference (49)

Table 10-10 Computed Specific Gravity of Hydrometallurgical Residue

Residue Component	Tons/Year (approximation)	% of Total	Specific Gravity (G_S)	Tons/Year x Specific Gravity (G_S)
Gypsum	208,326	66.6%	2.33	485,400
Natrojarosite	67,158	21.5%	3.30	221,621
Hematite	18,548	5.9%	5.30	98,304
Plagioclase	6,183	2.0%	2.75	17,003
Talc	4,157	1.3%	2.75	11,432
Quartz	3,804	1.2%	2.65	10,081
Brucite	2,975	1.0%	2.40	7,140
Goethite	1,542	0.5%	3.80	5,860
Halite	107	0.0%	2.17	232
Subtotal	312,800 (A)			857,073 (B)
Hydrometallurgical Residue Weighted Average Specific Gravity (G_S) = 2.74 (=B/A)				

Source: Adapted from Reference (49)

Table 10-11 HRF Stage Storage Relationship

Phase	Crest Elevation	Approximate Cumulative Residue Capacity (cubic yards)
1	1,600	1,090,000
2	1,630	3,760,000
3	1,650	6,170,000

Notes:
Approximate Cumulative Capacity is cubic yards for Residue. Capacity for water clarification and freeboard is above and beyond the Residue capacity presented.
Abbreviations:
HRF = Hydrometallurgical Residue Facility

Source: Adapted from Appendix 11.6

Table 10-12 Summary of Slope Stability Analyses for HRF

Analysis	Cross-Section A-A′ ESSA (South Dam)	Cross-Section A-A′ ESSA (North Dam)	Cross-Section C-C′ ESSA (Northwest Dam)
Target FS	1.5	1.5	1.5
Lift 1 – Computed FS	2.34	2.72	N/A
Lift 2 – Computed FS	2.32	N/A	N/A
Lift 3 – End of Operations (End of Mine Year 20) – Computed FS	2.32	N/A	2.27

Abbreviations:
ESSA = Effective Stress Stability Analysis
FS = factor of safety
N/A = not applicable

Source: Adapted from Reference (49)

Table 10-13 Typical Strain Values for Geosynthetic Components

Name(1)	Allowable Strain (%)	Elongation at Break (%)	Tensile Strength at Break (lb/in)
GSE HD Textured Geomembrane (60 mil)	12	100	115
GSE HD Textured Geomembrane (80 mil)	12	100	155
GSE Ultra Flex (LLDPE) Textured Geomembrane (60 mil)	N/A	500	168
GSE Ultra Flex (LLDPE) Textured Geomembrane (80 mil)	N/A	500	224
Geosynthetic Clay Liner (GCL)	1 to 19(2,3)	N/A	25 to > 50(3)

Notes:
(1) GSE Geomembrane data used for reference; actual geomembrane supplier may vary.
(2) Allowable strain in GCL liner depends on GCL type and installation procedures.
(3) GCL Tensile Strength at Break depends on GCL type (Reference (50))
Abbreviations:
GCL = geosynthetic clay liner
GSE = GSE Environmental
HD = high density
lb/in = pounds per inch
LLDPE = linear low-density polyethylene
mil = one thousandth of an inch
N/A = not applicable

Source Adapted from Reference (49)

Table 10-14 Waste Rock Production Placement Schedule

Mine Year	Category 1 Waste Rock Stockpile[1] (Million tons)	Category 2/3 Waste Rock Stockpile[1] (Million tons)	Category 4 Waste Rock Stockpile[1] (Million tons)	Backfilling East Pit[2][3]				Total Rock Moved (Million tons)
				Re-handling from Category 2/3 Waste Rock Stockpile to East Pit (Million tons)	Re-handling from Category 4 Waste Rock Stockpile to East Pit (Million tons)	Waste Rock from West Pit and Central Pit to East Pit (Million tons)	Total Placement in East Pit (Million tons)[3]	
1	18.7	5.2	1.5	0	0	0	0	25.4
2	15.0	4.4	0.8	0	0	0	0	20.2
3	16.1	4.3	1.1	0	0	0	0	21.6
4	12.8	3.7	0.8	0	0	0	0	17.3
5	11.7	2.4	0.4	0	0	0	0	14.6
6	16.8	4.3	0.7	0	0	0	0	21.9
7	10.4	2.6	0.5	0	0	0	0	13.5
8	16.9	4.3	0.1	0	0	0	0	21.4
9	12.6	4.7	0.1	0	0	0	0	17.3
10	13.0	4.1	0.1	0	0	0	0	17.1
11[4]	10.2	4.0	0.02	0	6.2	0	6.2	20.4
12	10.8	0	0	5.7	0	4.8	10.6	21.3
13	2.9	0	0	5.7	0	11.0	16.8	19.6
14	0	0	0	5.7	0	12.2	17.9	17.9
15	0	0	0	5.7	0	10.9	16.7	16.7
16	0	0	0	5.7	0	9.1	14.8	14.8
17	0	0	0	5.7	0	7.0	12.7	12.7
18	0	0	0	5.7	0	8.8	14.6	14.6
19	0	0	0	3.8	0	11.9	15.8	15.8
20	0	0	0	0	0	14.1	14.1	14.1
Total	168.0	44.0	6.2	44.0	6.2	89.8	140.2	358.2

(1) Category 1 Waste Rock Stockpile is permanent; Category 2/3 and Category 4 Waste Rock Stockpiles are temporary.
(2) Values reported above exclude the estimated 6.2 million tons of saturated mineral overburden that will also be backfilled in the East and Central Pits. Movement of this overburden to the pits is dependent on the quantity excavated and the quantity used for construction.
(3) East Pit capacity below closure water elevation 1592 feet AMSL is approximately 79 million cubic yards, or 150 million tons (at assumed waste rock in-pit density of 141 pounds per cubic foot). For planned East Pit backfill waste rock tonnage (140.2 million tons); the corresponding top of pit backfill elevation is 1589 feet AMSL.
(4) Portions of the Year 11 Waste Rock reported as stockpiled may be delivered directly to the East Pit backfill.

Estimates subject to change based on metal prices and other factors.
Source: Adapted from Appendix 16.22

Table 10-15 Maximum Stockpile Dimensions

Stockpile	Mine Year of Maximum Footprint	Maximum Area (acres)[2]	Maximum Height (feet)	Maximum Elevation (feet above sea level)
Category 1	21	526	280	1,840
Category 2/3	6	180	200	1,770
Category 4	3	57	180	1,790
Ore Surge Pile (OSP)	N/A[1]	31	120	1,644

(1) The OSP is a surge pile that will have ore moving in and out as needed to meet mine and plant operating requirements.
(2) Areas shown are the final footprints of the stockpiles, including the final cover footprint for the Category 1 Waste Rock Stockpile, and for the other stockpiles, the foundation grading and liner footprints.

Abbreviations:
N/A = not applicable

Estimates subject to change based on metal prices and other factors.
Source: Adapted from Appendix 11.1

Table 10-16 Proposed Construction Application for Saturated Mineral Overburden

Application	Water Quality Rationale	Estimated Quantity (cubic yards)[2]
Stockpile Foundation Material Below the Water Table	Operations: Overburden will remain below the water table. Closure: Overburden will remain below the water table.	823,000
Temporary Stockpile (Category 2/3 and 4 Waste Rock Stockpile and Ore Surge Pile) Drainage Layer	Operations: Water draining through this material will be collected and treated. Closure: This material will be removed prior to removal of the liner during stockpile reclamation.	1,045,000
In-Pit Haul Road Top Dressing	Operations: Water contacting this material will flow into the pit and be collected and treated, or used to fill the East Pit. Closure: Any material remaining above the water table will be moved down below the water table within the pits.	10,000
Mine Water Sumps and Ponds Liner Cover Material	Operations: Most of this material will be submerged; drainage through this material will be collected and treated. Closure: The liner will be removed from these ponds/basins. Mine Water Ponds may be reclaimed as wetlands, or will be regraded and revegetated; the liner cover material will be placed below the water level in the pits. The EQ Basin Area will be reclaimed by regrading and revegetating the areas, with liner cover material placed below the water level in the pits.	49,000
Compacted Soil Liner Below a Temporary Geomembrane Liner[1]	Operations: Geomembrane liner will prevent water from draining through this material. Closure: This material will be removed with the geomembrane liner during stockpile reclamation.	421,000
Total		2,348,000

(1) See Figure 10-21 for location of compacted soil liner.

(2) Values are preliminary and are subject to change as part of final design for construction bidding. Values exclude aggregation of smaller quantity uses of Saturated Mineral Overburden, such as at Mine water ponds.

Abbreviations:
WWTS = Waste Water Treatment System

Source: Adapted from Appendix 11.1

Table 10-17 Summary of Slope Stability Analyses for Category 1 Waste Rock Stockpile

Slope Configuration	Static or Seismic	Surface Type	Minimum Allowable FS (Design Criteria)	Computed FS
Initial operational configuration (a single lift of waste rock with a maximum height of 40 feet placed at the angle of repose)	Static	Circular	1.3	1.53
	Static	Block	1.3	1.56
	Seismic	Circular	1.0	1.45
Operational configuration at ultimate buildout prior to reclamation (assume four lifts to 160 feet)	Static	Circular	1.3	1.93
	Static	Block	1.3	2.09
	Seismic	Circular	1.0	1.78
Final reclaimed configuration with interbench slopes regraded to 3.75H:1V and ultimate slope height 240 feet	Static	Circular	1.5	2.31
	Seismic	Circular	1.1	2.07

Abbreviations:
FS = factor of safety

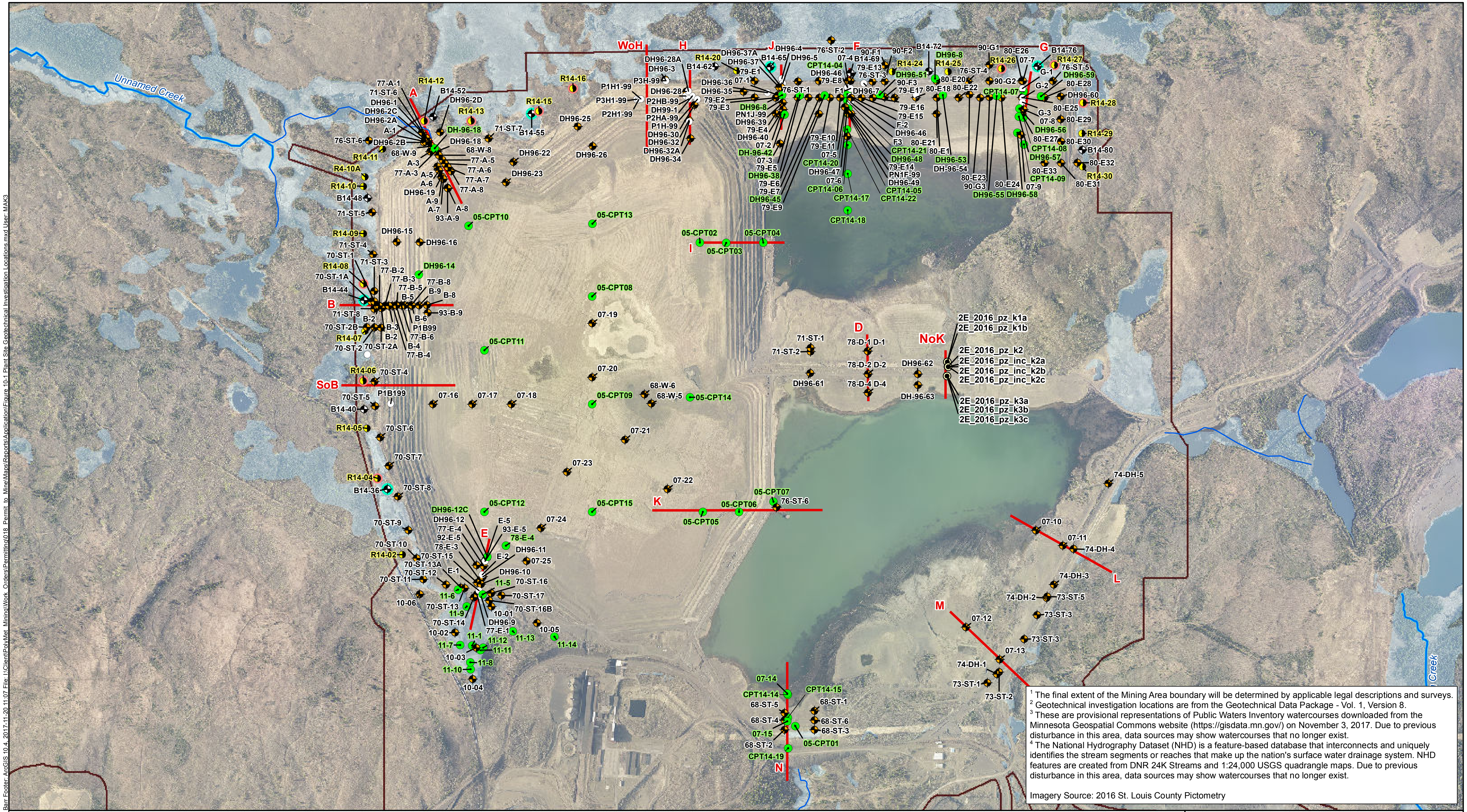
Source: Adapted from Reference (47)

Table 10-18 Sequence of East Pit Backfilling

Mine Year	Waste Rock Relocated to East Pit (million tons)(1)(2)	Origin of Waste Rock
11	6.18	Category 4 Waste Rock Stockpile
11	0.02	West Pit
12 to 19	44.0	Category 2/3 Waste Rock Stockpile
12 to 20	90.0	West and Central Pits

(1) Values reported above exclude the estimated 6.2 million tons of saturated mineral overburden that may also be backfilled in the East and Central Pits. Movement of saturated mineral overburden to the pits is dependent on the quantity excavated and the quantity used for construction.
(2) Portions of the Year 11 Waste Rock reported as stockpiled may be delivered directly to the East Pit backfill.

Source: Adapted from Appendix 11.1



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Geotechnical investigation locations are from the Geotechnical Data Package - Vol. 1, Version 8.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

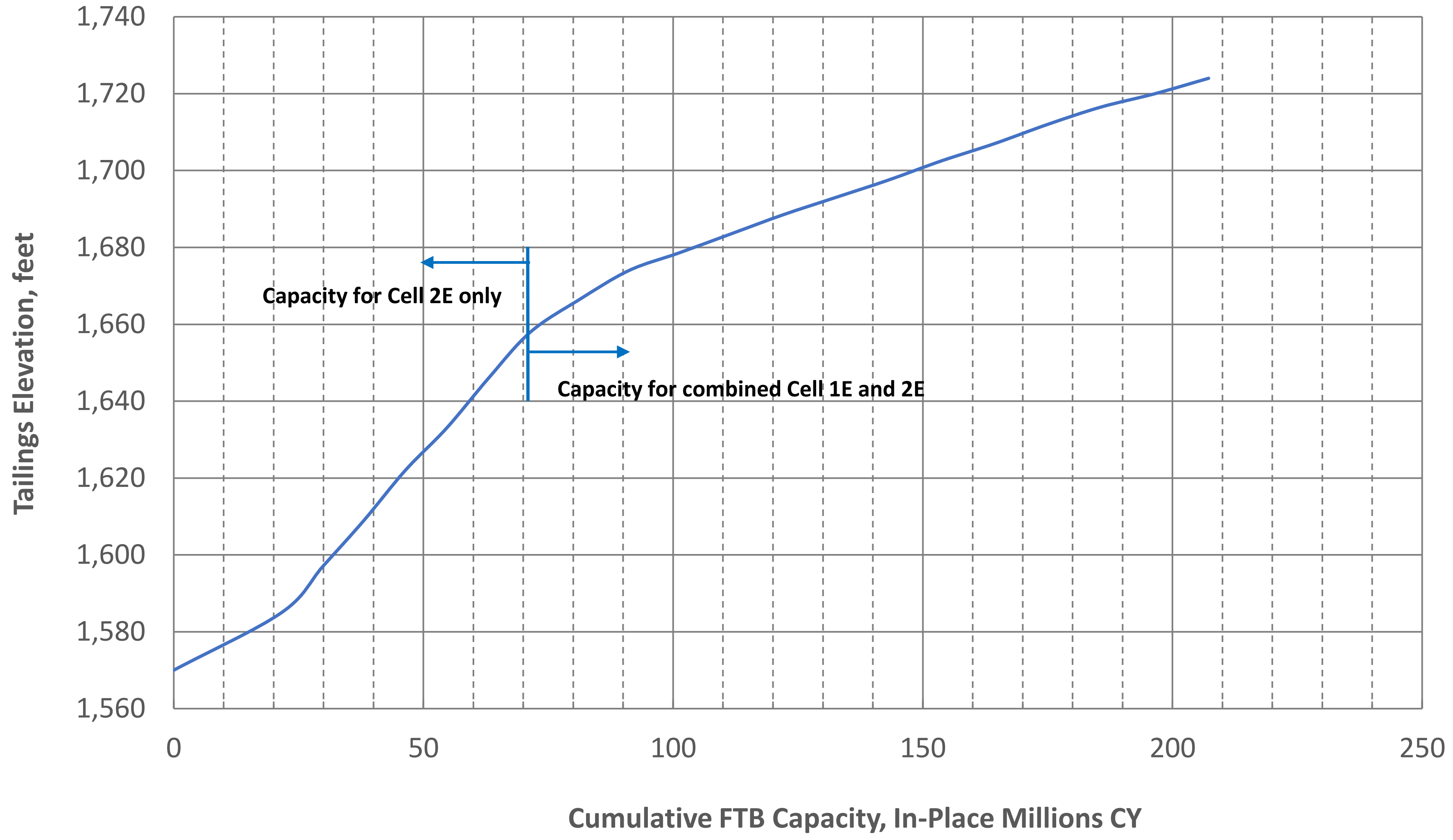
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Cross Section Alignment
Geotechnical Investigation Locations[2]
2016 Locations
2014 Rotasonic Location
2014 Rotasonic Location with a Piezometer
2014 Boring Locations
2014 Boring Locations with Packer
Historic Test Locations[2]
Other/Unknown
CPT Location
SPT Location
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]
Wetlands

0 1,500 3,000
Feet

PLANT SITE GEOTECHNICAL INVESTIGATION LOCATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 10-1
Permit to Mine Application



FLOTATION TAILINGS BASIN
STAGE STORAGE CURVE
NorthMet Project
Poly Met Mining, Inc.

Figure 10-2
Permit to Mine Application

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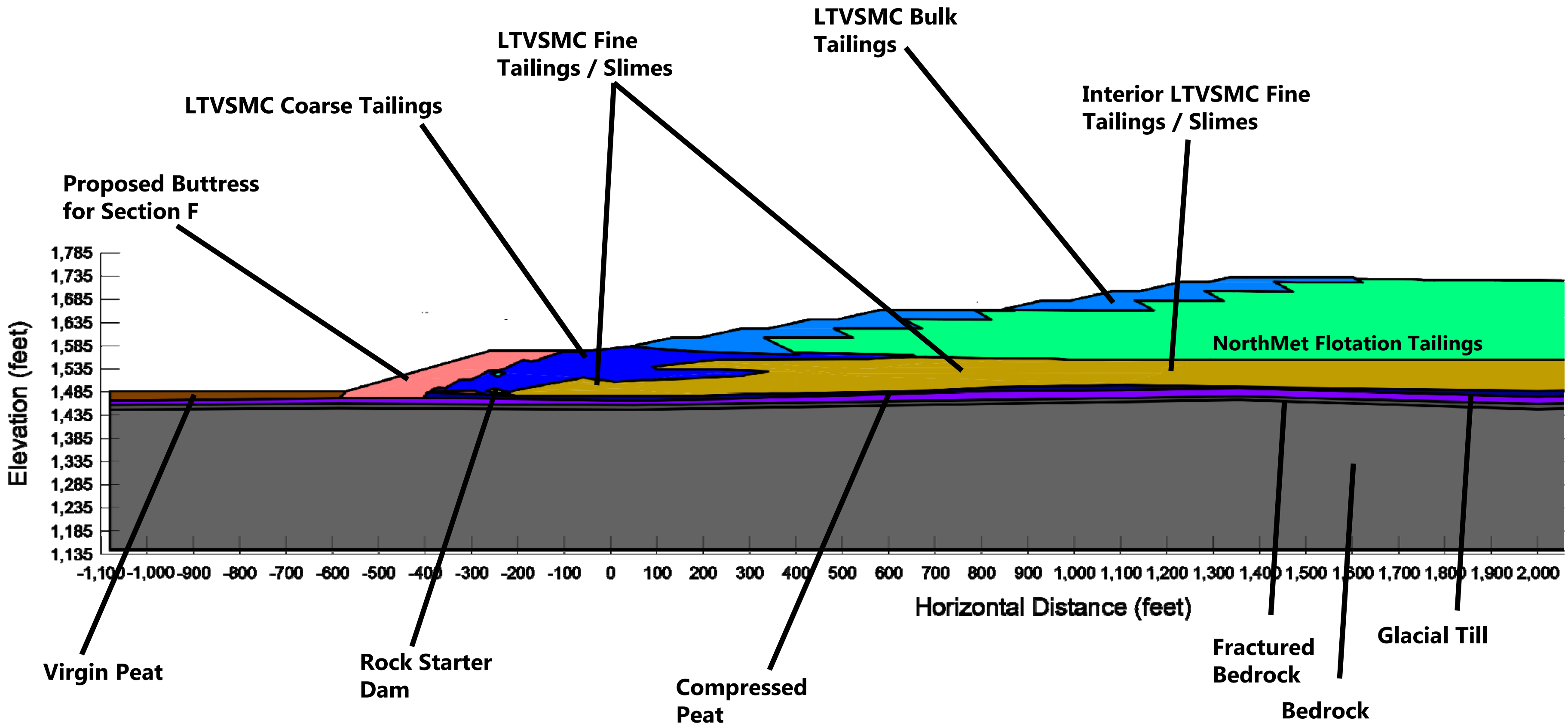

Note: Cross-section location shown on Figure 10-1

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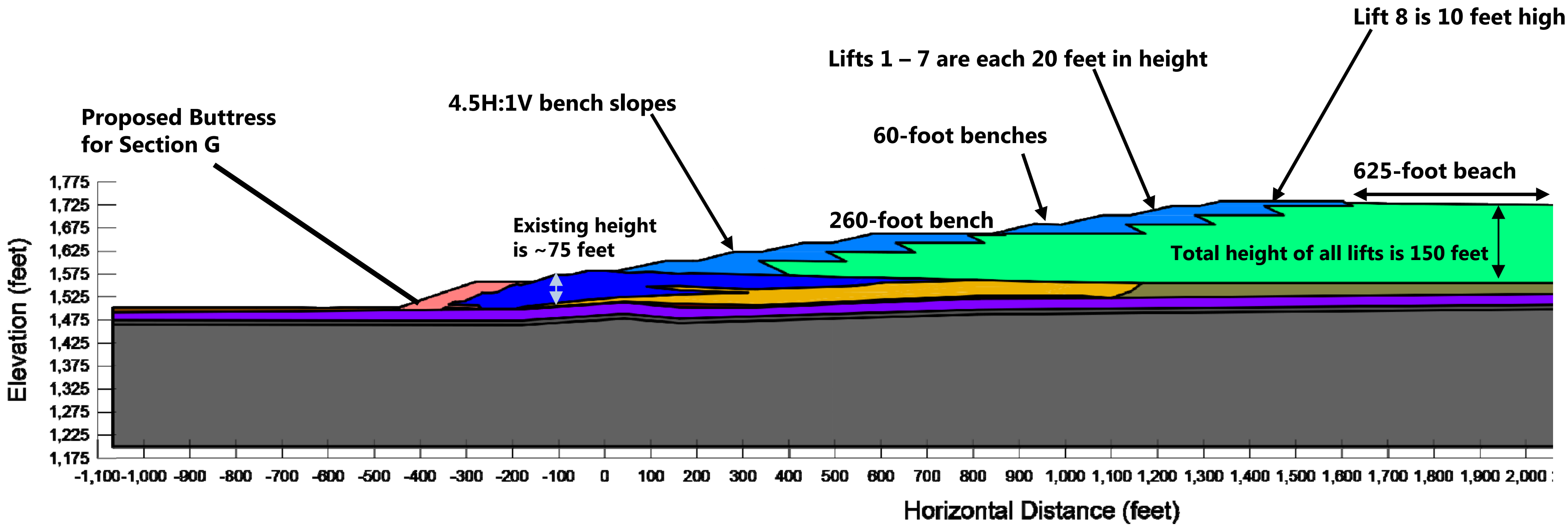
Figure 10-3 Proposed FTB Dam Design at Cross-Section F Mine Year 20 d5.pptx

PROPOSED FTB DAM DESIGN AT CROSS-SECTION F MINE YEAR 20 NorthMet Project Poly Met Mining, Inc.
Figure 10-3 Permit to Mine Application



Note: Cross-section location shown on Figure 10-1

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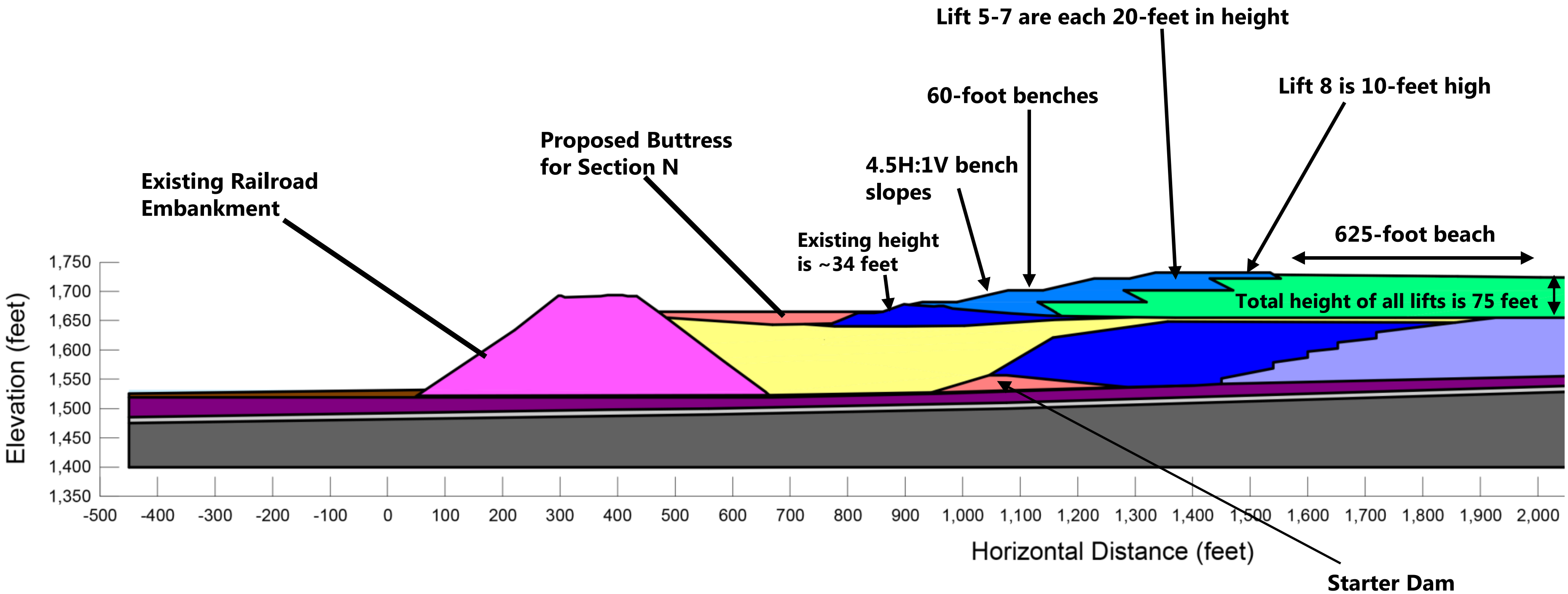
Figure 10-4 Proposed FTB Dam Design at Cross-Section G Mine Year 20 d4.pptx

PROPOSED FTB DAM DESIGN AT CROSS-SECTION G MINE YEAR 20 NorthMet Project Poly Met Mining, Inc.
Figure 10-4 Permit to Mine Application

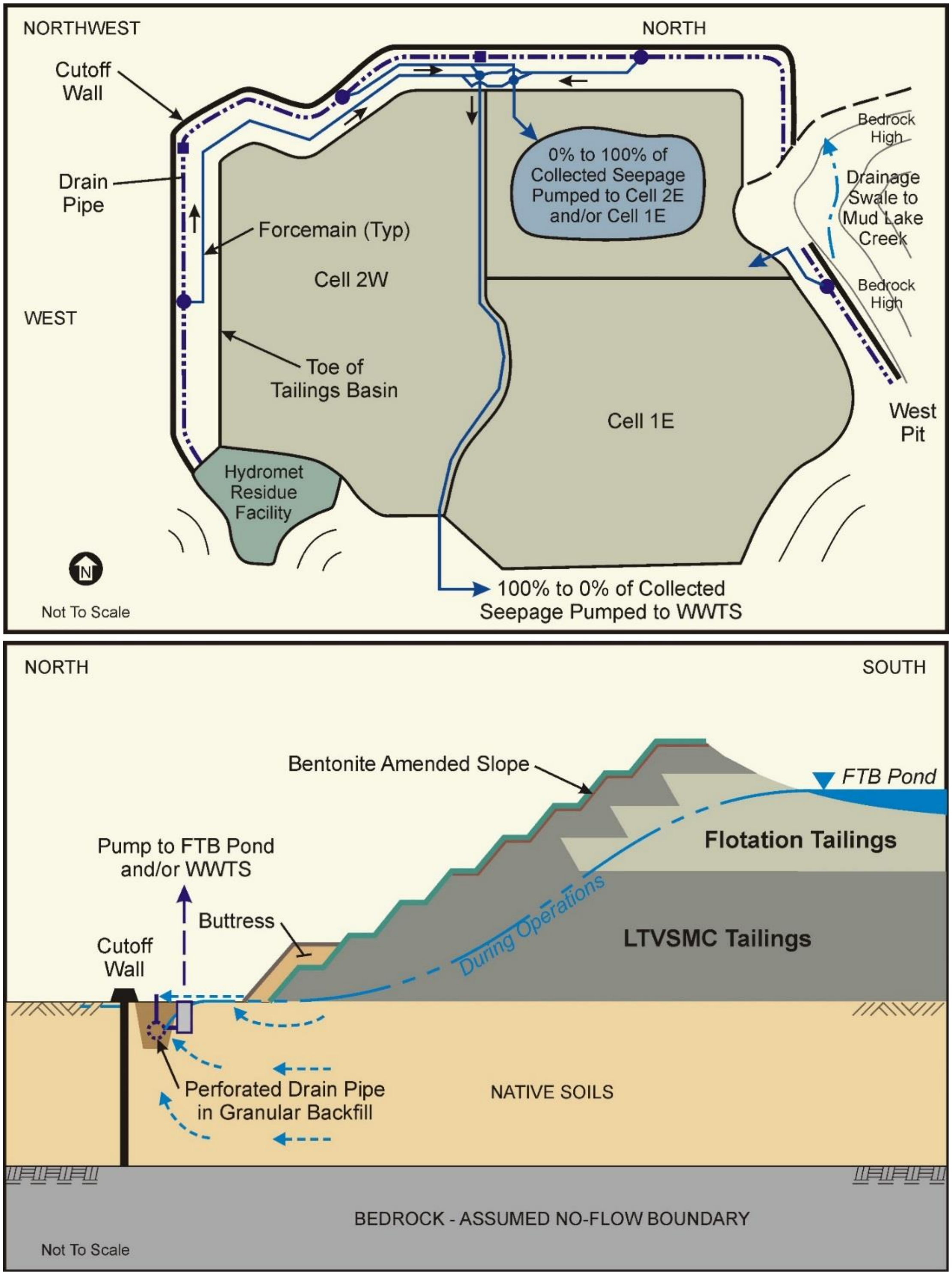


Note: Cross-section location shown on Figure 10-1

\\barr.com\projects\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v2\10 Waste\Figures\Figure 10-5 Proposed FTB Dam Design at Cross-Section N at Mine Year 20 d3.pptx

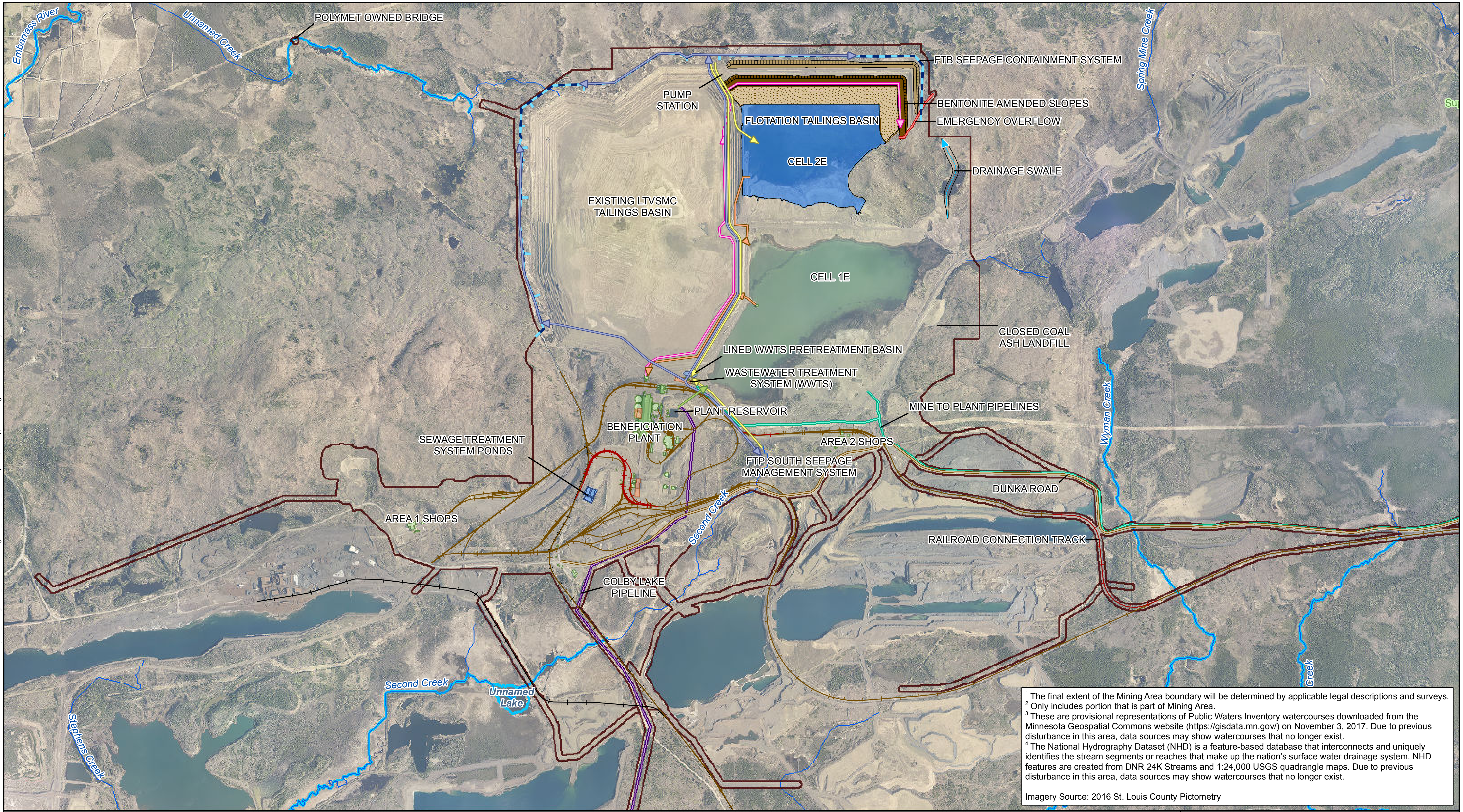
PROPOSED FTB DAM DESIGN AT CROSS-SECTION N MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 10-5
Permit to Mine Application



SCHEMATIC LAYOUT AND CROSS-SECTION OF THE FTB SEEPAGE CONTAINMENT SYSTEM
NorthMet Project
Poly Met Mining, Inc.

Figure 10-6
Permit to Mine Application

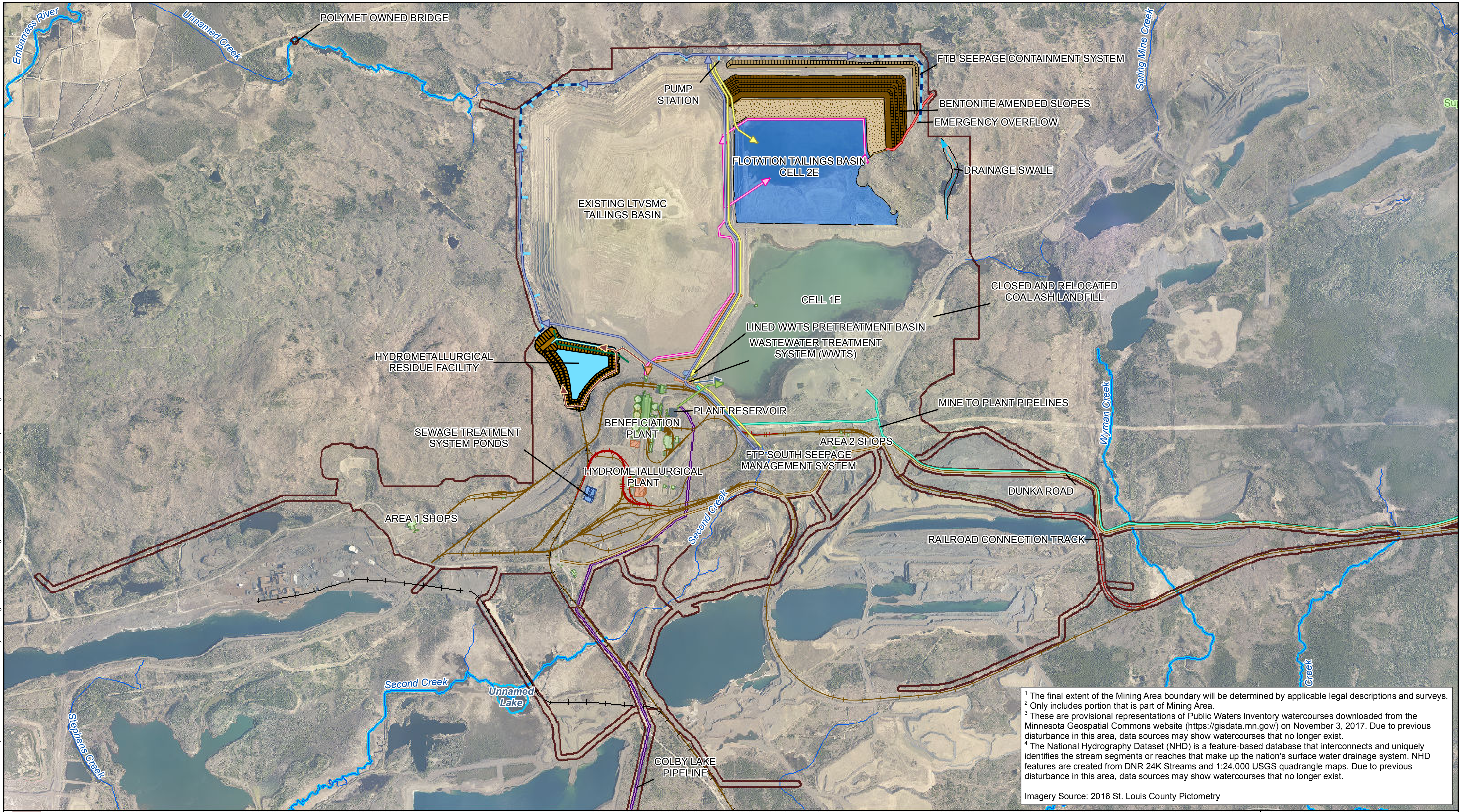


Mining Area[1]
Dunka Road[2]
Existing Railroad
Proposed Railroad
Minnesota Rail Lines
FTB Seepage Containment System
FTB Water Return Pipe
FTB Tailings Discharge Pipe
Tailings Basin Seepage Water Pipe
Treated Water Pipe
Plant Reservoir Overflow
Mine to Plant Pipelines
Colby Lake Pipeline
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Flotation Tailings Basin
Dam
Beach
Pond
Partial North Buttress
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 3,000 6,000
Feet

PLANT SITE LAYOUT - MINE YEAR 1
NorthMet Project
Poly Met Mining, Inc.

Figure 10-7
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

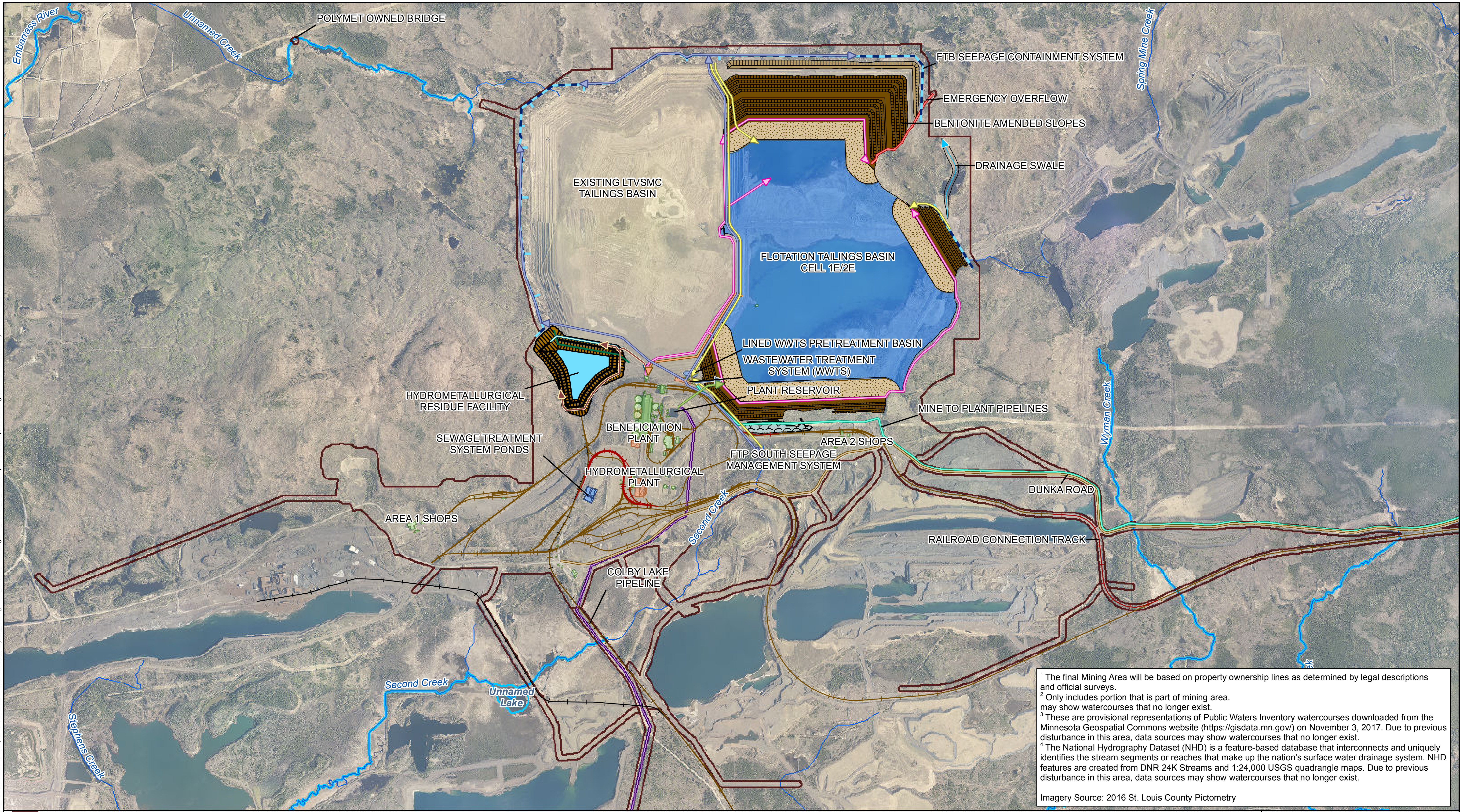
Mining Area[1]
Dunka Road[2]
Existing Railroad
Proposed Railroad
Minnesota Rail Lines
FTB Seepage Containment System
Mine to Plant Pipelines
Colby Lake Pipeline
FTB Water Return Pipe
FTB Tailings Discharge Pipe
Tailings Basin Seepage Collection Pipe
Plant Reservoir Overflow
Treated Water Pipe
Treated Mine Water Ppe
FTB Seepage Collection Drain (under HRF)
Return Water Pipe
Residue Discharge Pipe
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Hydrometallurgical Residue Facility Pond
Hydrometallurgical Residue Facility Dam
Flotation Tailings Basin
Dam
Beach
Pond
North Buttress
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,500 3,000
Feet

PLANT SITE LAYOUT - MINE YEAR 7
NorthMet Project
Poly Met Mining, Inc.

Figure 10-8
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-28 15:15 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 10-8 Plant Site Layout Mine Year 7.mxd User: arm2



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
may show watercourses that no longer exist.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Dunka Road[2]
- Minnesota Rail Lines
- Existing Railroad
- Proposed Railroad
- FTB Seepage Containment System
- FTB Water Return Pipe
- FTB Tailings Discharge Pipe
- Tailings Basin Seepage Water Pipe
- Plant Reservoir Overflow
- Treated Water Pipe
- Treated Mine Water Pipe
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe
- Mine to Plant Pipelines
- Colby Lake Pipeline
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- Hydrometallurgical Residue Facility Pond
- Hydrometallurgical Residue Facility Dam

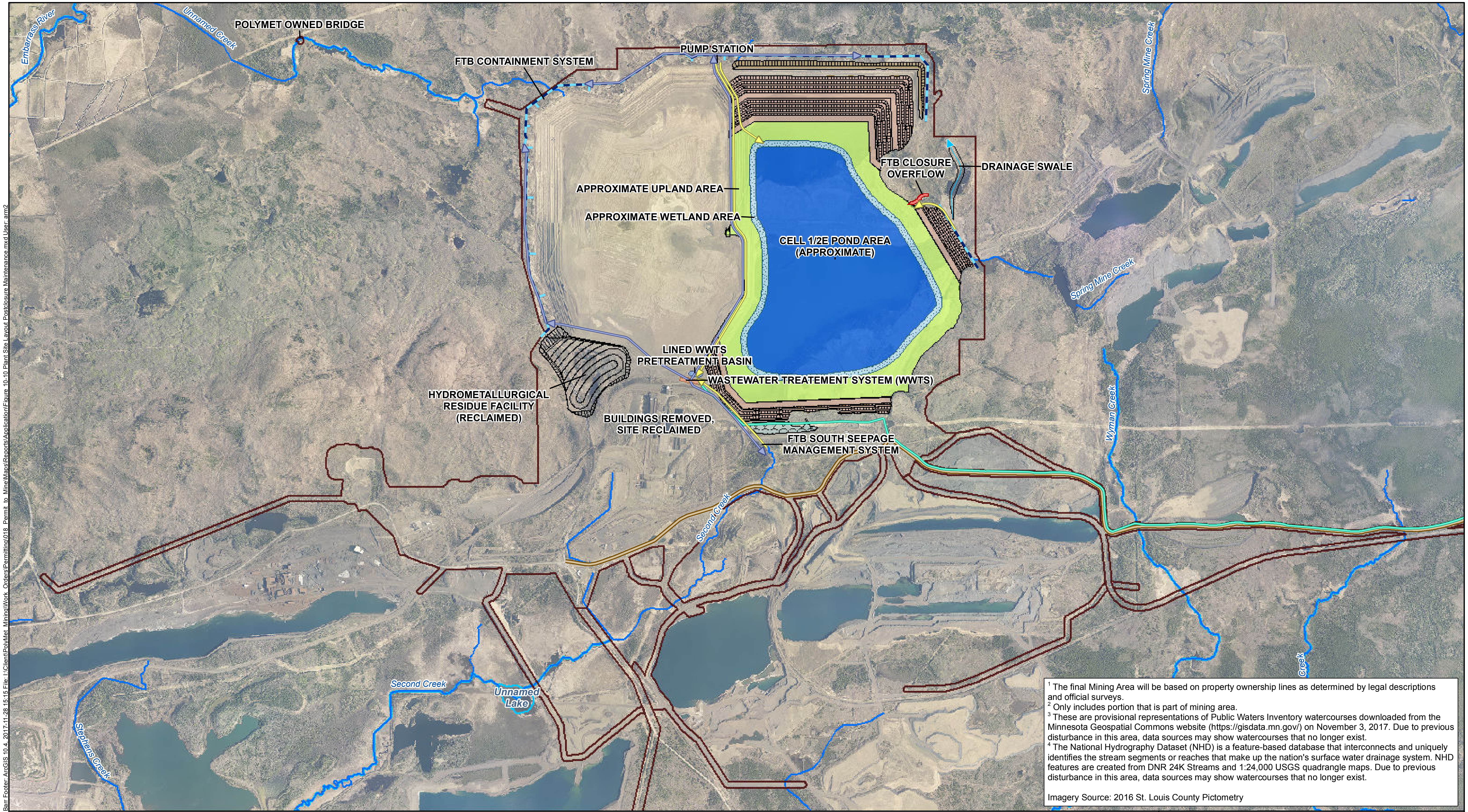
Flotation Tailings Basin
- Dam
- Beach
- Pond
- North Buttress
- South Buttress
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

N

0 1,500 3,000
Feet

PLANT SITE LAYOUT - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 10-9
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
FTB Seepage Containment System
Treated Water Pipe
Tailings Basin Seepage Water Pipe
Mine to Plant Pipelines

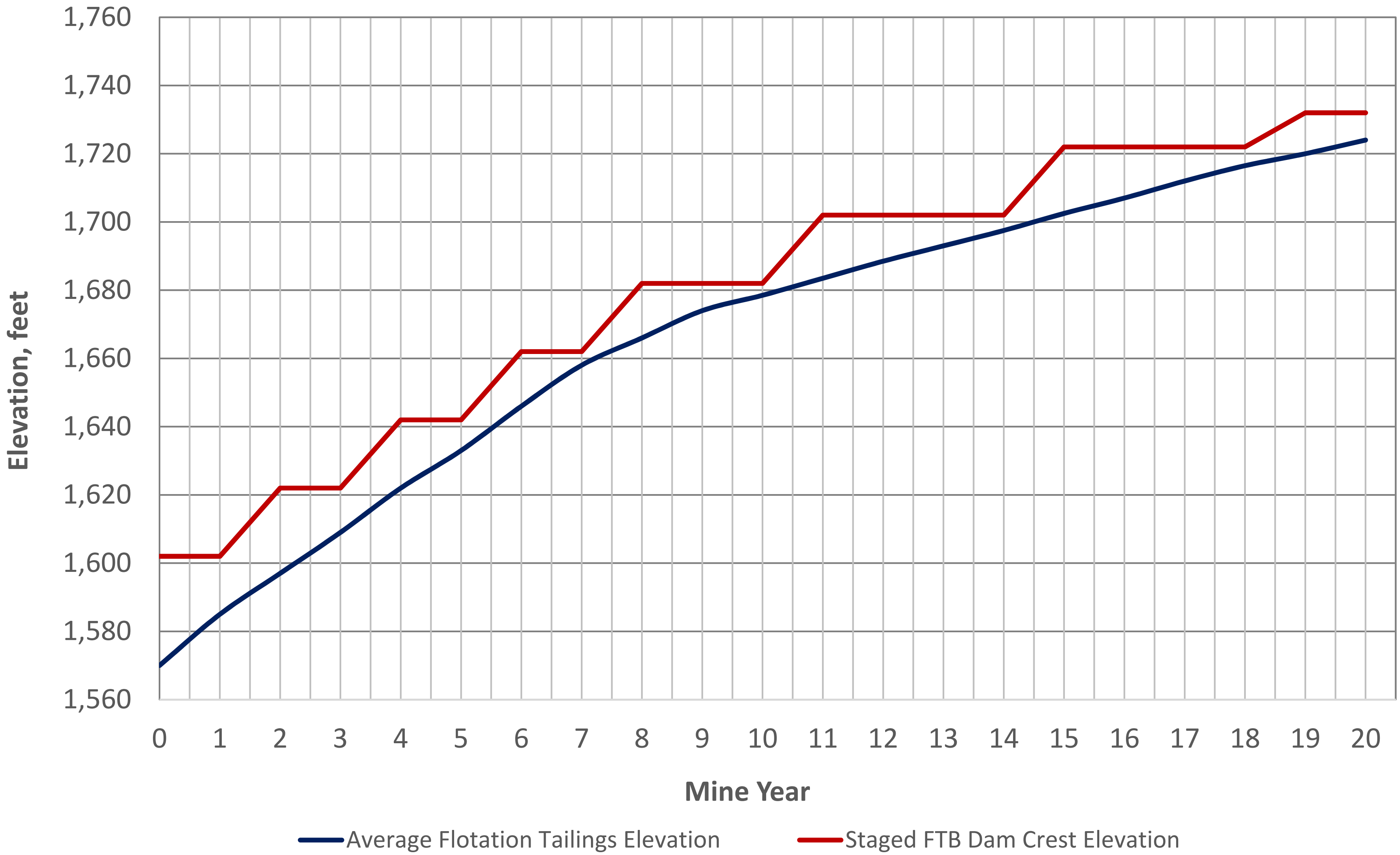
Flotation Tailings Basin
Pond
Wetland Area
Upland Area
Embankment
North Buttress
South Buttress

Public Waters Inventory (PWI) Watercourse[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 3,000 6,000
Feet

PLANT SITE LAYOUT
POSTCLOSURE MAINTENANCE
NorthMet Project
Poly Met Mining, Inc.

Figure 10-10
Permit to Mine Application



STAGED FLOTATION TAILINGS BASIN
DAM CREST AND TAILINGS ELEVATION
NorthMet Project
Poly Met Mining, Inc.

Figure 10-11
Permit to Mine Application

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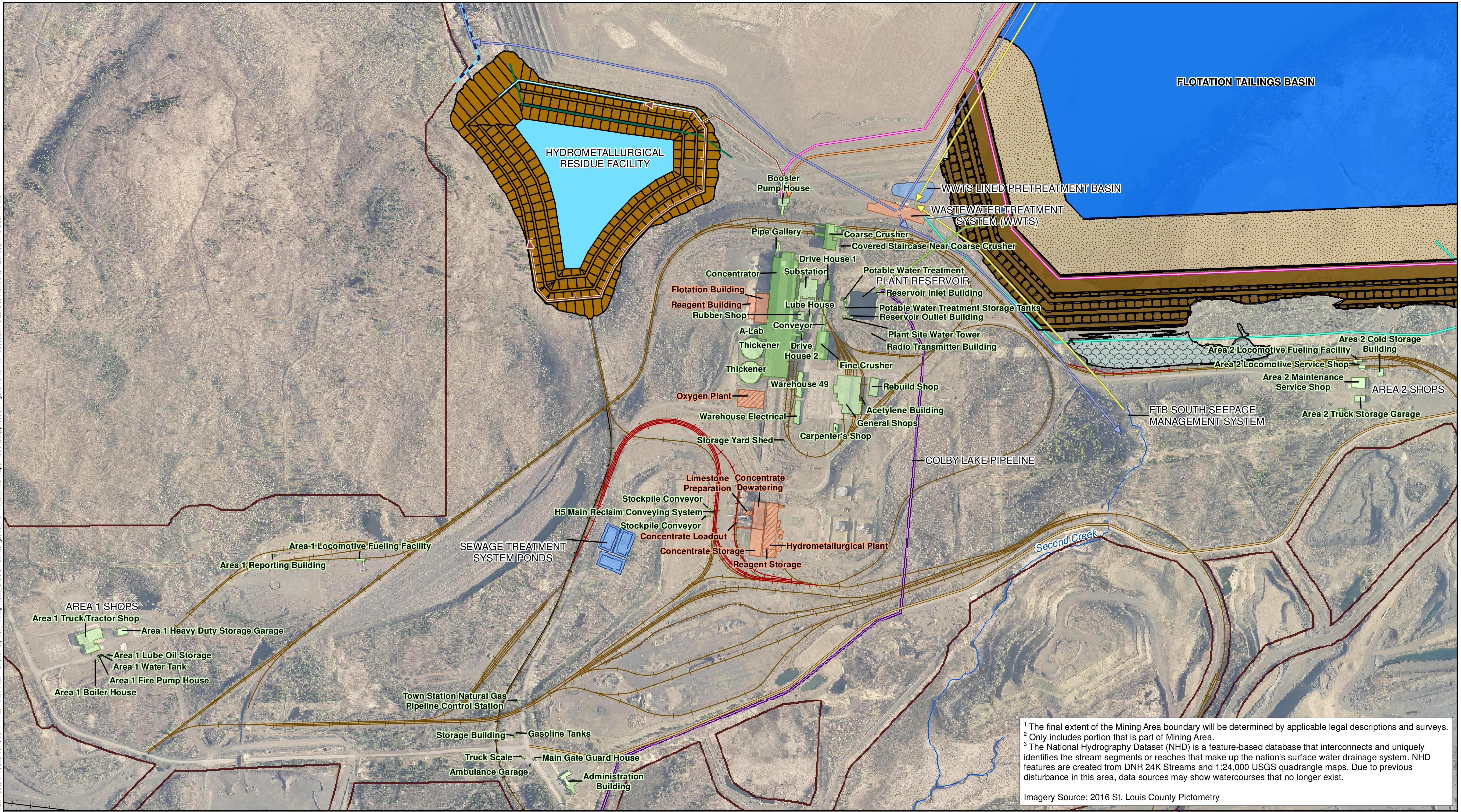


[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

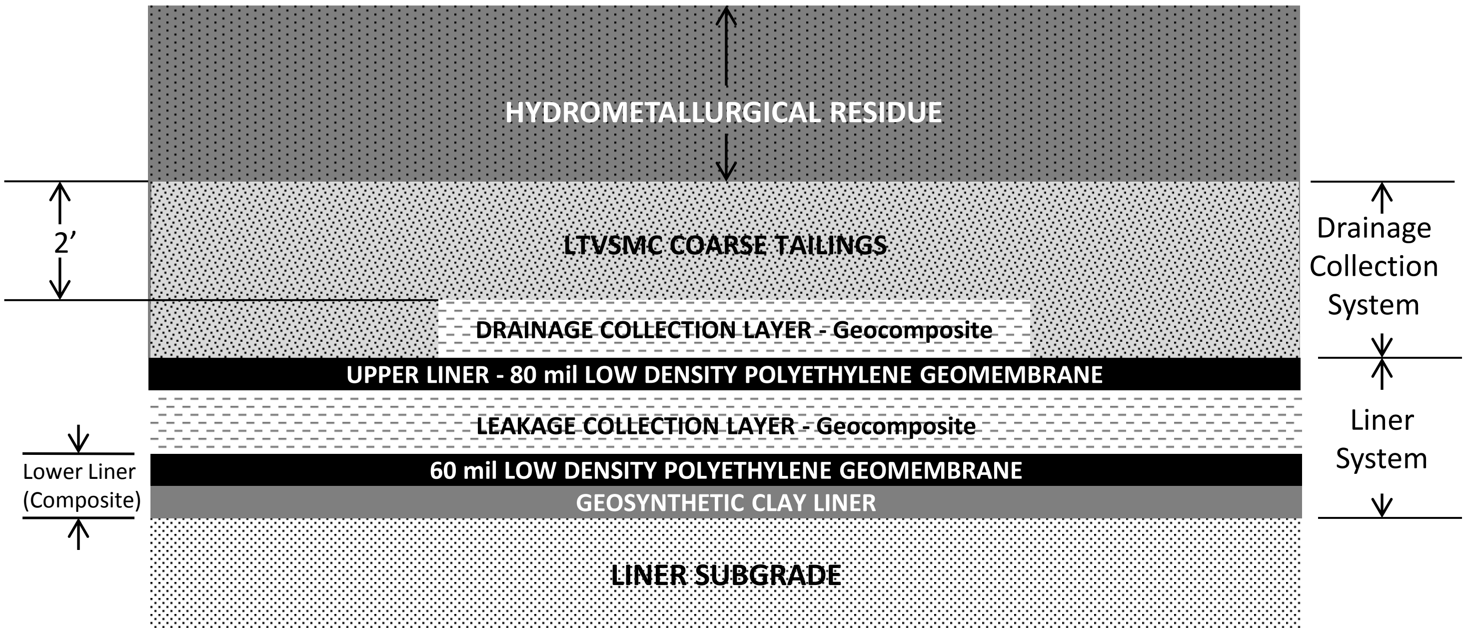
Mining Area[1]
Dunka Road[2]
Existing Railroad
Proposed Railroad
FTB Seepage Containment System
FTB Water Return Pipe
FTB Tailings Discharge Pipe
Tailings Basin Seepage Water Pipe
Plant Reservoir Overflow
Treated Water Pipe
Treated Mine Water Pipe
FTB Seepage Collection Drain (under HRF)
Return Water Pipe
Residue Discharge Pipe
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Hydrometallurgical Residue Facility Pond
Hydrometallurgical Residue Facility Dam

Flotation Tailings Basin
Dam
Beach
Pond
South Buttress
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 500 1,000 2,000
Feet

HRF LOCATION RELATIVE TO PLANT SITE FACILITIES
NorthMet Project
Poly Met Mining, Inc.

Figure 10-12
Permit to Mine Application



Notes

1. Drawing is not to scale.
2. Geocomposite and geomembrane type and thickness are preliminary.
3. Geocomposite consists of geonet and non-woven geotextile on top and bottom.
4. Source: Residue Management Plan V6, May 2017, included in Appendix 11 of the Application.

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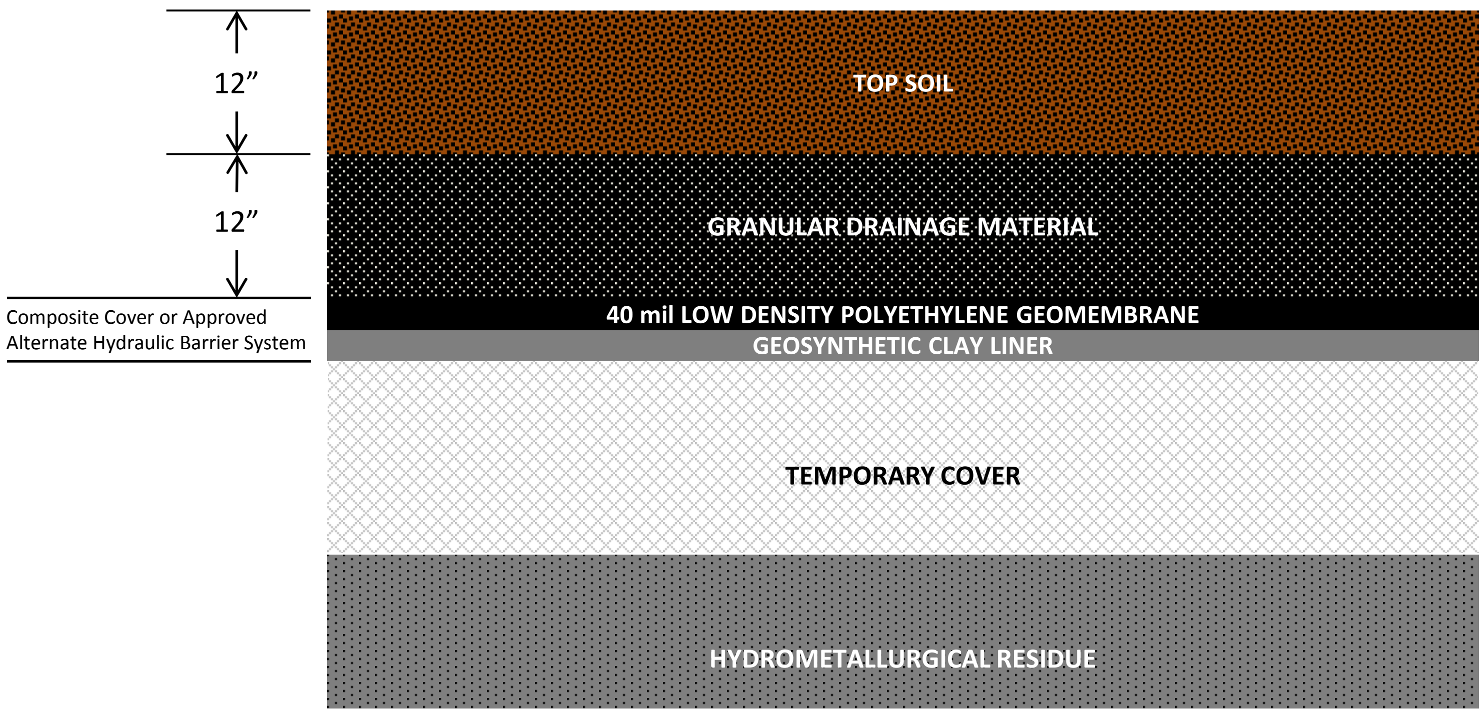
HRF LINER AND DRAINAGE COLLECTION SYSTEM
NorthMet Project
Poly Met Mining, Inc.

Figure 10-13
Permit to Mine Application



Notes

1. Drawing is not to scale.
2. Source: Residue Management Plan V6, May 2017, included in Appendix 11 of the Application.

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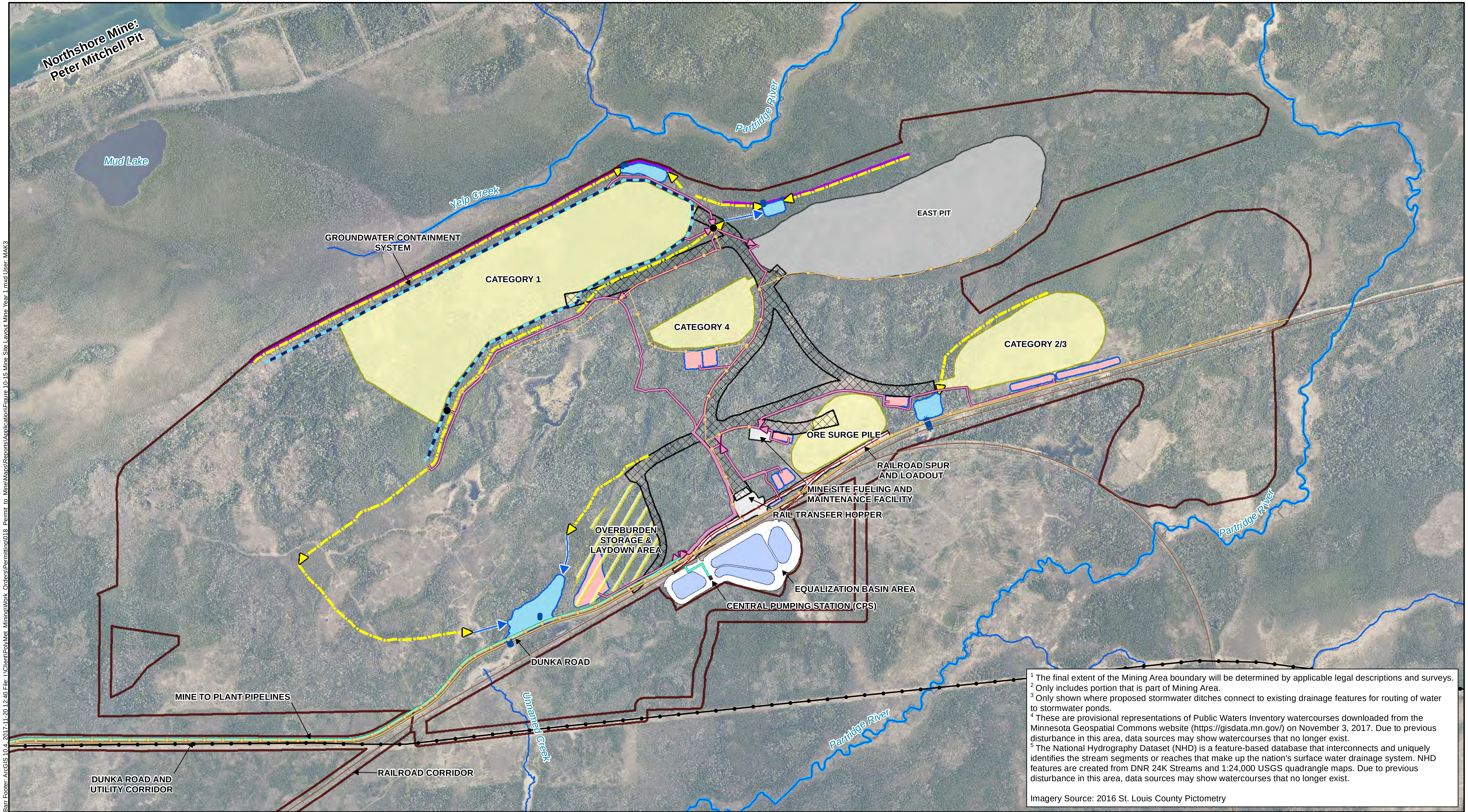
HRF FINAL COVER SYSTEM
NorthMet Project
Poly Met Mining, Inc.

Figure 10-14
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
PolyMet Power Distribution Lines
Minnesota Power Transmission Line
Dunka Road[2]
Existing Private Railroad
Proposed Railroad Track

Mine Year 1 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Haul Roads
Groundwater Containment System Sumps

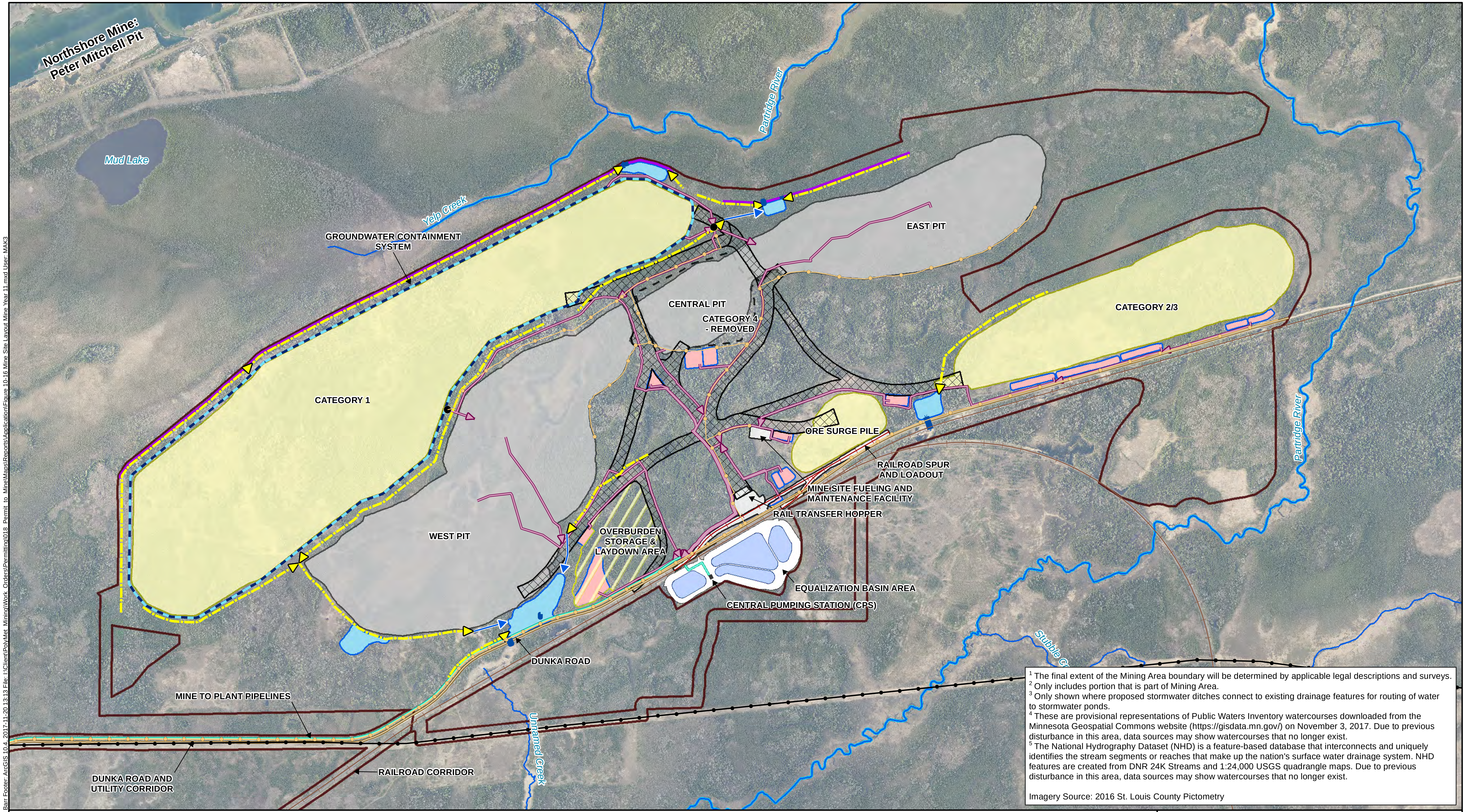
Groundwater Containment System
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps
Perimeter Dike
Existing Drainage[3]
Stormwater Ditches

Stormwater Culverts
Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE LAYOUT -
MINE YEAR 1
NorthMet Project
Poly Met Mining, Inc.

Figure 10-15
Permit to Mine Application



Mining Area [1]
PolyMet Power Distribution Lines
Minnesota Power Transmission Line
Dunka Road[2]
Existing Railroad
Proposed Railroad

Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Haul Roads

Groundwater Containment System Sumps
Groundwater Containment System
Mine Water Ponds and Sumps
Mine to Plant Pipelines
Mine Water Pipes
Perimeter Dike

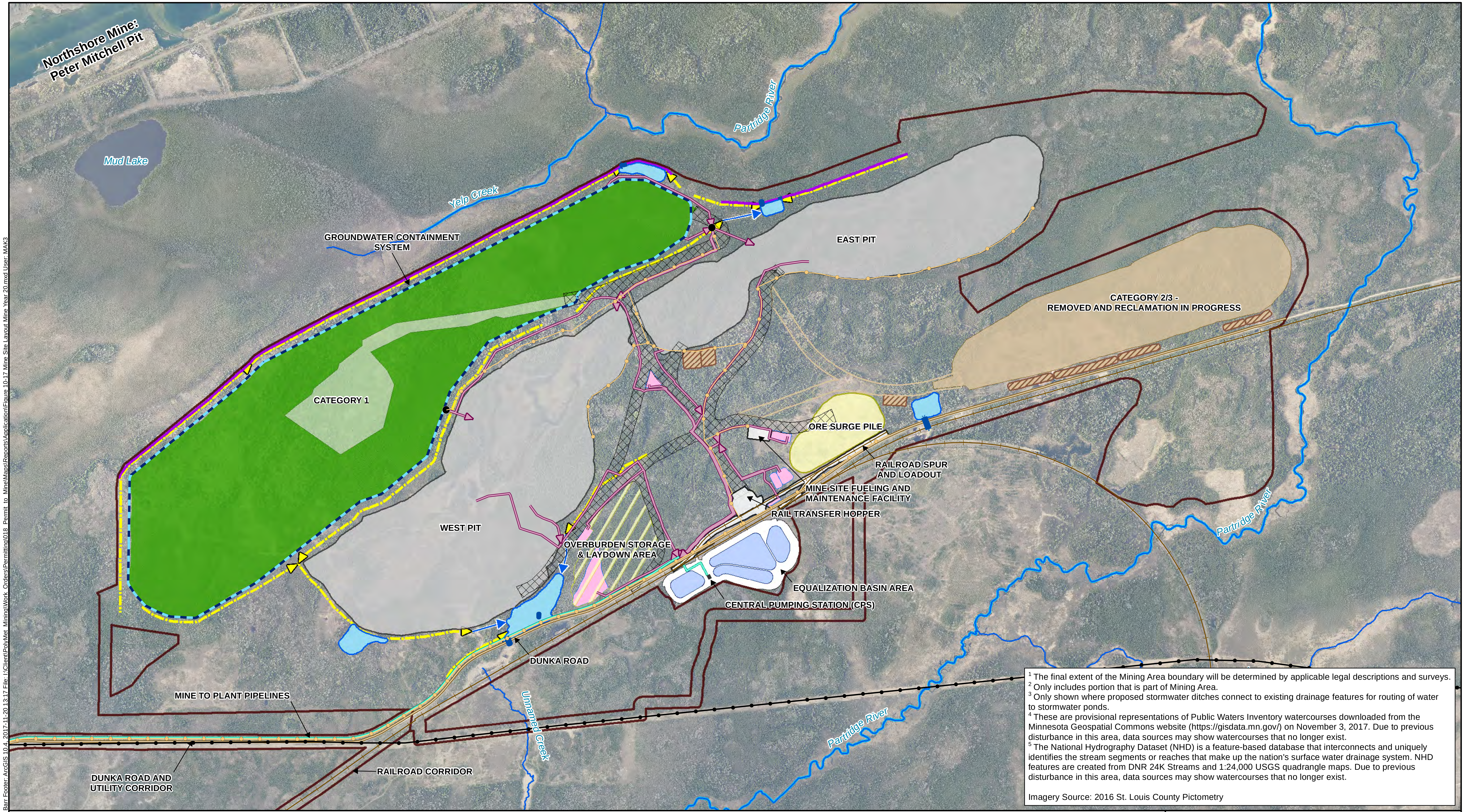
Existing Drainage[3]
Stormwater Ditches
Stormwater Culverts
Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[4]

National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE LAYOUT -
MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 10-16
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Barr Footer: ArcGIS 10.4, 2017-11-20 13:17 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 10-17 Mine Site Layout Mine Year 20.mxd User: MAK3

- Mining Area[1]
- PolyMet Power Distribution Lines
- Minnesota Power Transmission Line
- Dunka Road[2]
- Existing Railroad

Mine Year 20 Footprints

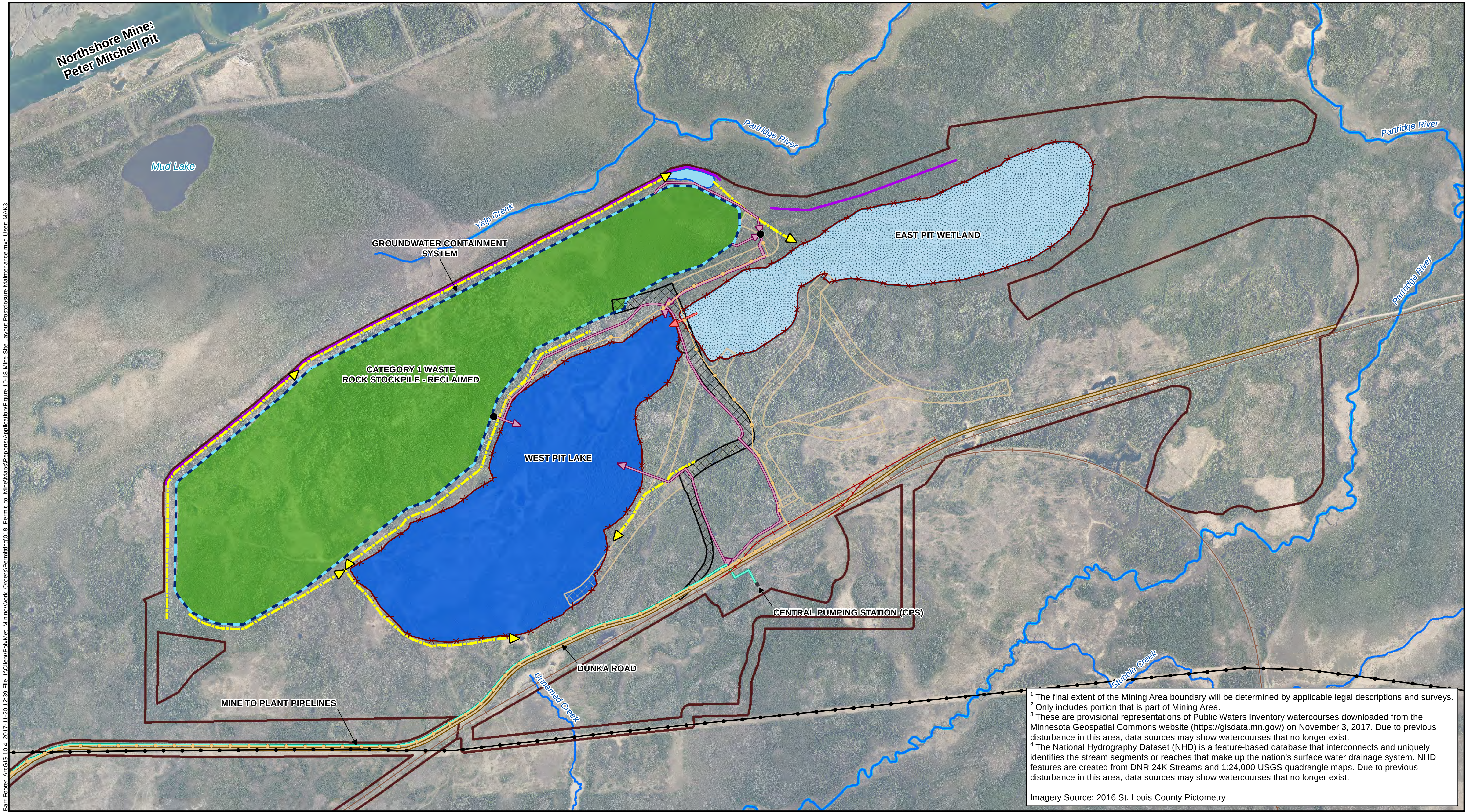
- Mine Pit
- Open Stockpile
- Covered Stockpile
- Active Stockpile
- Storage & Laydown Area
- Removed and Reclaimed Stockpiles
- Haul Roads
- Reclaimed Haul Roads
- Groundwater Containment System Sumps
- Groundwater Containment System
- Reclaimed Mine Water Ponds and Sumps
- Mine Water Ponds and Sumps
- Mine to Plant Pipelines
- Mine Water Pipelines
- Perimeter Dike
- Existing Drainage[3]
- Stormwater Ditches
- Stormwater Culverts
- Stormwater Ponds
- Public Waters Inventory (PWI) Watercourses[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

N

0 1,500 3,000
Feet

MINE SITE LAYOUT -
MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 10-17
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- PolyMet Power Distribution Lines
- Minnesota Power Transmission Line
- Dunka Road[2]
- Existing Railroad
- Proposed Railroad
- West Pit Lake
- East Pit Wetland
- Covered Stockpile
- Haul Roads
- Reclaimed Haul Roads and RTH
- Groundwater Containment System Sumps
- Groundwater Containment System
- Pit Perimeter Barrier System
- East Pit Overflow
- Mine to Plant Pipelines
- Mine Water Pipelines
- Perimeter Dike
- Stormwater Ditches
- Stormwater Pond
- Public Waters Inventory Watercourse[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

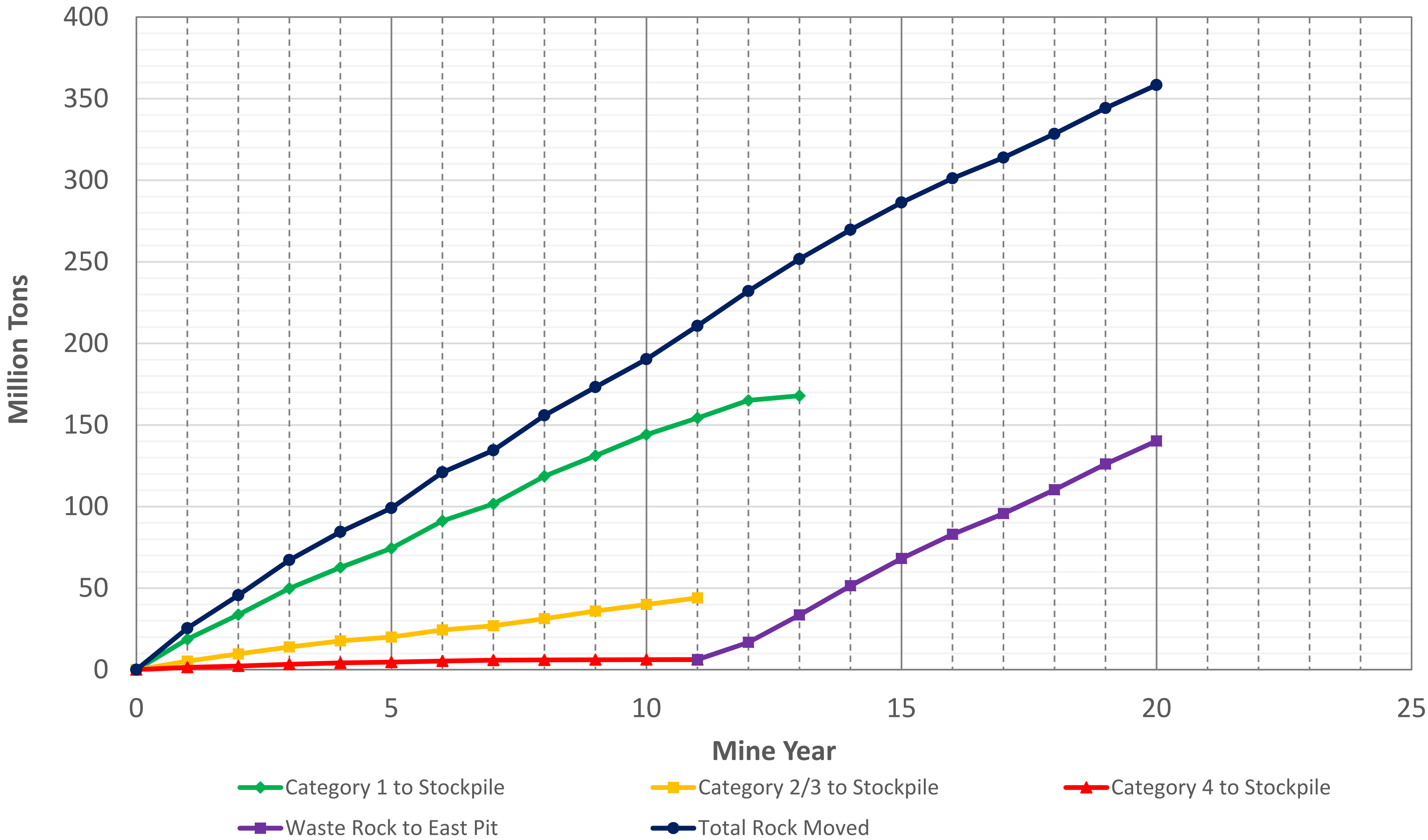
N

0 1,500 3,000
Feet

MINE SITE LAYOUT
POSTCLOSURE MAINTENANCE
NorthMet Project
Poly Met Mining, Inc.

Figure 10-18
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-20 12:39 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 10-18 Mine Site Layout Postclosure Maintenance.mxd User: MAK3



WASTE ROCK
PLACEMENT SCHEDULE
NorthMet Project
Poly Met Mining, Inc.

Figure 10-19
Permit to Mine Application

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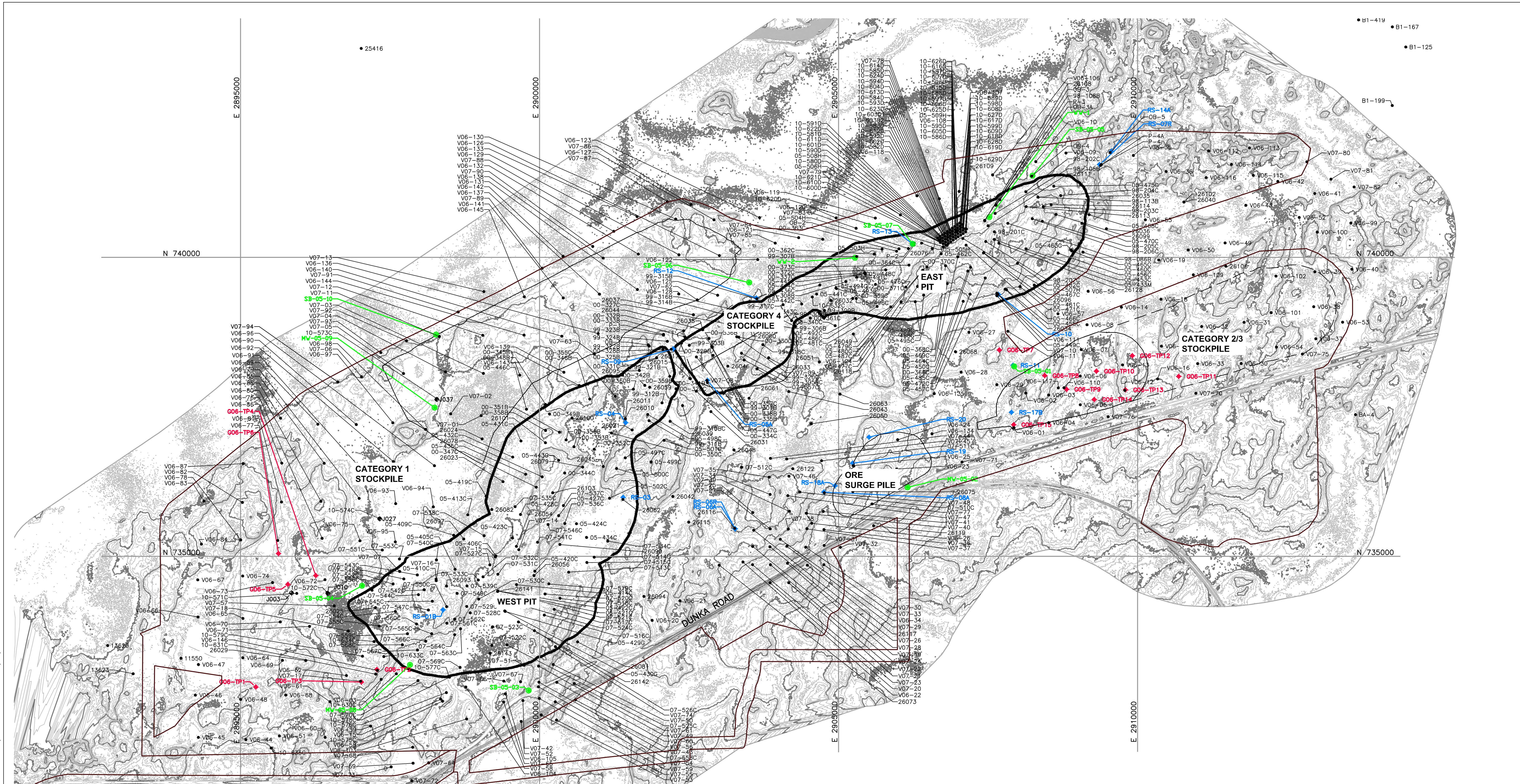


LEGEND

EXISTING GROUND TOPOGRAPHY

MINING AREA

MINE YEAR 11 PIT BOUNDARIES

MINE YEAR 1 ORE, AND WASTE ROCK STOCKPILE OUTLINES

MAXIMUM ORE, AND WASTE ROCK STOCKPILE OUTLINES

G06-TP11 GOLDER ASSOC. TEST PIT (2006)

SB-05-01 BARR ENGINEERING BOREHOLES (2005)

RS-07R BARR ENGINEERING BOREHOLES (2008)

05-444PM, 06-58 BORING OR GEOPHYSICAL SURVEY LOCATION

J003 AMERICAN ENGINEERING TESTING, INC. BOREHOLES (2010)

NOTES

1. FROM GOLDER ASSOCIATES INC. DRAWING SKP-008 INCLUDED IN APPENDIX 4 PERMIT APPLICATION SUPPORT DRAWINGS: CATEGORIES 1, 2/3, AND 4 STOCKPILES AND ORE SURGE PILE DESIGN.
2. SEE GEOTECHNICAL DATA PACKAGE VOLUME 3 FOR DETAILS ON TEST PITS, BOREHOLES AND GEOPHYSICAL SURVEYS.

REFERENCES

1. COORDINATE SYSTEM REFERENCE IS NAD83 MINNESOTA STATE PLANE NORTH
2. VERTICAL DATUM REFERENCE IS FEET ABOVE MEAN SEA LEVEL (AMSL).

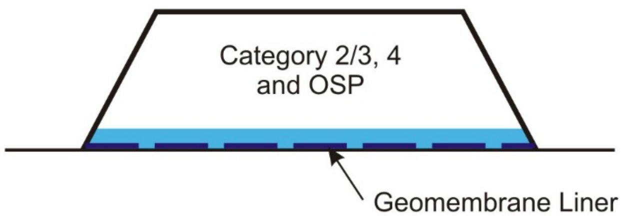
0 400 800 1600
Feet

MINE SITE GEOTECHNICAL INVESTIGATION LOCATIONS

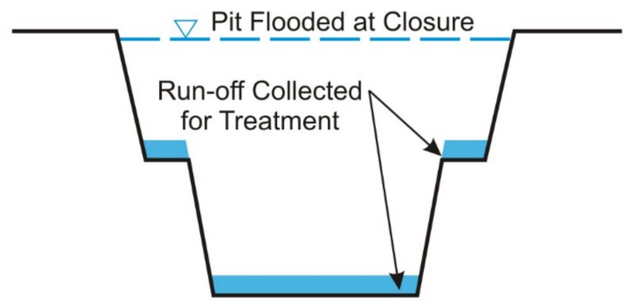
NorthMet Project
Poly Met Mining, Inc.

Figure 10-20
Permit to Mine Application

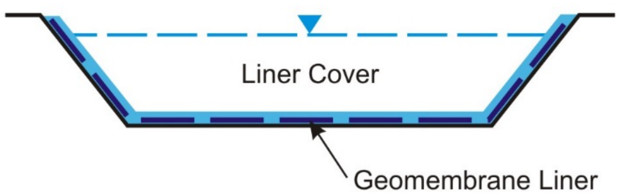
STOCKPILE FOUNDATION MATERIAL
BELOW THE WATER TABLE



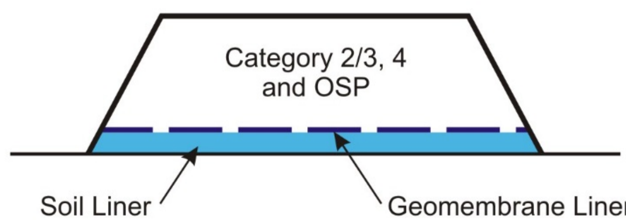
TEMPORARY DRAINAGE LAYER ABOVE THE
GEOMEMBRANE LINER OF THE CATEGORY 2/3 AND 4
STOCKPILE AND ORE SURGE PILE (OSP)



IN-PIT HAUL ROAD DRESSING



MINE WATER POND
LINER COVER MATERIAL



COMPACTED SOIL LINER BELOW A
TEMPORARY GEOMEMBRANE LINER

Legend

Saturated Mineral Overburden

POTENTIAL USES OF
SATURATED MINERAL OVERBURDEN
NorthMet Project
Poly Met Mining, Inc.

Figure 10-21
Permit to Mine Application

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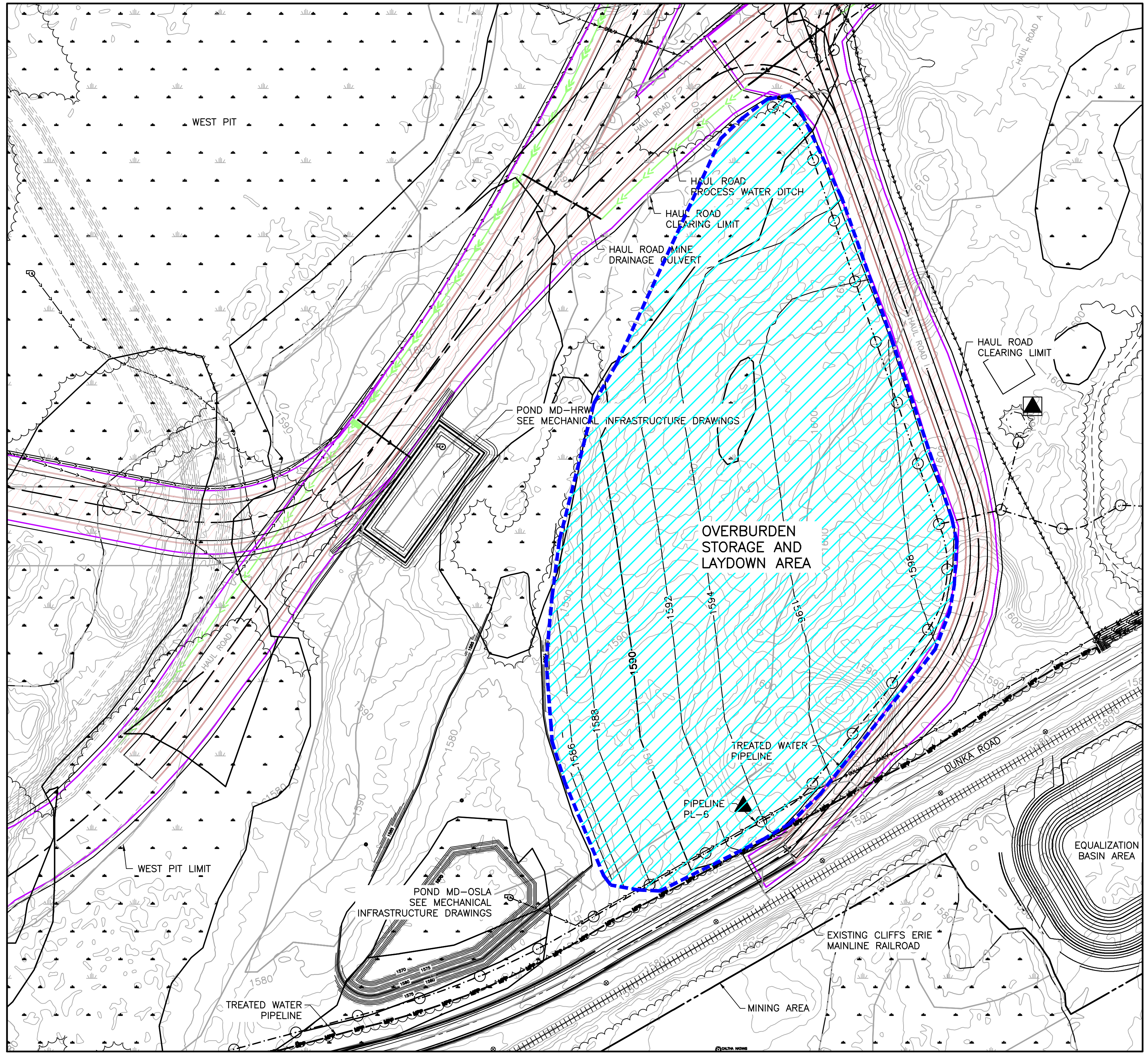


1 PLAN: OVERBURDEN STORAGE AND LAYDOWN AREA
005

NOTES:

1. ADAPTED FROM PERMIT SUPPORT DRAWING EW-009 – MINE SITE AND DUNKA ROAD EARTHWORK INCLUDED IN APPENDIX 3 OF THE APPLICATION

LEGEND

OVERBURDEN STORAGE AND LAYDOWN AREA

WETLANDS

0 75 150 300

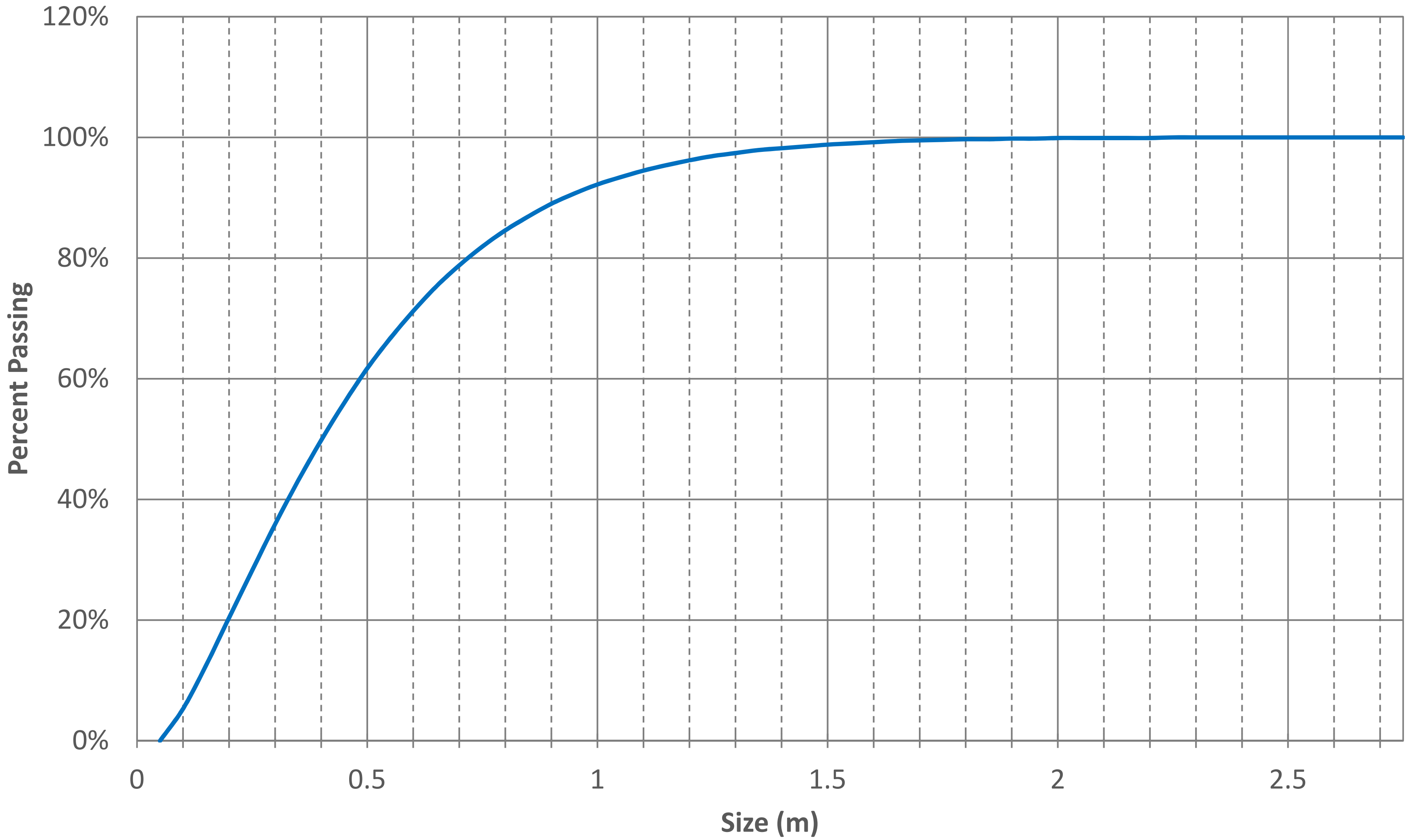
OVERBURDEN STORAGE AND LAYDOWN AREA GRADING PLAN

NorthMet Project
Poly Met Mining, Inc.

Figure 10-22
Permit to Mine Application

CADD USER: Kate K. Brown PLOT SCALE: 1:2 PLOT DATE: 11/20/2017 1:33 PM

BAR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50



WASTE ROCK BLAST CURVE
NorthMet Project
Poly Met Mining, Inc.

Figure 10-23
Permit to Mine Application

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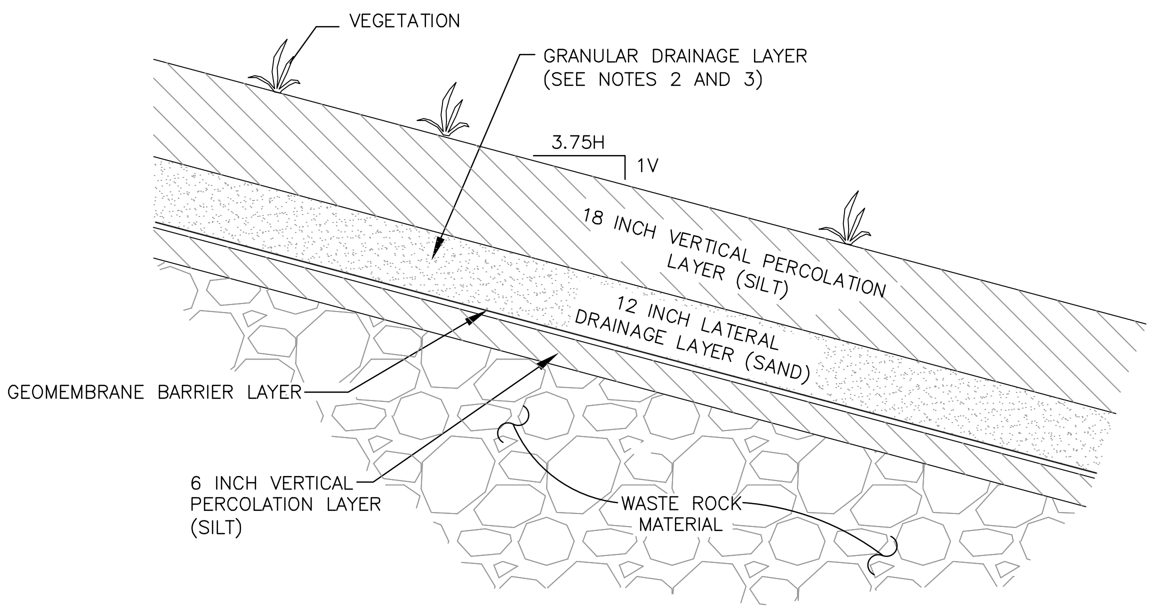


NOTES:

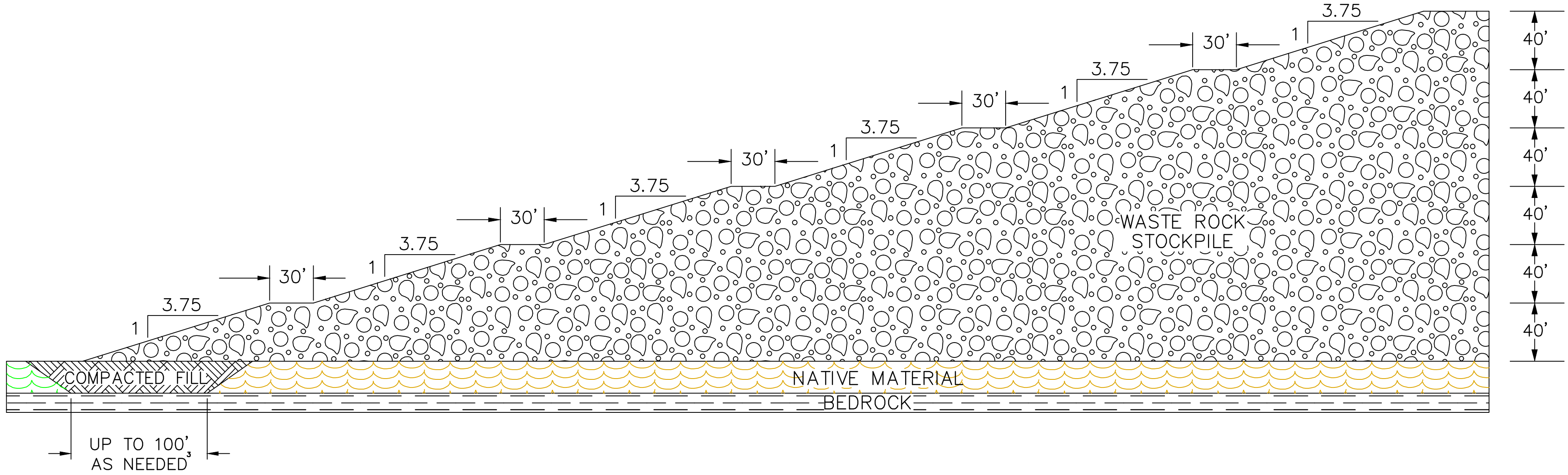
1. SOURCE: PERMIT SUPPORT DRAWING SKP–032 – CATEGORIES 1, 2/3, AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.

2. ON 1% SLOPE AREAS, PLACE 4 INCH DIAMETER PERFORATED CORRUGATED POLYETHYLENE PIPE (CPEP) WITH FILTER FABRIC SOCK AT 75 FOOT SPACING TO FACILITATE DRAINAGE OF GRANULAR DRAINAGE LAYER TO TOP SURFACE CHANNEL. PIPE LOCATION TO BE FIELD FIT.

3. AT BENCHES, PLACE 4 INCH PERFORATED CPEP DRAIN PIPE WITH FILTER FABRIC SOCK AT BASE OF COVER SYSTEM GRANULAR DRAINAGE LAYER AT SLOPE–BENCH INTERSECTION WITH OVERFLOW DIRECTED TO DOWNCHUTE CHANNELS.

TYPICAL CATEGORY 1 STOCKPILE RECLAMATION COVER DETAIL
NorthMet Project
Poly Met Mining, Inc.

Figure 10-24
Permit to Mine Application



NOTES:

1. SOURCE: GEOTECHNICAL DATA PACKAGE, VOLUME 3 – MINE SITE STOCKPILES, V5, JULY 2016, INCLUDED IN APPENDIX 16 OF THE APPLICATION.
2. COMPACTED FILL WILL BE USED TO REPLACE UNSUITABLE SOILS THAT ARE PRESENT ALONG THE TOE OF STOCKPILE.
3. GROUNDWATER CONTAINMENT SYSTEM DESIGNED TO TIE INTO STOCKPILE TOE. SEE POLYMET CATEGORY 1 STOCKPILE GROUNDWATER CONTAINMENT SYSTEM, PERMIT APPLICATION SUPPORT DRAWINGS, INCLUDED IN APPENDIX 4 OF THE APPLICATION.

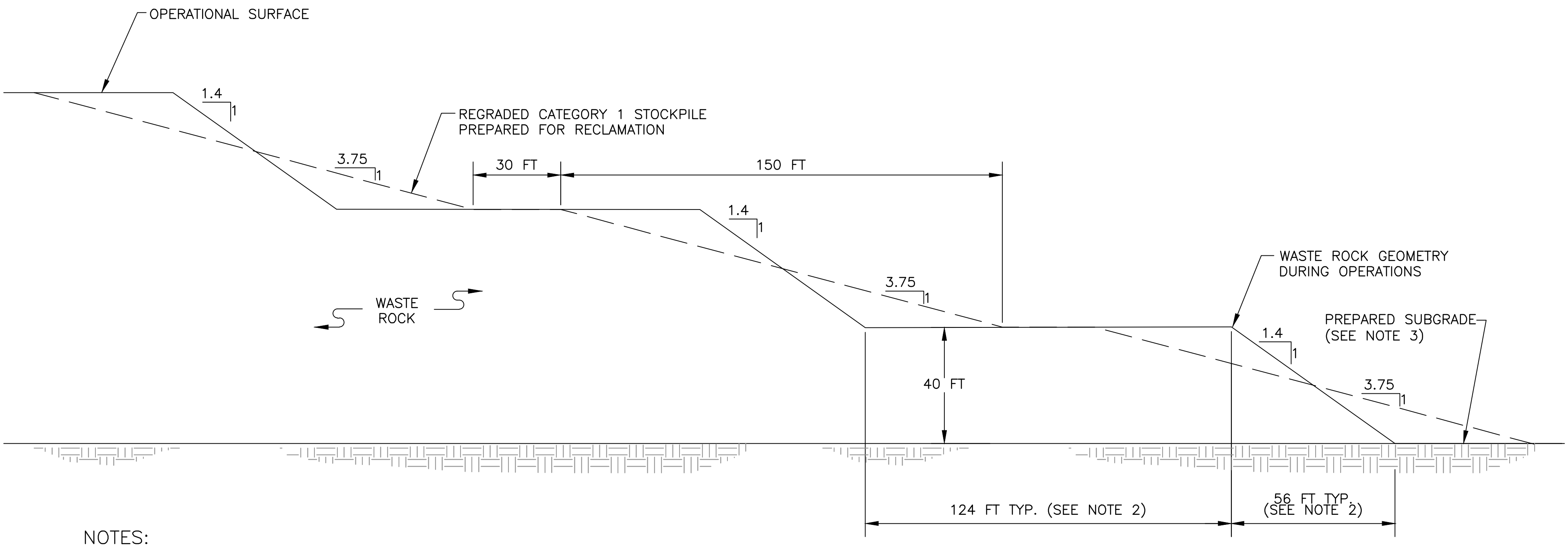
CATEGORY 1 STOCKPILE FINAL RECLAMATION CONFIGURATION

NorthMet Project

Poly Met Mining, Inc.

Figure 10-25

Permit to Mine Application



NOTES:

1. ADAPTED FROM PERMIT SUPPORT DRAWINGS SKP-013 AND SKP-032 – CATEGORIES 1, 2/3, AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.

2. STOCKPILE GEOMETRY DURING OPERATIONS BASED ON ASSUMED WASTE ROCK ANGLE OF REPOSE OF 35.5 DEGREES (1.4H:1V).

3. GEOTECHNICALLY UNSTABLE SOILS TO BE REMOVED AND REPLACED WITH COMPACTED STRUCTURAL FILL WITHIN 100 FT. OF CATEGORY 1 STOCKPILE PERIMETER LIMITS.

4. GROUNDWATER CONTAINMENT SYSTEM DESIGNED TO TIE INTO STOCKPILE TOE. SEE POLYMET CATEGORY 1 STOCKPILE GROUNDWATER CONTAINMENT SYSTEM, PERMIT APPLICATION SUPPORT DRAWINGS, INCLUDED IN APPENDIX 4 OF THE APPLICATION.

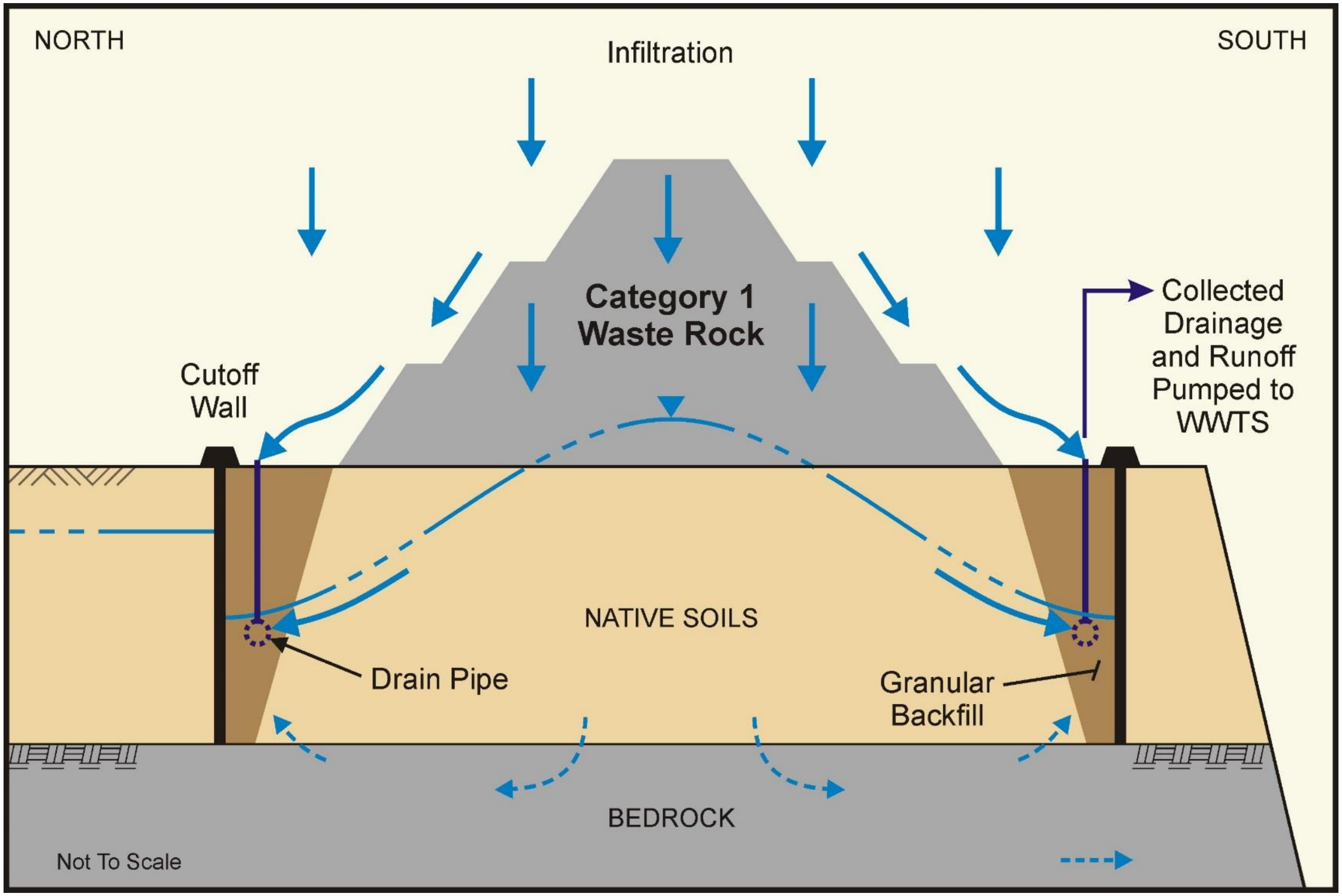
CATEGORY 1 STOCKPILE TYPICAL GEOMETRY DURING OPERATIONS AND REGRADED FOR RECLAMATION

NorthMet Project

Poly Met Mining, Inc.

Figure 10-26

Permit to Mine Application



CATEGORY 1 STOCKPILE AND
GROUNDWATER CONTAINMENT SYSTEM
CROSS-SECTION DURING OPERATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 10-27
Permit to Mine Application

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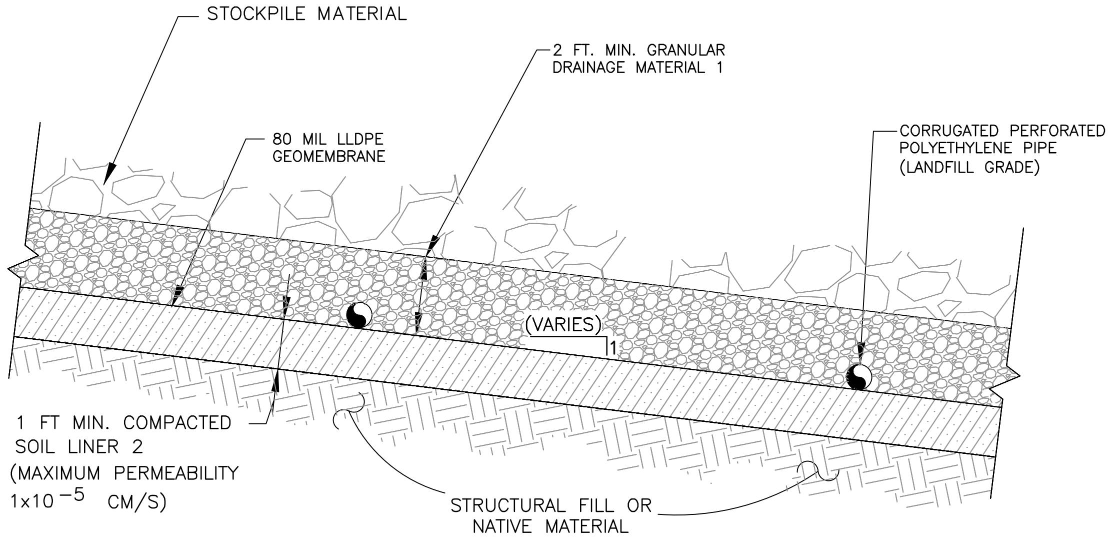
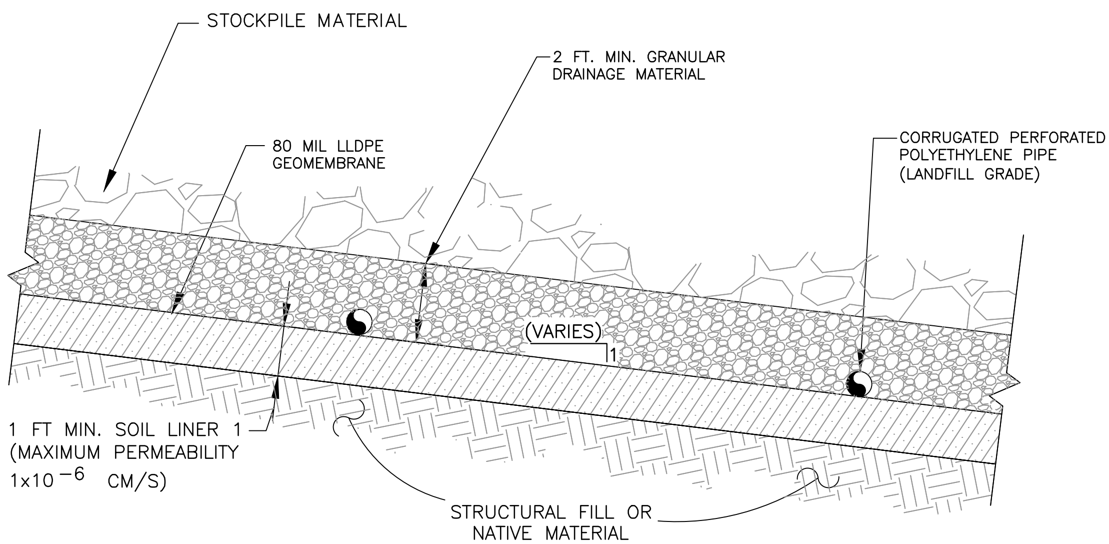
CATEGORY 2/3 STOCKPILE LINER



CATEGORY 4 STOCKPILE AND ORE SURGE PILE LINER



NOTE:

1. SOURCE: PERMIT SUPPORT DRAWING SPK−035 − CATEGORIES 1, 2/3 AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.

CATEGORY 2/3 AND 4 WASTE ROCK STOCKPILE AND ORE SURGE PILE LINER SYSTEM
NorthMet Project
Poly Met Mining, Inc.

Figure 10-28
Permit to Mine Application

11.0 Water Management

In accordance with Minnesota Rules, part 6132.0200, PolyMet designed the Project "to control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization." PolyMet will also conduct its operations "in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and leave the Mining Area in a condition that protects natural resources and minimizes, to the extent practicable, the need for maintenance." In addition, PolyMet designed and will construct and operate the Project to minimize hydrologic impacts associated with its facilities, including the FTB, HRF, mine pits, and stockpiles. The Project will result in some changes in watershed areas over the LOM and over the long-term; these changes are shown for the end of construction phase, Mine Year 11, Mine Year 20, and the postclosure maintenance phase on Figure 11-1 through Figure 11-4.

The overall Project water management strategy includes using water from the Mine Site at the Plant Site, as well as reusing water within various Plant Site facilities to maximize water recycling and minimize discharges to the environment. Discharge from the WWTS will be used to augment streamflow, where needed, in watersheds around the Tailings Basin. The Project design includes systems for managing and monitoring water to comply with applicable surface water and groundwater quality standards at appropriate compliance points. PolyMet designed the water management systems to achieve compliance based on modeling of expected water quantity and quality. Additionally, PolyMet has created adaptive management and contingency mitigation procedures for water management, which are discussed in more detail in Appendix 11.2, Appendix 11.3, Appendix 11.4 and Section 3.6.1, that it will utilize as necessary to maintain regulatory compliance.

PolyMet's water management strategy will require it to obtain permits in addition to the PTM, including an MPCA individual NPDES/SDS Permit, coverage under MPCA Construction Stormwater General Permit, coverage under MPCA Industrial Stormwater General Permit, CWA Section 401 Water Quality Certification, two DNR Dam Safety Permits, and six DNR Water Appropriation Permits, along with a number of other related permits and approvals. Once issued, these water-related permits and approvals will contain conditions and/or performance standards based on permit type that, together with the Project design, will minimize impacts to groundwater and surface waters from the Project. Because these related permits and approvals will contain the detailed requirements relating to, among other things, water quality and appropriation, this Section 11.0 is not intended to address those independent statutory and regulatory requirements. Rather, this Section 11.0 provides a summary of the Project's water management, which will be presented in more detail in the related permits and associated applications, so as to demonstrate that the Project meets the water-related requirements set forth in the nonferrous mining rules.

PolyMet proposes to manage water in 10 categories:

- mine water
- process water

- sewage
- tailings basin water
- tailings basin seepage
- HRF water
- Plant Reservoir water
- industrial stormwater
- construction stormwater
- non-contact stormwater

Table 11-1 presents project-specific definitions for each category of water and its associated terminology.

The remainder of Section 11.0 is organized as follows. Section 11.1 provides an overall summary of construction-related water management, including a description of procedures and BMPs for managing construction stormwater at various Project locations. Section 11.2 describes the water balance for the Project once operations commence. Sections 11.3 and 11.4 focus on water management at the Mine Site and the Plant Site, respectively, during operations. Section 11.5 provides information on water management in the Transportation and Utility Corridors and Colby Lake Pipeline Corridor. Finally, Section 15.8 discusses water management after operations cease.

11.1 Construction Stormwater Management

Prior to start of construction, PolyMet will submit permit applications requesting authorization to discharge stormwater associated with construction activities under the Minnesota NPDES/SDS Construction Stormwater General Permit (Permit No. MNR100001). For construction activities occurring during Project operations, the Project NPDES/SDS Permit Application requested that Construction Stormwater General Permit coverage be incorporated into the Project's individual NPDES/SDS Permit.

Stormwater associated with construction activities will be managed with controls and BMPs, including erosion and sediment control measures, construction water management control measures, dust control measures, and construction site reclamation practices. Prior to the start of each phase of construction activities, these management measures will be incorporated into a Construction SWPPP based on detailed construction plans and in accordance with Construction Stormwater General Permit requirements.

11.2 Project Water Balance

Figure 11-5 through Figure 11-8 depict the Project water balance in Mine Years 10, 25, and 55 (mechanical and non-mechanical treatment). These figures provide conceptual diagrams showing various water inputs to and outputs from the Project, along with estimated average annual flows for those years. The estimated values were compiled from water flow models developed for the Project, as documented in Section 5.3 of the Consolidated Water Appropriation Permit Applications (Reference (5)). The general flow of water for the Project is summarized below.

Mine water at the Mine Site is comprised of water that has contacted surfaces disturbed by mining activities, such as drainage collected on stockpile liners; pit dewatering; and runoff contacting ore, waste rock, and Mine Site haul road surfaces. PolyMet will manage water collected during excavation of saturated mineral overburden as construction mine water. The Project will collect mine water across the Mine Site in sumps and ponds, and then pump the collected water to the WWTS for treatment. High concentration mine water (e.g., from stockpile liners) will be pumped to the High Concentration Equalization Basin, then through the High Concentration Pipeline to the WWTS. Low concentration mine water (e.g., from mine pit dewatering) will be pumped to the Low Concentration Equalization Basin, then through the Low Concentration Pipeline to the WWTS. The WWTS will treat mine water through chemical precipitation and membrane separation, as described in Section 11.4.8, and then convey the treated water to the FTB Pond.

Construction mine water and runoff from the OSLA, which does not need treatment besides settling for total suspended solids as it only contains unsaturated mineral overburden and peat, will be pumped to the Construction Mine Water Basin, then through the Construction Mine Water Pipeline to the FTB Pond. Runoff from the OSLA is expected to be equivalent to construction stormwater runoff.

The FTB will serve as the primary collection point for storage and recycling of water from the Mine Site and Plant Site. The FTB will receive process water from the Beneficiation Plant, treated mine water from the WWTS, precipitation, and some of the water collected by the FTB seepage capture systems, along with other minor sources as shown on Figure 11-5, including construction mine water, treated water from the sewage treatment system, runoff from FTB dams, and filter backwash from the WWTS. Flotation Tailings will settle in the FTB Pond, and decanted tailings basin water will be recycled to the Beneficiation Plant. The Beneficiation Plant will also draw make-up water, as needed, from the Plant Reservoir, which will receive water from Colby Lake. Some of the water collected by the FTB seepage capture system will be pumped back to the FTB Pond and eventually recycled back to the Beneficiation Plant. The remainder of the water collected by the FTB seepage capture systems will be pumped to the WWTS for treatment and discharge, as described in Section 11.4.8. The WWTS will discharge to three streams for stream augmentation: Second Creek, Unnamed Creek, and Trimble Creek.

After the Hydrometallurgical Plant is commissioned, water will be pumped within a closed system between the HRF and the Hydrometallurgical Plant. The Hydrometallurgical Plant will discharge Residue and associated process water to the HRF, where it will mix in the HRF Pond with stormwater collected within the HRF and water collected by the leakage collection component of the HRF's double liner system. Residue will settle in the HRF Pond, and decanted HRF water will be recycled to the Hydrometallurgical Plant. The Hydrometallurgical Plant will draw make-up water, as needed, from the Plant Reservoir, which will receive water from Colby Lake.

Water will also be used to control fugitive dust emissions. The appropriate water sources will be determined depending on the location and runoff management for the road to be watered. At the Mine

Site, fugitive dust control water could be drawn from multiple sources, including mine pit dewatering collection sumps within the open pits, haul road mine water ponds, the OSLA pond, the Low Concentration Equalization Basins, or the stormwater ponds. At the Plant Site, fugitive dust control water for roads outside the footprint of the FTB seepage capture systems will be drawn from the Plant Reservoir. For roads inside the FTB seepage capture systems footprint (i.e., roads on the Tailings Basin), water could be drawn from the FTB Pond.

11.3 Mine Site Water Management and Infrastructure

Water management at the Mine Site will include collecting and managing mine water, stormwater, and sewage, and separating stormwater from mine water. The following sections describe the existing site conditions and the planned water management systems related to mine water, sewage, and stormwater during operations.

11.3.1 Existing Conditions

The Mine Site naturally drains toward the Partridge River, a tributary of the St. Louis River, as shown in Figure 5-4. Specifically, most of the Mine Site naturally drains to the south through culverts under Dunka Road and the adjacent mainline railroad, then into the Partridge River downstream of the Dunka Road crossing. Runoff from the northernmost portion of the Mine Site generally drains north into the One Hundred Mile Swamp and Yelp Creek. These water bodies and associated wetlands form the headwaters of the Partridge River, which meanders around the eastern end of the Mine Site before turning southwest. The Mine Site is currently a mixture of forested upland and wetland areas, with the most common wetland types consisting of coniferous bog, shrub swamp, and coniferous swamp.

11.3.1.1 Surface Water

Tributaries to the Partridge River above Colby Lake and immediately downstream of the Mine Site include Yelp Creek (a portion of the Mine Site drains north into Yelp Creek) and an Unnamed Creek downstream of the future West Pit overflow. Other tributaries located between the Mine Site and Colby Lake that will not be directly or indirectly affected by the Mine Site, from upstream to downstream, are Stubble Creek, the South Branch of the Partridge River, Colvin Creek, and three unnamed creeks between Longnose Creek and Wyman Creek. The three remaining tributaries to the Partridge River above Colby Lake include Wetlegs Creek, Longnose Creek, and Wyman Creeks, which are located along the Transportation and Utility Corridors, as discussed in Section 11.5.1. Additional information on surface water hydrology and watersheds at the Mine Site is provided in Section 5.2. PolyMet has monitored surface water quality and quantity within the Partridge River watershed since 2004. PolyMet's NPDES/SDS Permit Application provides surface water quality results through 2015.

11.3.1.2 Groundwater

Groundwater at the Mine Site is located in both the surficial aquifer and bedrock units. Information on the geology of the surficial deposits and bedrock is provided in Section 5.1.1 and 5.1.2, respectively. Information on groundwater flow and hydrogeology is provided in Section 5.4.1. PolyMet has been monitoring baseline groundwater quality through a network of monitoring wells in the surficial aquifer and bedrock since 2005. PolyMet's NPDES/SDS Permit Application provides groundwater quality results through 2015.

11.3.2 Mine Water Management and Infrastructure

This Section 11.3.2 describes the design and operation of the infrastructure that PolyMet will use to manage mine water at the Mine Site in accordance with the provisions of the PTM Regulations and other applicable regulations, including those applicable under MPCA permitting requirements. Mine water is defined in Table 11-1. A conceptual overview of the mine water management system is shown on Figure 11-5. Additional details on water management during different periods of the operations phase are provided on Figure 11-9 and Figure 11-10. Components of the mine water management system at the end of Mine Years 1, 2, and 11 are shown on Figure 11-11, Figure 11-12, and Figure 11-13, respectively.

The Project will capture mine water with a series of ditches, dikes, and stockpile foundation liners, along with the Category 1 Stockpile Groundwater Containment System, to keep this water separate from stormwater. PolyMet will manage the captured mine water through a system of sumps and ponds, and piping systems to convey the water to the Equalization Basin Area for further conveyance by the MPP to the Plant Site. During the later years of the operation, drainage from the OSLA will be conveyed to the East Pit to aid in flooding rather than conveyance to the Plant Site.

PolyMet designed this water management system to route mine water by gravity flow to mine water sumps or ponds that are designed to contain water generated by design storm events occurring within the various drainage areas. The design storm event used for each type of infrastructure and the type of liner used for the sumps and ponds are based on the expected water quality and overflow potential for the infrastructure. This design allows matching the level of protection applied to each sump and pond to the expected water quality handled. Mine water ponds and sumps are lined with a double liner, single liner, or are not lined, depending on the expected quality of the water to be collected. Appendix 8 includes the Mechanical Infrastructure Permit Application Support Drawings, which provides details on the design criteria of the mine water sumps, ponds, and pipes (Drawing ME-004), as well as typical details of the single and double liner systems (Drawing ME-014). The following sections describe the design and operation of the major components of the mine water management system.

11.3.2.1 Pit Dewatering

PolyMet will dewater the mine pits during mining operations. Pit inflows will consist of groundwater, runoff from areas within the pits and direct precipitation. PolyMet will direct this water to sumps within the pits. The pit floors will be sloped toward the water collection sumps where it will be collected and pumped to the Equalization Basin Area for further conveyance by the MPP to the Plant Site..

PolyMet will adjust the size and location of the sumps, pumps, and pipes as the pits expand in size and depth, requiring periodic evaluation of the pumping system. PolyMet designed the mine pit pump capacities to remove within three days the water resulting from a peak annual snowmelt runoff event (approximately equivalent to the runoff volume expected during a 5-year, 24-hour storm event). In the event that a storm exceeds the sump and pump capacity, PolyMet will use the lowest level of the pit to store the excess water, with mining operations relocated to higher levels or delayed until water levels are pumped down. The Water Management Plan – Mine (Appendix 11.2) contains further discussion of pit dewatering in Section 2.1.3; estimated average annual and peak inflow rates, and pump and sump capacities are provided in Section 5.3 of the Consolidated Water Appropriation Permit Applications (Reference (5)).

11.3.2.2 Stockpile Drainage

PolyMet will store overburden, waste rock, and ore in stockpiles at the Mine Site. PolyMet will use engineered systems for stockpiles containing Category 1, 2, 3, and 4 waste rock, ore, and saturated mineral overburden to collect drainage. PolyMet will store the unsaturated mineral overburden and peat in stockpiles in the OSLA, or will use these materials for construction or reclamation.

The three temporary stockpiles (the Category 2/3 Waste Rock Stockpile, the Category 4 Waste Rock Stockpile, and the OSP) will be lined and will have engineered systems to collect drainage. The design of these temporary stockpiles is described in further detail in Section 10.4.6.2. These temporary stockpiles will be structurally sound, will have erosion controls, and will be designed in accordance with Minnesota Rules, part 6132.2200 and Minnesota Rules, part 6132.2400. PolyMet will use an engineered system for the stockpile liners comprised of, from the bottom up, a foundation; underdrain system with sumps, if needed for stockpile foundation stability; a composite liner consisting of compacted soil liner overlain by geomembrane; and an overliner drainage layer with double lined sumps and single lined overflow ponds. PolyMet will locate the overflow ponds adjacent to the sumps to provide storage for mine water that exceeds the sump design volumes. Each paired sump and pond will be surrounded by dikes and will have a combined capacity for the 100-year, 24-hour mine water yield plus a safety factor in the form of freeboard. PolyMet will pump the collected stockpile drainage to the Equalization Basin Area.

In areas where elevated groundwater is encountered at or near the liner grades in combination with potentially compressible foundation soils, PolyMet will construct foundation underdrain systems to alleviate excess pore water pressure that may subsequently develop in foundation soils as load is placed during stockpile development. If underdrains are needed, the water collected would flow by gravity to underdrain sumps, be transferred to the mine water sumps, and then be pumped to the Equalization Basin Area for further conveyance by the MPP to the Plant Site. Water collected in the stockpile underdrain sumps is expected to be the same as groundwater quality. If the underdrains are needed, resultant water quality will be monitored as part of the NPDES/SDS Permit monitoring program, and water quantity will be monitored as part of the Water Appropriation Permit monitoring program.

The Project will collect drainage from the Category 1 Waste Rock Stockpile through a groundwater containment system, and then convey the collected water to the Equalization Basin Area for further conveyance by the MPP to the Plant Site. PolyMet will develop the groundwater containment system in lieu of a liner system under the stockpile. This groundwater containment system has been designed in accordance with Minnesota Rules, part 6132.2200, and Minnesota Rules, part 6132.2400. Section 10.4.5.3 includes further information on design of the Category 1 Stockpile Groundwater Containment System.

11.3.2.3 Mine Water Ponds for Other Infrastructure

Mine water ponds will provide storage for gravity flow of mine water during heavy precipitation or short power outages. In addition to the temporary stockpile sumps and overflow ponds, PolyMet will construct other mine water ponds at the Mine Site for the following features:

- a series of haul road ponds to collect mine water from the haul roads
- an RTH Pond to collect mine water from the RTH
- an OSLA Pond to collect mine water from the OSLA (the OSLA will contain unsaturated mineral overburden and peat)

The liner systems for these mine water ponds are designed based on the quality of the water that will report to the pond. The RTH Pond will be constructed with a double liner, haul road mine water ponds will be constructed with a single liner, and the OSLA Pond will be compacted but unlined. These design criteria and design volumes are listed on the Mine Site permit application support drawing ME-004 in Appendix 8. Typical details of these liner systems are shown on MW-014 in Appendix 8.

The design of the mine water ponds for the haul roads and RTH will be sufficient to contain runoff volumes from the 100-year, 24-hour storm, and the OSLA Pond is designed to handle the 25-year, 24-hour storm. The storm event used for the design was selected based on the quality of water that will report to the pond. Pond designs are included in Appendix 8, as follows: haul roads are shown on MW-010 through MW-013, RTH is shown on MW-009, and OSLA is shown on MW-008.

A pump and piping system will convey mine water from the haul road ponds and the RTH Pond to the Equalization Basin Area for further conveyance to the Plant Site. A pump and piping system will convey water from the OSLA Pond to the Construction Mine Water Basin for further conveyance by the Construction Mine Water Pumping Station to the FTB or to the East or Central Pits in later years of operations. Typical piping details are shown on MW-015 in Appendix 8.

The Water Management Plan – Mine (Appendix 11.2) contains more detailed information on these ponds and pump and piping systems in Sections 2.1.5 and 4.1.4 through 4.1.6. Water quality monitoring of the mine features, including internal waste stream monitoring of these ponds, is discussed in Section 14.3.1.4.

11.3.2.4 Equalization Basin Area and Mine to Plant Pipelines

PolyMet will combine mine water at the Equalization Basin Area into three different waste streams: construction mine water, mine water with low volume and relatively high concentrations of dissolved constituents, and mine water with high volume and relatively low concentrations of dissolved constituents. PolyMet will route mine water containing relatively high concentrations of dissolved constituents (drainage from the temporary Category 2/3 and Category 4 Waste Rock Stockpile liners and the temporary OSP liner) into the High Concentration Equalization Basin. PolyMet will route mine water containing relatively low concentrations of dissolved constituents (runoff from haul roads and the RTH, pit dewatering water, and Category 1 Waste Rock Stockpile drainage) into Low Concentration Equalization

Basin 1 and Low Concentration Equalization Basin 2. Construction mine water and runoff from the OSLA will be routed into the Construction Mine Water Basin.

Three pipelines will convey water between the Mine Site and the Plant Site. The Low Concentration Mine Water Pipeline will transport water from the Low Concentration Equalization Basins to membrane separation units at the WWTS. The High Concentration Mine Water Pipeline will transport water from the High Concentration Equalization Basin to the chemical precipitation treatment train at the WWTS. The Construction Mine Water Pipeline will transport water from the Construction Mine Water Basin to the FTB Pond (Figure 10-7) until about Mine Year 11; starting in about Mine Year 11, the Construction Mine Water Pipeline will be used to send treated water from the WWTS to the East Pit to aid in pit filling.

When treated water is needed during operations to manage water levels in the East Pit, operation of the Construction Mine Water Pipeline will be changed to direct treated water from the WWTS to the Mine Site. No construction mine water will need to be managed after Mine Year 11, because all construction of the mine features will be complete at that time. When East Pit backfill begins in Mine Year 11, runoff from the OSLA, which reports to the Construction Mine Water Basin prior to Mine Year 11, will be routed directly to the East Pit, making the Construction Mine Water Pipeline available to transport treated water from the WWTS to the Mine Site. The Construction Mine Water Pumping System and the Construction Mine Water Basin will be reclaimed, if no longer needed. East Pit water level management will need to start in Mine Year 12, after the Category 4 waste rock is disposed of in the pit. At that time, the Construction Mine Water Pipeline would be available to use for conveying water from the WWTS to the East Pit because no more construction mine water will be generated. The WWTS is discussed in more detail in Section 11.4.8.

11.3.3 Sewage Management and Infrastructure

The Mine Site will have portable sanitary facilities to manage sewage. Sewage collected from Mine Site portable sanitary facilities will be transported to the Plant Site for treatment by the Plant Site Sewage Treatment System (Section 11.4.2).

11.3.4 Stormwater Management and Infrastructure for Mine Site Operations

This Section 11.3.4 describes stormwater management at the Mine Site during operations (Section 11.1 discusses stormwater management during initial construction). These controls include design features and BMPs for the following types of stormwater:

- Industrial stormwater, which consists of stormwater associated with industrial activities (as defined in Minnesota Rules, part 7090.0080, subpart 6) and includes precipitation and runoff from the industrial areas at the Mine Site that is composed entirely of stormwater and not combined with other water types (such as the MSFMF).
- Construction stormwater during operations, which consists of stormwater associated with construction activities (as defined in Minnesota Rules, part 7090.0080, subpart 4) and includes

precipitation, runoff, and dewatering water from construction areas with the exception of dewatering water from saturated mineral overburden, which is managed as mine water.

- Non-contact stormwater, which consists of precipitation and runoff that contacts natural, stabilized, or reclaimed surfaces and has not been exposed to mining activities, construction activities, or industrial activities. This includes runoff from on-site features constructed of overburden (unsaturated mineral overburden or peat) once stabilized with permanent cover and the reclaimed Category 1 Waste Rock Stockpile.

The Project will separate stormwater from mine water through a system of ditches, dikes, and ponds. The Mine Site stormwater management infrastructure is shown on Figure 11-14.

PolyMet will manage stormwater to meet water quality standards either without treatment when possible, or if necessary, by removing total suspended solids (TSS) either through settling or through the use of flocculants, in on-site sedimentation ponds. PolyMet will control stormwater in and around the Mine Site in a manner that reduces potential impacts to mining activities, protects the environment, and maintains existing flow patterns off-site to the extent practicable.

Industrial stormwater will be managed through appropriate BMPs, including engineered controls and spill prevention and response procedures, to reduce or eliminate contact or exposure of pollutants to stormwater or to remove pollutants from stormwater. Prior to the start of operations, PolyMet will develop and implement an Industrial SWPPP in accordance with Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

As described in the following sections, PolyMet will control stormwater flowing on and off the Mine Site along natural watershed divides using a series of dikes and ditches constructed around the perimeter of the Mine Site, along the pit rims, and around the interior of the Mine Site. Sedimentation ponds along the perimeter of the Mine Site will allow for settling to reduce TSS from stormwater before it is discharged off-site. Receiving waterbodies for Mine Site stormwater include the Partridge River and its tributaries.

PolyMet will design the Mine Site stormwater management systems to direct stormwater from up to the 100-year, 24-hour storm event away from mine water areas. The Project will base the overall system capacity on the Mine Site configuration, and will install specific system controls when needed during the LOM.

11.3.4.1 Perimeter and Exclusion Dikes

The Project will place perimeter dikes at strategic locations around the perimeter of the Mine Site and around the pit rims. PolyMet will construct perimeter dikes of silty sand or glacial material excavated during construction of ditches and removal of overburden. The dikes and ditches near the perimeter of the Mine Site will minimize the amount of surface water flowing on to the Mine Site, minimize Project impacts to wetlands outside the perimeter of the Mine Site, eliminate mine water flowing uncontrolled off the Mine Site, and manage the rate and location of stormwater flowing off the Mine Site.

PolyMet will construct ditches along the interior of most of the perimeter dike system to convey stormwater adjacent to the dikes, prevent surface runoff from entering the mine pits, intercept stormwater prior to reaching mine water areas, and prevent water from pooling in areas where the dikes cut across low areas. The existing ground along some of the site perimeter is already relatively high, which will allow a ditch to capture the surface runoff without a dike. PolyMet will direct stormwater captured by the ditches to sedimentation ponds and then route the captured stormwater into a natural drainage system off the Mine Site.

PolyMet will construct exclusion dikes in areas where surface water might otherwise drain into the mine pits. The exclusion dikes will be temporary in nature, in place only as long as the rim of the mine pit is at a specific location. Reconstruction of the dikes will be necessary as the mine pit expands. PolyMet will construct dikes by pushing up a ridge of soil where needed around the rims of the pits during overburden stripping operations. The purpose of the exclusion dikes is to intercept and direct surface runoff, not to impede groundwater flow.

11.3.4.2 Stormwater Ditches

The Project will use stormwater ditches throughout the interior of the Mine Site to route stormwater away from areas of mining activity. The stormwater ditches will decrease the amount of mine water created on the Mine Site by conveying stormwater separately, which will help minimize the overall impacts on the Partridge River.

Interior ditches will convey collected stormwater to perimeter ditches and sedimentation ponds prior to controlled discharge. The layout of the proposed stormwater system will follow the existing drainage patterns at the Mine Site to the extent practical while meeting the objectives of the system.

11.3.4.3 Sedimentation Ponds and Outlets

The Project will use sedimentation ponds around the perimeter of the Mine Site to reduce TSS and to control stormwater discharge. Based on preliminary design, PolyMet proposes to construct up to five stormwater sedimentation ponds (Figure 11-14); the final number and configuration of stormwater ponds will be determined in final design, which will take into account construction stormwater needs and NPDES/SDS Permit requirements. PolyMet selected the proposed pond locations to match existing flow paths to the extent practical and to minimize the overall hydrologic impacts to the Partridge River.

- Pond A will be located at the northeastern corner of the Category 1 Waste Rock Stockpile and will direct stormwater off site from the northern and western sides of the stockpile.
- Pond B will be located between the East Pit and northern border of the property.
- Pond C (West) is an interior stormwater pond located west of the West Pit and will be designed to provide additional flood storage upstream of Pond C (East).
- Pond C (East) will be located west of the OSLA.

- Pond D will be located west of the Category 2/3 Waste Rock Stockpile and east of the OSP, on the northern side of Dunka Road.

PolyMet will construct Ponds A, B, C (East), and D during the construction phase, and will construct the Pond C (West) during the development of the West Pit (Figure 11-14). The pond design will reduce sediment in runoff from storms up to the 100-year, 24-hour storm event, and will achieve the industrial stormwater TSS benchmark value of 100 milligrams per liter (mg/L). PolyMet will inspect the sedimentation ponds annually to determine the sediment depth within the pond, and will dredge the ponds if sediment accumulation reduces the available volume to below the required design storage capacity.

PolyMet will evaluate and design primary outlets and emergency outlets for each of the exterior stormwater sedimentation ponds on a site-specific basis. PolyMet will design primary outlets to provide flood attenuation capacity, and will design the emergency outlets to pass flows larger than the design values used to size the pond. Stormwater sedimentation Ponds A and B will have their outlets fitted with controls to temporarily shut off discharge to or from the Mine Site during flooding conditions in the Partridge River.

The Mine Site Stormwater Permit Application Support Drawings are included in Appendix 5, which provides a permit level design of the Mine Site stormwater system. The Water Management Plan – Mine (Appendix 11.2) contains more detailed information regarding sedimentation ponds and outlets in Section 2.2.4.

11.4 Plant Site Water Management and Infrastructure

This Section 11.4 focuses on water management associated with the Plant Site, which includes the Tailings Basin, during operations. The following sections describe the existing site conditions and the planned water management systems related to sewage treatment, potable water, stormwater, the Beneficiation Plant, the Tailings Basin, the Hydrometallurgical Plant, and the HRF.

11.4.1 Existing Conditions

The existing LTVSMC plant includes the Beneficiation Plant and other buildings, sewage treatment plant, the LTVSMC tailings basin, and the Emergency Basin (site of proposed HRF). The Beneficiation Plant, sewage treatment plant, other supporting infrastructure, and the southern portion of the LTVSMC tailings basin are located in the Second Creek watershed, a sub-watershed of the Partridge River watershed. Most of the LTVSMC tailings basin is located within the Embarrass River watershed. Additional detail on existing conditions at the Plant Site is presented in Section 11.4.2.1 on the sewage treatment infrastructure, Section 11.4.6.1 on the LTVSMC tailings basin water management and infrastructure, and Section 11.4.7.1 on the existing conditions within the footprint of the planned HRF.

11.4.2 Sewage Management and Infrastructure

This Section 11.4.2 describes the design and operation of the infrastructure that PolyMet will use to manage sewage at the Plant Site in accordance with applicable regulations. Project operations will generate sewage at various locations, including the Beneficiation Plant, Administration Building, Area 1 Shops, and Area 2 Shops. Sewage generated at the Mine Site will also be transported to the Plant Site for treatment and disposal. The Plant Site Sewage Treatment System is shown on Figure 11-15.

PolyMet will upgrade and refurbish the existing sewage collection system and construct new stabilization ponds to replace the former LTVSMC sewage treatment plant. At the Area 1 and Area 2 Shops, PolyMet will evaluate and upgrade, if necessary, the existing septic systems. The septic tanks at the Area 1 and Area 2 Shops will be subject to a St. Louis County Subsurface Sewage Treatment System Permit, and are not discussed further in this Application.

11.4.2.1 Existing Sewage Treatment Infrastructure

The LTVSMC taconite processing facility used an on-site sewage treatment system to treat domestic wastes generated from restrooms, shower facilities, and a lunchroom area, as well as waste water from the Heating Plant and the Potable Water Treatment Sytem. The LTVSMC sewage treatment system consisted of two parts: a collection system and a mechanical sewage treatment plant. As originally designed, this sewage treatment system discharged treated effluent into a ditch that flowed to Second Creek. A pump station was later added to re-route the treated effluent to the northeast into the Emergency Basin. The existing sewage collection system consists primarily of original (1955) equipment, including sanitary sewer piping and manholes extending throughout the process plant area.

After the LTVSMC facility ceased taconite operations, Cliffs Erie decommissioned the mechanical sewage treatment plant. Sewage generated by the few employees at the Administration Building is currently routed to a septic system that was constructed in 2001.

11.4.2.2 Planned Sewage Treatment System

The Sewage Treatment System will transport sewage to the new stabilization ponds. PolyMet will refurbish the existing sewage collection system to meet current design standards. Existing piping will be repaired to minimize losses from and infiltration and inflow (I/I) to the sewer system. PolyMet will add new piping and associated infrastructure to connect new Plant Site facilities to the sewer system. The Project also will discharge waste water from the Plant Site Potable Water Treatment System to the Sewage Treatment System.

11.4.2.3 Stabilization Ponds

PolyMet will construct stabilization ponds, to be located west of the proposed Hydrometallurgical Plant, to treat Project sewage. The pond design will comply with the *MPCA Recommended Pond Design Criteria* (Reference (51)) and will include lined ponds and a controlled discharge. Design and operation of the facility will be in accordance with a permit to be issued by the state. The proposed stabilization ponds will consist of two primary ponds and one secondary pond with operating depths of four feet. The secondary pond will discharge to the FTB Pond via an effluent pump station. The controlled discharge will occur in the spring and fall of each year. Each controlled discharge will typically last 10 to 14 days, depending on weather conditions. The preliminary design is shown on the drawings in Appendix 9.

11.4.3 Potable Water Treatment System

Potable water is needed to supply drinking water to serve the Plant Site, including the Area 1 Shops, Area 2 Shops, and the Administration Building. In addition to drinking water, the primary potable water use at the Plant Site will be restrooms and showers within the existing buildings. Raw water supplied to the Potable Water Treatment System will be obtained from Colby Lake, via the existing Colby Lake Pipeline which will be refurbished prior to operation. Before distribution, PolyMet will treat water from Colby Lake at the Potable Water Treatment Plant. The Potable Water Treatment System will meet requirements established by MDH and USEPA for a public, non-transient, non-community water supply system. Components of the Potable Water Treatment System are shown on Figure 11-16 and include clarification, flocculation, sedimentation, filtration, and disinfection. Distribution systems will be constructed or refurbished to comply with applicable plumbing codes.

11.4.4 Stormwater Management

This Section 11.4.4 describes stormwater management at the Plant Site (other than the Tailings Basin and Hydrometallurgical facilities) during operations. The following sections describe the existing site conditions and the stormwater management systems. Stormwater management at the Tailings Basin and Hydrometallurgical facilities is summarized in Sections 11.4.6 and 11.4.7, respectively.

11.4.4.1 Existing Stormwater Conditions

The Plant Site is located in two watersheds: the majority of the Tailings Basin is located in the Embarrass River watershed, and the Process Plant area is located in the Partridge River watershed (Figure 5-4) The Plant Site is split into two drainage areas (referred to as the East Plant and the West Plant) by a topographic divide running generally in the north-south direction. Figure 11-17 identifies the East and West Plant drainage areas.

The West Plant drainage area includes the majority of the existing buildings, including the Beneficiation Plant and other infrastructure in the Plant Site. Historically, LTVSMC operations either collected water generated within many buildings and combined it with roof drainage for use in the production process or discharged water within buildings through floor drains to the stormwater system. Since LTVSMC operations ceased, water from building floor drains and roof drains has been routed to the Emergency Basin. Stormwater from the West Plant drainage area is routed through a series of ditches, culverts, manholes, catch basins, ponds, and pipes to a large stormwater ditch in the southwest corner of the Plant Site before being discharged off-site through a culvert (West Plant discharge location on Figure 11-17).

The East Plant drainage area includes some existing buildings, but is more vegetated than the West Plant drainage area. Stormwater from the East Plant is routed through a series of ditches and culverts before being discharged off-site; there are currently two locations where stormwater leaves the East Plant via culverts (East Plant #1 and East Plant #2 discharge locations on Figure 11-17). There are no existing stormwater ponds in the East Plant drainage area.

Stormwater from the Area 1 Shops, Area 2 Shops, and ancillary areas mainly discharge as dispersed sheetflow; however, there are some ditches and culverts associated with these areas.

11.4.4.2 Plant Site Stormwater

PolyMet will improve, repair, and replace the stormwater infrastructure at the Plant Site because most of the existing stormwater infrastructure, including the Beneficiation Plant's stormwater facilities, have been filled or partially filled with sediment or otherwise are in poor condition.

Additionally, with the planned changes to Project drainage patterns and routing of roof drains to stormwater, much of the existing stormwater infrastructure at the Plant Site is undersized and would not be able to handle the additional stormwater flow. PolyMet will inspect and cleanout the existing infrastructure that potentially will be reused. PolyMet expects that the majority of the infrastructure will likely be removed and replaced, and many existing ditches, if used, will need to be excavated deeper and/or wider than they currently are to restore or increase capacity. PolyMet will design the stormwater infrastructure for the Plant Site based on the 10-year, 24-hour storm event, with consideration and evaluation of depth of flooding so as not to enter buildings or overtop railroad tracks up to the 100-year, 24-hour storm.

Stormwater improvements in the East Plant drainage area will consist primarily of reinstalling site drainage features through repair or removal and replacement, as necessary, and re-sizing stormwater infrastructure where required as a result of added roof drainage, details of which are provided in the permit application support drawings in Appendix 10. Site drainage features include culverts, pipes, manholes, and riprap spillways. The East Plant has no existing stormwater ponds, and PolyMet anticipates no future need for such ponds because stormwater will be managed through vegetated surfaces that will naturally treat for TSS. The East Plant currently has two culverts discharging stormwater via ditches tributary to Second Creek, and both of these locations will be maintained as stormwater outfalls.

Stormwater improvements in the West Plant drainage area will include reinstalling site drainage features and re-sizing stormwater infrastructure where necessary, and constructing stormwater ponds. Site drainage features include culverts, pipes, manholes and weirs. Once the HRF construction begins, PolyMet will install a pipe through the railroad embankment to direct drainage from the HRF sub-drainage area to the south, where it will be collected and managed with the West Plant industrial stormwater.

As shown on Figure 11-18, PolyMet will construct three new stormwater ponds (the North, Central, and Southwest Ponds) in the West Plant drainage area. Once construction commences on the HRF, stormwater drainage around that facility will also be managed through ditches and culverts. The Project will generally maintain existing drainage patterns, routing stormwater from the West Plant drainage area in a generally north-to-south direction, through the ponds and improved and repaired ditches, culverts, manholes, catch basins, and pipes. Stormwater from the North Pond and Central Pond will be routed to the Southwest Pond, the largest and the last pond that stormwater from the West Plant will flow through before flowing off-site. The Southwest Pond will be located in the southwestern corner of the Plant Site where there currently is a long, wide ditch. PolyMet will install a series of weirs or ditch blocks to create a pond in this location, and this ditch may be widened to the west if additional capacity is necessary. Water from the Southwest Pond will flow off-site to the south through an existing culvert under the railroad grade. This culvert discharges to a system of ditches tributary to Second Creek.

The construction of the HRF and FTB dams result in a minor change of the watershed divide between the Embarrass River and Partridge River watersheds as shown before construction on Figure 11-6 and after construction on Figure 11-16. The watershed divide currently follows the raised railroad embankment between Process Plant area and the Tailings Basin. The area directly north of the divide currently drains to the Emergency Basin. Construction of the elevated HRF in the Emergency Basin and the FTB dams will change this drainage. The area between the FTB and HRF, labeled as West Plant HRF – Subdrainage Area on Figure 11-16, will be routed south through a pipe under the railroad to the North Pond. The area south of the HRF, labeled as West Plant HRF – Subdrainage Area, will be routed through a series of ditches and pipes to the West Plant drainage area. The watershed divide follows the FTB dam to the east of the Process Plant area. Runoff from the central portion of the FTB South Dam exterior will infiltrate into the FTB south buttress, and then be collected by the FTB South Seepage Management System and managed with tailings basin seepage. Runoff from the easternmost portion of the FTB South Dam exterior will flow south within the Second Creek watershed.

Some of the existing building floor drains in the Beneficiation Plant currently discharge to the stormwater system. The state of Minnesota's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (Permit No. MNR050000; herein referred to as the Industrial Stormwater General Permit) does not allow floor drains from process areas to be discharged as industrial stormwater. Therefore, PolyMet will permanently seal any existing floor drains that are currently routed to the stormwater system or emergency basin, and will route this water to the Plant Site overflow collection system to be reused in the process or pumped to the FTB.

11.4.5 Beneficiation Plant

The largest user of water at the Plant Site is the Beneficiation Plant. PolyMet will use an annual average of approximately 13,800 gpm of process water in the Beneficiation Plant. PolyMet will recirculate water between the Beneficiation Plant and the FTB Pond, as described in the following section. PolyMet will pipe most of this water (99%) with the tailings to the FTB; less than 1% will be lost to evaporation or included with the concentrate.

The FTB Pond will supply most of the process water for the Beneficiation Plant. Other minor sources of process water will include water in the raw ore, reagents, gland seals of slurry pumps, and other processes. PolyMet will draw make-up water, as needed, from the Plant Reservoir, which will secure raw water pumped from Colby Lake under a DNR Water Appropriation Permit. Make-up water demand will vary depending on factors such as precipitation and Project operations. The Beneficiation Plant average annual demand for make-up water from Colby Lake will be about 560 gpm and will vary from about 20 gpm to about 1,750 gpm depending on the Mine Year.

Section 11.4.6 provides additional information regarding the relationship between the Beneficiation Plant and FTB with respect to water management.

11.4.6 Tailings Basin Water Management and Infrastructure

This Section 11.4.6 focuses on water management at the Tailings Basin during operations. The following sections describe the existing site conditions; the systems for managing Flotation Tailings and associated water at the FTB; and the stormwater management systems associated with the Tailings Basin.

11.4.6.1 Existing Conditions

The history and development of the existing LTVSMC tailings basin is described in Section 10.2.1.2. LTVSMC discontinued the tailings basin operations in January 2001 and the facility has been inactive since that time. The exception to this is Cliffs Erie's ongoing reclamation and remediation activities pursuant to its DNR-approved Closure Plan and MPCA-supervised Consent Decree. Cell 2W does not impound water on a regular basis, although it may hold water in a small pond in the spring and during other wet periods. Ponds of water remain in Cells 1E and 2E.

Seepage

LTVSMC managed surface seepage from the toes of the tailings basin dams through a system of ditches, pumps, and pipelines that captured seepage water and returned it to the pond. When LTVSMC shut down in 2001 and discontinued tailings deposition to the cells, the toe-of-slope seepage flow reduced. Many of the seeps are no longer flowing, and the LTVSMC pumps are no longer active. Additional details about the surface seepage, including measured flows, are provided in Section 1.4.3 of Appendix 11.3.

Currently, most tailings basin seepage enters the groundwater below the basin (groundwater seepage), and some emerges at surface seeps (surface seepage). Groundwater seepage currently follows the northwesterly gradient in the surficial aquifer and discharges to wetlands located north and west of the tailings basin. Surface seepage from seeps that remain active is collected and pumped back to the LTVSMC tailings basin through pumpback systems that were installed in 2011, under terms of the Consent Decree between MPCA and Cliffs Erie. Activities related to ongoing remediation for former operations are outside the scope of this Application.

Surface Water

The majority of the existing LTVSMC tailings basin is located in the Embarrass River watershed, upstream of the Embarrass River chain of lakes. A small portion of the existing tailings basin is located in the Second Creek watershed, a sub-watershed of the Partridge River watershed. Before Cliffs Erie installed the seepage collection system at SD026, tailings basin seepage was a major contributor to the headwaters of Second Creek.

The Project could potentially affect the following tributaries (east to west) to the Embarrass River located between the Tailings Basin and the Embarrass River: Unnamed (Mud Lake) Creek, Trimble Creek, and Unnamed Creek (see Section 5.2 and Figure 5-6 for additional details on water courses and hydrology at the Plant Site). The Project is not expected to affect other tributaries located between the Tailings Basin and the Embarrass River, which include (east to west) Spring Mine Creek, an unnamed creek, and Heikkilla Creek.

PolyMet and Cliffs Erie have monitored several locations within the Embarrass River watershed and the Second Creek watershed for surface water quality and quantity since 2004. PolyMet's NPDES/SDS Permit Application provides surface water quality results through 2015.

Groundwater

Information on the geology of the surficial deposits and bedrock at the Plant Site is provided in Section 5.1.1 and 5.1.2, respectively. Information on groundwater flow and hydrogeology is provided in Section 5.4.2.

PolyMet continues to carry out baseline monitoring of groundwater quality and elevation at the existing tailings basin via a network of monitoring wells completed into the unconsolidated surficial aquifer. PolyMet's NPDES/SDS Permit Application provides groundwater quality results through 2015.

11.4.6.2 Flotation Tailings and Associated Water Management

This Section 11.4.6.2 describes the design and operation of the infrastructure that will be used to manage Flotation Tailings and water at the Tailings Basin in accordance with applicable regulations. The Tailings Basin and associated water management infrastructure are shown on Figure 11-19. The FTB Pond will be the primary collection and distribution point for water used in the beneficiation process. The FTB Pond will receive process water from the Beneficiation Plant, treated mine water from the WWTS, precipitation, and tailings basin seepage collected by the FTB seepage capture systems, along with other minor sources. PolyMet will recycle water from the FTB Pond back to the Beneficiation Plant for uses as process water.

PolyMet designed the FTB as a closed system: during operations, no water from the FTB will be released through overflow or outlet structures (except in the event of a storm event greater than the PMP event, as described below), and tailings basin seepage will be collected to the extent practical by the FTB seepage capture systems. The Water Management Plan – Plant (Appendix 11.3) and the Flotation Tailings Management Plan (Appendix 11.5) contain more information on tailings basin water management.

Flotation Tailings Basin

PolyMet designed the FTB to contain Flotation Tailings generated over 20 years of operation. The pond design has sufficient freeboard and emergency overflow infrastructure to safely accommodate the 72-hour PMP rainfall event based on Hydrometeorological Report 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, and Hydrometeorological Report 52, Application of Probable Maximum Precipitation Estimates – United States East of the 105th Meridian (Reference (52) and Reference (53)). The design of the FTB based on the PMP rainfall event is discussed in more detail in Section 10.2.3.3 and in Sections 2.2.3 and 2.5 of Appendix 11.5. The PMP, which is defined as "the theoretically greatest depth of precipitation for a given duration over a particular drainage area…" is quantified by the Office of Hydrology of the National Oceanic and Atmospheric Administration. PMP rainfall events are rare, and such an event has a low likelihood of being experienced during the life of the basin. The PMP does not have an assigned return period, but has been estimated to range from 100,000 to 1 billion years (Reference (46)). On this basis, there is a low likelihood of overflow (rainfall would have to exceed 35-inch rainfall in 72 hours); however, it is standard practice in dam design to accommodate even low probability overflows in a manner that protects the integrity of the dams, and therefore an emergency overflow is included in the dam design.

PolyMet will use three basic management techniques to minimize water quality impacts from the Flotation Tailings. First, it will process the ore using a bulk flotation process to minimize the amount of sulfide minerals in tailings reporting to the FTB. Second, it will deposit the Flotation Tailings in a manner that will minimize segregation of coarse and fine tailings, resulting in a bulk material, as evaluated in lab-scale experiments in Saint Anthony Falls Laboratory (SAFL; Attachment A of Appendix 11.5); residual water saturation is greater in bulk tailing than for coarse tailings alone, which limits infiltration of oxygen and resulting oxidation. Third, the FTB design includes other features to minimize oxidation of the tailings, because oxidation increases release rates from the tailings. Section 10.2.2 contains additional information on the characteristics of the Flotation Tailings, and Section 14.2.5 describes the monitoring associated with tailings deposition.

PolyMet will manage inflows to the FTB Pond to keep the water level as high as possible without exceeding dam safety criteria. Setting the pond level as high as safely possible will minimize environmental impacts: smaller beaches minimize fugitive dust generation and reduce the potential for oxidation of exposed Flotation Tailings. The Flotation Tailings Management Plan (Appendix 11.5) contains additional information on the FTB pond management and dam safety criteria, which include beach length and freeboard. In addition, Appendix 6 includes FTB permit application support drawings.

The Project will not discharge water from the FTB Pond during operations. PolyMet has designed the FTB to prevent surface overflow, and the FTB seepage capture systems will capture tailings basin seepage and either return it to the FTB Pond or route it to the WWTS for treatment prior to discharge as stream augmentation. PolyMet will manage the water level in the FTB Pond to maintain adequate freeboard by adjusting the relative amount of water routed back to the pond and sent to the WWTS. As noted previously there will be an emergency overflow system, based on industry standard practices, for protection of dam integrity in the rare event that freeboard within the FTB is not sufficient to contain all stormwater from a PMP rainfall event. PolyMet will implement a geotechnical and dam safety monitoring program to support long-term performance of the FTB under the terms of its DNR Dam Safety Permit.

Flotation Tailings Transport and Deposition

PolyMet will pump Flotation Tailings from the Beneficiation Plant to the FTB in slurry form through a system of pumps and pipes. For approximately the first seven years of operation, PolyMet will spigot the Flotation Tailings into Cell 2E. PolyMet will integrate the design of the tailings transport and deposition system with FTB dam design to define spigot locations and system head; the pumping capacity required to account for tailings transport design, including considerations of pipeline type, diameter, length, elevation change along pipeline route, and desired minimum and maximum flow velocities. The Tailings Transport and Return Water Pipelines are shown onFigure 11-19, and a conceptual overview of the process water management system is shown on Figure 11-5.

The Project will use movable pipelines to place tailings in the FTB. PolyMet will configure its system to spigot Flotation Tailings by gravity flow over beaches or subaqueously in the FTB Pond. Roughly, 30% of the tailings will be discharged on the beaches and 70% will be discharged subaqueously in the FTB Pond. Subaqueous deposition will spread slurry across the bottom of the FTB Pond without mixing with the pond water, and will minimize particle size segregation during deposition.

The return water system will recycle tailings basin water from the FTB Pond for use in the Beneficiation Plant. As the dams are raised in the FTB, PolyMet will move the Return Water Pipeline to maintain the pipeline at or near the surface of the dam. Section 2.3 of Appendix 11.5 contains additional information on the Flotation Tailings transport and deposition systems.

11.4.6.3 FTB Seepage Containment System and FTB South Seepage Management System

Seepage from the Tailings Basin will be collected by the FTB seepage capture systems, which include both the FTB Seepage Containment System and FTB South Seepage Management System. The FTB seepage capture systems are integral to the design and operation of the FTB, and are described in Section 10.2.3.4. Collected seepage either will be returned to the FTB Pond for reuse at the Beneficiation Plant or pumped to the WWTS for treatment and then discharged from permitted locations. The locations of the FTB seepage capture systems are shown on Figure 11-19.

The FTB Seepage Containment System along the northern and western sides of the Tailings Basin will be operational in Mine Year 1 before PolyMet places its first Flotation Tailings in the FTB. The segment along the eastern side of the Tailings Basin will be constructed before Cells 2E and 1E merge, which is anticipated in Mine Year 7. PolyMet does not anticipate tailings basin seepage along the eastern side of the Tailings Basin before that time.

11.4.6.4 FTB Stormwater Management and Infrastructure

Stormwater management at the FTB during Plant Site operations will include design features and BMPs for industrial stormwater, which includes precipitation and runoff from the Tailings Basin dam exterior slopes, where not captured by the seepage capture systems. The majority of the stormwater runoff from these areas will initially be construction stormwater as the dams are constructed. Once constructed, runoff will become industrial stormwater, and eventually, as these areas are reclaimed, runoff will be non-contact stormwater.

The only area associated with the FTB that will generate runoff to be managed as industrial stormwater will be the exterior slopes of the South Dam. Stormwater runoff from other portions of the Tailings Basin dam exterior slopes and the access road associated with the FTB Seepage Containment System will be captured by the FTB Seepage Containment System and routed to either the FTB or the WWTS. PolyMet will incorporate management measures for runoff from these areas, including engineered controls and BMPs as necessary, into its Plant Site Industrial SWPPP. The drainage swale that will transport non-contact stormwater to augment Unnamed (Mud Lake) Creek is discussed in Section 11.4.8 in connection with stream augmentation.

Industrial stormwater will be managed through appropriate BMPs, including engineered controls and spill prevention and response procedures, to reduce or eliminate contact of pollutants to stormwater or to remove pollutants from stormwater. Prior to the start of operations, as required by the Project's Individual NPDES/SDS Permit, PolyMet will develop and implement an Industrial SWPPP in accordance with the Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

11.4.7 Hydrometallurgical Plant and HRF Water Management and Infrastructure

This Section 11.4.7 focuses on water management associated with the Hydrometallurgical Plant and HRF during operations. The Hydrometallurgical Plant and HRF are a closed-loop system, where water is only lost to evaporation from the cell surface and entrapment within the Residue's pore space. PolyMet plans to construct the Hydrometallurgical Plant and HRF several years after mining starts. The timing for construction will depend on customer requirements and overall Project economics.

The HRF design includes structures and systems for managing water to prevent discharge from the facility. The HRF will retain precipitation, and has a double liner system to prevent leakage. Water management will include collection and management of process water and HRF water within the facility. PolyMet will monitor the water quality and quantity from the FTB Seepage Containment System, which is located downgradient of the HRF, to confirm the performance of the HRF double liner system.

11.4.7.1 Existing Conditions

PolyMet will construct the HRF on top of the former LTVSMC Emergency Basin, which is near the southwestern corner of the existing tailings basin. Figure 11-19 shows the location of the proposed HRF. Similar to the Tailings Basin, the majority of the HRF will be in the Embarrass River watershed and a small portion will be in the Second Creek subwatershed. The Emergency Basin was designed to contain taconite tailings from the main LTVSMC tailings thickeners in the event of a power failure. Historical, accidental overflows, spillage, and floor drainage from the LTVSMC concentrator also reached the Emergency Basin.

The Emergency Basin drains to the northwest, between LTVSMC tailings basin Cell 2W and the railroad grade along the western perimeter. Historically water only ponded in this area during periods of extended wet weather; the area currently has a relatively permanent pond as a result of activities associated with the Cliffs Erie Consent Decree. Since LTVSMC operations ended in 2001, there has been little consolidation of materials in the Emergency Basin, which will serve as the foundation for portions of the HRF. The absence of consolidation is due to the hydraulic placement of the material and hydrostatic pressures resulting from previously impounded water in the Emergency Basin. Before commencing HRF construction, PolyMet will compress the existing materials in the Emergency Basin by placement of a preload fill. The Emergency Basin and its history are further described in Section 3.0 of Geotechnical Data Package – Volume 2: HRF (Appendix 16.16). Appendix 7 provides the HRF permit application support drawings, which are further described in Section 10.3.3.

11.4.7.2 Hydrometallurgical Plant

The Hydrometallurgical Plant will require up to an annual average of approximately 410 gpm of process water. Of this amount, approximately 180 gpm is lost to evaporation, out vents, with the product, or chemically consumed. Approximately 220 gpm, will be piped with the Residue to the HRF. Figure 11-18 shows the Plant Site and the location of the HRF.

The process water sources will include recycled water from the HRF Pond (approximately 170 gpm) and make-up water from the Plant Reservoir that will be supplied with raw water pumped from Colby Lake. Make-up water demand will vary slightly, depending on factors such as precipitation and Project operations; however, the demand for make-up water from Colby Lake will be relatively constant at 240 gpm, with other inflows (gland seal water, water in the concentrate, and water in the reagents) contributing approximately 60 gpm to the Hydrometallurgical Plant. These other inflows are not shown on Figure 11-1 because the water is consumed in processing and does not affect the water balance between the Hydrometallurgical Plant and the HRF, nor what is drawn from the Plant Reservoir.

11.4.7.3 HRF and Associated Water Management and Infrastructure

This Section 11.4.7.3 describes the design and operation of the infrastructure that will be used to manage the Residue and associated water at the HRF in accordance with applicable regulations.

Residue Transport and Deposition

PolyMet will pump Residue from the Hydrometallurgical Plant as slurry to the HRF, where it will settle out and be permanently contained. The HRF will function as a large-scale sedimentation basin. PolyMet will pump the slurry into the HRF through a high-density polyethylene pipe with multiple discharge ports. PolyMet will maintain a pond within the HRF such that the solid fraction of the slurry will settle out, while the majority of the liquid fraction will be recovered by the return water system and pumped back to the Hydrometallurgical Plant for reuse. The amount of water recovered after residue settling will be dependent on a variety of factors, such as the percent solids in the residue transport system, the void space in the deposited residue, and the amount of precipitation received in the HRF. The levels of both the solids and liquid within the cell will increase incrementally over time. Each discharge port will have a valve to control the solids deposition in the HRF, and connections to change the discharge configuration as the water and Residue levels rise in the cell.

The return water system will consist of a floating pump system coupled to an adjustable pipe that can be shortened as the water level rises in the pond. PolyMet will automate the system to balance water return from the HRF with the water demand at the Hydrometallurgical Plant. PolyMet will accommodate a fluctuation in demand by temporary water level changes in the HRF and in the process water tank at the Hydrometallurgical Plant. PolyMet also will manage the water level in the HRF to facilitate Residue deposition at the desired locations within the HRF and to achieve the desired water clarity for process water at the Hydrometallurgical Plant.

Hydrometallurgical Residue Facility

PolyMet designed the HRF as a closed-loop system with the capacity to permanently contain Residue that is generated during approximately 18 years of operation. It is considered a closed-loop system because water from the HRF is kept separate from other water on the Project; there is no discharge of water from the HRF during operations, and the only make-up water is from Colby Lake. To comply with Dam Safety permitting requirements, the facility will be operated to maintain six feet of freeboard.

PolyMet will construct HRF dams using downstream construction methods: the interior segments of the dam will be constructed first, then the dam will be raised upward and outward from the cell perimeter as additional capacity is needed. Southeastern and southwestern segments of the HRF dam will abut existing high ground. The northern HRF dam will abut Tailings Basin Cell 2W. PolyMet will construct dams using soil borrow and possibly quarried rock. PolyMet may also use LTVSMC coarse tailings to supplement the other borrow sources. PolyMet designed the HRF to meet all required factors of safety, and it will construct and operate the dams in accordance with Minnesota state dam safety regulations.

In addition to Residue from the Hydrometallurgical Plant, PolyMet may also place in the HRF gypsum from the Waste Water Treatment System and coal combustion residuals (coal ash) from an existing legacy Coal Ash Landfill near the Tailings Basin. These additional materials, if placed in the HRF, would represent up to approximately 5% to 6% of the solids stored in the HRF.

The HRF Pond will receive water from three sources: process water with the Residue slurry from the Hydrometallurgical Plant; stormwater run-on and direct precipitation; and water collected by the HRF Leakage Collection System. PolyMet will pump decanted water from the HRF Pond back to the Hydrometallurgical Plant for reuse in the process. The Residue Management Plan (Appendix 11.6) further describes operation of the facility.

Double Liner and Leakage Collection System

The HRF will include a double liner and a Leakage Collection System. Leakage is water that penetrates the upper layer of the liner system. The liner and Leakage Collection System incorporate two barrier layers separated by a leakage collection layer. The double liner and leakage collection system is designed to be virtually leak-free, as described below.

- Upper liner – The upper geomembrane liner will serve as the primary barrier to leakage from the HRF. PolyMet designed its thickness for durability and to resist ice impacts in the event of a temporary shutdown of the hydrometallurgical process in winter months. The upper liner will be subject to hydraulic head equal to the water level in the HRF.
- Leakage collection layer – The leakage collection layer will collect water that passes through the upper liner. The system will direct collected leakage to a sump and then pump it back to the HRF Pond. Together, the leakage collection layer and the associated sump, pumps, and piping comprise the Leakage Collection System. The Leakage Collection System is designed to keep the hydraulic head on the lower liner system very low.

- Lower liner – The lower composite liner provides a virtually leak free barrier to prevent water passing through the upper liner from leaving the HRF. This performance is achieved because the hydraulic head on the lower liner will be so low (less than 1foot) that there will not be enough force to drive leakage through the lower liner system. Leakage through the upper liner will be retained above the lower liner and collected by the Leakage Collection System. Leakage Collection System design computations are provided in Attachment E to Geotechnical Data Package (Reference (49)). The computations:
    - predict the amount of leakage that could occur through the upper liner component of the HRF liner system
    - provide transmissivity requirements for the geocomposite component of the leakage detection layer of the HRF liner system to accommodate continuous collection and removal of leakage, if it occurs

The HRF will also have a Drainage Collection System, which PolyMet will install during HRF construction, but will not activate until after closure. Drainage, in this context, is water that flows through the Residue and is captured above the upper layer of the liner system. The Drainage Collection System will be used during reclamation to aid in dewatering after Residue and water discharge into the HRF has ceased.

11.4.7.4 HRF Stormwater Management and Infrastructure

This Section 11.4.7.4 describes the management of stormwater at the HRF, including the design and operation of the infrastructure that will be used to manage stormwater in accordance with applicable regulations.

The Hydrometallurgical Plant and HRF will generate some industrial stormwater within the HRF as a result of precipitation or runoff from areas internal to the HRF. PolyMet will collect this water in the HRF Pond and then manage it as HRF water.

The tributary area reporting to the HRF is relatively small. It is limited by the system of HRF dams and by the high ground areas to the west and south. Potential surface water run-on into the HRF Pond will be limited to parts of the South Dam of Tailings Basin Cell 2W, the railroad embankment (Hinsdale Bridge Approach), and portions of the land area located to the northeast of the cell. PolyMet will install diversion swales in these areas to redirect surface water away from the HRF Pond, generally in a southerly direction and around the perimeter of the HRF to the northwest. During initial phases of the HRF development, a land-locked area may be created immediately east of the cell. PolyMet may allow surface water runoff in this area to discharge into the HRF Pond until elevations accommodate development of a surface water pond that will divert runoff from this area away from the HRF Pond through the railroad embankment to the Plant Site. Once directed south, PolyMet will manage runoff from the eastern exterior slopes of the HRF with Plant Site industrial stormwater, which is described above in Section 11.4.4.2.

PolyMet will manage industrial stormwater at the HRF through appropriate BMPs, including engineering controls and spill response procedures, to reduce or eliminate contact or exposure of pollutants to stormwater or to remove pollutants from stormwater. PolyMet will include these management measures in the Industrial SWPPP for the Plant Site, as required by the Project's Individual NPDES/SDS Permit.

11.4.8 Waste Water Treatment System and Stream Augmentation

PolyMet will construct a new WWTS, which will be located south of the Tailings Basin as shown on Figure 11-15. In accordance with Minnesota Rules, part 6132.0200, PolyMet has designed the WWTS "to control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization."

PolyMet based the preliminary WWTS design on both the expected influent quantity and quality and on the desired effluent quantity and quality. High concentration mine water will report to chemical precipitation treatment units at the WWTS, and low concentration mine water will report to membrane separation treatment units at the WWTS. Treated mine water from the membrane separation and chemical precipitation treatment units will be routed to the FTB Pond.

Tailings basin seepage will be treated in a separate treatment train, using a reverse osmosis unit or similar membrane separation technology designed to meet applicable effluent limitations and water quality standards. Tailings basin seepage will first report to a pre-treatment basin and greensand filtration unit to remove soluble iron. Primary membrane separation will remove metals and sulfate using a combination of reverse osmosis and nanofiltration membranes. Primary membrane permeate will be stabilized in a limestone contactor prior to discharge.

PolyMet will treat primary membrane concentrate in a secondary membrane system, with the secondary membrane concentrate reporting to the chemical precipitation units along with the high concentration mine water. Initially, solids removed during the chemical precipitation process will be dewatered and disposed off-site at a licensed and approved disposal facility. When the Autoclave begins operations, the solids from the WWTS will be routed to the Autoclave for metals recovery as described in Section 8.4.1.

Treated tailings basin seepage will be discharged to two tributaries of the Embarrass River (Unnamed Creek and Trimble Creek) and a tributary of the Partridge River (Second Creek). PolyMet will obtain an NPDES/SDS Permit from MPCA that will include relevant terms sufficient to meet the above criteria from the PTM Regulations.

Membrane separation is a mature technology that has been used for water treatment for over 40 years. Membrane separation is generally considered the best-proven, commercially available technology for removing dissolved, inorganic constituents. Along with distillation, it is a method for treating water with high concentrations of dissolved salts. A schematic illustration of the treatment trains to be constructed at the WWTS is presented in Figure 11-20. The design of the WWTS can be adapted as needed, based on results of influent and effluent water quality monitoring and monitoring internal to the process. Details on adaptive processes for the WWTS are included in the AWMP (Appendix 11.4). The details of the WWTS design are under review by the MPCA and included in the NPDES/SDS Permit Application.

WWTS discharge will augment flow in streams downgradient of the FTB seepage capture systems. This discharge strategy, referred to as stream augmentation, is designed to avoid hydrologic impacts to downgradient streams due to operation of the FTB seepage capture systems which will significantly reduce the amount of tailings basin seepage currently flowing to Unnamed Creek, Trimble Creek, Unnamed (Mud Lake) Creek, and Second Creek. PolyMet will augment flow to Unnamed Creek, Trimble Creek, and Second Creek with treated water from the WWTS, for as long as the FTB seepage capture system and WWTS operate, to offset potential hydrologic impacts to these creeks. PolyMet will augment flow to Unnamed (Mud Lake) Creek by constructing a drainage swale east of the tailings basin to re-route the non-contact stormwater currently flowing into the tailings basin. PolyMet will construct this drainage swale before the FTB Seepage Containment System is operational. In addition to augmenting streamflow in Unnamed (Mud Lake) Creek, the drainage swale will prevent water from ponding at the toe of the East Dam.

11.5 Transportation and Utility Corridors Water Management and Infrastructure

This Section 11.5 focuses on water management associated with the Transportation and Utility Corridors. Water management includes stormwater and mine water. Mine water associated with the Transportation and Utility Corridors is limited to the mine water conveyed within the MPP from the Mine Site to the Plant Site.

11.5.1 Existing Conditions

The Transportation and Utility Corridors will connect the Mine Site and the Plant Site. These corridors include the existing Dunka Road and the Railroad Corridor. Runoff from the Transportation and Utility Corridors drain toward the Partridge River, a tributary of the Upper St. Louis River, and water naturally drains to the south through culverts under Dunka Road and the Railroad Corridor. Specifically, the Transportation and Utility Corridors are located within the watersheds of the following Partridge River tributaries above Colby Lake: Wetlegs Creek, Longnose Creek, and Wyman Creek. These tributaries have been monitored for water quality and quantity since 2004. PolyMet's NPDES/SDS Permit Application provides surface water quality results through 2015.

11.5.2 Stormwater Management and Infrastructure

This Section 11.5.2 describes the management of industrial stormwater along the Transportation and Utility Corridors, including the design and operation of the infrastructure that will be used to manage stormwater in accordance with applicable regulations. Industrial stormwater will include precipitation and runoff from Dunka Road and the mainline railroad between the Mine Site and the Plant Site. PolyMet will manage stormwater along the Transportation and Utility Corridors to reduce potential impacts to the Project, minimize earthwork, protect the environment, and maintain existing flow patterns to the extent practical.

PolyMet will use a series of ditches and culverts to maintain existing drainage patterns to the extent practical. PolyMet will retain and extend existing ditches and culverts along the Dunka Road and the railroad lines, as necessary. Additional culverts will be installed in the Connection Track embankment, and through the MPP embankment. Industrial stormwater will discharge to natural watercourses, including to Wetlegs Creek, Longnose Creek, and Wyman Creek in the Partridge River watershed.

PolyMet will manage industrial stormwater along the Transportation and Utility Corridors through appropriate BMPs, including engineered controls and spill prevention and response procedures. This management will reduce or eliminate contact or exposure of pollutants to stormwater or to remove pollutants from stormwater. Prior to the start of operations, as required by the Project's Individual NPDES/SDS Permit, PolyMet will develop and implement an Industrial SWPPP in accordance with Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

Table 11-1 Project Water Definitions

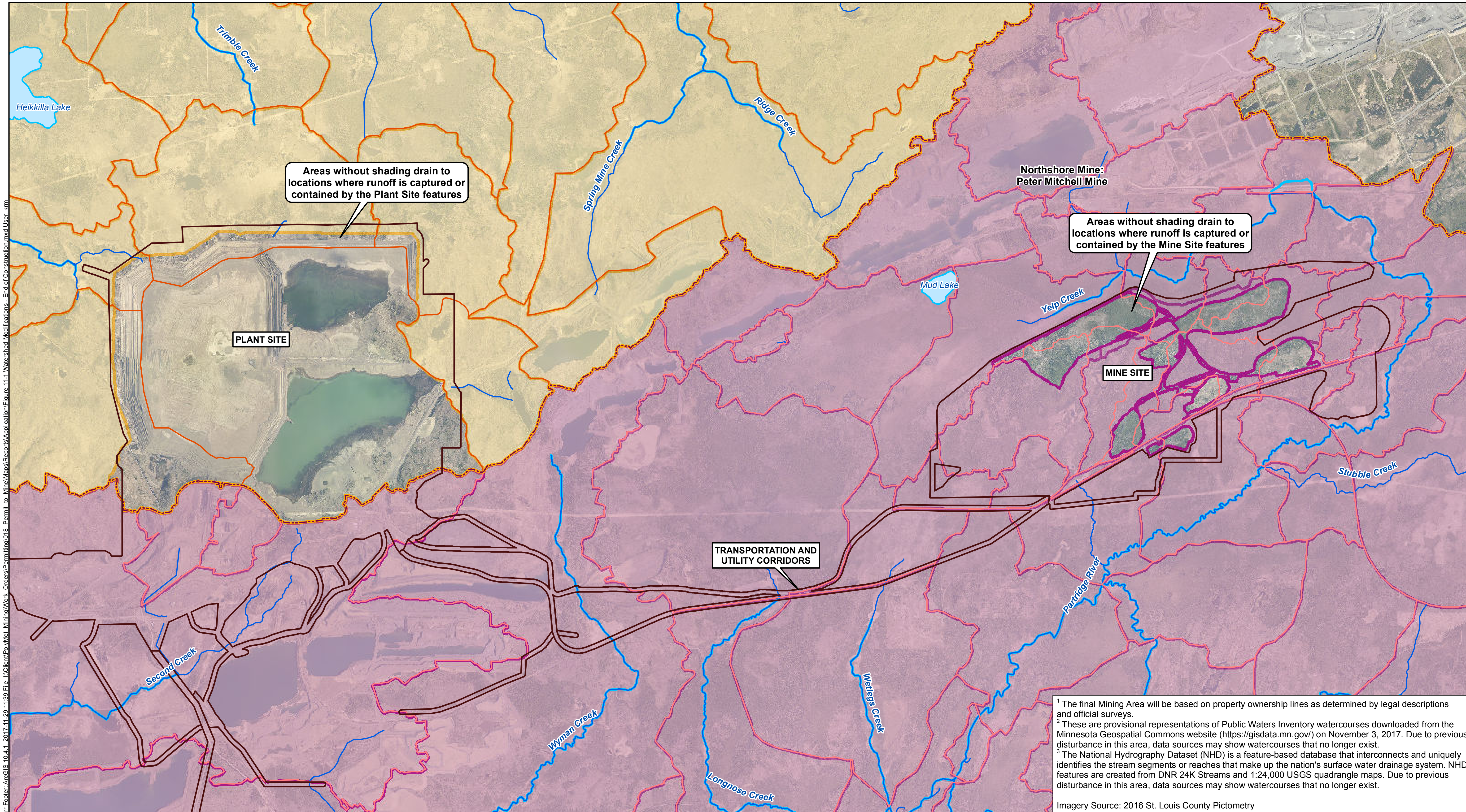
NorthMet-Specific Term	Project-Wide Definition(1)	Mine Site Specifics	WWTS Specifics	Plant Site Specifics	Tailings Basin Specifics	HRF Specifics	Transportation and Utility Corridors Specifics
Mine Water	Water collected by the mine water management systems, including precipitation, runoff, groundwater, and other water collected from areas of the Mine Site and routed from the Mine Site to the Waste Water Treatment System (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.	Water that has contacted surfaces disturbed by mining activities, such as drainage collected on stockpile liners, pit dewatering, and runoff contacting ore, waste rock, and Mine Site haul road surfaces. This water is conveyed by pipe to the equalization basins for further conveyance through the MPP to the WWTS. Runoff from construction dewatering of saturated mineral overburden, which is a subset of mine water called construction mine water, is conveyed by pipe to the Construction Mine Water Basin for further conveyance through the MPP to the FTB. Runoff from the Overburden Storage and Laydown Area (OSLA), which is a subset of mine water collected in the OSLA Pond, is conveyed by pipe to either the Construction Mine Water Basin for further conveyance through the MPP to the FTB or, in later years, to aid in East and Central Pit flooding.	The WWTS treats mine water conveyed from the equalization basins. The construction mine water and the 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.	N/A	(no additions to Project-Wide Definition)	N/A	(no additions to Project-Wide Definition)
Process Water	Water that has been used in the beneficiation process or hydrometallurgical process.	N/A	Process water is an internal flow within the operation of the Beneficiation and Hydrometallurgical Plants and is not managed directly at the WWTS.	(no additions to Project-Wide Definition)	Water that has been used in the beneficiation process.	Water that has been used in the hydrometallurgical process.	N/A
Sewage	Water collected from sanitary facilities and sedimentation tank and filter backwash waste collected from the Plant Site Potable Water Treatment System.	Water collected from Mine Site sanitary facilities, handled in holding tanks, periodically pumped out by a commercial vendor, and transported via truck to the Plant Site for treatment by the Sewage Treatment System.	N/A	Water collected from the Plant Site and Mine Site sanitary facilities and sedimentation tank and filter backwash waste collected from the Plant Site Potable Water Treatment Plant for treatment by the Sewage Treatment System (STS). Also, water collected by the Area 1 and Area 2 septic systems.	N/A	N/A	N/A

NorthMet-Specific Term	Project-Wide Definition[1]	Mine Site Specifics	WWTS Specifics	Plant Site Specifics	Tailings Basin Specifics	HRF Specifics	Transportation and Utility Corridors Specifics
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 within the FTB dams and tributary to the FTB Pond	N/A	(no additions to Project-Wide Definition)	N/A	The primary water source for the Beneficiation Plant.	N/A	N/A
Tailings Basin Seepage	Tailings basin water that infiltrates through Flotation Tailings, LTVSMC tailings, and/or Tailings Basin dams and migrates through the base or the external dam faces of the Tailings Basin.	N/A	The WWTS treats tailings basin seepage collected by the FTB seepage capture systems.	N/A	(no additions to Project-Wide Definition)	N/A	N/A
HRF Water	Water collected and stored within the HRF, which includes the following: • process water resulting from the hydrometallurgical process and routed to the HRF as part of the residue slurry • precipitation and runoff from within the HRF dams	N/A	N/A	N/A	N/A	The primary water source for the Hydrometallurgical Plant.	N/A
Plant Reservoir Water	Water collected and stored within the Plant Reservoir, which includes the following: • water pumped from Colby Lake • precipitation that falls on the Plant Reservoir	N/A	N/A	(no additions to Project-Wide Definition)	The make-up water source for the Beneficiation Plant.	The make-up water source for the Hydrometallurgical Plant.	N/A
Industrial Stormwater	Stormwater associated with industrial activities.[2]	Includes precipitation and runoff from the industrial areas at the Mine Site that is composed entirely of stormwater and not combined with other water types. This definition does not include water defined as mine water.	N/A	Includes precipitation and runoff from the industrial areas at the Plant Site and, after construction of the HRF, runoff from portions of the southern exterior of the new Tailings Basin dams (Cell 1E) and the eastern exterior of the HRF dams (if constructed of exposed significant materials) which will sheet flow onto the Plant Site.	Includes precipitation and runoff from the new Tailings Basin dam exterior slopes, where not captured by the seepage capture systems.	Includes precipitation and runoff from the HRF dam exterior slopes if constructed of exposed significant materials.	Includes precipitation and runoff from Dunka Road and the railroad between the Mine Site and the Plant Site.

NorthMet-Specific Term	Project-Wide Definition[1]	Mine Site Specifics	WWTS Specifics	Plant Site Specifics	Tailings Basin Specifics	HRF Specifics	Transportation and Utility Corridors Specifics
Construction Stormwater	Stormwater associated with construction activities.[2]	During operations, includes precipitation, runoff, and dewatering water from construction areas with the exception of dewatering water from saturated mineral overburden, which is managed as construction mine water.	N/A	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)
Non-Contact Stormwater	Precipitation and runoff that contacts natural, stabilized, or reclaimed surfaces and has not been exposed to mining activities, construction activities, or industrial activities.[2]	Includes runoff from natural areas, from on-site features constructed of overburden (unsaturated mineral overburden or peat) once stabilized with permanent cover, and from the reclaimed Category 1 Waste Rock Stockpile.	N/A	(no additions to Project-Wide Definition)	Includes runoff from reclaimed Tailings Basin dam exterior slopes.	Includes runoff from reclaimed HRF dam exterior slopes and from HRF dam exterior slopes prior to reclamation if not constructed of exposed significant materials.	(no additions to Project-Wide Definition)

(1) If two types of waters mix, the mixture is handled as the more actively managed type of water (e.g., a mixture of non-contact stormwater and mine water is managed as mine water).
(2) Industrial activities are as defined in Minnesota Rules, part 7090.0080, subpart 6; construction activities are as defined in Minnesota Rules, part 7090.0080, subpart 4.

Abbreviations:
CPS = Central Pumping Station
FTB = Flotation Tailings Basin
HRF = Hydrometallurgical Residue Facility
LTVSMC = LTV Steel Mining Company
N/A = not applicable
OSLA = Overburden Storage Laydown Area
WWTS = Waste Water Treatment SystemSources: Table 1-1 of Reference (4), Table 1-2 of Reference (54), Table 1-2 of Reference (55), Table 1-2 of Reference (56), Table 1-2 of Reference (28), Table 1-2 of Reference (29), and Table 1-2 of Reference (57)



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

End of Construction Phase
- Watershed Divide
- Embarrass River Subwatersheds
- Partridge River Subwatersheds
- Area Drains to Plant Site Features
- Area Drains to Mine Site Features

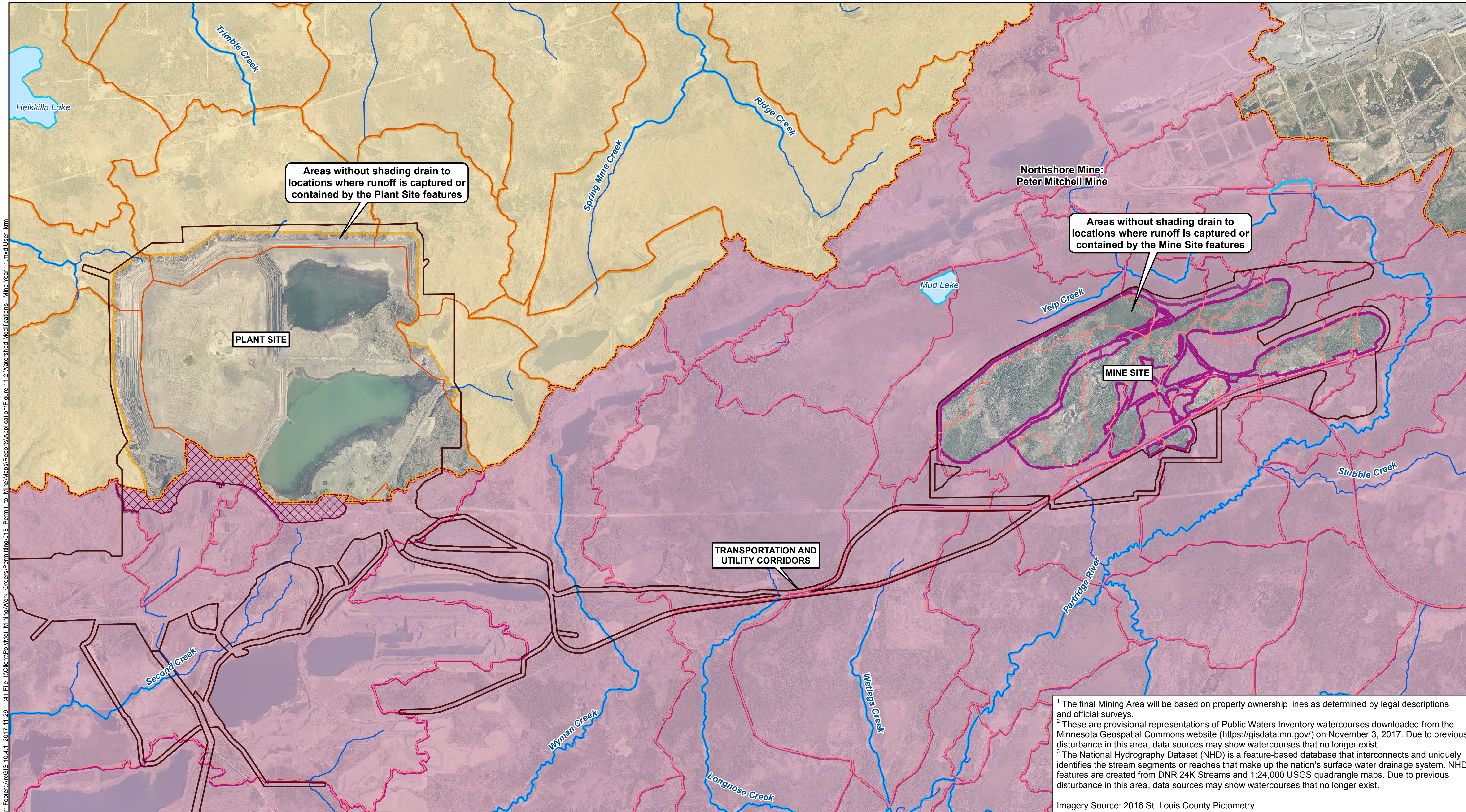
Existing Conditions
- Partridge River Subwatersheds
- Embarrass River Subwatersheds

- Mining Area[1]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

0 2,000 4,000 8,000
Feet

WATERSHED MODIFICATIONS -
END OF CONSTRUCTION PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-1
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mine Year 11
- Watershed Divide
- Embarrass River Subwatersheds
- Partridge River Subwatersheds
- Area Drains to Plant Site Features
- Area Drains to Mine Site Features
- Area Drains to Partridge River, Drains to Embarrass River in Existing Conditions

Existing Conditions
- Partridge River Subwatersheds
- Embarrass River Subwatersheds

- Mining Area[1]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

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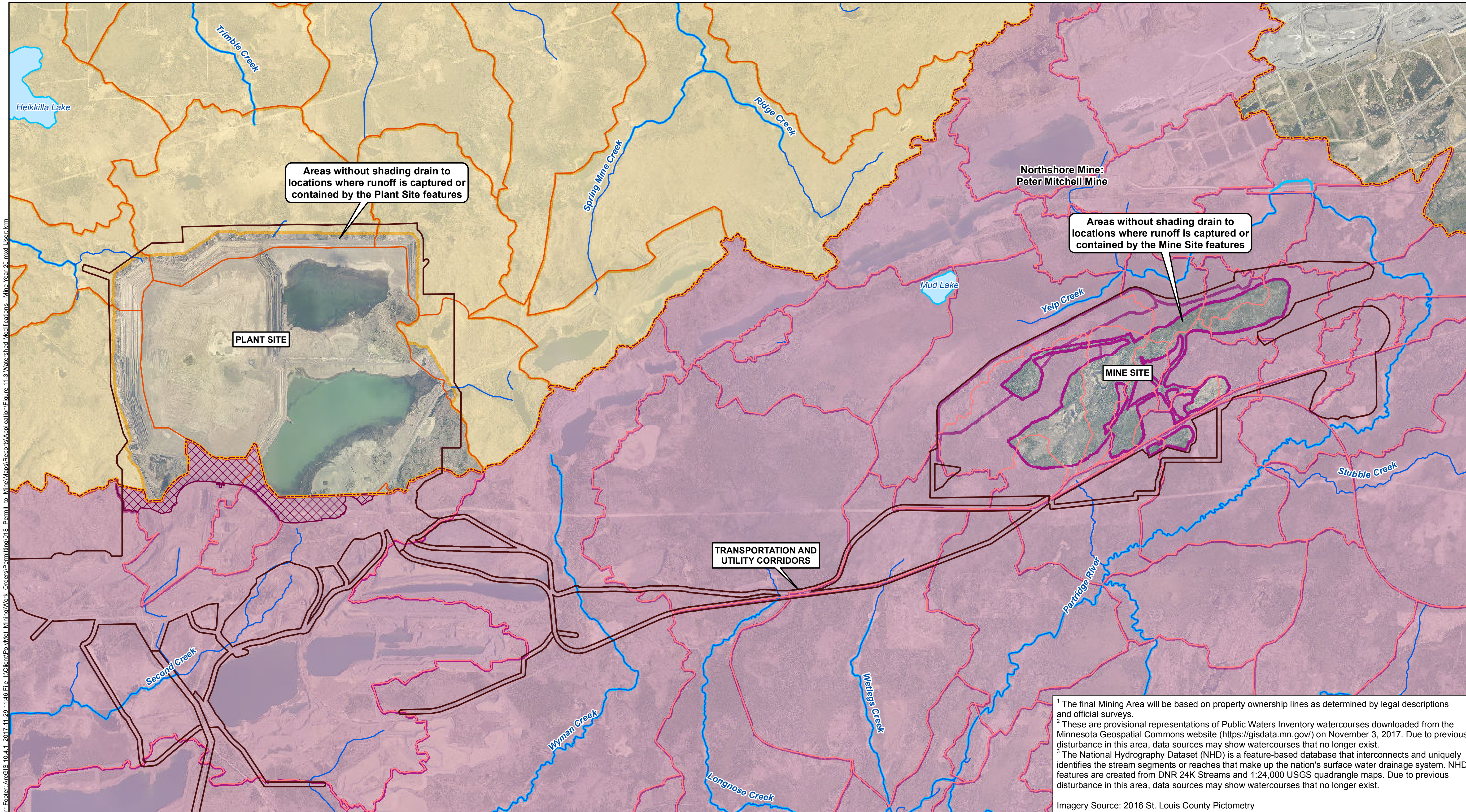
Feet

WATERSHED MODIFICATIONS - MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 11-2
Permit to Mine Application



Mine Year 20

- Watershed Divide
- Embarrass River Subwatersheds
- Partridge River Subwatersheds
- Area Drains to Plant Site Features
- Area Drains to Mine Site Features
- Area Drains to Partridge River, Drains to Embarrass River in Existing Conditions

Existing Conditions

- Partridge River Subwatersheds
- Embarrass River Subwatersheds
- Mining Area[1]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

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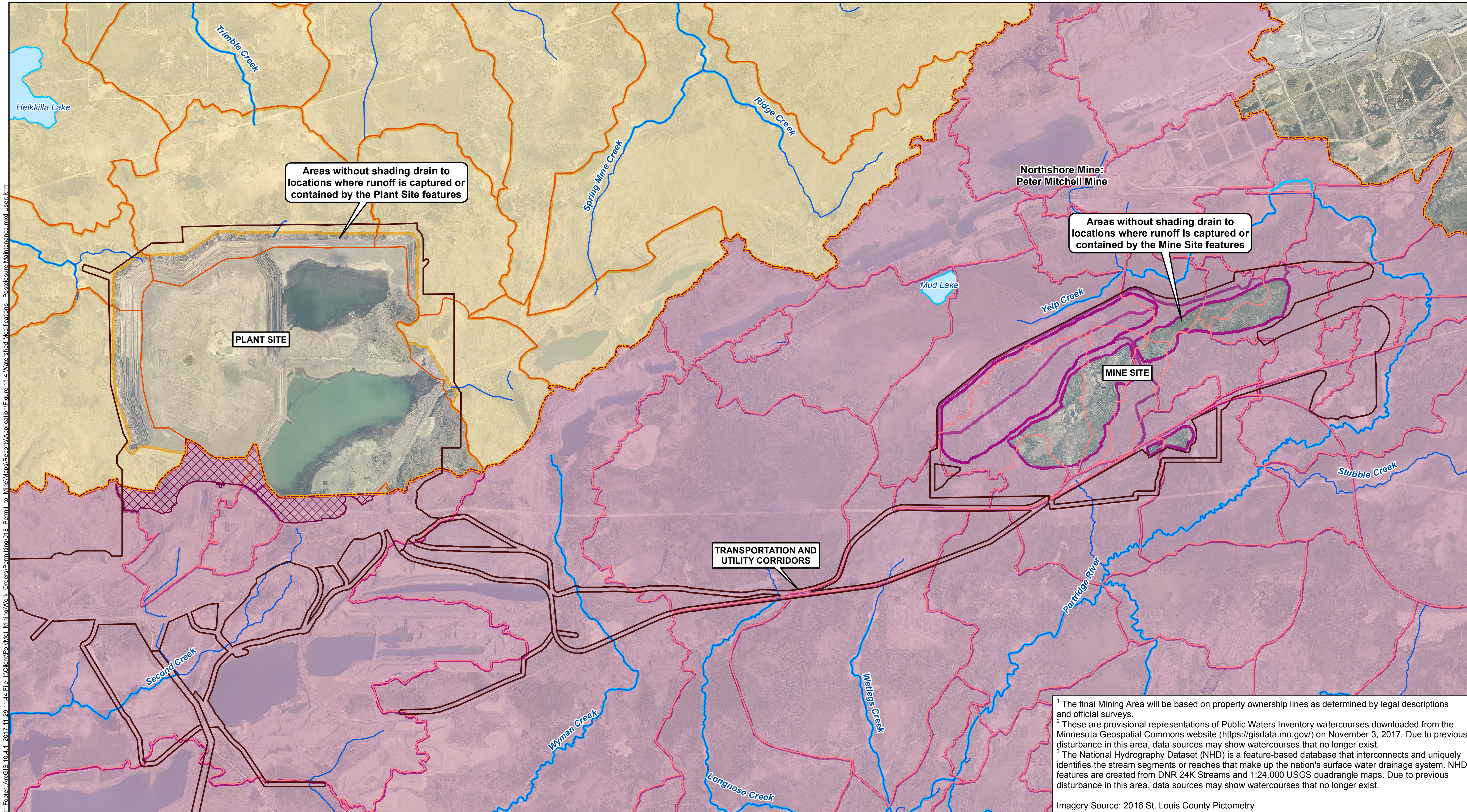
Feet

WATERSHED MODIFICATIONS - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Figure 11-3
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Postclosure Maintenance
- Watershed Divide
- Embarrass River Subwatersheds
- Partridge River Subwatersheds
- Area Drains to Plant Site Features
- Area Drains to Mine Site Features
- Area Drains to Partridge River, Drains to Embarrass River in Existing Conditions

Existing Conditions
- Partridge River Subwatersheds
- Embarrass River Subwatersheds

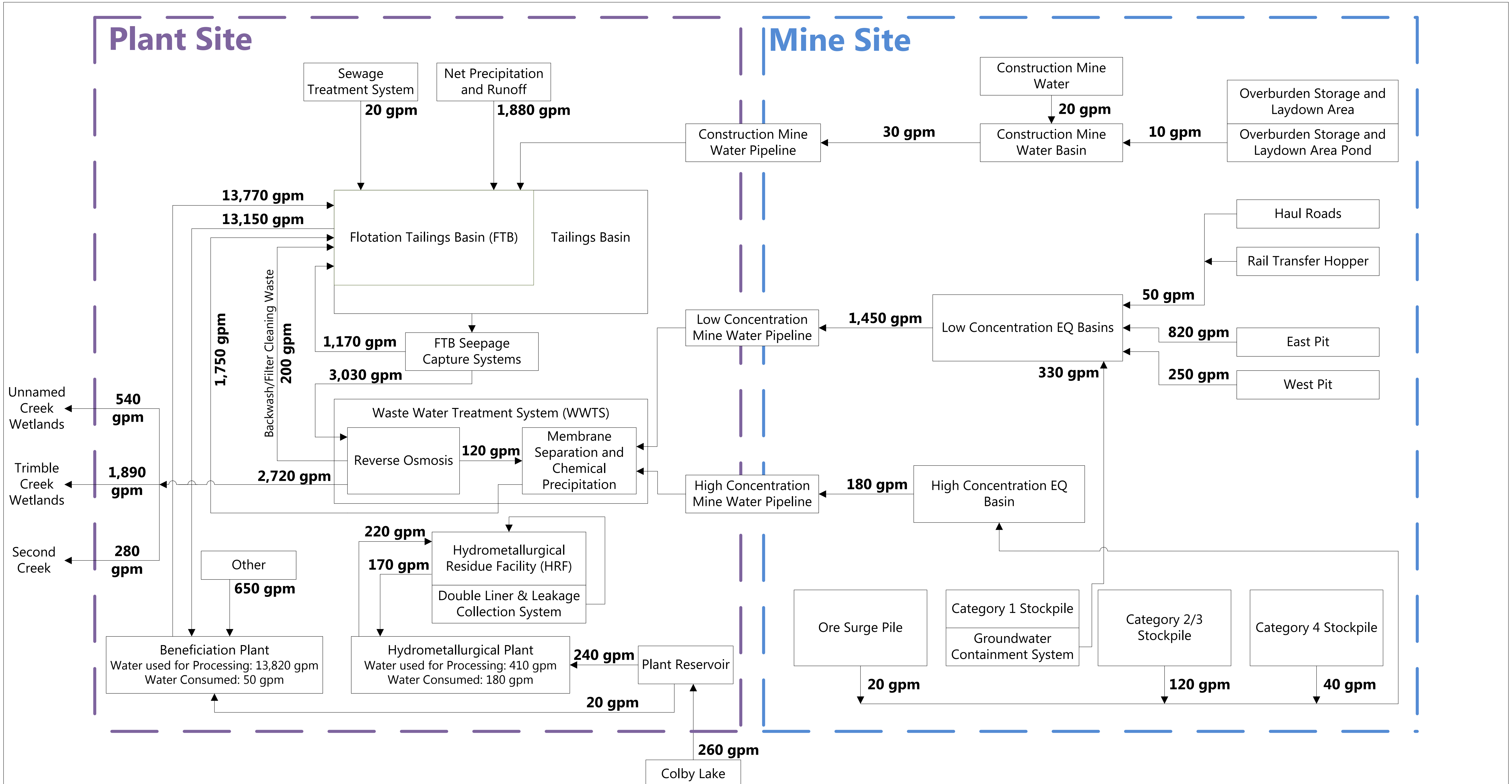
- Mining Area[1]
- Public Waters Inventory (PWI) Basins
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

N

0 2,000 4,000 8,000
Feet

WATERSHED MODIFICATIONS - POSTCLOSURE MAINTENANCE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-4
Permit to Mine Application



Legend

xx → = Approximate Water Flow in Gallons Per Minute (gpm)

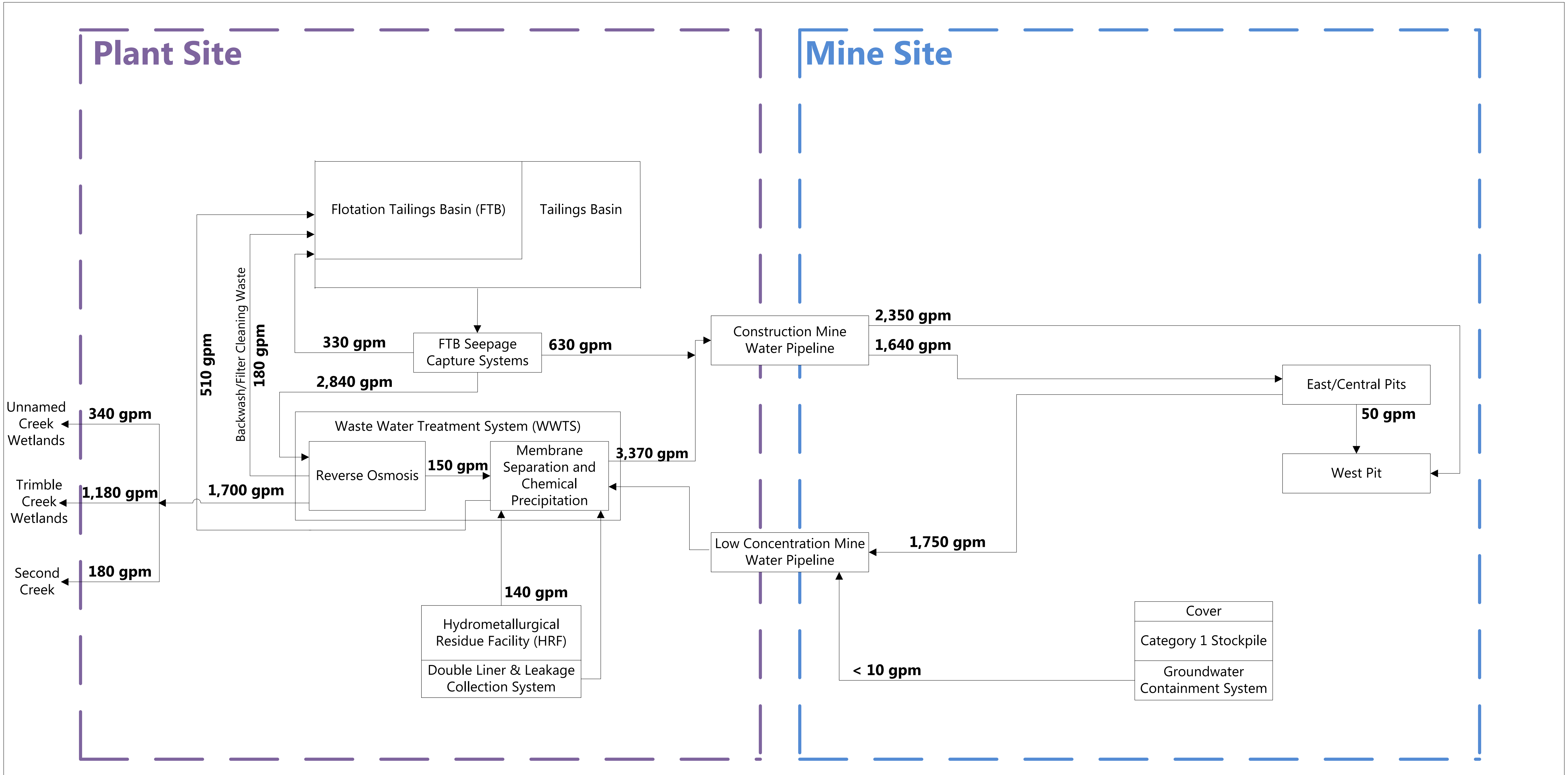
Notes:

1. This figure is not a comprehensive water balance. For clarity, it shows flows that are key to the NorthMet Project's overall water use strategy, and omits flows such as some inflows due to net precipitation and outflows due to potential liner leakage and other potential losses. Because not all flows are shown, and because flow rates are rounded to the nearest 10 gpm, total flows may not equal the sum of their contributing parts.
2. Flows provided are estimated average annual flows for Mine Year 10.
3. Water flows are based on the Water Modeling Data Package – Mine Site, Version 14 (February 2015) and the Water Modeling Data Package – Plant Site, Version 11 (March 2015), included in Appendix 16 of the application.

PROJECT WATER BALANCE IN MINE YEAR 10
NorthMet Project
Poly Met Mining, Inc.

Figure 11-5
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v3\sections\11 Water\figures\Figure 11-5 Project Water Balance in Mine Year 10 d4.vsd



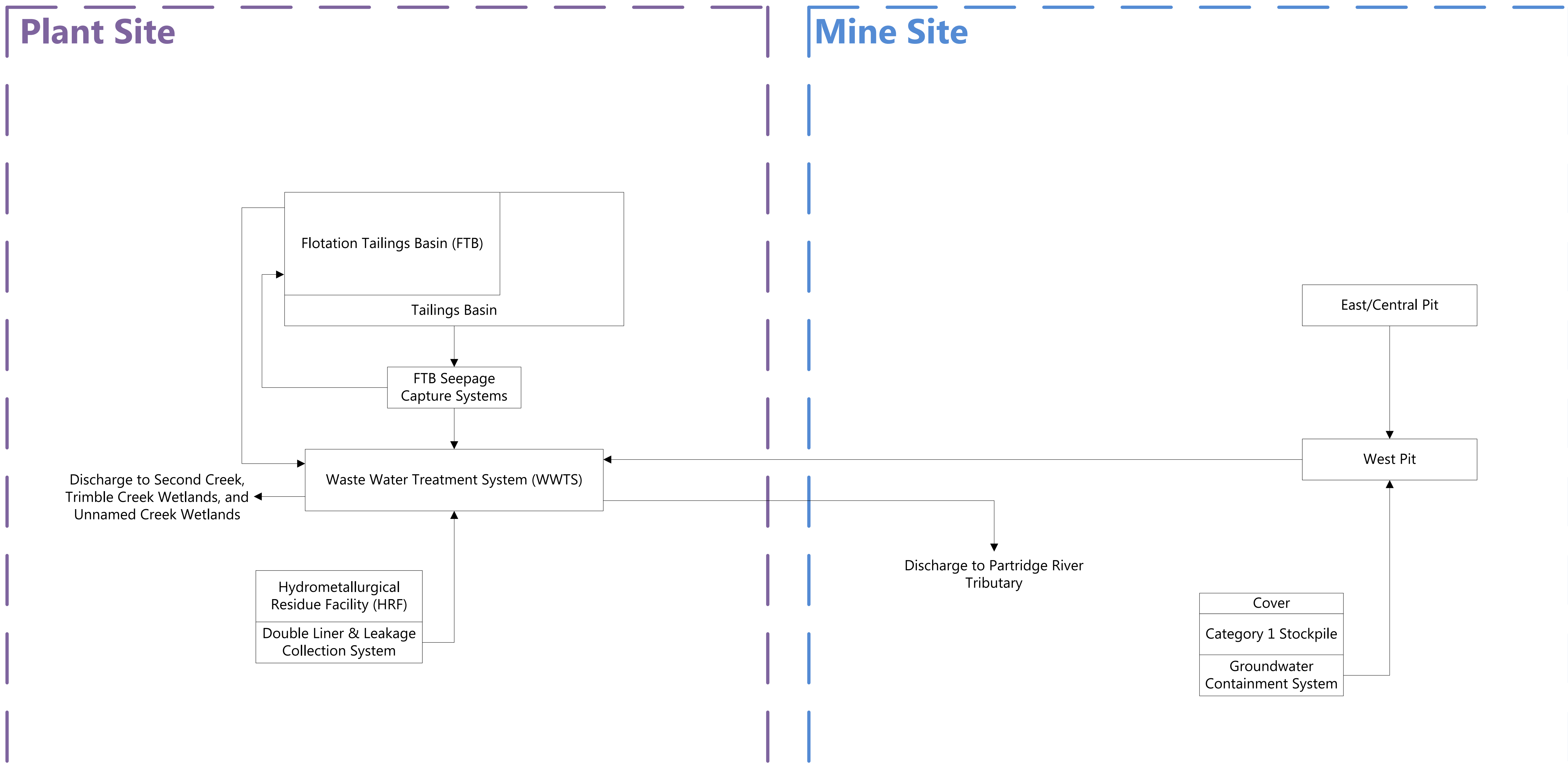
Legend

xx → = Approximate Water Flow in Gallons Per Minute (gpm)

Notes:
1. Flow from the West Pit does not occur during reclamation.
2. Flow directions shown apply for Mine Year 21 to Mine Year 40.
3. Flows provided are estimated average annual flows for Mine Year 25.
4. This figure is not a comprehensive water balance. For clarity, it shows flows that are key to the NorthMet Project's overall water use strategy, and omits flows such as some inflows due to net precipitation and outflows due to potential liner leakage and other potential losses. Because not all flows are shown, and because flow rates are rounded to the nearest 10 gpm, total flows may not equal the sum of their contributing parts.
5. Water flows were obtained from the Water Modeling Data Package – Mine Site, Version 14 (February 2015) and the Water Modeling Data Package – Plant Site, Version 11 (March 2015), included in Appendix 16 of the Application.

PROJECT WATER BALANCE IN MINE YEAR 25
NorthMet Project
Poly Met Mining, Inc.

Figure 11-6
Permit to Mine Application

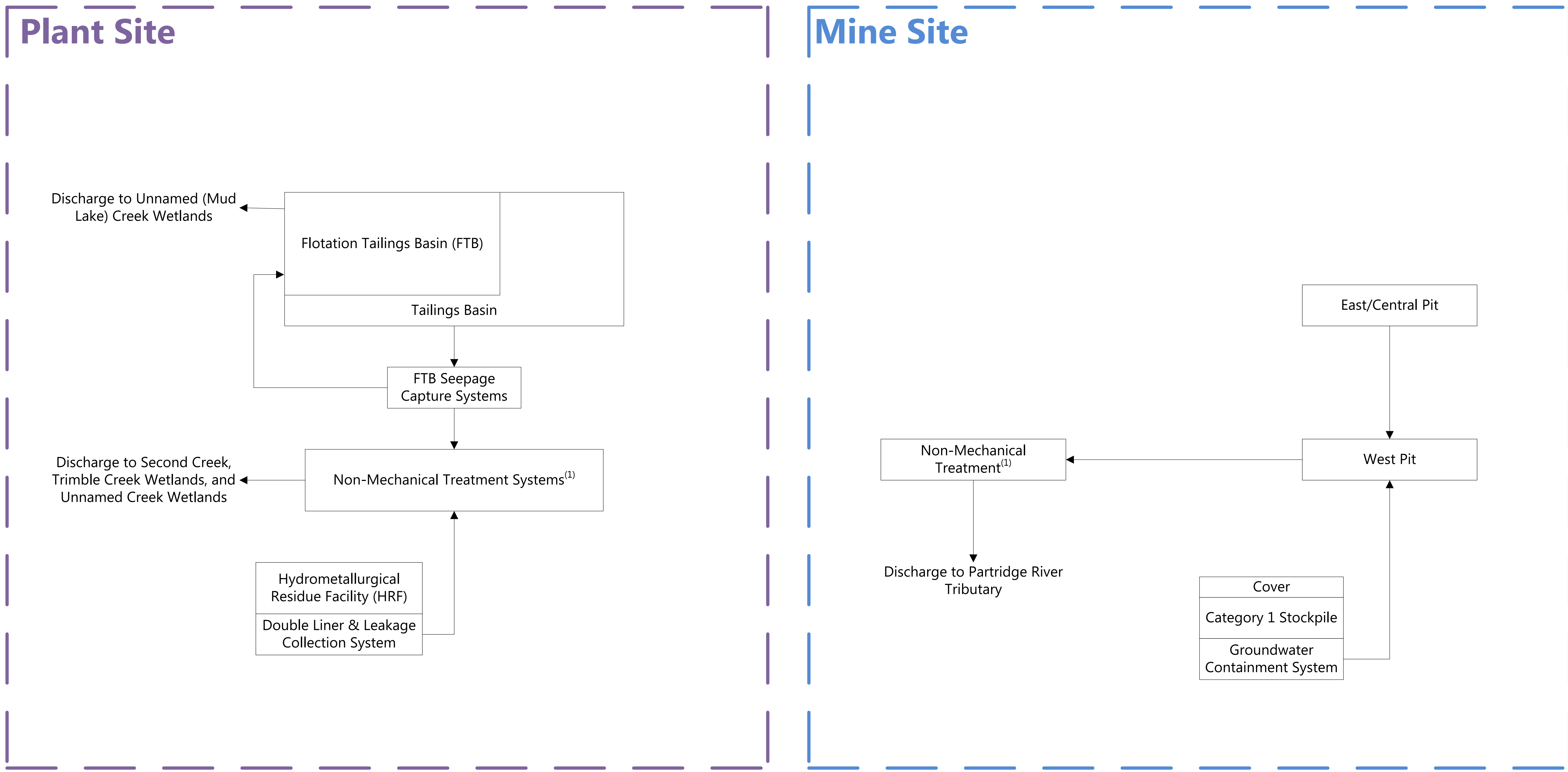


Legend
→ = Water Flow Direction

Notes:
(1) Transition from Mechanical to Non-Mechanical Treatment could take place prior to or after Mine Year 55 depending on water quality and Agency approvals.

PROJECT WATER FLOWS, MINE YEAR 55
MECHANICAL TREATMENT PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-7
Permit to Mine Application



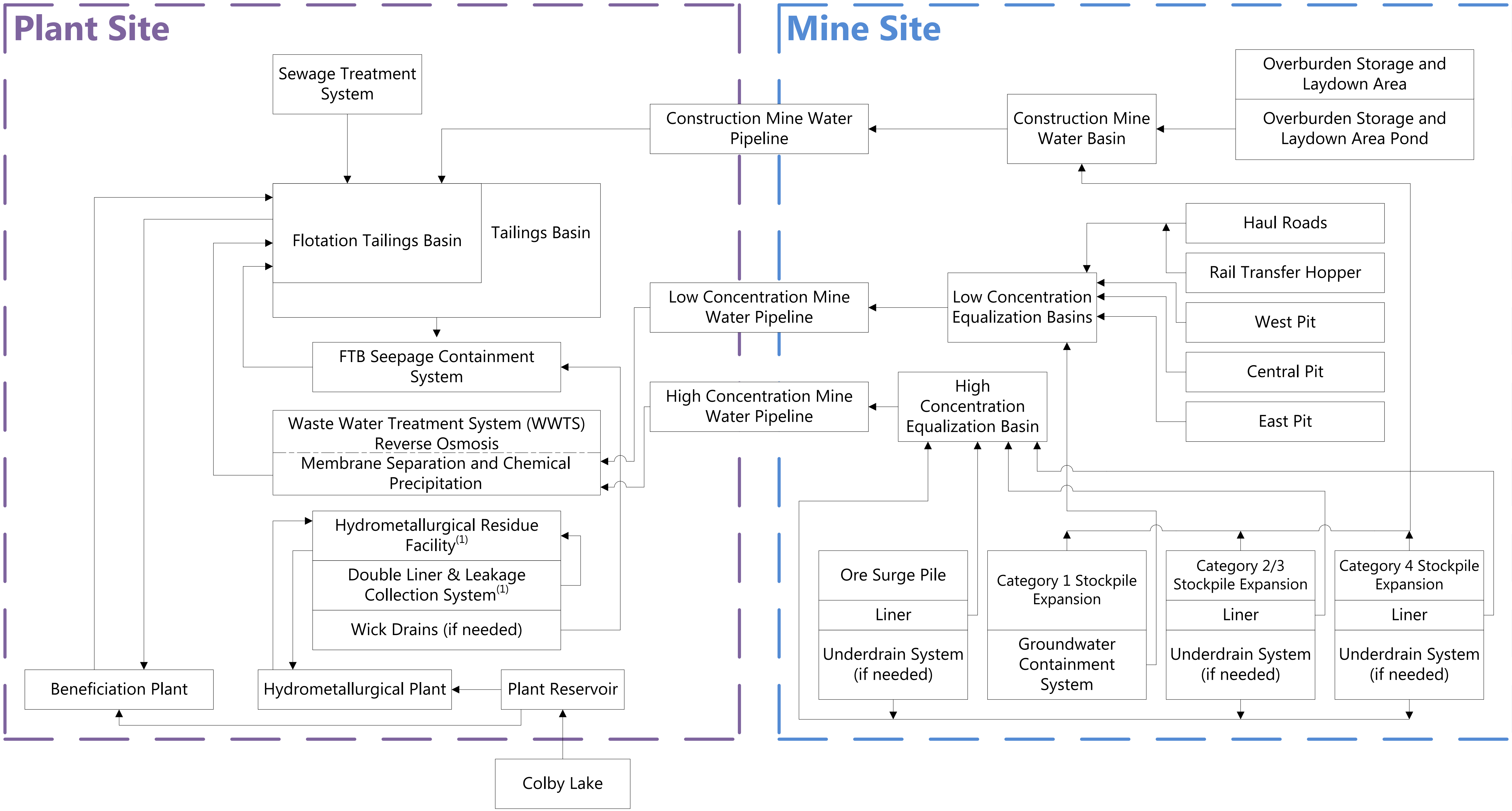
Legend
→ = Water Flow Direction

Notes:
(1) Transition from Mechanical to Non-Mechanical Treatment could take place prior to or after Mine Year 55 depending on water quality and Agency approvals.

PROJECT WATER FLOWS, MINE YEAR 55
NON-MECHANICAL TREATMENT PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-8
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v3\sections\11 Water\figures\Figure 11-8 Project Water Flows Mine Year 55 Non-Mechanical Treatment d5.vsd

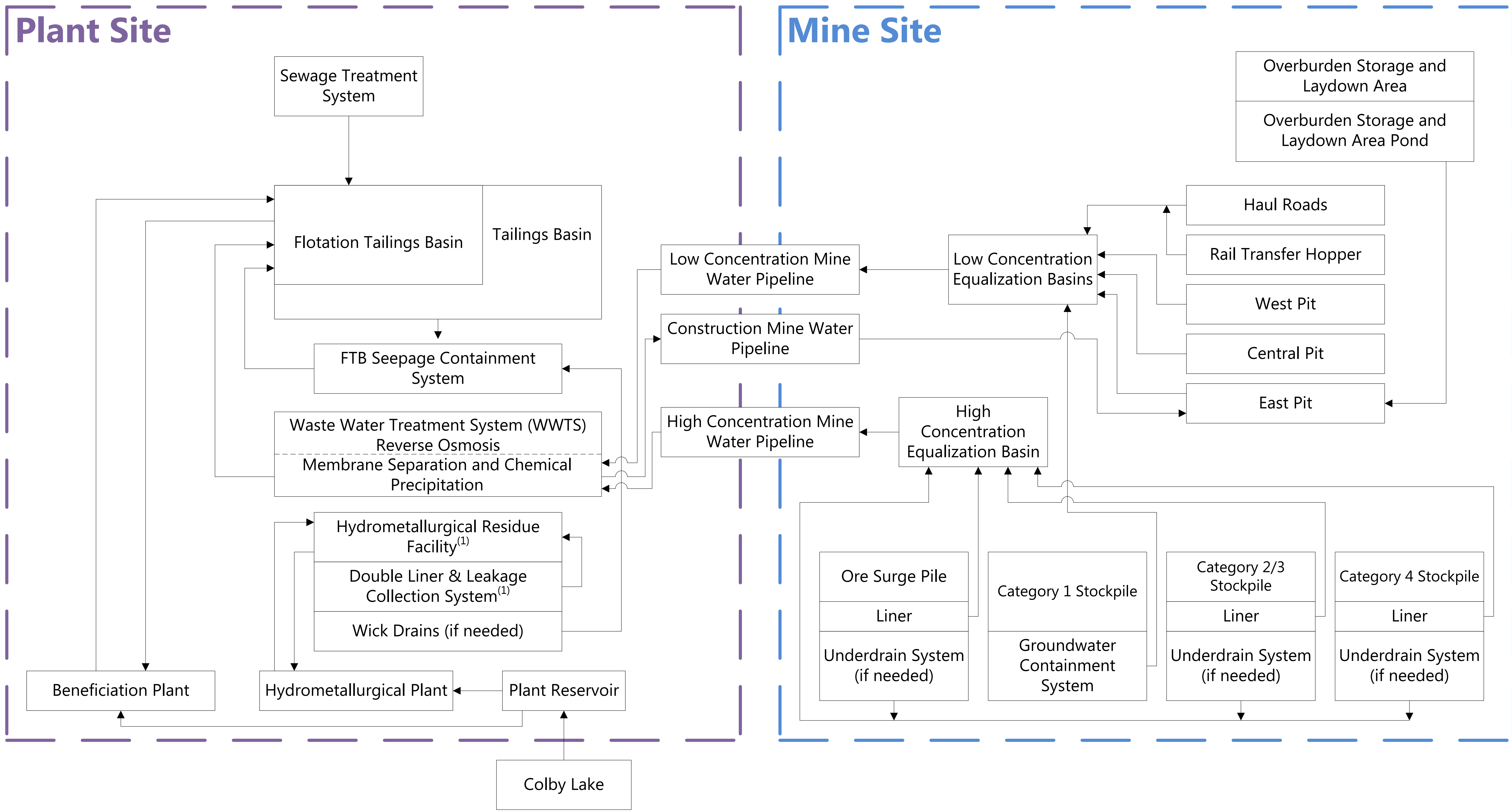


Legend
→ = Water
▭ = Water Management Feature

Notes:
(1) The Hydrometallurgical Residue Facility will be built several years after the start of operations, in approximately Mine Year 3.

WATER MOVEMENT DURING OPERATIONS – Mine Years 1 to 11
NorthMet Project
Poly Met Mining, Inc.

Figure 11-9
Permit to Mine Application



Legend

→ = Water

▭ = Water Management Feature

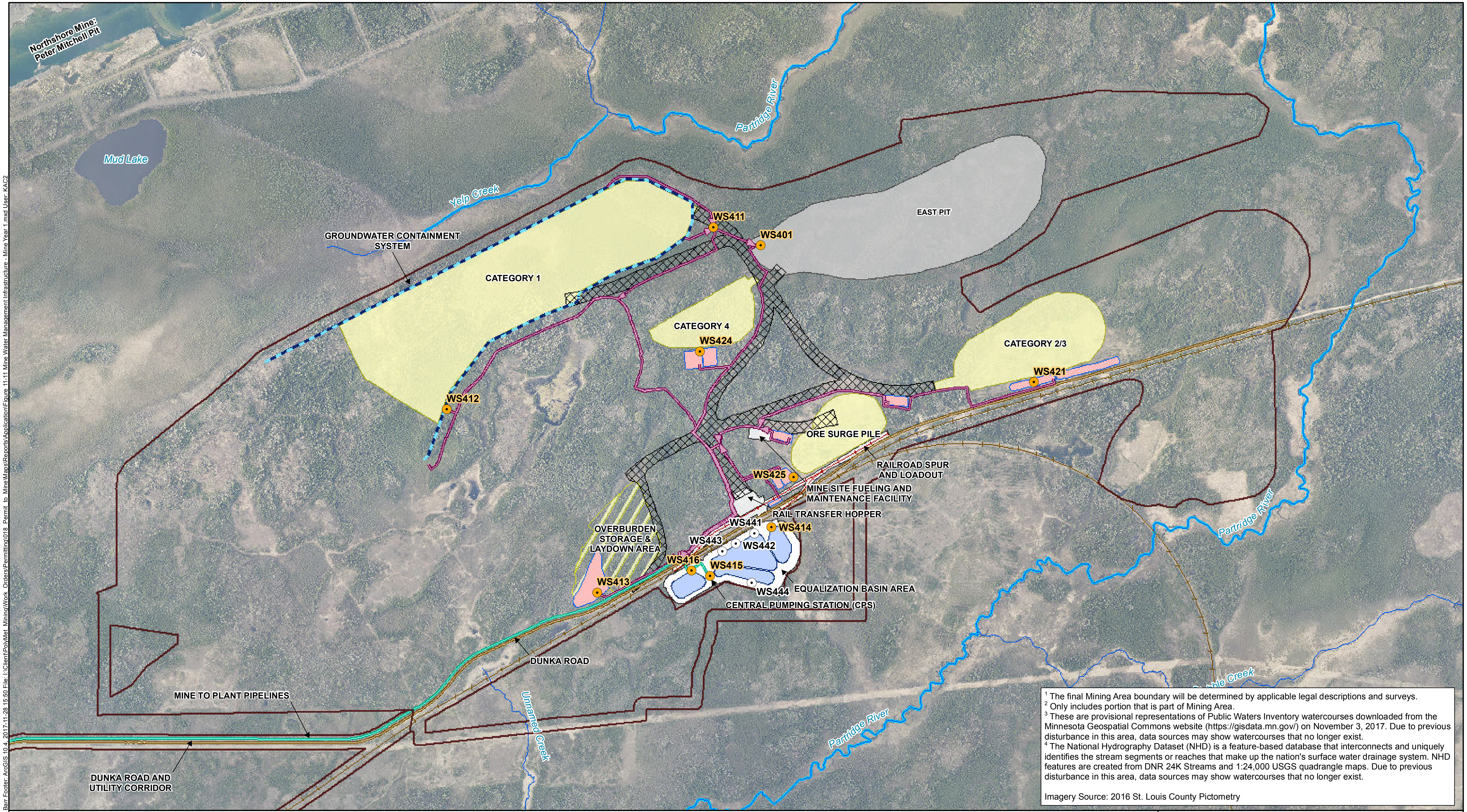
Notes:

[1] The Hydrometallurgical Residue Facility will be built several years after the start of operations, in approximately Mine Year 3.

WATER MOVEMENT DURING OPERATIONS – MINE YEARS 12 to 20
NorthMet Project
Poly Met Mining, Inc.

Figure 11-10
Permit to Mine Application

P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Permitting\Permit To Mine\Application\v3\sections\11 Water\figures\Figure 11-10 Water Movement During Operation 12-20 d3.vsd



[1] The final Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

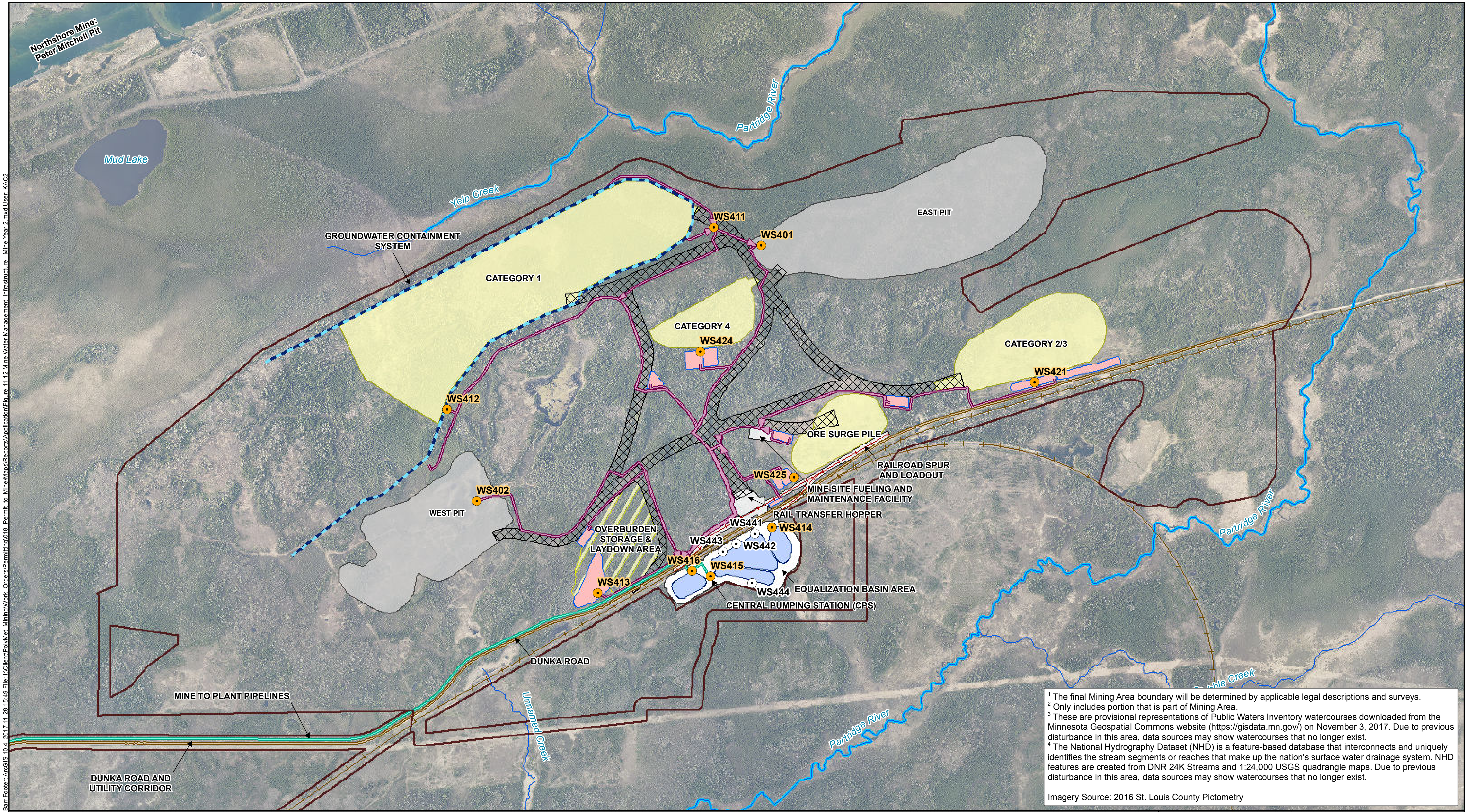
Imagery Source: 2016 St. Louis County Pictometry

NPDES/SDS and Water Appropriation Monitoring Stations
Water Appropriation Only Monitoring Stations
Mining Area[1]
Mine Year 1 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Haul Roads
Dunka Road[2]
Existing Railroad
Proposed Railroad
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps
Groundwater Containment System Sump
Groundwater Containment System
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE WATER MANAGEMENT INFRASTRUCTURE - MINE YEAR 1
NorthMet Project
Poly Met Mining, Inc.

Figure 11-11
Permit to Mine Application



[1] The final Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Barr Footer: ArcGIS 10.4, 2017-11-28 15:49 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 11-12 Mine Water Management Infrastructure - Mine Year 2.mxd User: KAC2

- NPDES/SDS and Water Appropriation Monitoring Stations
- Water Appropriation Only Monitoring Stations
- Mining Area[1]

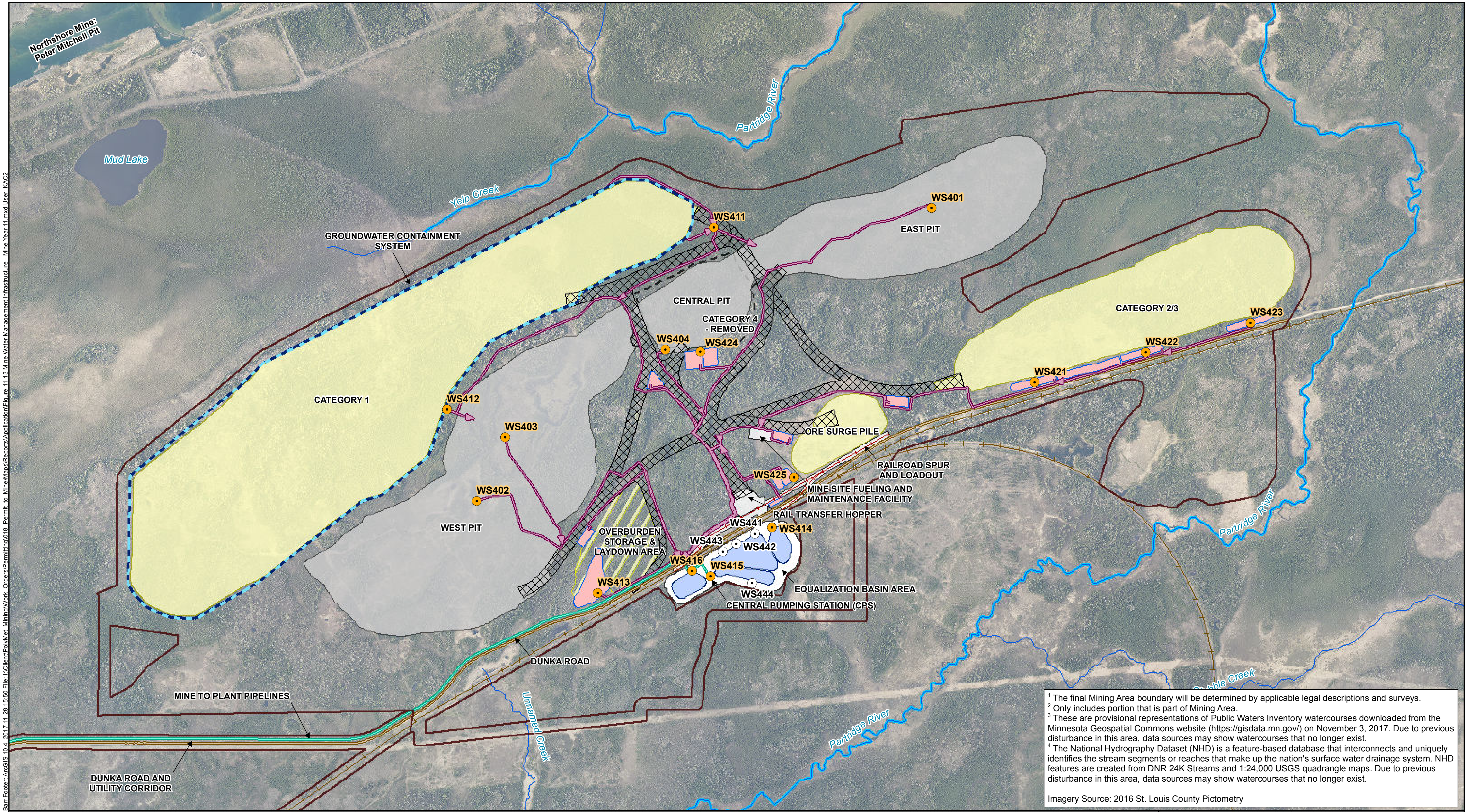
Mine Year 2 Footprints

- Mine Pit
- Active Stockpile
- Storage & Laydown Area
- Haul Roads
- Dunka Road [2]
- Existing Railroad
- Proposed Railroad
- Mine to Plant Pipelines
- Mine Water Pipe
- Mine Water Ponds and Sumps
- Groundwater Containment System Sump
- Groundwater Containment System
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE WATER MANAGEMENT
INFRASTRUCTURE - MINE YEAR 2
NorthMet Project
Poly Met Mining, Inc.

Figure 11-12
Permit to Mine Application



[1] The final Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

NPDES/SDS and Water Appropriation Monitoring Stations
Water Appropriation Only Monitoring Stations
Mining Area[1]

Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Haul Roads

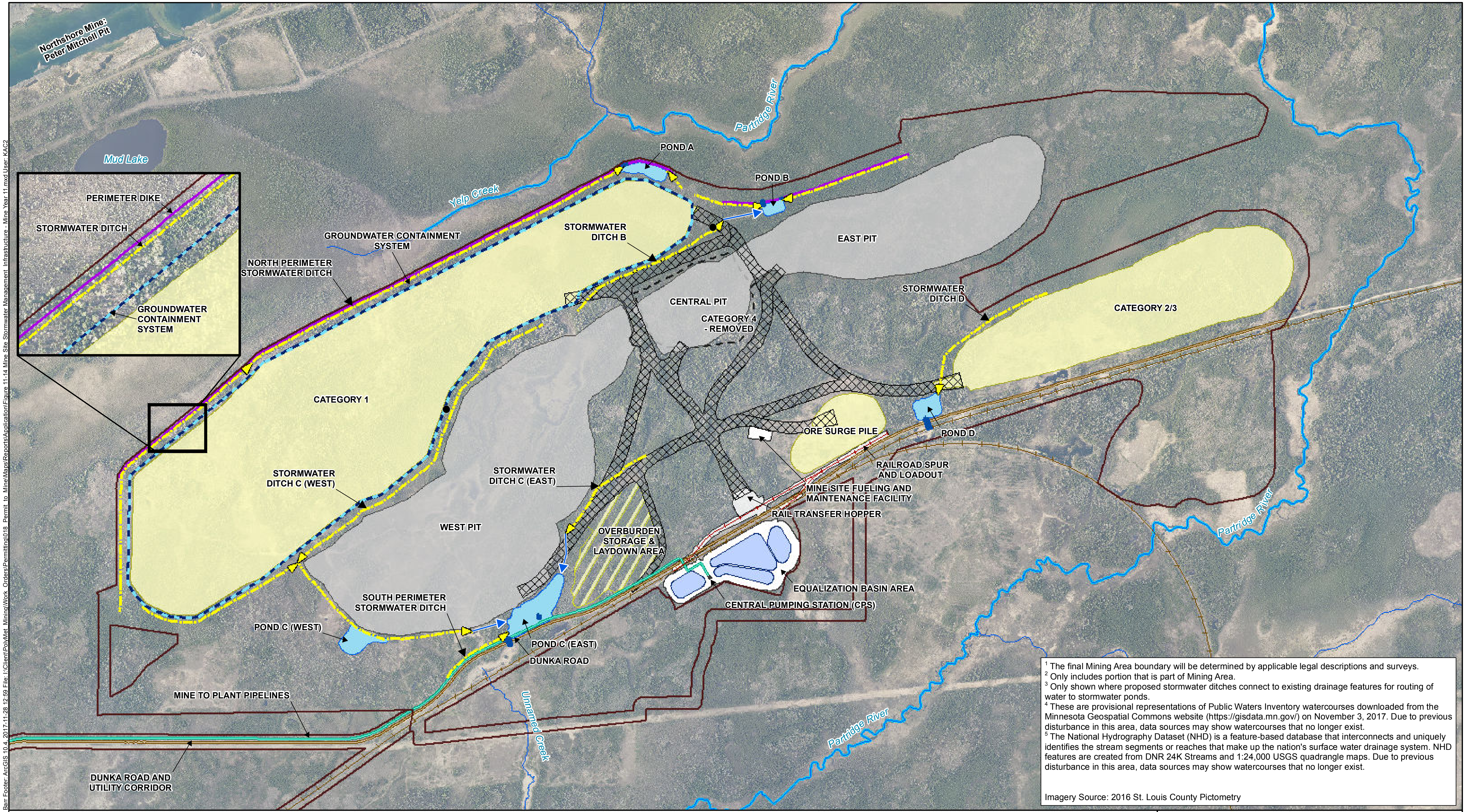
Dunka Road[2]
Existing Railroad
Proposed Railroad
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps

Groundwater Containment System Sump
Groundwater Containment System
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 750 1,500 3,000
Feet

MINE WATER MANAGEMENT INFRASTRUCTURE - MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 11-13
Permit to Mine Application



[1] The final Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

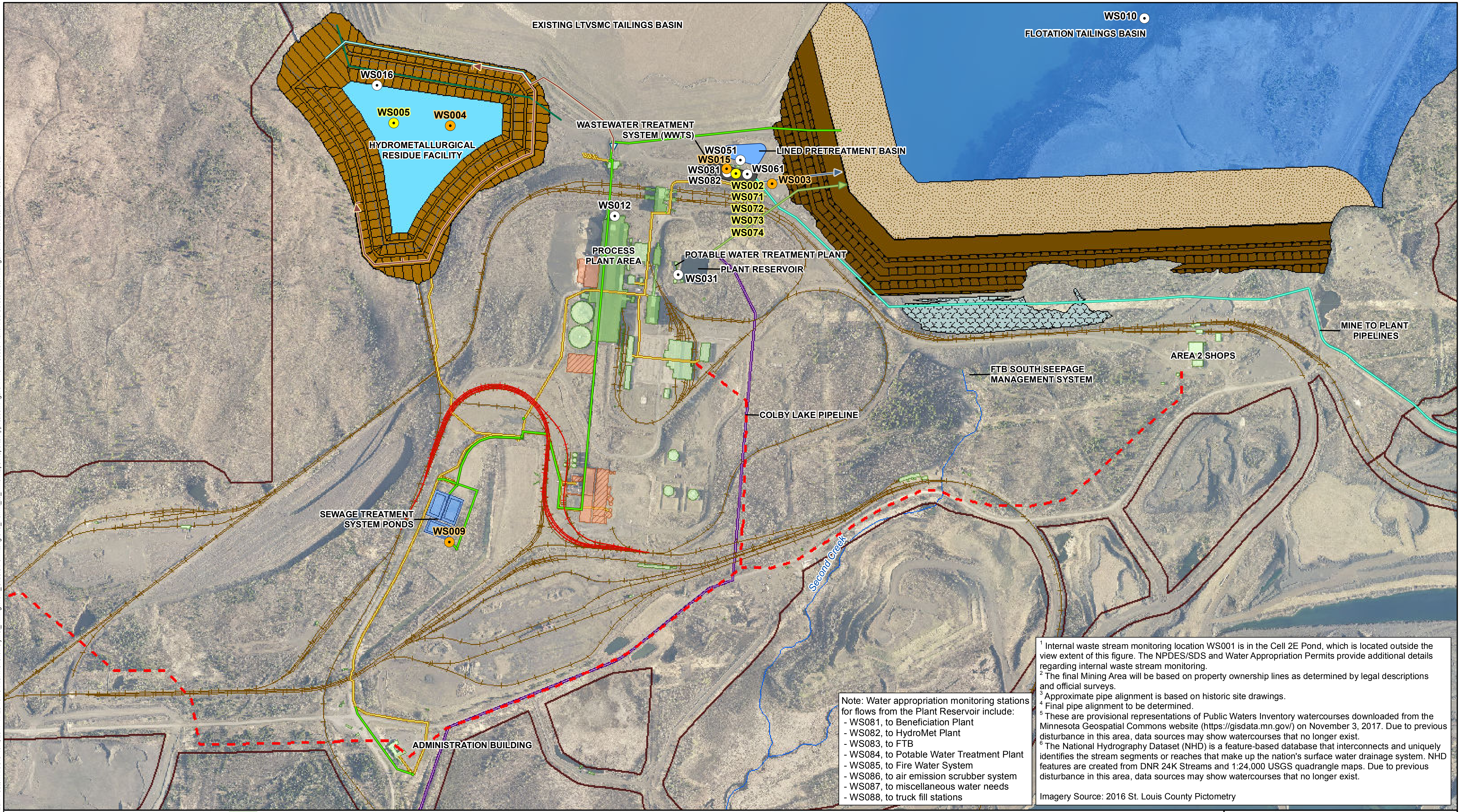
Mining Area[1]
Mine Year 11 Footprints
Mine Pit
Active Stockpile
Storage & Laydown Area
Removed Stockpile
Haul Roads
Dunka Road [2]
Existing Railroad
Proposed Railroad
Groundwater Containment System Sump
Groundwater Containment System
Mine to Plant Pipelines
Perimeter Dike
Stormwater Ditches
Stormwater Culverts
Existing Drainage[3]
Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 750 1,500 3,000
Feet

MINE SITE STORMWATER MANAGEMENT - MINE YEAR 11
NorthMet Project
Poly Met Mining, Inc.

Figure 11-14
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-28 12:59 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 11-14 Mine Site Stormwater Management Infrastructure - Mine Year 11.mxd User: KAC2



Note: Water appropriation monitoring stations for flows from the Plant Reservoir include:
- WS081, to Beneficiation Plant
- WS082, to HydroMet Plant
- WS083, to FTB
- WS084, to Potable Water Treatment Plant
- WS085, to Fire Water System
- WS086, to air emission scrubber system
- WS087, to miscellaneous water needs
- WS088, to truck fill stations

[1] Internal waste stream monitoring location WS001 is in the Cell 2E Pond, which is located outside the view extent of this figure. The NPDES/SDS and Water Appropriation Permits provide additional details regarding internal waste stream monitoring.
[2] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[3] Approximate pipe alignment is based on historic site drawings.
[4] Final pipe alignment to be determined.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- NPDES/SDS and Water Appropriation Monitoring Stations[1]
- Water Appropriation Only Monitoring Stations
- NPDES/SDS Only Monitoring Stations
- Mining Area[2]
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- Existing Railroads
- Proposed Railroads
- Colby Lake Pipeline
- Existing Potable Water Pipeline (Underground)
- Existing Sewer Pipe[3]
- Mine to Plant Pipelines
- Proposed Sewer Pipe[4]
- Plant Reservoir Overflow
- Treated Mine Water Ppe
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe

Mine Year 20 Footprints
- Dam
- Beach
- Pond
- South Buttress
- Hydrometallurgical Residue Facility Pond
- Hydrometallurgical Residue Facility Dam
- Public Waters Inventory (PWI) Watercourses[5]
- National Hydrography Dataset (NHD) Rivers & Streams[6]

N

0 500 1,000

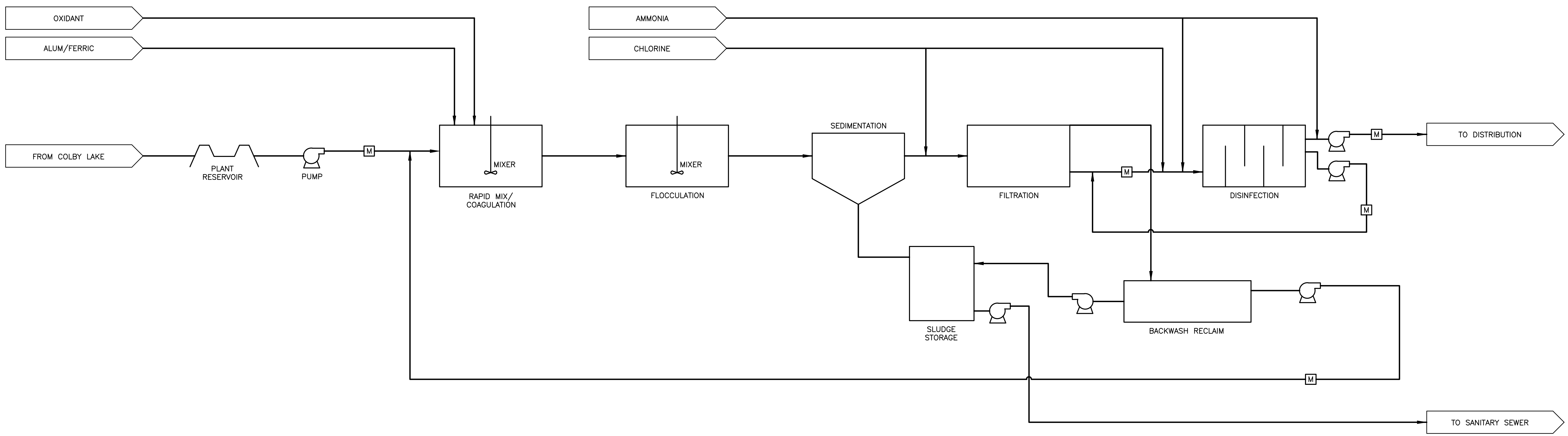
Feet

Figure 11-16 shows the Tailings Basin Water Management Infrastructure
Figures 11-18 and 11-19 shows the Stormwater Management Infrastructure

PROCESS PLANT AREA SELECT WATER MANAGEMENT INFRASTRUCTURE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-15
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-28 15:49 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 11-15 Process Plant Area Select Water Mangement Infrastructure.mxd User: KAC2



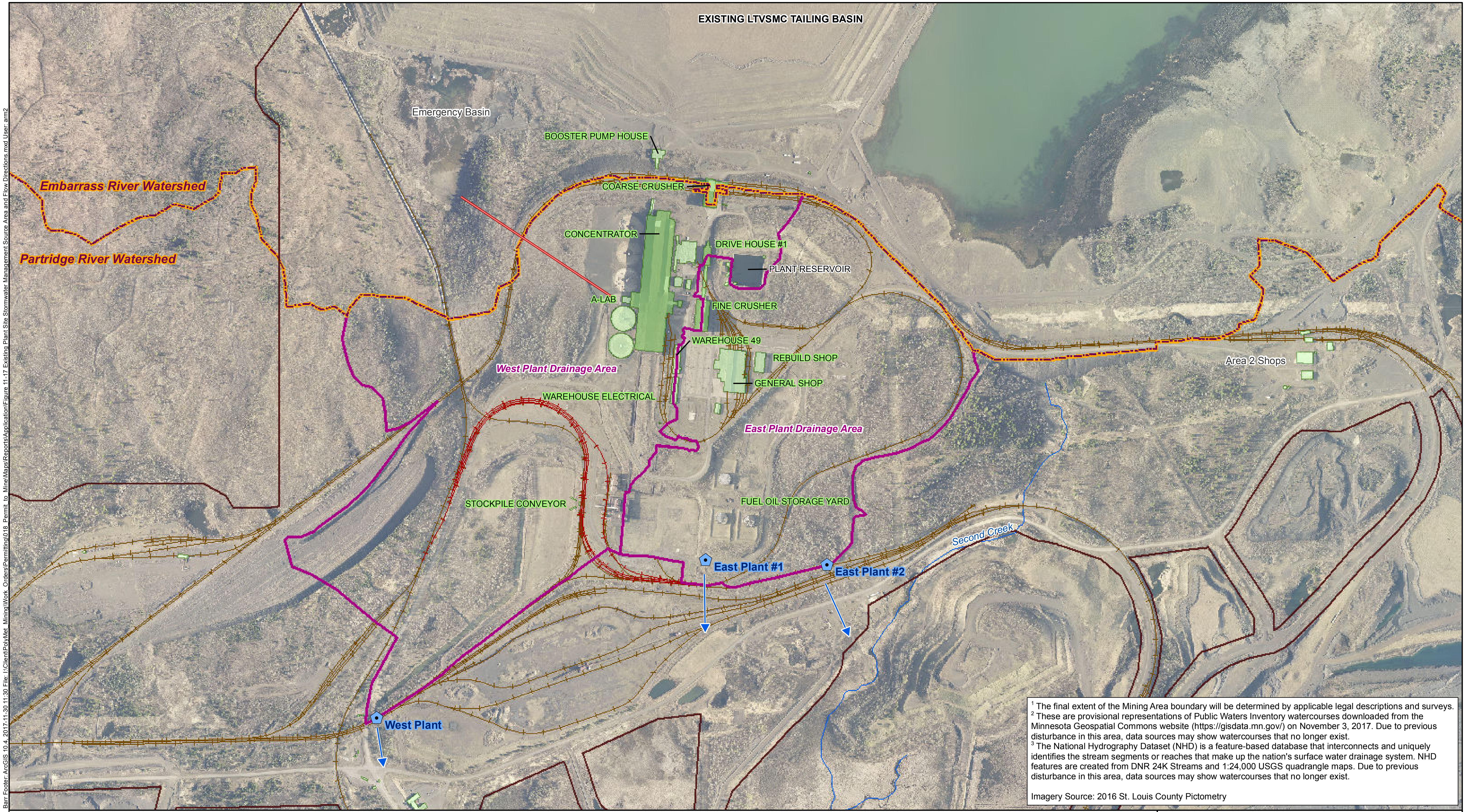
LEGEND:

M METER

NOTE:
POLYMET POTABLE WATER SYSTEM DESIGN BASIS, BARR TECHNICAL MEMO 7/31/15

POTABLE WATER TREATMENT SYSTEM
NorthMet Project
Poly Met Mining, Inc.

Figure 11-16
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

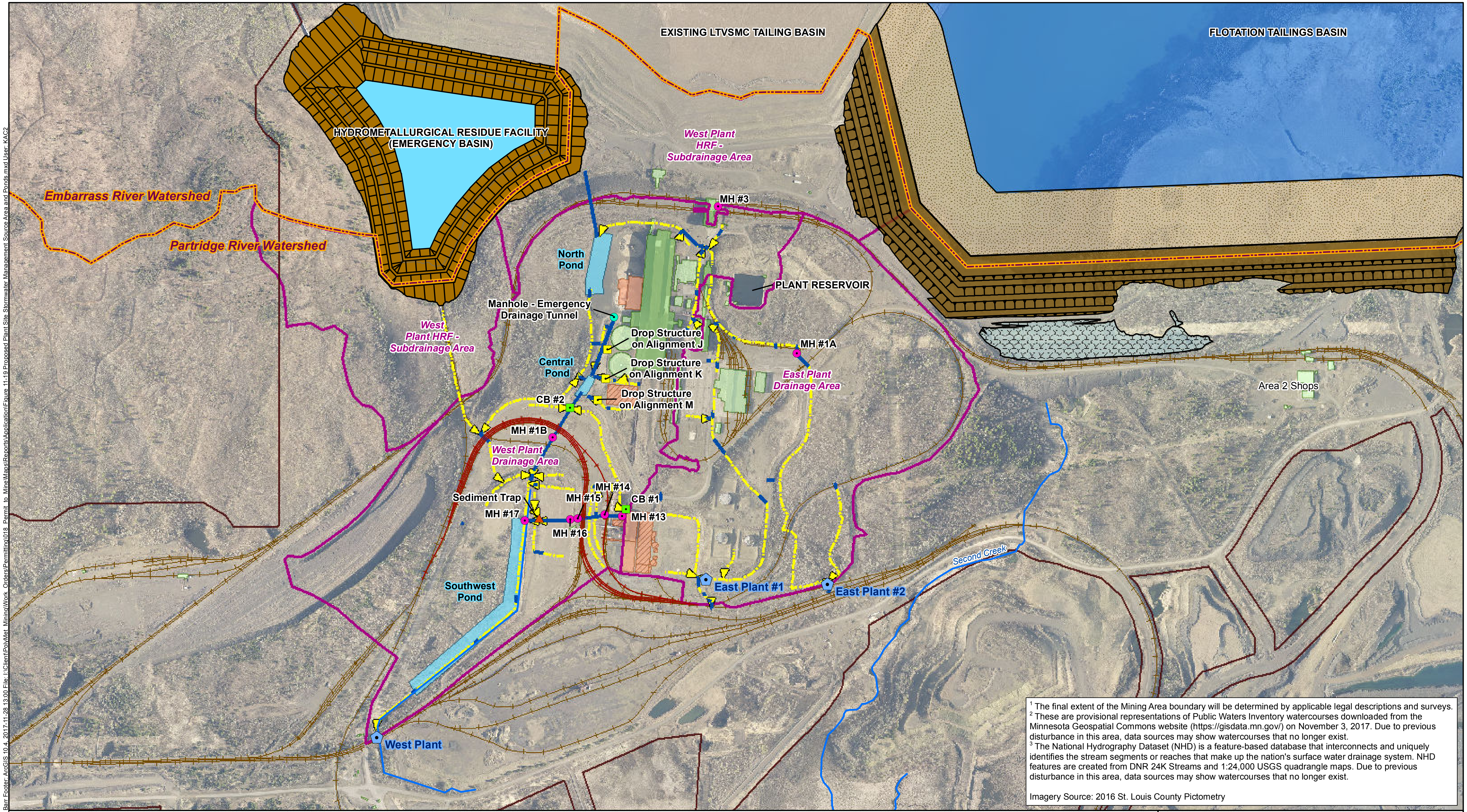
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Existing Railroads
- Proposed Railroads
- Plant Site Stormwater Discharge Location
- Existing Outflows
- Emergency Overflow Tunnel
- Watershed Boundary
- Plant Site Watersheds
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

0 450 900 1,800
Feet

EXISTING PLANT SITE STORMWATER MANAGEMENT SOURCE AREA AND FLOW DIRECTIONS
NorthMet Project
Poly Met Mining, Inc.

Large Figure 11-17
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

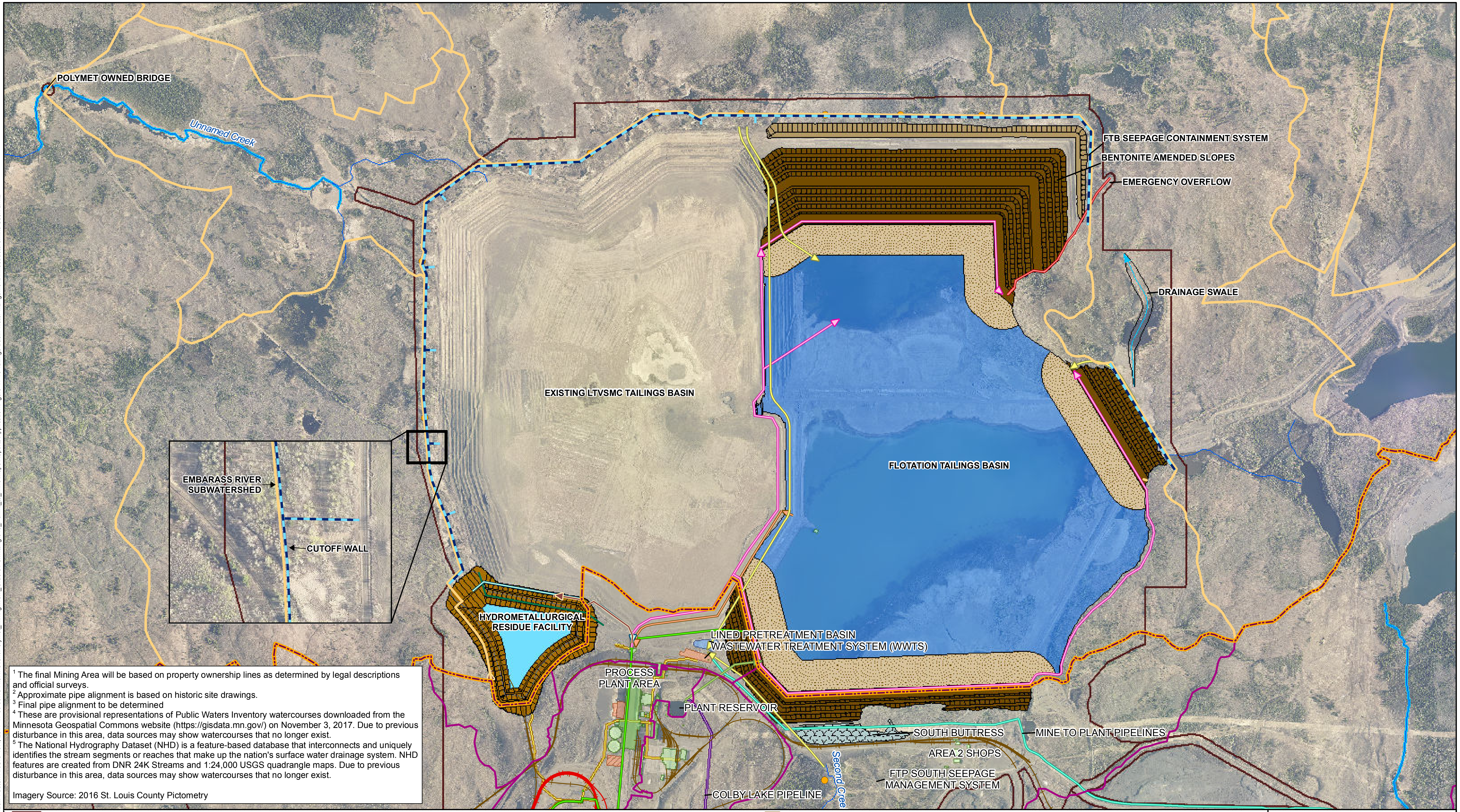
Barr Footer: ArcGIS 10.4, 2017-11-28 13:00 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 11-19 Proposed Plant Site Stormwater Management Source Area and Ponds.mxd User: KAC2

- Mining Area[1]
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- Existing Railroads
- Proposed Railroads
- Catch Basin
- Manhole
- Manhole - Emergency Drainage Tunnel
- Sediment Trap
- Drop Structure
- Plant Site Stormwater Discharge Location
- Stormwater Culvert
- Stormwater Ditch
- Stormwater Pond
- Mine Year 20 Footprints
  - Dam
  - Beach
  - Pond
  - South Buttress
- Hydrometallurgical Residue Facility Pond
- Hydrometallurgical Residue Facility Dam
- Watershed Divide
- Plant Site Watersheds
- Public Waters Inventory (PWI) Watercourse[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

0 450 900
Feet

PROPOSED PLANT SITE
STORMWATER MANAGEMENT
SOURCE AREA AND PONDS
NorthMet Project
Poly Met Mining, Inc.

Large Figure 11-18
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Approximate pipe alignment is based on historic site drawings.
[3] Final pipe alignment to be determined
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Existing Beneficiation Plant Building
- Existing Other Plant Building
- Proposed Beneficiation Plant Building
- Proposed Hydrometallurgical Plant Building
- Existing Railroads
- Proposed Railroads
- Colby Lake Pipeline
- Existing Sewer Pipe[2]
- Proposed Sewer Pipe[3]
- Mine to Plant Pipelines
- Surface Water Discharge Outfall
- FTB Seepage Containment System
- FTB Water Return Pipe
- FTB Tailings Discharge Pipe
- Tailings Basin Seepage Water Pipe
- Plant Reservoir Overflow
- FTB Seepage Collection Drain (under HRF)
- Return Water Pipe
- Residue Discharge Pipe

Mine Year 20 Footprints
- Hydrometallurgical Residue Facility Pond
- Hydrometallurgical Residue Facility Dam
- Dam
- Beach
- Pond
- North Buttress
- South Buttress
- Watershed Divide
- Embarrass River Subwatersheds
- Partridge River Subwatersheds
- Public Waters Inventory (PWI) Watercourses[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

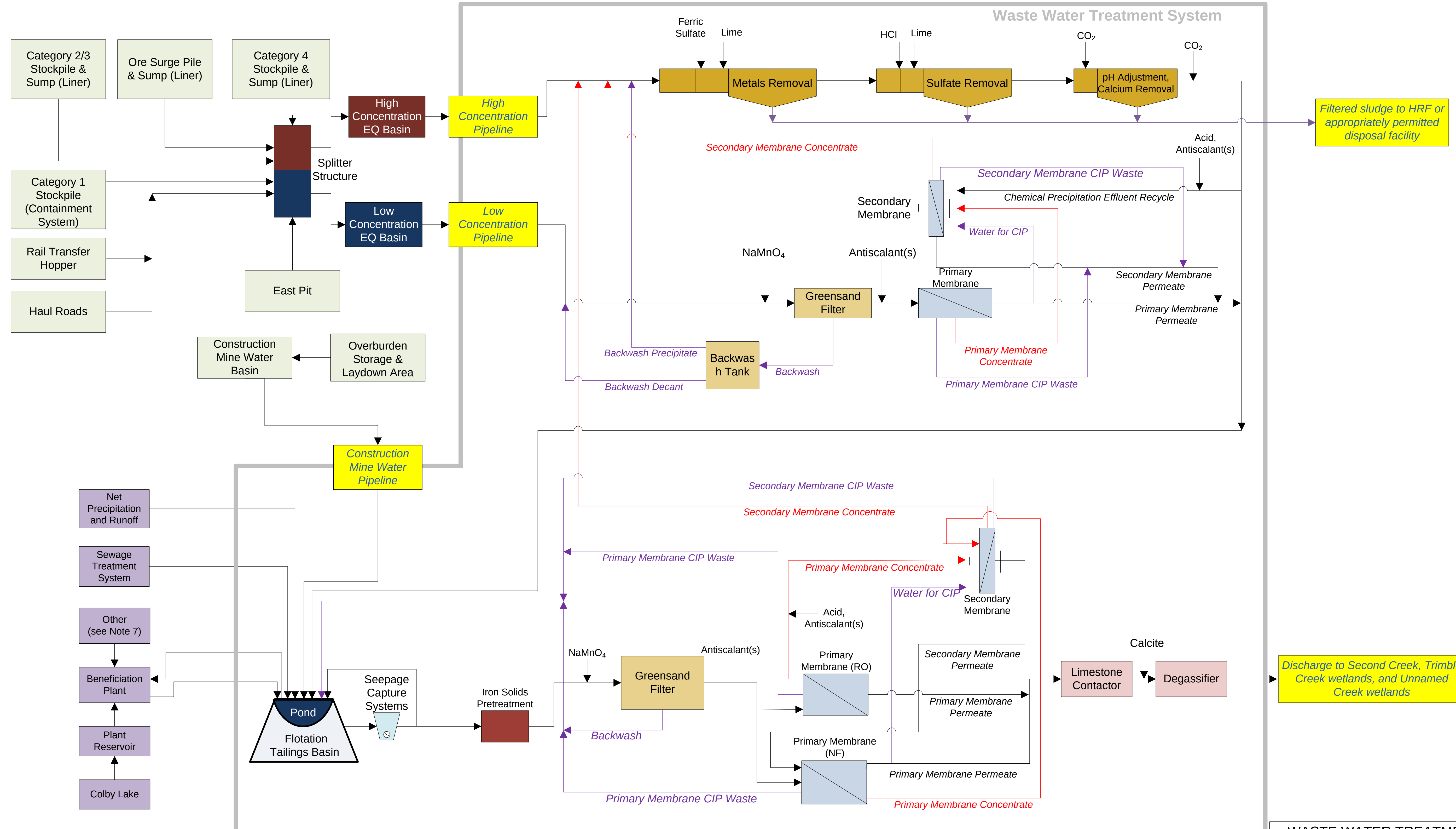
0 900 1,800
Feet

Figure 11-15 shows the Process Plant Area Water Management Infrastructure
Figures 11-18 and 11-19 shows the Stormwater Management Infrastructure

TAILINGS BASIN WATER MANAGEMENT INFRASTRUCTURE
NorthMet Project
Poly Met Mining, Inc.

Figure 11-19
Permit to Mine Application

Barr Footer: ArcGIS 10.4, 2017-11-30 09:18 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 11-19 Tailings Basin Water Mangement Infrastructure.mxd User: arm2



Legend

- Forward flow
- Membrane concentrate flow
- Intermittent flows for filter cleaning

Notes:

(1) This figure shows the Waste Water Treatment System flow configuration at the beginning of operations.

(2) Other inflows to the Beneficiation Plant include water in the raw ore, reagents, and gland seals of slurry pumps.

WASTE WATER TREATMENT SYSTEM OVERALL FLOW SHEET
NorthMet Project
Poly Met Mining Inc.

Figure 11-20
Permit to Mine Application

12.0 Wetland Assessment and Mitigation

Wetland impacts associated with the Project are regulated under Section 404 of the CWA WCA, including Minnesota Rules, chapter 8420, and the PTM Regulations, specifically Minnesota Rules, part 6132.5300. In conjunction with the Section 404 permitting process, PolyMet and the Co-Lead Agencies thoroughly evaluated wetland impacts in the FEIS, with input and review by USEPA. In addition, the Section 404 authorization process requires certification under CWA Section 401 that the Project will meet applicable Minnesota water quality standards. As documented in detail in the FEIS (Appendix 16.1) and the Wetland Replacement Plan (Appendix 18.1), PolyMet designed the Project to meet CWA Section 401 and 404 requirements, Minnesota's water quality standards, and WCA requirements.

Regulations under Section 404 of the CWA and WCA require that PolyMet avoid, minimize, and mitigate wetland impacts associated with the Project. If such impacts cannot be avoided, then PolyMet must replace impacted wetlands by creating, enhancing, or restoring other wetland areas under a mitigation plan that meets Section 404 and WCA requirements and that is approved by USACE and DNR, respectively. Similarly, Minnesota's PTM Regulations and the regulations implementing WCA both require that, before a company can conduct a mining activity that will result in the "draining or filling of wetlands," the company must have mining and reclamation operating plans that include a wetland replacement plan approved by DNR (Minnesota Rules, part 6132.5300; Minnesota Rules, part 8420.0930, subpart 2). As part of this Application, PolyMet is submitting information on the proposed wetland bank that will be used to mitigate wetland impacts.

This Section 12.0 of the Application addresses the applicable wetland requirements by describing PolyMet's assessment of wetland impacts, documenting measures PolyMet took to avoid, minimize, and/or mitigate such impacts in its design of the Project, and summarizing PolyMet's plan to address unavoidable wetland impacts. The proposed wetland mitigation was designed to address the St. Paul District USACE policy and meet WCA requirements.

12.1 Identification and Assessment of Wetlands

PolyMet conducted delineations and functional assessments of wetlands potentially impacted by the Project within the following areas: Mine Site, Plant Site, Transportation and Utility Corridors, Railroad Connection Corridor, and Colby Lake Pipeline Corridor (Figure 12-1). PolyMet conducted these delineations and functional assessments in these Project areas between 2004 and 2012.

In 2013, an additional non-project area, the Second Creek area, was evaluated for wetlands using aerial photograph review. The purpose of evaluating the Second Creek area was to provide data regarding potential indirect wetland impacts associated with stream flow augmentation activities for Second Creek. No Project construction is planned in the Second Creek area.

PolyMet conducted the wetland delineations according to the Routine On-Site Determination Method specified in the USACE Wetland Delineation Manual (Reference (58)). PolyMet classified the wetlands using the Wetland Community Classification System (Reference (13)) and the USFWS Circular 39

Classification System (Reference (59)). More information on the wetland delineation can be found in Section 3.1 of the Wetland Data Package provided in Appendix 16.21. These wetlands are depicted and summarized on Figure 12-1 and Table 12-1, respectively.

There were 201 wetlands covering approximately 1,862 acres in the areas. The percentage (based on acreage) of Eggers and Reed wetland community types identified include: coniferous bog (47%); alder thicket (17%); shallow marsh (14%); coniferous swamp (9%); deep marsh (8%); hardwood swamp (2%); sedge meadow (1%); open bog (1%); wet meadow (1%); shrub-carr less than 1%); and shallow, open water (less than 1%) (Reference (13)).

The overall quality of these wetlands was evaluated using the Minnesota Rapid Assessment Method (MnRAM 3.0). Within the areas, 105 of the 201 wetlands (52%) were rated as high quality, 14 wetlands (7%) rated as moderate quality, and 82 wetlands (41%) rated as low quality. Low quality wetlands are located at the Plant Site, Colby Lake Pipeline Corridor, and within the Second Creek area. Moderate quality wetlands are located at the Mine Site, Plant Site, and Colby Lake Pipeline Corridor. High quality wetlands are located at the Mine Site and within the Transportation and Utility Corridors. See Section 11.0 of the Wetland Replacement Plan in Appendix 18.1 for more details on the types and quality of the wetlands delineated in each Project Area.

12.2 Consideration of Wetland Impact Avoidance and Impact Minimization/Mitigation

PolyMet prioritized avoiding, minimizing, and mitigating wetland impacts throughout the design and environmental review of the Project in accordance with the sequencing requirements in Minnesota Rules, part 8420.0520. This effort included exploration of a range of alternative configurations of the Project that affect the magnitude of the Project's direct wetland impacts. For a comprehensive analysis of the full range of alternatives explored and evaluated, see Section 3.2 of the FEIS (Appendix 16.1), and Sections 6.3, 6.4, 6.5, and 6.6 of the Wetland Replacement Plan (Appendix 18.1). This comprehensive alternatives analysis is briefly summarized below.

Since the Project is a mine, it must be located where the minerals are located and can be economically extracted from the ground. However, under wetland regulations, the Project is not "water-dependent", in that it does not rely on wetland features or functions to fulfill the basic purpose of the Project. In light of this, PolyMet engaged in an alternatives analysis that resulted in changes to the Project design that avoided certain impacts and mitigated or minimized other impacts. Table 12-2 summarizes modifications made to the Project plans to avoid and minimize potential wetland impacts and to reduce or eliminate wetland impacts over time. Overall, the modifications for the Project have reduced the potential for all wetland impacts from approximately 1,320 acres to 930 acres:

- minimize the footprint and optimize the placement of mining features, mainly at the Mine Site
- maintain a smaller disturbance footprint by re-using existing infrastructure, mainly at the Plant Site brownfield site

- use existing facilities and structures, to the extent practicable, to support ongoing activities, mainly at the Plant Site, Transportation and Utility Corridors, and Colby Lake Pipeline Corridor
- maintain future tailings disposal in a single location and within the existing watershed where the current facility is located
- expand the existing tailings disposal site upward, to the extent geotechnically practicable, thus disturbing less surface area while allowing more material to be placed in the same footprint
- collect mine water, which is water that has contacted surfaces disturbed by mining activities, and route it to the Plant Site for use as process water
- route stormwater away from areas of mining activity and then off site following existing drainage patterns to the extent practical
- install culverts to facilitate flow between wetland areas
- maintain Industrial SWPPPs, using BMPs, to prevent site erosion and subsequent downstream sedimentation
- collect and treat mine water and tailings basin seepage, and appropriately separate stormwater from mine water
- implement interim, concurrent (as practicable), and permanent reclamation at the site

12.3 Evaluation of Wetland Impacts

12.3.1 Methods

Where wetland impacts are unavoidable despite the comprehensive alternatives analysis described above, PolyMet evaluated the nature and scope of the projected impacts. The Wetland Work Plan (Attachment B of Appendix 16.21) describes the methods used to identify both direct wetland impacts and potential indirect wetland impacts for the Project.

12.3.2 Direct Wetland Impacts

For the impact analysis, PolyMet defined direct impacts as mining-related activities that result in filling or excavation within the boundaries of a wetland. This analysis used accepted tools and protocols as defined in the Wetland Work Plan (Attachment B of Appendix 16.21). Wetland types within the Project footprint were identified using the wetland community classification system (Reference (13)).

The direct impacts associated with each wetland within the Project Areas are shown in Table 12-1, and summarized by wetland type in Table 12-3. Of the 201 wetlands in the Project Areas, 127 wetlands will be directly impacted, totaling 903.3 acres of direct wetland impact. The Mine Site will contain the majority of direct wetland impacts (83%), followed by the FTB (15%), HRF (less than 1%), Dunka Road and Utility Corridor (less than 1%), and the Railroad Corridor (less than 0.1%). There will be no direct impacts in the Colby Lake Pipeline Corridor or the Second Creek area.

These direct wetland impacts will occur in the following wetland types: coniferous bog (56%), alder thicket (12%), coniferous swamp (9%), shallow marsh (8%), deep marsh (8%), sedge meadow (3%), wet meadow (2%), hardwood swamp (1%), open bog (1%), and shrub-carr (less than 1%).

The Project will also result in 26.9 acres of fragmented wetlands. Fragmented wetlands are remnants of a directly impacted wetland. The determination of fragmentation is based on an analysis of wetland type, source of hydrology, size of remaining wetland, location in the current watershed, location in the future watershed, connectivity to other wetlands, and direction of flow in the area; more details on fragmentation are provided in Section 5.2.1.1 of Attachment A of Appendix 18.1. As agreed upon with the Co-Lead Agencies during the EIS process, the acreage of fragmented wetlands will be treated as if directly impacted and included in the compensatory mitigation needed for the Project's direct impacts.

There will be 903.3 acres of direct wetland impacts and 26.9 acres of fragmented wetlands, for a total of 930.2 acres of wetland impacts treated as direct impacts. The locations of direct wetland impacts across the Mining Area are shown on Figure 12-2 through Figure 12-8. In the FTB, there is shallow drainage that flows on the southeastern side of the LTVSMC coal ash landfill which was artificially created to facilitate drainage off the landfill (Figure 12-6). The landfill was closed by placing layers of LTVSMC tailings, a liner, and soil on top of the coal ash with the final covered area seeded and mulched as upland. This 0.3-acre area is proposed as an incidental wetland under Minnesota Rules, part 8420.0930, subpart1 and Minnesota Rules, part 8420.0105, subpart 2, item D.

12.3.3 Potential Indirect Wetland Impacts

In addition to unavoidable direct wetland impacts that are addressed in the wetland mitigation plan, described in Section 12.5, PolyMet analyzed the potential for indirect wetland impacts. A detailed description of the potential indirect assessment methodology and results is provided in Section 5.2 of the Wetland Data Package (Appendix 16.21). The purpose of this analysis was to identify wetlands to be monitored for potential indirect impacts as part of the monitoring plan (Appendix 18.2) to be implemented under the Section 404 and WCA permits for the Project.

12.4 Wetland Mitigation

Wetland mitigation will be accomplished by purchasing compensatory mitigation credits from a wetland bank. Preference for the bank selection follows the preferential sequencing for compensatory mitigation per the Corps' St. Paul District Policy for Compensatory Mitigation in Minnesota (Reference (60)). Under that policy, the preference is that wetland mitigation banks under consideration be located in the Bank Service Area (BSA) #1, which is the BSA where the Project wetland impacts will occur.

Wetlands that are directly impacted and impacted by fragmentation will be replaced and mitigated by credit purchase from an off-site wetland bank (Section 14 of Appendix 18.1). PolyMet will purchase wetland bank credits in BSA #1, in the St. Louis River watershed, prior to construction of the Project.

12.4.1 State WCA Wetland Mitigation Overview

Based on the WCA wetland mitigation standards (Minnesota Rules, part 8420.0522, subpart 4), the mitigation credits are proposed at a ratio of one mitigation credit to one acre of wetland impact (1:1). The rationale for this proposal is that the mitigation credits will be purchased from a wetland bank within the same BSA as the project wetland impacts, all of which are in a greater than 80% area. See Table 12-4 for wetland replacement in accordance with the WCA using established wetland bank credits.

12.4.2 Federal CWA Wetland Mitigation Overview

PolyMet is working with the USACE St. Paul District to ascertain how many wetland bank credits will satisfy federal requirements. Based on the St. Paul District policy for wetland mitigation, the base ratio for compensation of wetland impacts is 1.5:1. Utilizing wetland bank credits located within the Project BSA allows for a 0.25:1 reduction from the base compensation ratio. Providing wetland bank credits of the same wetland type as the impacted wetlands (using the modified Eggers and Reed plant community classification system [Reference (13)) allows for a 0.25:1 reduction from the base compensation ratio. Finally, compensatory wetland mitigation that is established in advance of the impacts, which is typically the case for wetland bank credits, also allows for a 0.25:1 reduction from the base compensation ratio, but no less than a ratio of 1:1. A draft guidance document from the USACE St. Paul District for the Project states that an increase in the base ratio to 2:1 may be required for certain wetland types, but no details are provided for established wetland bank credits containing mature plant communities of the same type as the impacts (Reference (61)). The proposed credits for wetland mitigation using the USACE mitigation policy ratios for the Project are summarized in Table 12-5. A final decision on this compensation ratio has not yet been made. Any credits obtained are available for additional wetland impacts that may occur under WCA rules.

12.4.3 Wetland Monitoring Plan for Potential Indirect Wetland Impacts

There has been pre-Project wetland monitoring and there will be monitoring throughout the construction and operation phases to determine whether wetlands are indirectly impacted by Project activities. Wetland monitoring is being conducted for the Project to provide baseline data to use in identifying potential indirect impacts to wetlands that may be caused by Project activities. Monitoring is currently being conducted within wetlands identified as having a potential indirect wetland impact factor rating of 3, 4, and 5 and a sampling of those wetlands with factor ratings of 1 and 2 (Attachment A of Appendix 16.21). Hydrology, vegetation, and wetland boundaries will continue to be monitored, documented, and compared with baseline monitoring and reference wetlands to determine if indirect impacts occur during the construction and operations phases. A total of 56 wetland monitoring wells and five reference wells (61 total locations) have been installed to collect baseline hydrology data and to document potential indirect wetland impacts. The monitoring protocol is provided in the Monitoring Plan for Potential Indirect Wetland Impact (Attachment F of Appendix 18.2). This monitoring will continue for the period necessary to evaluate potential indirect impacts, though portions of the monitoring design may be altered to improve the design or to eliminate unnecessary data collection.

Pre-Project hydrology monitoring of wetlands and groundwater within and surrounding the Mining Area has been conducted since 2005 at well locations approved by USACE and DNR. Hydrology data collected from 2005-2009 are presented in reports submitted to USACE and DNR, as discussed in Appendix 18.1. During 2008 through 2011, there were 21 locations monitored for hydrology. During 2012-2017, there were 61 wetland locations monitored for hydrology (Large Figure 16 through Large Figure 18 of Appendix 18.1). In 2015, pre-Project baseline vegetation monitoring was completed in the wetlands that are currently monitored for hydrology. The hydrology monitoring and vegetation monitoring protocols are described in Appendix 18.2. Pre-Project monitoring did not include evaluation of wetland boundaries other than what was completed in the wetland delineation and baseline wetland type evaluation for the Project.

Pre-Project monitoring locations include five reference wetlands approved by the USACE and DNR to document the natural hydrologic fluctuations in wetlands that will not be affected by the Project. The reference wetland data will be used to facilitate interpretation of the Project hydrologic and vegetation data. At the Mine Site, wetland hydrology monitoring wells were installed in 2008 and 2014 in reference wetlands (Large Figure 16 and Large Figure 18 of Appendix 18.1). At the Plant Site, wetland hydrology monitoring wells were installed in 2010 and 2014 in reference wetlands (Large Figure 17 of Appendix 18.1).

Wetland hydrology monitoring will continue at the monitoring locations and at reference wetland locations every year throughout the growing season for the LOM. If it is determined that certain wells are not providing useful information, the monitoring may be modified with the approval of the USACE and DNR.

Wetland monitoring data will be submitted to the USACE and DNR annually for the LOM. Wetland hydrology data will be presented every year to show monitoring locations, hydrographs, and analysis of wetland hydrologic conditions in the context of precipitation conditions. Vegetation and wetland boundary data will be presented every five years and will be used to determine the acreage of impacts and potential indirect impacts that are not evident based on hydrologic data. Indirect impacts will be assessed in the annual reports to the extent possible. Acreage of indirect impacts will be determined, if any, and will be used to determine the requirements for wetland mitigation credits, if such credits are needed. If compensatory mitigation is necessary, credits will be proposed in the annual report (Appendix 13.1).

Table 12-1 **Summary of Wetlands in Project Areas**

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	1	3	0.42	0	0	0.42	Shallow marsh	Moderate	
Mine Site	3	3	0.35	0	0	0.35	Shallow marsh	Moderate	
Mine Site	5	2	0.61	0.61	0	0	Wet meadow	High	F
Mine Site	6	3	0.62	0	0	0.62	Shallow marsh	Moderate	
Mine Site	7	2	0.07	0	0	0.07	Wet meadow	Moderate	
Mine Site	8	2	6.80	6.80	0	0	Sedge meadow	Moderate	F,E
Mine Site	9	3	1.80	0.07	0	1.73	Shallow marsh	High	F
Mine Site	10	2	1.17	0	0	1.17	Sedge meadow	High	
Mine Site	11	8	8.88	0	0	8.88	Coniferous bog	High	
Mine Site	12	6	0.13	0	0	0.13	Alder thicket	High	
Mine Site	13	4	5.03	0.09	0	4.94	Deep marsh	High	F
Mine Site	14	2	0.33	0.33	0	0	Wet meadow	High	F
Mine Site	16	3	0.31	0	0	0.31	Shallow marsh	High	
Mine Site	18	3	18.90	18.9	0	0	Shallow marsh	High	E
Mine Site	19	3	1.68	0.05	0	1.63	Shallow marsh	High	E
Mine Site	20	2	17.06	16.96	0.10	0	Sedge meadow	High	E, Fr
Mine Site	22	3	1.43	0	0	1.43	Shallow marsh	High	
Mine Site	22A	7	0.89	0	0	0.89	Coniferous swamp	High	
Mine Site	24	6	0.80	0.39	0	0.41	Alder thicket	High	E
Mine Site	25	8	1.95	0	0	1.95	Coniferous bog	High	
Mine Site	27	8	1.07	1.07	0	0	Coniferous swamp	Moderate	E
Mine Site	29	3	12.02	0	0	12.02	Shallow marsh	High	
Mine Site	32	8	73.36	70.99	2.37	0	Coniferous bog	High	F,E, Fr
Mine Site	33A	6	18.46	5.77	0	12.69	Alder thicket	High	E
Mine Site	33B	7	4.56	0	0	4.56	Coniferous swamp	High	
Mine Site	37	6	2.39	2.39	0	0	Shrub-carr	High	F
Mine Site	43	6	8.29	7.26	0	1.03	Alder thicket	High	F
Mine Site	44	6	3.27	1.99	0	1.28	Alder thicket	High	E
Mine Site	45	6	37.55	28.83	3.58	5.14	Alder thicket	High	F,E, Fr
Mine Site	47	8	0.54	0.40	0.14	0	Open bog	High	F, Fr

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	48	8	89.16	27.80	1.86	59.50	Coniferous bog	High	F,E, Fr
Mine Site	48A	7	2.65	2.19	0.02	0.43	Coniferous swamp	High	F, Fr
Mine Site	51	6	7.47	7.45	0.02	0	Alder thicket	High	F, Fr
Mine Site	52	6	3.88	3.88	<0.01	0	Alder thicket	High	F,E, Fr
Mine Site	53	6	18.59	0	0	18.59	Alder thicket	High	
Mine Site	53A	7	2.35	0	0	2.35	Coniferous swamp	High	
Mine Site	53B	7	0.43	0	0	0.43	Coniferous swamp	High	
Mine Site	53C	7	2.88	0	0	2.88	Coniferous swamp	High	
Mine Site	54	7	4.11	0	0	4.11	Coniferous swamp	High	
Mine Site	54C	6	0.74	0	0	0.74	Alder thicket	High	
Mine Site	55	6	3.91	3.85	0.06	0	Alder thicket	High	F,E, Fr
Mine Site	56	8	2.79	2.79	0	0	Open bog	High	E
Mine Site	57	7	78.06	50.49	1.41	26.16	Coniferous swamp	High	F,E, Fr
Mine Site	58	6	34.58	0	0	34.58	Alder thicket	High	
Mine Site	60	6	6.71	6.71	0	0	Alder thicket	High	F
Mine Site	61	7	0.45	0	0	0.45	Coniferous swamp	High	
Mine Site	62	8	12.13	0	0	12.13	Coniferous bog	High	
Mine Site	64	7	0.31	0	0	0.31	Hardwood swamp	High	
Mine Site	68	7	23.81	10.89	0.09	12.83	Coniferous swamp	High	F,E, Fr
Mine Site	72	7	1.39	0	0	1.39	Coniferous swamp	High	
Mine Site	74	7	6.12	6.12	0	0	Hardwood swamp	High	E
Mine Site	76	8	3.92	2.21	0	1.71	Coniferous bog	High	E
Mine Site	77	8	13.01	0.92	<0.01	12.09	Coniferous bog	High	F,E, Fr
Mine Site	78	8	1.75	1.75	0	0	Coniferous bog	High	F
Mine Site	79	8	2.39	0	0	2.39	Coniferous bog	High	
Mine Site	80	8	0.29	0	0	0.29	Coniferous bog	High	
Mine Site	81	7	1.68	1.44	0.24	0	Coniferous swamp	High	F,E, Fr
Mine Site	82	8	62.40	60.77	1.63	0	Coniferous bog	High	F,E, Fr
Mine Site	83	8	3.99	0	0	3.99	Open bog	High	
Mine Site	84	8	1.33	0	0	1.33	Coniferous bog	High	
Mine Site	85	8	1.41	1.41	0	0	Coniferous bog	High	E

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	86	8	2.47	0	0	2.47	Coniferous bog	High	
Mine Site	88	8	5.58	2.84	0	2.74	Coniferous bog	High	F
Mine Site	90	8	176.08	34.22	0	141.86	Coniferous bog	High	F,E
Mine Site	90A	8	7.91	1.20	0	6.71	Open bog	High	F
Mine Site	95	8	2.54	2.54	0	0	Coniferous swamp	High	E
Mine Site	96	8	17.30	13.14	0	4.16	Coniferous bog	High	F,E
Mine Site	97	8	4.46	2.57	1.89	0	Coniferous bog	High	F,E, Fr
Mine Site	98	8	15.50	15.07	0.42	0	Coniferous bog	High	F,E, Fr
Mine Site	99	8	1.40	0.49	0	0.91	Coniferous bog	High	F,E
Mine Site	100	8	176.19	102.96	3.44	69.79	Coniferous bog	High	F,E, Fr
Mine Site	100A	6	1.66	1.66	0	0	Alder thicket	High	F
Mine Site	101	8	14.21	11.73	0.08	2.40	Coniferous bog	High	F,E, Fr
Mine Site	103	8	118.84	109.97	8.86	0	Coniferous bog	High	F,E, Fr
Mine Site	104	8	3.57	1.82	0.10	1.65	Coniferous bog	High	F, Fr
Mine Site	105	8	15.48	0	0	15.48	Coniferous bog	High	
Mine Site	107	8	40.92	31.63	0.10	9.19	Coniferous bog	High	F,E, Fr
Mine Site	107A	7	1.74	1.69	0.05	0	Coniferous swamp	High	F,E, Fr
Mine Site	107B	3	4.51	2.89	0	1.62	Shallow marsh	High	F,E
Mine Site	107C	6	27.60	27.60	0	0	Alder thicket	High	E
Mine Site	114	8	0.73	0.73	0	0	Coniferous bog	High	F
Mine Site	120	3	0.58	0.12	0	0.46	Shallow marsh	Moderate	E
Mine Site	200	7	6.36	6.36	0	0	Hardwood swamp	High	F
Mine Site	201	2	13.49	13.49	0	0	Wet meadow	High	F
Mine Site	202	8	3.11	3.11	0	0	Open bog	High	F
Mine Site	552	8	8.72	8.72	0	0	Coniferous bog	High	F
Mine Site	567	3	1.40	1.40	0	0	Shallow marsh	High	F
MINE SITE SUBTOTAL	**87**		**1297.78**	**751.52**	**26.46**	**519.77**		**80/87 High 7/87 Moderate**	
Railroad Connection Corridor	1038	7	0.07	0.07	0	0	Coniferous swamp	High	F
Railroad Connection Corridor	R-3	6	0.10	0.10	0	0	Shrub-carr	High	F
Railroad Connection Corridor	R-4	6	0.20	0.20	0	0	Alder thicket	High	F
Railroad Connection Corridor	R-5	3	0.07	0.07	0	0	Shallow marsh	High	F

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
RAILROAD CONNECTION CORRIDOR SUBTOTAL	**4**		**0.44**	**0.44**	**0**	**0**		**4/4 High**	
Dunka Road and Utility Corridor	22B	3	0.34	0.34	0	0	Shallow marsh	High	F
Dunka Road and Utility Corridor	22C	6	0.38	0.38	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	54A	7	0.60	0.60	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	54B	6	0.13	0.13	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	54D	7	0.09	0.09	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	390	6	0.41	0.41	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	392	6	0.14	0.14	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	394	7	0.64	0.64	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	395	7	0.01	0.01	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	396	6	0.65	0.65	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	400	8	0.14	0.14	0	0	Coniferous bog	High	F
Dunka Road and Utility Corridor	553	7	0.09	0.09	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	554	7	0.11	0.11	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	569	6	0.68	0.68	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	716	6	0.02	0.02	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	814	8	0.75	0.75	0	0	Coniferous bog	High	F
Dunka Road and Utility Corridor	862	6	0.78	0.78	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	1034	6	0.02	0.02	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	1035	6	0.16	0.16	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	1124	6	0.44	0.44	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	R-7	3	0.18	0.18	0	0	Shallow marsh	High	F
DUNKA ROAD AND UTILITY CORRIDOR SUBTOTAL	**21**		**6.76**	**6.76**	**0**	**0**		**21/21 High**	
FTB	251	6	1.43	1.43	0	0	Alder thicket	Moderate	C
FTB	272	4	1.11	1.10	0.01	0	Deep marsh	Low	C, Fr
FTB	278	6	1.04	0.23	0	0.81	Alder thicket	Low	C
FTB	279	6	4.84	3.33	<0.01	1.51	Alder thicket	Low	C, Fr
FTB	282	3	14.25	7.42	0	6.83	Shallow marsh	Moderate	C
FTB	284	6	2.92	2.51	0	0.41	Alder thicket	Low	C
FTB	290	7	0.48	0.37	0.02	0.10	Coniferous swamp	Moderate	F,E, Fr

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
FTB	292	4	1.71	1.71	0	0	Deep marsh	Low	C
FTB	307	3	0.78	0.78	0	0	Shallow marsh	Low	C
FTB	308	4	7.17	2.91	0	4.26	Deep marsh	Low	C
FTB	309	2	0.02	0.02	0	0	Wet meadow	Low	C
FTB	312	6	1.98	1.33	0	0.65	Shrub-carr	Low	C
FTB	314	3	24.87	6.01	0	18.86	Shallow marsh	Low	C
FTB	572	4	7.33	0.02	0	7.31	Deep marsh	Moderate	C
FTB	573	3	0.12	0	0	0.12	Shallow marsh	Low	
FTB	582	4	27.49	8.11	0	19.38	Deep marsh	Low	C
FTB	585	6	1.58	0	0	1.58	Alder thicket	Low	
FTB	586	4	1.89	1.53	0	0.36	Deep marsh	Low	C
FTB	587	3	0.97	0.17	0	0.80	Shallow marsh	Low	C
FTB	590	3	5.43	5.38	0	0.05	Shallow marsh	Low	C
FTB	591	4	2.71	0.70	0	2.01	Deep marsh	Low	C
FTB	593	4	9.80	8.47	0.15	1.18	Deep marsh	Low	C, Fr
FTB	594	4	0.06	0	0	0.06	Deep marsh	Low	
FTB	595	4	2.14	1.09	0.01	1.04	Deep marsh	Low	F, Fr
FTB	811	7	0.20	0.20	0	0	Coniferous swamp	Low	C
FTB	968	7	13.76	11.37	0	2.40	Coniferous swamp	Low	C
FTB	1027	6	0.20	0	0	0.20	Alder thicket	Moderate	
FTB	1125	2	0.07	0.07	0	0	Sedge meadow	Low	C
FTB	1126	7	0.69	0.69	0	0	Hardwood swamp	Low	C
FTB	1134	3	14.45	8.73	0.02	5.70	Shallow marsh	Low	C, Fr
FTB	1135	4	0.51	0	0	0.51	Deep marsh	Low	
FTB	1139	3	20.25	2.54	0	17.71	Shallow marsh	Low	C
FTB	1155	3	0.55	0.41	0.15	0	Shallow marsh	Low	C, Fr
FTB	1156	3	15.07	11.08	0.06	3.35	Shallow marsh	Low	C, Fr
FTB	1159	3	0.05	0	0.05	0	Shallow marsh	Low	Fr
FTB	1160	5	0.85	0	0	0.85	Deep water	Low	
FTB	1176	7	0.34	0	0	0.34	Hardwood Swamp	Moderate	
FTB	P10	6	0.34	0	0	0.34	Alder thicket	Low	

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
FTB	T1	4	1.93	0.11	0	1.82	Deep marsh	Low	F
FTB	T2	4	0.90	0.90	0	0	Deep marsh	Low	F
FTB	T3	2	0.09	0.09	0	0	Wet meadow	Low	F
FTB	T4	2	1.02	1.02	0	0	Wet meadow	Low	F
FTB	T5	2	0.24	0.24	0	0	Wet meadow	Low	F
FTB	T6	6	0.07	0.07	0	0	Shrub-carr	Low	F
FTB	T7	3	0.92	0.92	0	0	Shallow marsh	Low	F
FTB	T10	4	1.48	1.48	0	0	Deep marsh	Low	F
FTB	T11	4	0.95	0.95	0	0	Deep marsh	Low	F
FTB	T12	3	0.39	0.39	0	0	Shallow marsh	Low	F
FTB	T13	4	1.05	0.97	0	0.08	Deep marsh	Low	F
FTB	T13A	4	12.72	0.16	0	12.56	Deep marsh	Low	F
FTB	T14	4	45.20	45.20	0	0	Deep marsh	Low	E
FTB	T15	3	1.70	1.70	0	0	Shallow marsh	Low	F
FTB SUBTOTAL	**52**		**257.53**	**143.91**	**0.47**	**113.18**		**6/53 Moderate 47/53 Low**	
HRF	1159	3	0.62	0.62	0	0	Shallow marsh	Low	F
HRF SUBTOTAL	1		0.62	0.62	0	0		2/2 Low	
Colby Lake Water Pipeline Corridor	P1	4	0.23	0	0	0.23	Deep marsh	Low	
Colby Lake Water Pipeline Corridor	P2	6	0.03	0	0	0.03	Shrub-carr	Low	
Colby Lake Water Pipeline Corridor	P3	3	0.25	0	0	0.25	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P4	6	1.28	0	0	1.28	Shrub-carr	Low	
Colby Lake Water Pipeline Corridor	P5-1	4	0.77	0	0	0.77	Deep marsh	Low	
Colby Lake Water Pipeline Corridor	P5-2	3	0.14	0	0	0.14	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P6	3	0.18	0	0	0.18	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P7-1	3	0.11	0	0	0.11	Shallow marsh	Low	

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Colby Lake Water Pipeline Corridor	P7-2	3	1.90	0	0	1.90	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P8	2	0.07	0	0	0.07	Wet meadow	Low	
Colby Lake Water Pipeline Corridor	P9	2	1.28	0	0	1.28	Wet meadow	Low	
Colby Lake Water Pipeline Corridor	P10	6	0.41	0	0	0.41	Alder thicket	Low	
Colby Lake Water Pipeline Corridor	P11	6	0.03	0	0	0.03	Shrub-carr	Low	
Colby Lake Water Pipeline Corridor	P12	6	0.31	0	0	0.31	Shrub-carr	Moderate	
COLBY LAKE WATER PIPELINE SUBTOTAL	**14**		**6.99**	**0**	**0**	**6.99**		**1/14 Moderate 13/14 Low**	
Second Creek Area	1031	4	2.06	0	0	2.06	Deep marsh	Low	
Second Creek Area	1161	4	9.41	0	0	9.41	Deep marsh	Low	
Second Creek Area	1162	3	40.84	0	0	40.84	Shallow marsh	Low	
Second Creek Area	1163	7	14.80	0	0	14.80	Hardwood swamp	Low	
Second Creek Area	1164	6	8.23	0	0	8.23	Alder thicket	Low	
Second Creek Area	1165	7	6.25	0	0	6.25	Hardwood swamp	Low	
Second Creek Area	1166	3	28.04	0	0	28.04	Shallow marsh	Low	
Second Creek Area	1167	3	2.88	0	0	2.88	Shallow marsh	Low	
Second Creek Area	1168	5	0.36	0	0	0.36	Shallow, open water	Low	
Second Creek Area	1169	3	4.92	0	0	4.92	Shallow marsh	Low	
Second Creek Area	1170	4	3.32	0	0	3.32	Deep marsh	Low	
Second Creek Area	1171	6	3.87	0	0	3.87	Shrub-carr	Low	
Second Creek Area	1172	3	1.96	0	0	1.96	Shallow marsh	Low	
Second Creek Area	1173	5	0.93	0	0	0.93	Shallow, open water	Low	
Second Creek Area	1174	6	118.75	0	0	118.75	Alder thicket	Low	
Second Creek Area	1175	7	16.82	0	0	16.82	Coniferous swamp	Low	
Second Creek Area	P1A	4	0.61	0	0	0.61	Deep marsh	Low	
Second Creek Area	P2A	6	0.43	0	0	0.43	Shrub-carr	Low	
Second Creek Area	P3A	3	24.24	0	0	24.24	Shallow marsh	Low	
Second Creek Area	P4A	6	0.29	0	0	0.29	Shrub-carr	Low	

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Second Creek Area	P5-1A	4	0.03	0	0	0.03	Deep marsh	Low	
Second Creek Area	P5-2A	3	2.75	0	0	2.75	Shallow marsh	Low	
SECOND CREEK AREA SUBTOTAL	**22**		**291.79**	**0**	**0**	**291.79**		**22/22 Low**	
PROJECT TOTAL	**201**		**1,861.91**	**903.25**	**26.93**	**930.18**		**105/201 High 14/201 Moderate 82/201 Low**	

(1) The types of wetland impact are excavation (E), fill (F), fragmentation (Fr), and seepage containment system

Abbreviations:
FTB = Flotation Tailings Basin
HRF = Hydrometallurgical Residue Facility
Source: Adapted from Large Table 1 of Appendix 18.1

Table 12-2 Summary of Reduced Aquatic Ecosystem Impacts Based on Draft Alternative Development

Refinement made from Alternatives Evaluation	Project Aspects Changed	Environmental Impact Reduced
Mine Site Alternative in Draft EIS adopted as part of Project and refined based on additional drilling and engineering with Category 1 Stockpile Groundwater Containment System	Only Category 1 Waste Rock Stockpile is permanent – all other stockpiles relocated to the East Pit	Three permanent stockpiles and all associated long-term impacts were eliminated. Also, the highest sulfur rock will be backfilled into the East Pit and stored subaqueously.
	Move Temporary Category 4 Waste Rock Stockpile to be above Central Pit and Central Pit rescheduled so that floor of pit above East Pit backfill during operations	Reduce wetland impacts
	Eliminate a stockpile by combining the Category 2 and Category 3 waste rock into one stockpile, having a Category 4 Waste Rock Stockpile, and processing the lean ore as ore	Reduce wetland impacts
	Revise haul roads to reduce wetland fragmentation	Reduce wetland impacts
	Category 1 waste rock in East Pit or Category 1 Waste Rock Stockpile	Category 1 Waste Rock Stockpile can be closed, and cover system construction can begin in Mine Year 14 - less water flow through the pile once the cover is constructed.
	Replace Category 1 liner with Groundwater Containment System and pump collected water to WWTS	Capture and treat virtually all water from stockpile
	Maximize use of Category 1 rock and overburden for construction in above liner or below the water table applications	Any water that contacts these materials will be captured and treated, or used in an application where the redox conditions will not change
	Minor changes in pit and stockpile footprints due to updated drilling	Reduce wetland impacts
Category 1 Stockpile Cover System	ET cover system replaced with membrane cover system	Minimize long-term water flow through the stockpile
Waste Water Treatment System (WWTS)	Plan for sulfate treatment during operations and upgrade to Reverse Osmosis (RO) for long term	Project discharge meets current wild rice standard
New Concentrate Shipping Building near the Additive Plant with dewatering by filter instead of dryer	New dewatering equipment and required concentrate storage will not fit in existing building; alternate location evaluated	New building on previously disturbed ground = no wetland impacts
Relocate Hydrometallurgical Residue Facility	Move Hydrometallurgical Residue Facility from south end of Cell 2W to the Emergency Basin	Eliminate concerns about liner failure on location that is still settling and provide a virtually zero leakage liner system
FTB Seepage Containment System	Vertical wells on north side of FTB replaced by trench/barrier system on north and west sides	Capture and treat virtually all groundwater and surface seepage from FTB
Enhanced FTB Pond Cover (liner)	Additional bentonite amendment to further reduce seepage - results in routine overflow in closure	Further reduce seepage
Waste Water Treatment System (WWTS)	Pumping of excess water to Partridge River replaced by RO treatment of excess water also cleans up FTB pond to allow overflow in closure	Project discharge meets current wild rice standard
Adaptive Water Management Plan (AWMP)	Formal plan to adaptively manage water in operations, reclamation, and long-term closure via financially assured fixed and adaptive engineering controls that relies on mechanical treatment but has the ultimate objective of non-mechanical treatment in the long term	Provides a high degree of certainty in achieving water quality objectives based on proactive management; lessens impacts in the long term with low maintenance non-mechanical treatment

Abbreviations:
AWMP = Adaptive Water Management Plan
FTB = Flotation Tailings Basin
RO = reverse osmosis
WWTS = Waste Water Treatment System

Source: Adapted from Large Table 3 of Appendix 18.1

Table 12-3 Summary of Direct Wetland Impacts

Project Area	Circular 39 Wetland Classification	1	2	2	3	4	5	6	6	7	7	8	8		Wetland Total
	Eggers and Reed Wetland Community	Seasonally Flooded	Fresh (Wet) Meadow	Sedge Meadow	Shallow Marsh	Deep Marsh	Shallow, Open Water	Shrub-Carr	Alder Thicket	Hardwood Swamp	Coniferous Swamp	Open Bog	Coniferous Bog	Deepwater	
Mine Site	Direct Impact (acres)	0	14.43	23.76	23.43	0.09	0	2.39	95.39	12.48	70.31	7.50	501.74	0	751.52
	Fragmentation Impacts (acres)	0	0	0.1	0	0	0	0	3.66	0	1.81	0.14	20.75	0	26.46
	# of directly impacted wetlands	0	3	2	6	1	0	1	11	2	7	4	20	0	57
Railroad Connection Corridor	Direct Impact (acres)	0	0	0	0.07	0	0	0.10	0.20	0	0.07	0	0	0	0.44
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	1	0	0	1	1	0	1	0	0	0	4
Dunka Road and Utility Corridor	Direct Impact (acres)	0	0	0	0.52	0	0	0	3.81	0	1.54	0	0.89	0	6.76
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	2	0	0	0	11	0	6	0	2	0	21
FTB[1]	Direct Impact (acres)	0	1.37	0.07	45.53	75.41	0	1.40	7.50	0.69	11.94	0	0	0	143.91
	# of directly impacted wetlands	0	0	0	0.28	0.17	0	0	0	0	0.02	0	0	0	0.47
	# of directly impacted wetlands	0	4	1	13	16	0	2	4	1	3	0	0	0	44
HRF	Direct Impact (acres)	0	0	0	0.62	0	0	0	0	0	0	0	0	0	0.62
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Colby Lake Water Pipeline Corridor	Direct Impact (acres)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Area	Circular 39 Wetland Classification	1	2	2	3	4	5	6	6	7	7	8	8		Wetland Total
	Eggers and Reed Wetland Community	Seasonally Flooded	Fresh (Wet) Meadow	Sedge Meadow	Shallow Marsh	Deep Marsh	Shallow, Open Water	Shrub-Carr	Alder Thicket	Hardwood Swamp	Coniferous Swamp	Open Bog	Coniferous Bog	Deepwater	
Second Creek area	Direct Impact (acres)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	(acres)	0	15.80	23.93	70.45	75.67	0	3.89	110.56	13.17	85.69	7.64	523.38	0	930.18

(1) Wetland (0.0.3 acres) in FTB on the LTVSMC coal ash landfill is proposed as an incidental wetland incidental wetlands for purposes of WCA.

Abbreviations:
FTB = Flotation Tailings Basin
HRF = Hydrometallurgical Residue Facility
Source: Adapted from Large Table 2 of Appendix 18.1

Table 12-4 Wetland Replacment Requirements Proposed for WCA Utilizing Wetland Bank Credits from Bank Service Area #1

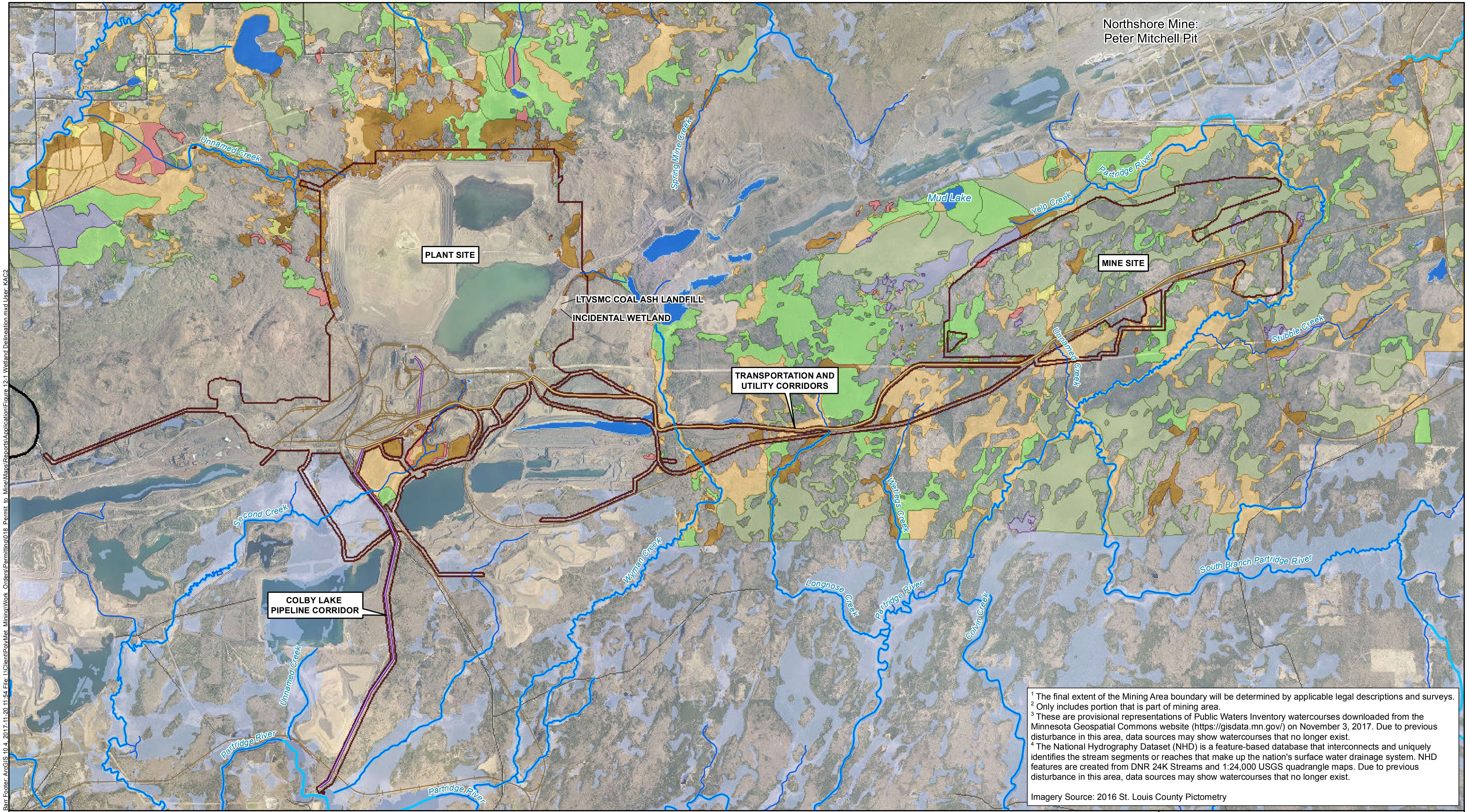
Wetland	NorthMet Project Proposed Direct Wetland Impacts (acres)(1)(2)	Bank Credits Required for Replacement(3)	Total Mitigation Ratio
Type 2 Fresh (Wet) Meadow(4)	15.80	15.80	1:1
Type 2 Sedge Meadow	23.93	23.93	1:1
Type 3 Shallow Marsh	70.45	70.45	1:1
Type 4 Deep Marsh	75.67	75.67	1:1
Type 5 Shallow, Open Water	0	0	1:1
Type 6 Shrub-Carr	3.89	3.89	1:1
Type 6 Alder Thicket	110.56	110.56	1:1
Type 7 Hardwood Swamp	13.17	13.17	1:1
Type 7 Coniferous Swamp	85.69	85.69	1:1
Type 8 Open Bog	7.64	7.64	1:1
Type 8 Coniferous Bog	523.38	523.38	1:1
Wetland Total	930.18	930.18	---

(1) Totals may not add exactly due to rounding.
(2) The total includes fragmentation of wetlands (26.93 acres).
(3) Per Minnesota Rules 8420.0522 Subp. 4.A.(1), the replacement ratio for withdrawal of existing wetland bank credits from within the project bank service area (#1) is 1:1 for a greater than 80% area.
(4) Wetland (0.0.3 acres) in FTB on the LTVSMC coal ash landfill is proposed as an incidental wetland incidental wetlands for purposes of WCA and is not included in the mitigation crediting.

Table 12-5 Wetland Mitigation Credits Proposed for USACE Using Wetland Bank Credits from Bank Service Area 1

Wetland Type	NorthMet Project Proposed Direct Wetland Impacts in Acres(1)(2)					Total Credits Required for Mitigation at Base Ratio(3)(4)(5)(6)	Total Credits Required After Applying Incentives(7)	Applied Mitigation Ratio
	Non-forested, Non-bog, and Low or Medium Quality (Base Ratio 1.5:1)(3)	Non-forested, Non-bog, and High Quality (Base Ratio 1.75:1)(4)	Bogs and Forested, and Low or Medium Quality Wetlands (Base Ratio 1.75:1)(5)	Bogs, Forested, and High Quality (Base Ratio 2:1)(6)	Total Impacts			
Type 2 Fresh (Wet) Meadow(8)	1.37	14.43	0	0	15.80	27.31	19.41	1.23:1
Type 2 Sedge Meadow	6.87	17.06	0	0	23.93	40.16	28.20	1.18:1
Type 3 Shallow Marsh(9)	46.55	23.90	0	0	70.45	111.65	76.43	1.08:1
Type 4 Deep Marsh	75.58	0.09	0	0	75.67	113.53	75.69	1:1
Type 5 Shallow, Open Water	0	0	0	0	0	0	0	---
Type 6 Shrub-Carr	1.40	2.49	0	0	3.89	6.46	4.51	1.16:1
Type 6 Alder Thicket	7.50	103.06	0	0	110.56	191.61	136.33	1.23:1
Type 7 Hardwood Swamp	0	0	0.69	12.48	13.17	26.17	19.58	1.49:1
Type 7 Coniferous Swamp	0	0	13.03	72.66	85.69	168.12	125.28	1.46:1
Type 8 Open Bog	0	0	0	7.64	7.64	15.28	11.46	1.5:1
Type 8 Coniferous Bog	0	0	0	523.38	523.38	1,046.76	785.07	1.5:1
Wetland Total	139.27	161.03	13.72	616.16	930.18	1,747.04	1,281.95	1.38:1

(1) Totals may not add exactly due to rounding.
(2) The total includes fragmentation of wetlands (26.9 acres).
(3) Base ratio 1.5:1 per USACE St. Paul District Policy for wetlands that are not considered High quality or Difficult-to-Replace.
(4) Base ratio 1.75:1 per USACE May 29, 2013 Draft Memorandum for wetlands that are high quality.
(5) Base ratio 1.75:1 per USACE May 29, 2013 Draft Memorandum for wetlands that are difficult-to-replace, which includes forested swamp and bog communities.
(6) Base ratio 2:1 per USACE May 29, 2013 Draft Memorandum for wetlands that are high quality AND difficult-to-replace, which includes forested wetland and bog communities.
(7) Per USACE St. Paul District Policy, includes 0.25 reduction for "in-place" (within the project BSA) and 0.25 reduction for "in-advance" (Corps-approved mitigation bank credits) from the base ratio.
(8) Wetland (0.0.3 acres) in FTB on the LTVSMC coal ash landfill is located within the Cliffs Erie, L.L.C. (formerly LTVSMC) Permit to Mine permitted boundary of the Tailings Basin and is not federally regulated, so the acreage is not included in the mitigation crediting.
(9) Wetland ID 11(28.56 acres) in HRF is located within the Cliffs Erie, L.L.C. (formerly LTVSMC) Permit to Mine permitted boundary of the Tailings Basin and is not federally regulated, so the acreage is not included in the mitigation crediting.



Mining Area[1]
Dunka Road[2]
Existing Private Railroad
National Wetlands Inventory
Incidental Wetland

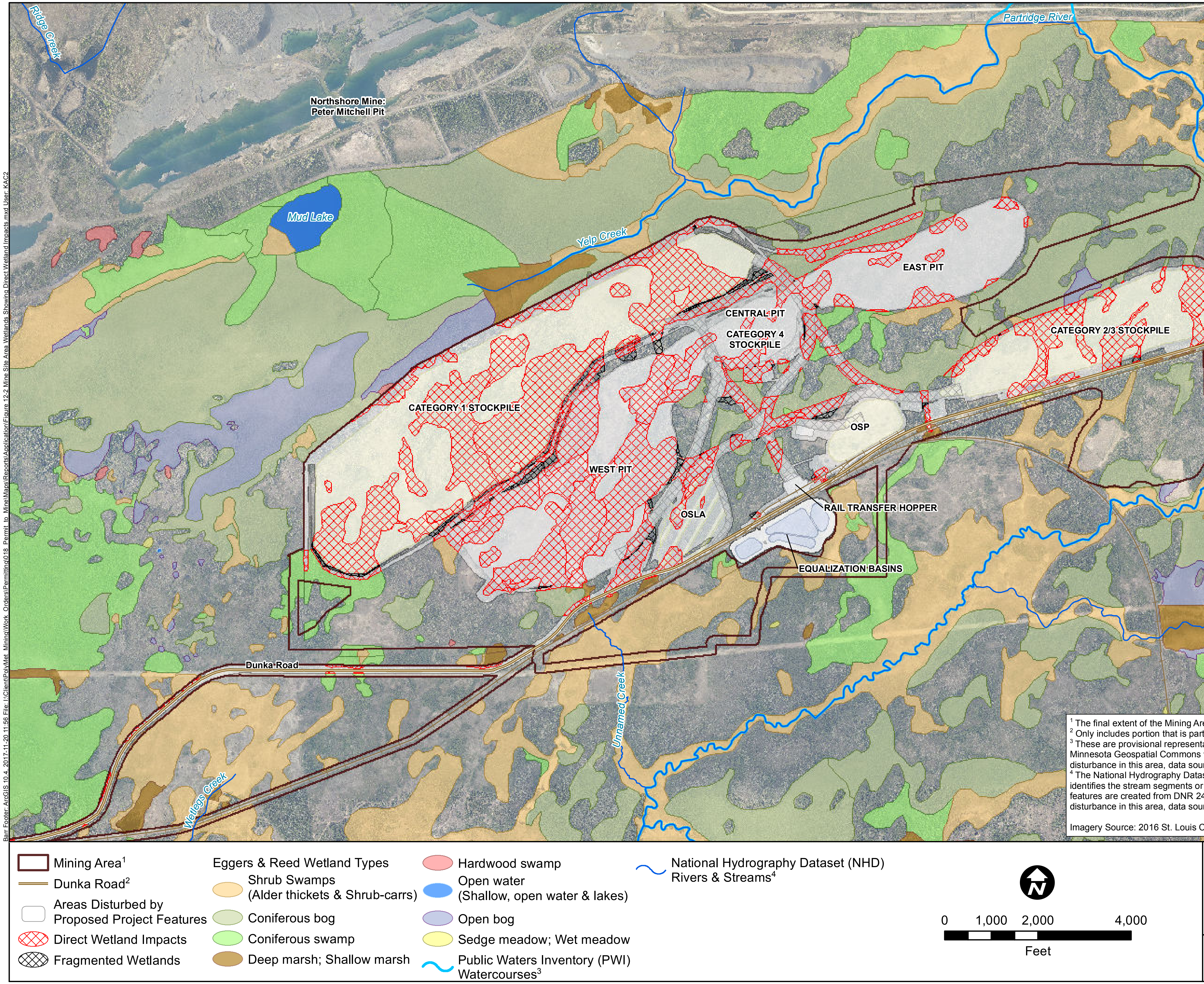
Eggers & Reed Wetland Types
Shrub Swamps (Alder thickets & Shrub-carrs)
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow; Wet meadow
Public Waters Inventory (PWI) Watercourses[3]

National Hydrography Dataset (NHD) Rivers & Streams[4]

0 0.5 1 2
Miles

WETLAND DELINEATION
NorthMet Project
Poly Met Mining, Inc.

Figure 12-1
Permit to Mine Application

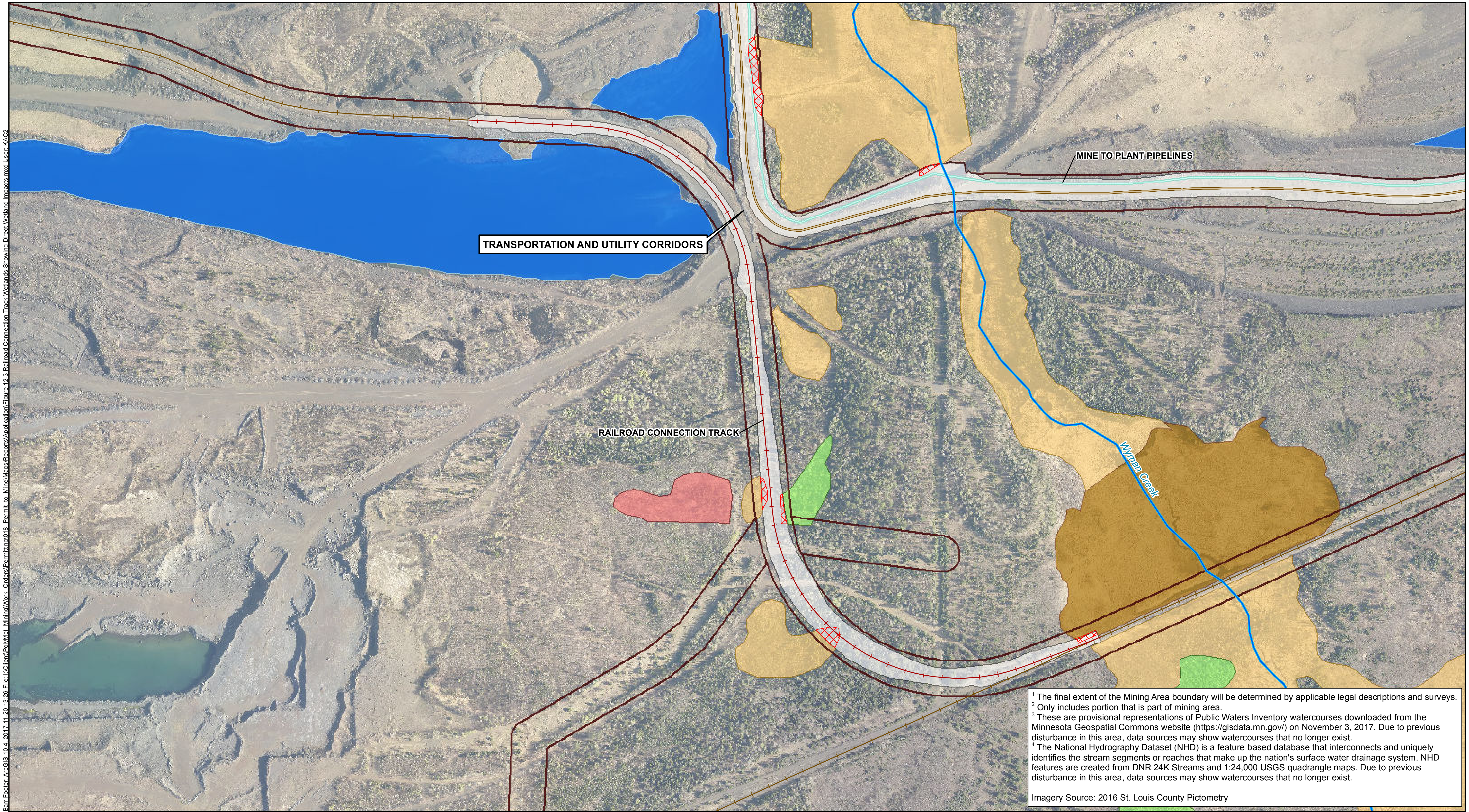


[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of mining area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

MINE SITE AREA WETLANDS SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-2
Permit to Mine Application



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[2] Only includes portion that is part of mining area.
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Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Proposed Track
Existing Railroad
Areas Disturbed by Proposed Project Features

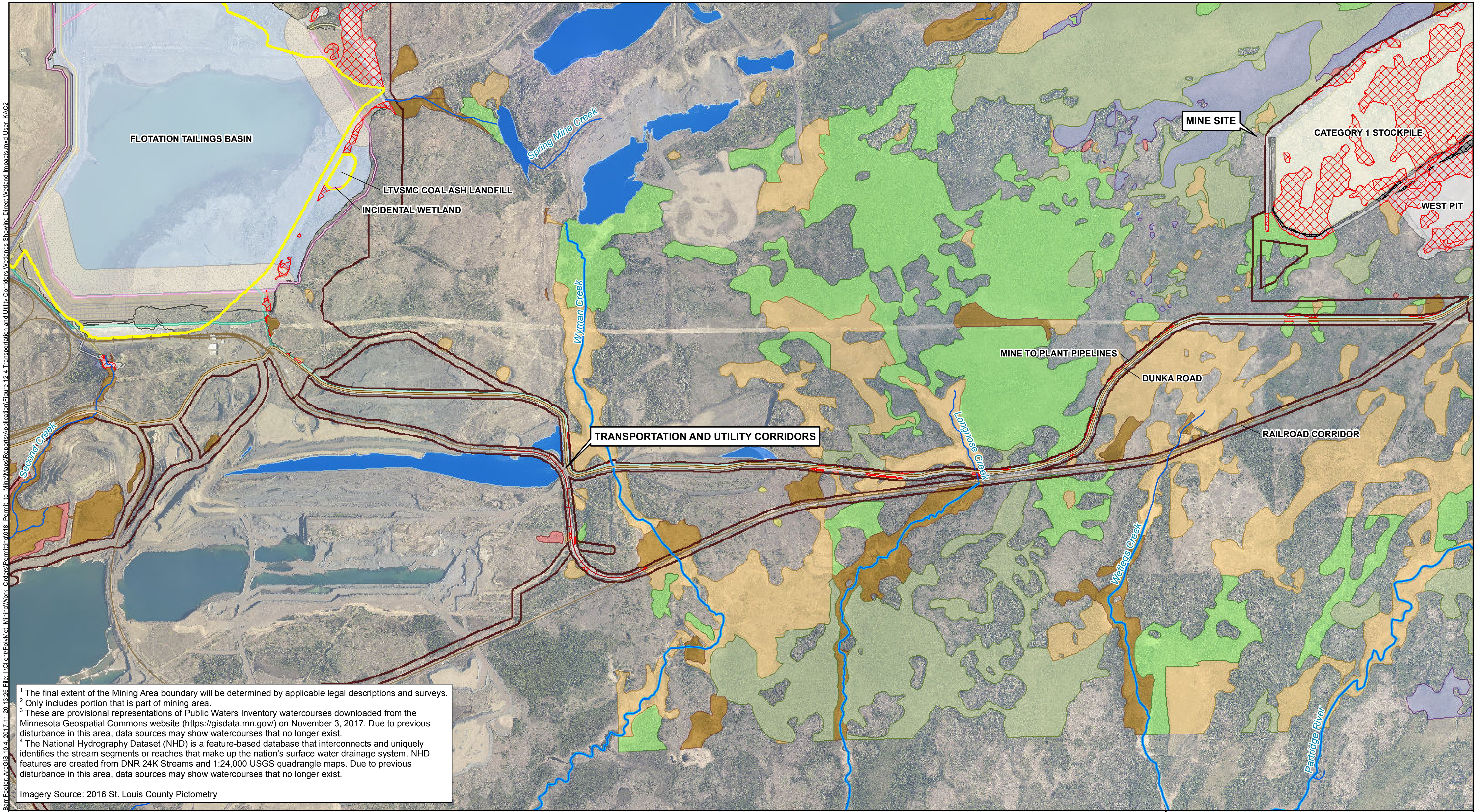
Direct Wetland Impacts
Fragmented Wetlands
Eggers & Reed Wetland Types
Shrub Swamps (Alder thickets & Shrub-carrs)
Coniferous swamp
Deep marsh; Shallow marsh

Hardwood swamp
Open water (Shallow, open water & lakes)
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

0 250 500 1,000
Feet

RAILROAD CONNECTION TRACK
WETLANDS SHOWING DIRECT
WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-3
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of mining area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Areas Disturbed by Proposed Project Features
LTVSMC's Permit to Mine Ultimate Tailings Basin Limit
Existing Private Railroad
Proposed Railroad Track
Incidental Wetland
Direct Wetland Impacts
Fragmented Wetlands

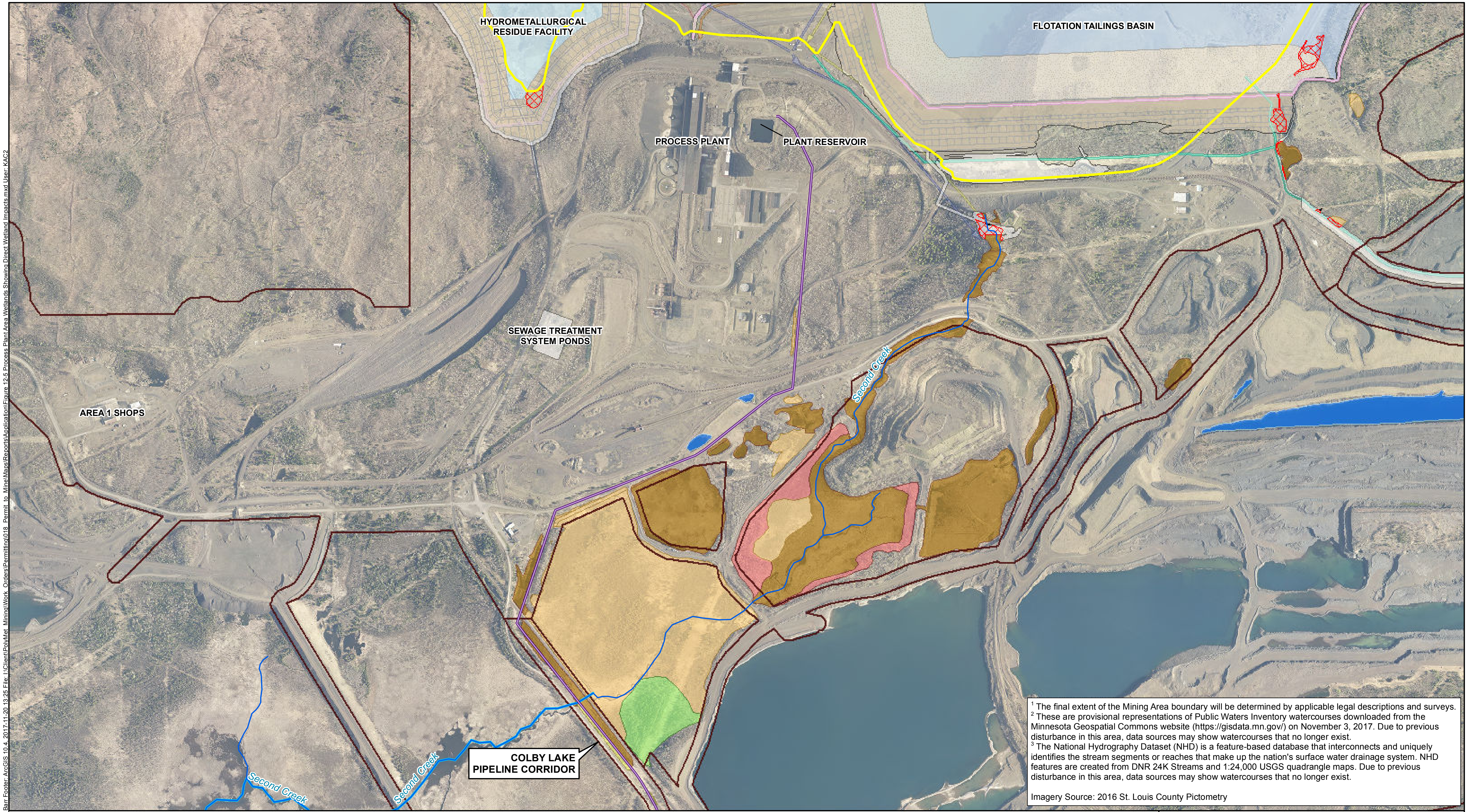
Eggers & Reed Wetland Types
Shrub Swamps (Alder thickets & Shrub-carrs)
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow; Wet meadow
Public Waters Inventory (PWI) Watercourses[3]
National Hydrography Dataset (NHD) Rivers & Streams[4]

N

0 1,000 2,000 4,000
Feet

TRANSPORTATION AND UTILITY CORRIDORS WETLANDS SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-4
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
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[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

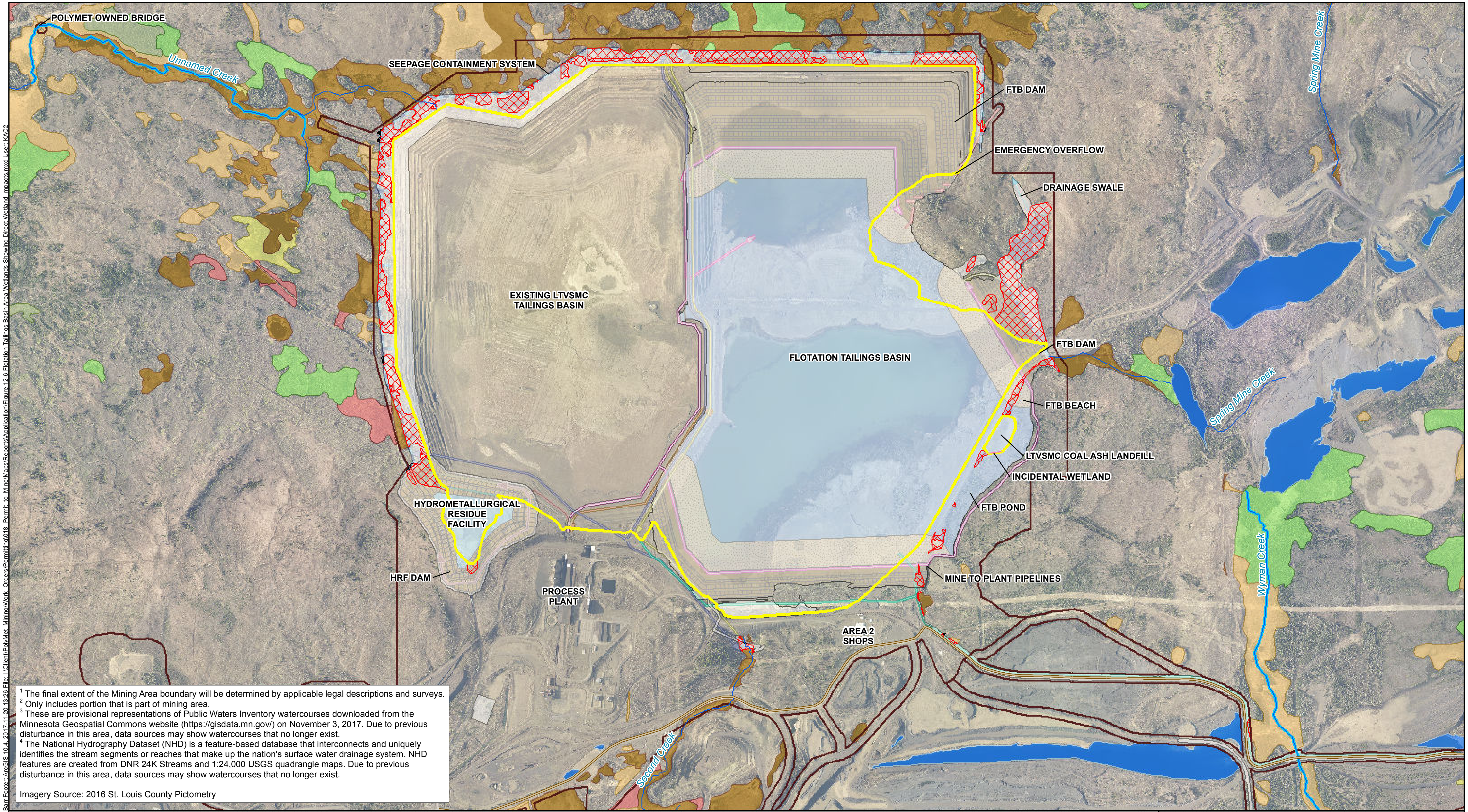
- Mining Area[1]
- Colby Lake Pipeline
- Areas Disturbed by Proposed Project Features
- LTVSMC's Permit to Mine Ultimate Tailings Basin Limit
- Direct Wetland Impacts
- Fragmented Wetlands

Eggers & Reed Wetland Types
- Shrub Swamps (Alder thickets & Shrub-carrs)
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Sedge meadow; Wet meadow
- Public Waters Inventory (PWI) Watercourses[2]
- National Hydrography Dataset (NHD) Rivers & Streams[3]

0 600 1,200 2,400
Feet

PROCESS PLANT AREA WETLANDS
SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-5
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of mining area.
[3] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

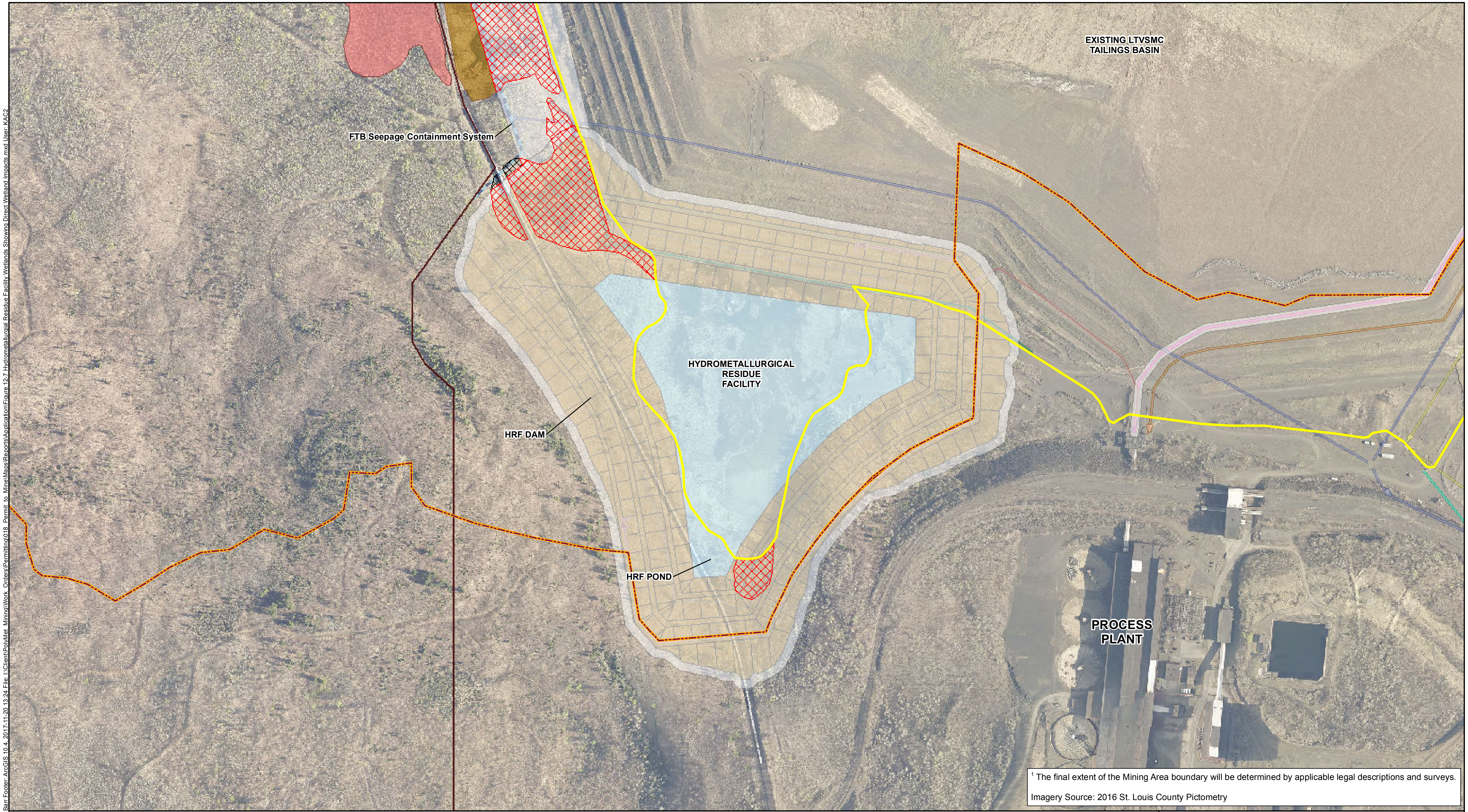
- Mining Area[1]
- Dunka Road[2]
- Areas Disturbed by Proposed Project Features
- LTVSMC's Permit to Mine Ultimate Tailings Basin Limit
- Incidental Wetland
- Direct Wetland Impacts
- Fragmented Wetlands

Eggers & Reed Wetland Types
- Shrub Swamps (Alder thickets & Shrub-carrs)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Sedge meadow; Wet meadow
- Public Waters Inventory (PWI) Watercourses[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]

0 1,000 2,000 4,000
Feet

FLOTATION TAILINGS BASIN AREA WETLANDS SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-6
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Areas Disturbed by Proposed Project Features
- LTVSMC's Permit to Mine Ultimate Tailings Basin Limit
- Watershed Divide
- Direct Wetland Impacts
- Fragmented Wetlands

Eggers & Reed Wetland Types

- Deep marsh; Shallow marsh
- Hardwood swamp

0 250 500 1,000
Feet

HYDROMETALLURGIAL RESIDUE FACILITY SHOWING DIRECT WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-7
Permit to Mine Application

[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[3] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Colby Lake Pipeline
Eggers & Reed Wetland Types
Shrub Swamps (Alder thickets & Shrub-carrs)
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Sedge meadow; Wet meadow
Public Waters Inventory (PWI) Watercourses[2]
National Hydrography Dataset (NHD) Rivers & Streams[3]

0 750 1,500 3,000
Feet

COLBY LAKE PIPELINE CORRIDOR
WETLANDS SHOWING DIRECT
WETLAND IMPACTS
NorthMet Project
Poly Met Mining, Inc.

Figure 12-8
Permit to Mine Application

13.0 Air Quality Management

13.1 Overview

The Project includes both mining and associated ore processing facilities. PolyMet will use conventional air pollution control techniques common to mining and other industrial operations. These control techniques include fabric filters, venturi and packed-bed scrubbers, and fugitive dust control procedures at various facilities, locations, and phases within the Project to provide levels of emission control that will protect human health and the environment. These control techniques are considered to be state-of-the-art with respect to air pollution control.

The MPCA, pursuant to its authority under state law and under the federal CAA as delegated by the USEPA, will be responsible for the air permitting for the Project. PolyMet anticipates that its pending application with MPCA for an air permit, if issued, will contain the necessary terms and conditions to protect human health and the environment as applicable to air quality management, and accordingly, those terms and conditions will not be duplicated in the Permit to Mine for the Project.

13.1.1 Regulatory Requirements

The FEIS determined that the Project "…has been shown to not cause or contribute to significant air quality effects" (Section 5.2.7, page 5-471 of Appendix 16.1). Furthermore, while not required by law, the FEIS process evaluated the potential local and regional effects, up to 180 miles from the Project, to demonstrate that its operation would not produce adverse impacts to sensitive resources such as the Boundary Waters Canoe Area Wilderness and Voyageurs National Park.

The Project design includes mitigation measures to control fugitive dust emissions. It also incorporates control technologies similar to the Best Available Control Technologies (termed BACT-like) established by USEPA to minimize potential air pollutant emissions. In particular, various facilities will use BACT-like emission controls for fine particulates to control any potential amphibole fibers in the ore. Best available controls to reduce mercury emissions to levels that will not impede the state of Minnesota's mercury emissions reduction goals will also be implemented.

With respect to the DNR's PTM Regulations, PolyMet designed its planned construction, operation, and reclamation activities to minimize potential adverse impacts to natural resources and the public, and to comply with applicable air quality requirements, including air pollution control and mitigation requirements. In particular, the Project will meet the siting requirements of Minnesota Rules, part 6132.2000, including setback and separation from adjacent non-mining land uses, and the buffer requirements in Minnesota Rules, part 6132.2100 to diminish impacts from mining activities on surrounding non-mining uses. In addition, PolyMet located and designed Project facilities, structures, and infrastructure to minimize and control air emissions from sources of fugitive particulates. PolyMet will implement BMPs such as using dust-suppression techniques and planting vegetation to minimize erosion in compliance with Minnesota Rules, parts 6132.2700 and 6132.2800. These regulations, administered by DNR, require the control of fugitive particulate emissions (referred to as fugitive dust or fugitive emissions in the remainder of Section 13) from areas disturbed by mining, processing, transportation, construction, operations, and reclamation activities. PolyMet's Fugitive Emissions Control (FEC; Appendix 12) Plans are designed to comply with the PTM Regulations' dust suppression requirements.

13.1.2 Air Permit Application

PolyMet submitted an application for an air permit to MPCA August 24, 2016. All references to the "air permit application" in Section 13.0 are to the pending application, including all associated supplemental and supporting information, submitted to MPCA for the Project.

The air permit application also includes regulatory analyses and proposed language for the operating permit to describe how the Project will comply with applicable state and federal statutes and regulations.

The air permit application also contains references to operating practices and processes to control air emissions, including the Effective Fenceline Control Plan (Appendix Q3 of Reference (62)), the FEC Plans (Appendix 12 of this Application), and the Special Purpose Monitoring Plan (Reference (63)). The Effective Fenceline Control Plan defines where and how PolyMet will control facility access providing the basis to prove compliance with ambient air quality standards. The FEC Plans, one for the Plant Site and one for the Mine Site and Transportation and Utility Corridors, describe actions PolyMet will implement during operations to minimize fugitive dust emissions. The Special Purpose Monitoring Plan (Reference (63)) describes collection of data to assess the effectiveness of the FEC Plans at minimizing fugitive dust generation and subsequent airborne transport.

13.2 Air Emissions Inventory and Emissions Estimate

13.2.1 Emissions within the Mine Site and Transportation and Utility Corridors

The emission sources at the Mine Site and Transportation and Utility Corridors will be mostly fugitive in nature, meaning the emissions cannot be routed to a stack or vent for control. Limited point source emissions will occur. The point source and fugitive emissions at the Mine Site and Transportation and Utility Corridors are shown on Figure 13-1 and are summarized below.

13.2.1.1 Point Source Emissions

Point source emissions will primarily be from portable space heaters and backup generators at the MSFMF. Emissions from these sources will be controlled with the use of low emitting fuels (propane for heaters and diesel fuel for generators). One of the small point sources at the Mine Site will be a lime silo with associated mixing equipment located in the vicinity of the MSFMF and the RTH. This silo is included in the air emissions inventory to account for the potential future lime need if powdered lime is preferred. PolyMet will control these emissions with a fabric filter on the silo vent. Details on air emissions and controls are provided in the Project’s air permit application (Reference (64)).

13.2.1.2 Fugitive Emission Sources

The open-pit mining operation and related transportation logistics will be the primary sources of fugitive emissions at the Mine Site and Transportation and Utility Corridors. These emission sources will include the following:

- Unpaved mine roads will generate dust from haul trucks and other vehicles moving ore, waste rock, and overburden, as well as other materials and personnel, around the Mine Site.
- Dunka Road will generate dust from PolyMet traffic transporting personnel, equipment, and materials through areas controlled by PolyMet, both at the Mine Site and in the Transportation and Utility Corridors.
- Material handling will produce fugitive emissions from the loading and unloading of haul trucks with overburden, waste rock, and ore and the loading of railcars with ore.
- Crushing and screening will generate dust from the processing of overburden and other approved rock for use in the construction of roads, dams, berms, etc., and as railroad ballast.
- Blasthole drilling will create fugitive emissions, both from drilling holes and from blasting.
- Rail traffic moving ore to the Plant Site is not expected to generate much dust in the Transportation and Utility Corridors, because the ore will be transported in large pieces in rail cars, minimizing the generation of dust.

PolyMet will minimize fugitive dust within the Mine Site and Transportation and Utility Corridors through the development and adoption of a FEC Plan. The FEC Plan includes control procedures for each source discussed above. This plan includes fugitive dust controls which will be used for the Mine Site roads to achieve a target control efficiency of 90% for Mine Site haul roads and 80% efficiency for the Dunka Road. The plan includes control procedures for each source.

The air permit application contains further detail on the FEC Plan for the Mine Site. The FEC Plan may be updated throughout the permitting process. Any updates to the plan will be provided to both the MPCA and DNR. PolyMet has also agreed to conduct special purpose ambient monitoring at the Mine Site including locations upwind and downwind of mining and transportation activities, based on prevailing winds, to demonstrate the performance of the FEC Plan. The plan was updated again after air permit application submittal, and the current version is included in Appendix 12.

13.2.2 Emissions within the Plant Site

The majority of emissions at the Plant Site will be from point sources. Fugitive emissions will primarily be from activities at the FTB and HRF. The point source and fugitive emissions at the Plant Site are shown on Figure 13-2 and are summarized below.

13.2.2.1 Point Source Emissions

The primary Plant Site point source emissions will include the following:

- The Beneficiation Plant will generate emissions from the crushing and grinding of ore, the flotation steps, and other elements of the concentration process. These emissions include the Beneficiation Plant operation from the ore railcar dumping to the flotation process where the minerals of interest are concentrated. Equipment for the storage and shipping of flotation concentrate will also be installed.
- The Hydrometallurgical Plant will generate emissions from various processes, including the autoclave and other tanks, equipment, and processes used to leach valuable metals from the nickel concentrate and, then separate and recover the valuable metals from the autoclave leach solution.
- Process consumables handling sources will create emissions in connection with handling, transferring, and storing additives used in the Beneficiation Plant, WWTS, and Hydrometallurgical Plant.
- Combustion sources and fuel tanks will generate emissions from equipment such as boilers, heaters, emergency diesel engines, and fuel oil and gasoline tanks.

PolyMet will use pollution control devices, and pollution prevention measures, as appropriate, so the Plant Site point sources will comply with all applicable state and federal air quality statutes and regulations. Details on air emissions and controls are provided in the Project's air permit application (Reference (64)).

13.2.2.2 Fugitive Emission Sources

There will be several sources of fugitive emissions at the Plant Site. PolyMet used the same emissions calculation procedures as those used for the Mine Site (where sources are similar) to determine the extent of the emissions. The fugitive emission sources at the Plant Site will be limited to the following:

- Limestone handling – There will be four fugitive sources associated with limestone handling:
    - transfers from the limestone conveyor coming from the railcar unloading building to the stacker conveyor
    - transfers from the stacker conveyor to the limestone stockpile
    - transfers via a front end loader to the reclaim pocket for conveyance to the limestone crusher in the additive plant
    - transfers from the reclaim feeder to the tunnel conveyor running to the limestone crusher
- FTB activities – There will be three tailings-related fugitive sources:
    - Emissions from the construction of FTB dams and the HRF.
    - Light truck traffic on unpaved roads.

    - Wind erosion off the portions of the FTB dams and beaches above the water line. (Wind erosion will be limited to the exposed beaches where the deposited tailings are not saturated with water and have not been stabilized with vegetation or other means. The water level will be managed such that exposed beaches will be kept to a minimum. To the extent practicable, erosion will also be controlled through vegetation for progressive reclamation of non-active portions of the FTB).

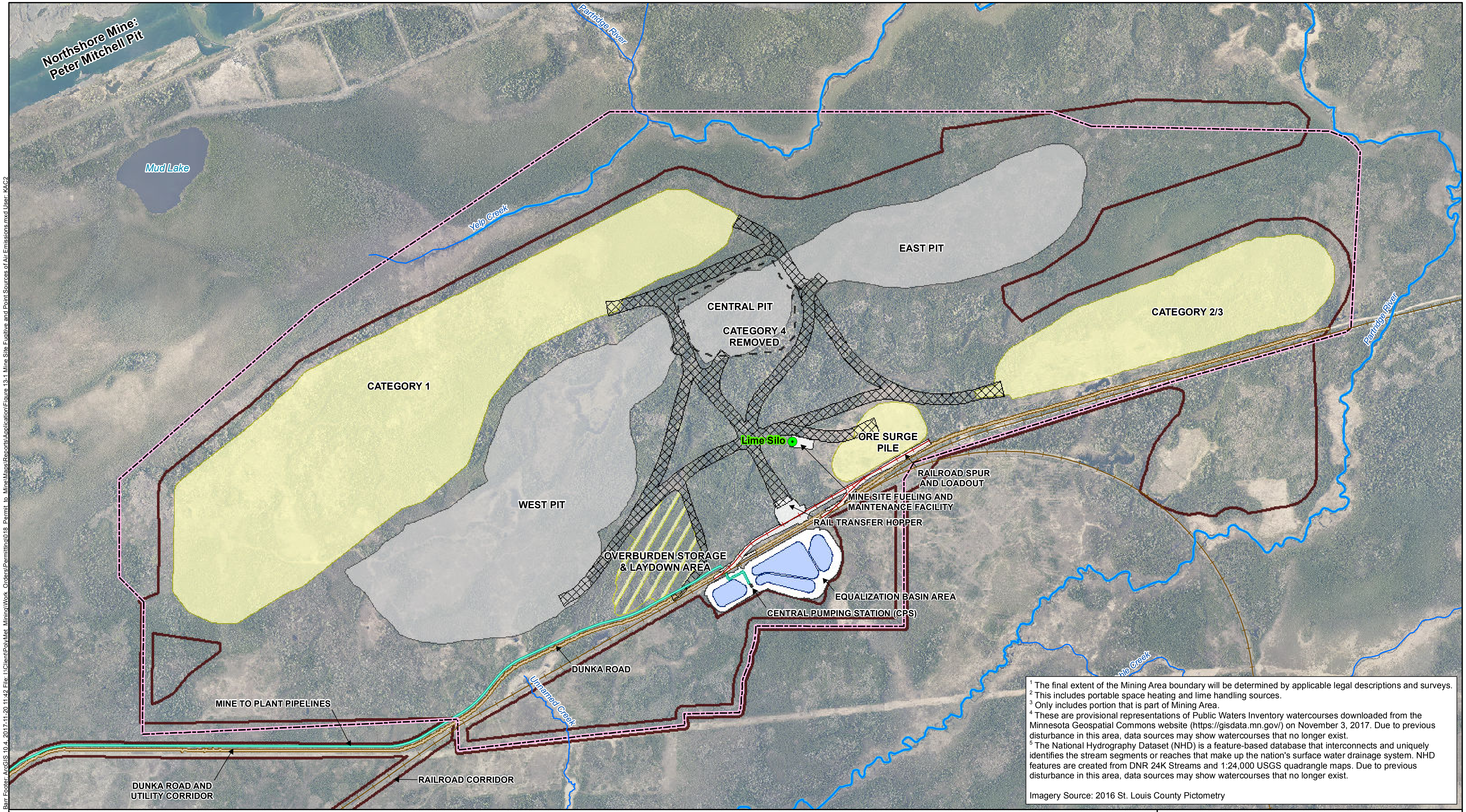
- Hydrometallurgical Plant –Fugitive emissions from the HRF will be minimized through management of Residue in a pond that substantially reduces the potential for fugitive dust. To the extent practicable, erosion will be controlled through use of vegetation in non-active portions of the HRF as part of progressive reclamation.

- General vehicle traffic – Light truck traffic on Plant Site roads will generate fugitive emissions.

- Miscellaneous storage stockpiles – Wind erosion may generate fugitive emissions from various small stockpiles stored on-site.

PolyMet will minimize Plant Site fugitive emissions through the development and implementation of a FEC Plan. Consistent with modeling conducted for the Project air permit and MPCA guidance, fugitive emissions controls will be used for the Plant Site roads to achieve 80% control of fugitive dust emissions. The FEC Plan includes control procedures for each source discussed above.

The air permit application contains the FEC Plan for the Plant Site. The FEC Plan may be updated during the permitting process. Updates to the FEC plan will be provided to both the MPCA and DNR. The FEC plan was updated after the air permit application submittal, and the current version is included in Appendix 12.



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] This includes portable space heating and lime handling sources.
[3] Only includes portion that is part of Mining Area.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Point Sources[2]
- Effective Fenceline
- Dunka Road[3]
- Existing Railroad
- Proposed Railroad
- Mine to Plant Pipelines
- Mine Year 11 Footprints
- Mine Pit
- Active Stockpile
- Storage & Laydown Area
- Removed Stockpile
- Haul Roads
- Public Waters Inventory (PWI) Watercourse[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

0 750 1,500 3,000
Feet

MINE SITE FUGITIVE AND POINT SOURCES OF AIR EMISSIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 13-1
Permit to Mine Application

[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Point sources data is from Air Quality Management Plant - Plant V7, December 2014, in Appendix 16 of the Application.
[3] Only includes portion that is part of Mining Area.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Point Source[2]
Point Source Not Modeled
Tailings Basin Construction Material Handling Source Locations
Effective Fenceline
Coal Ash Landfill
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Proposed Hydrometallurgical Plant Building
Dunka Road[3]
Existing Railroad
Proposed Railroad
Public Waters Inventory (PWI) Watercourse[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

N

0 1,500 3,000 6,000
Feet

PLANT SITE FUGITIVE AND POINT SOURCES OF AIR EMISSIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 13-2
Permit to Mine Application

14.0 Project Monitoring Programs

This Section 14.0 summarizes PolyMet's monitoring plans for the Project. The following information is summarized in this Section 14.0:

- Section 14.1 provides an overview of the Project monitoring
- Section 14.2 summarizes monitoring that will be completed per requirements of the PTM Regulations
- Section 14.3 summarizes monitoring that will be done under required permits including:
  - NPDES/SDS Permits administered by MPCA (Section 14.3.1)
  - Construction and Industrial Stormwater Permits administered by MPCA (Section 14.3.2)
  - Wetland Permits administered by DNR, MPCA, and USACE (Section 14.3.3)
  - Air Permit administered by MPCA (Section 14.3.4)
  - Water Appropriation Permits administered by DNR (Section 14.3.5)
  - Dam Safety Permits administered by DNR (Section 14.3.6)

14.1 Project Monitoring Overview

PolyMet will comprehensively monitor the Mine Site, Plant Site, and Transportation and Utility Corridors during construction, operations, reclamation, closure, and postclosure maintenance phases of the Project. Monitoring will occur at multiple levels that cover both operational and environmental aspects of the Project. PolyMet developed the monitoring programs to meet several goals summarized below:

- continuously assess the Project relative to the DNR's PTM Regulations
- include indicator monitoring as an early detection tool for operational performance
- determine compliance with conditions from required permits
- monitor performance of engineering infrastructure and pollution control facilities and equipment
- enable detection and assessment of any impacts related to the Project
- verify the long-term integrity and performance of reclamation and closure
- support and inform adaptive management

An overview of monitoring during the various stages of the Project, described below, is provided in Table 14-1. A proposed work plan documenting how some of the monitoring data discussed below will be used to assess the performance of water quality models relative to observed condition, facilitate ongoing use of the models, and confirm that the modeling assumptions and constructs are appropriate for continued use has been submitted to the MPCA as part of the NPDES/SDS Permit application (Appendix E of Reference (4)).

14.2 Permit to Mine Monitoring

The PTM Regulations, Minnesota Rules, chapter 6132, outline certain monitoring requirements. Most of these requirements are discussed in the reclamation standards in Minnesota Rules, parts 6132.2000 through 6132.3200. Monitoring programs to satisfy the PTM Regulations' requirements are listed below and described in the following sections:

- Mine pit monitoring
- Stockpile monitoring
- Transportation and Utility Corridors monitoring
- FTB and HRF monitoring
- Tailings monitoring
- Wetland monitoring

14.2.1 Mine Pit Monitoring

Monitoring will occur at the Mine Site to cover the following aspects of the Project:

- assessment of rock stability in the mine pit and slopes
- management of blasting in the pit
- monitoring of groundwater inflows into the pit (in conjunction with similar requirements for Water Appropriation permits)
- dust control (described in Section 14.2.6)

14.2.1.1 Mine Pit Stability Monitoring

PolyMet will conduct stability monitoring to verify the safety and stability of the mine pit walls, facilitate effective segregation of rock, and manage groundwater inflow to the mine pit. This will begin with planning the pit excavation, including slope angle, ramp width, and inter-ramp height, followed by monitoring, which will include the following:

- Collection of additional geotechnical and geological data – Data collection will include in-field mapping of rock type and structure, including joint frequency, joint spacing, joint angles, faults, and characteristics of contacts at joints, and collecting and confirming data on rock mass strength and joint strength through in-laboratory testing of rock core. Data will be collected throughout the LOM to continually assess and revise, if necessary, the interpretation of stratigraphy and stability.

- Geologic mapping of mine pit walls – Routine geologic and geotechnical observations will be an important part of slope management. Observations will result in monthly mapping of certain features during operations. This will also include monitoring for new rock types or formations encountered during mining that have not been previously characterized, as required under Minnesota Rules, part 6132.1300, subpart 2, item E.

- Slope stability monitoring – This monitoring will include weekly surveys of pit slopes, survey monuments, and inclinometers (used for pit wall movement monitoring as necessary) and daily visual inspections of pit walls and other features. Analysis of inter-ramp stability and global stability (deep-seated failure through the rock mass) using limit equilibrium and more complex numerical modeling will also be performed as appropriate.

- Slope pore water pressure assessment – If deemed necessary based on slope stability monitoring, PolyMet will monitor pore water pressure in the pit wall.

- Mine sequencing and development – This monitoring will include daily reporting of the types, amounts, sequence, and schedule of mining of the ore body, including the distinction among ore and waste rock, as required under Minnesota Rules, part 6132.1300, subpart 2, item A.

The above information will be developed and/or reviewed by on-site personnel and tracked in the Project files.

14.2.1.2 Blast Monitoring

PolyMet will conduct monitoring of blasting activities to verify compliance with overpressure and ground vibration requirements of Minnesota Rules, part 6132.2900, to limit the distance fly rock travels within the blast radius, and to maintain pit wall stability during blasting. Monitoring will include the following aspects:

- pre-blast warning, assessment of atmospheric conditions and timing
- control of blast area and explosives
- seismograph monitoring
- keeping and maintaining a blasters' log
- conducting vibration monitoring and air overpressure monitoring

Monitoring will be conducted consistent with the requirements of Minnesota Rules, part 6132.2900 at the nearest structures located on lands not owned or controlled by PolyMet; monitoring is discussed further in the Blasting Plan (Appendix 12.3). The specifics of the blast monitoring will be developed and/or reviewed by on-site personnel and tracked in the Project files.

14.2.1.3 Mine Pit Inflow Monitoring

During operations, mine pit inflow will be monitored to minimize indirect impacts to wetlands, maintain pit wall stability, and minimize the need for enhanced management and mitigation of pit inflows. Monitoring will also be used to assess the need for adaptive management or mitigation of pit inflows (Appendix 17.3). Monitoring will include the following:

- Groundwater monitoring – Water levels in specified groundwater monitoring wells completed in bedrock and the surficial deposits surrounding the pit will be monitored monthly as part of the Water Appropriation Permit requirements.
- Mine pit dewatering rates – Pumping rates from the mine pits will be monitored continuously as part of the Water Appropriation Permit requirements.
- Field inspections – Visual inspections will be performed to assess erosion of pit slope surficial soils, open fractures in mine pit walls, and wetland areas in the vicinity of the mine pits.
- Data review – Monitoring data and field observations will be compiled and reviewed to establish and monitor mitigation triggers, as described in the NorthMet Pit: Conceptual Plan for Bedrock Groundwater Flow Mitigation (Appendix 17.3).

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files.

14.2.2 Stockpile Monitoring

Stockpiles at the Mine Site will include several categories of waste rock (Categories 1, 2/3, and 4) and the OSP. In general, the monitoring program for each type of stockpile will include the following monitoring aspects:

- Placement verification monitoring – This type of monitoring will be performed daily, primarily for waste rock to verify proper placement and amounts of material into the appropriate stockpile.
- Survey monitoring – This type of monitoring will verify that the stockpile is built to the lines, grades, and slope as designed.
- Stability monitoring – PolyMet will use a combination of visual inspection and surveying to monitor the stockpiles for any irregular or unusual movements, including significant settling.
- Drainage monitoring – Surfaces will be regularly checked for water seeps and erosion; pipes and sumps will be checked for blockage; and outslopes will be checked for presence of seeps and material displacement.
- Dust control (described in Section 14.2.6).

Additionally, there will be confirmation sampling completed for the Category 1 Waste Rock Stockpile. Confirmation sampling will be performed to verify the average sulfur concentration of the stockpile. The stockpile will be sampled in a grid pattern across the surface of the stockpile, collecting composite samples in each grid cell to determine average sulfur content by grid cell. This sampling will be performed within a timeframe that would facilitate excavation of the material in the event of an exceedance of the maximum sulfur content of 0.12%. Details associated with this sampling is included in Section 4.1.6.5 of Appendix 11.1.

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files.

14.2.3 Transportation and Utility Corridors Monitoring

Monitoring will be performed along the Transportation and Utility Corridors to verify the integrity of ore rail car equipment, confirm pipeline integrity, and assess water quality along rail track areas. Monitoring will include the following aspects:

- Ore car inspections – Ore cars will be inspected daily to verify they meet certain specifications for transport of ore from the Mine Site to the Plant Site.
- Quarterly track inspections – Trained individuals will perform inspections for ore spillage and track integrity along track sections within the Transportation and Utility Corridors.
- Surface water monitoring – surface water monitoring will be conducted in Wyman Creek, Longnose Creek, and Wetlegs Creek to assess water quality in accordance with the NPDES/SDS Permit requirements (see Section 5.3 of Appendix 11.2 for additional details).
- Dust monitoring – Dust monitoring is described in Section 14.2.6.

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files.

14.2.4 FTB and HRF Monitoring

At the Plant Site, monitoring will take place at both the FTB and HRF to maintain safety and stability of the structures and minimize impacts to water resources. Following are the general types of monitoring that will be performed at both facilities:

- Material characteristics verification – Testing will take place during construction to verify materials used meet specifications for type, gradation, moisture content, and density. Ongoing tests on construction materials will continue while constructing features throughout operations. Post-construction testing (such as in-field Cone Penetration Testing and/or in-laboratory triaxial compression testing) will periodically be performed to confirm material strengths.
- HRF geosynthetics evaluation – Monitoring during construction will evaluate HRF geosynthetics' seam strength and seam integrity; compliance with specification for type, thickness, and strength; and installation quality and installation defects location and repair.

- Stability monitoring – Section 14.3.6 discusses the stability monitoring proposed under the Dam Safety Permit applications for the FTB and HRF.
- Vegetation and erosion control monitoring – Monitoring will be performed to confirm adequate density of vegetation on the dam slopes for erosion control.
- Seepage monitoring – The quantity of seepage that leaves the Tailings Basin and is captured by the FTB seepage capture systems will be continuously monitored in accordance with the NPDES/SDS Permit requirements and Water Appropriation Permit requirements. This monitoring is discussed in more detail in Sections 5.1 and 5.2 of Appendix 11.3. Seepage from the double-lined HRF is not anticipated, but to confirm this, monitoring for seepage will occur via groundwater quality monitoring near the facility as discussed in more detail in Section 5.2 of Appendix 11.3.
- Dust control (described in Section 14.2.6).

Information from this monitoring program will be developed and/or reviewed by on-site personnel and tracked in Project files.

14.2.5 Flotation Tailings Monitoring

The Flotation Tailings deposition within the FTB will periodically be tested for comparison with lab-scale test data used for the Tailings Basin performance modeling (geotechnical, geochemical). Tailings sampling and in-situ testing will be conducted using standard geotechnical subsurface exploration techniques, such as but not limited to:

- split spoon sampling
- cone penetrometer testing
- bulk sampling (by test pit or auger)

Characteristics of the tailings deposit to be tested will include:

- particle size distribution
- hydraulic conductivity
- in-situ strength and density
- mineralogy

Sampling distribution (horizontal) will be dependent on actual distribution of the tailings within the basin once basin operations begin. On a preliminary basis, sampling will occur within the first year of basin operations and on a biennial basis thereafter. Sample locations will be distributed over the area of tailings deposition; generally occurring as one sampling location per each 50 to 100-acre area having received flotation tailings since the last sampling event. Sampling frequency with depth at each sampling location will be dependent on the sampling method used and based on the overall thickness of the tailings deposit being sampled; frequency will be confirmed at the time that sampling occurs.

Information from this monitoring program will be developed and/or reviewed by on-site personnel and tracked in Project files.

14.2.6 Dust Control

PolyMet will maintain and follow a Mine Site Fugitive Emission Control (FEC) Plan and Plant Site FEC Plan (Appendix 12.1 and Appendix 12.2, respectively). The FEC Plans are an enforceable part of the air permit issued by the MPCA and the MPCA will approve all revisions to the Plans . The current version of the Mine Site and/or Plant Site FEC Plans will be included as an appendix to the Annual Report if the respective FEC Plan has been revised during the past year. If substantive changes are made to either the Mine Site or Plant Site FEC Plan, which would include any reduction in control techniques employed or associated corrective actions, monitoring, recordkeeping, and reporting requirements, PolyMet will submit the respective MPCA-approved FEC Plan to the DNR within 30 calendar days of MPCA approval.

An MPCA air quality permit deviation related to the FEC Plan would occur if PolyMet failed to follow the requirements of the FEC Plan or if dusty conditions led to a violation of an air quality rule, such as:

- Fugitive emissions observed beyond the property boundary
- Corrective action was not taken as required by the FEC Plans

The air quality permit deviations related to the FEC Plans that occurred during the previous calendar year will be reported in that calendar years Annual Report. Records described in the Mine Site or Plant Site FEC Plans will be available for review during an inspection or will be provided upon request from the DNR.

14.3 Other Permit Monitoring

Other permits upon issuance for the Project will provide detailed environmental monitoring requirements if required to meet conditions of each permit. The purpose of this Section 14.3 is to provide an overall summary of the monitoring proposed in the relevant permit applications. Actual monitoring requirements may change as permitting progresses on each specific permit. Other permits that set forth environmental monitoring requirements will include the following:

- NPDES/SDS
- Construction Stormwater
- Industrial Stormwater
- Wetlands
- Air Quality
- Water Appropriation

- Dam Safety

14.3.1 NPDES/SDS Permit Monitoring

The Project's NPDES/SDS Permit Application includes proposed monitoring relating to water quality. The NPDES/SDS Permit Application proposes monitoring for groundwater, surface water, surface water discharge from the WWTS, and internal waste streams. PolyMet will apply for construction stormwater and industrial stormwater general permit coverage via two or more separate permits from the MPCA. Monitoring stations are divided between the Plant Site and the Mine Site and Transportation and Utility Corridors combined. The proposed monitoring that was included in the NPDES/SDS Permit Application (Reference (54)) is included in the Water Management Plan – Mine (Appendix 11.2) and the Water Management Plan – Plant (Appendix 11.3). In these management plans, the Transportation and Utility Corridors are grouped with the Mine Site, whereas the WWTS, Beneficiation Plant, Tailings Basin, and HRF are grouped with the Plant Site.

Monitoring for the Project is specified by monitoring type. The categories of monitoring are briefly described below. The management plans also contain the proposed number of monitoring locations for each category, the proposed parameters to be monitored, the proposed frequency of monitoring, and the proposed method of reporting. Upon NPDES/SDS Permit issuance, details of required monitoring will be incorporated into updated versions of these documents.

14.3.1.1 Groundwater Monitoring

Groundwater monitor wells will be established at the Mine Site and Plant Site. Following are the types of monitoring that are proposed:

- Compliance monitoring – This will be performed at locations where the Project will need to demonstrate compliance with applicable permit limits. Locations are downgradient of potential Project impacts, typically at or near property boundaries.

- Indicator monitoring – This type of monitoring will be conducted at locations between Project features and the compliance monitoring stations to allow for early detection of potential Project impacts. This type of monitoring is also used to monitor water levels for potential north flow from the NorthMet pits toward the Northshore Mine, as described in Reference (10).

- Performance monitoring – This type of monitoring will be performed to assess the performance of engineering infrastructure (e.g., liner systems, containment systems). Performance monitoring stations will include monitoring wells, paired monitoring wells, paired piezometers, and stockpile underdrains (if utilized to control pore water pressure in stockpile foundations).

- Background monitoring – This type of monitoring will be performed to document groundwater quality upgradient of the Project.

- Monitor-only – At these types of stations, which are not required for NPDES/SDS compliance, no limits or standards will apply; however, there may be triggers that will initiate further investigation.

These stations will be located downgradient of potential Project impacts and upgradient of compliance points.

Proposed groundwater monitoring locations are shown on Figure 5-22 and Figure 5-26.

14.3.1.2 Surface Water Monitoring

Surface water monitoring will consist of sampling at upstream and downstream locations off-site to assess potential surface water quality impacts from the Project. Following are the types of monitoring that are proposed:

- Background monitoring – Background water quality monitoring will be conducted to document surface water quality upstream of potential Project impacts.
- Monitor-only – At these types of stations, no limits or standards will apply; however, there may be triggers that will initiate further investigation. These will be located downstream of potential Project impacts.

Proposed surface water monitoring locations, none of which are for compliance monitoring, are shown on Figure 5-24 and Figure 5-28.

14.3.1.3 Surface Water Discharge Monitoring

Surface water discharge monitoring will measure the quality and quantity of treated WWTS discharge. The Project will need to demonstrate compliance with the NPDES/SDS Permit limits at these locations. Proposed surface water discharge monitoring locations are shown on Figure 5-24, Figure 5-25, Figure 5-28, and Figure 5-29.

14.3.1.4 Internal Waste Stream Monitoring

Certain internal waste streams will be monitored to evaluate resultant water quality as compared to estimated quality. Most internal waste stream monitoring stations are proposed as monitor-only; therefore, no numerical limits would apply, but there may be triggers that will initiate further investigation or analysis. MPCA will make this determination in the conditions of the NPDES/SDS Permit. Internal waste stream monitoring locations at the Mine Site are shown on Figure 11-11, Figure 11-12, and Figure 11-13. Internal waste stream monitoring locations at the Plant Site are shown on Figure 11-15.

14.3.2 Stormwater Monitoring

14.3.2.1 Construction Stormwater Monitoring

Permit applications will be submitted requesting authorization to discharge stormwater associated with Project construction activities. PolyMet will request that the Project receive coverage under the Construction Stormwater General Permit. PolyMet will develop and submit a series of SWPPPs for activities during construction, which will be included in this permit application request. Monitoring related to construction stormwater will include inspections and maintenance requirements, which will be specified in the SWPPPs.

14.3.2.2 Industrial Stormwater Monitoring

Industrial stormwater monitoring, as required under the Industrial Stormwater General Permit, will include inspections and benchmark stormwater monitoring. Benchmark stormwater monitoring will be performed at benchmark stormwater monitoring locations to evaluate the potential impact of industrial activities on stormwater runoff. Results will be compared against applicable benchmark values to determine whether additional stormwater control measures may be necessary. Proposed industrial stormwater monitoring locations are shown on Figure 5-25.

14.3.3 Wetland Monitoring

Specific requirements for wetland monitoring will be outlined in the WCA approval, CWA Section 404 wetland permit, and CWA Section 401 water quality certification. Wetland monitoring is designed to monitor direct and potential indirect impacts to wetlands at the Mine Site, Plant Site, and Transportation and Utility Corridors. Monitoring will include assessing pre-project conditions, establishing hydrology monitoring locations in wetlands, conducting vegetation monitoring, conducting wetland boundary assessments, and comparing results to established impact criteria. Monitoring will assess whether facility activities have directly or indirectly impacted wetland areas. If monitoring identifies additional wetland impacts, provisions will be made to avoid, minimize, or restore wetland impacts, or to provide additional mitigation (Minnesota Rules, part 8420.0520, subpart 6). More details on proposed monitoring requirements are outlined in the Wetland Replacement Plan in Appendix 18.1.

14.3.4 Air Quality Monitoring

Specific air quality monitoring requirements would be set forth in the Project Air Permit, if issued. Monitoring will include measurements associated with federal and state regulations and specific measures to control fugitive dust as described in the FEC Plans (Appendix 12.1 and Appendix 12.2). Below is a summary of the general types of air quality monitoring that typically occur.

14.3.4.1 Mine Site

Most of the air emissions from this location will be in the form of fugitive emissions from unpaved roads, material handling, crushing and screening of aggregate materials, and blasthole drilling. Monitoring will include visual observations of sources of fugitive dust emissions in accordance with the Mine Site FEC Plan (Appendix 12.1). The general types of monitoring for fugitive sources will include the following:

- Materials produced – Quantities of ore, waste rock, and overburden will be tracked annually to estimate fugitive emissions.
- Mobile equipment mileage – Vehicle miles traveled will be tracked for haul trucks used to remove materials from the mine pits to estimate annual fugitive particulate emissions.
- Application rates of water or other dust suppressants – In accordance with the FEC Plan (Appendix 12.1), the rates of application of water and other dust suppressants will be tracked.

- Monitoring will include daily visual emission checks for potential fugitive dust sources in the mine pits; on the stockpiles; at the RTH; on unpaved roads within the Mine Site.

- If dusty conditions are observed, any corrective action taken will be recorded.

PolyMet will also conduct PM_{10} monitoring from the potential fugitive dust sources within the Mine Site per the specifications in the Special Purpose Monitoring Plan (SPMP; Reference (63)). PolyMet will install ambient air quality monitors at specified locations near the effective fenceline for the Mine Site and Transportation and Utility Corridors. Monitors will be located at opposite ends of the Mine Site such that contributions from the Project can be isolated from impacts from off-site sources. The frequency for monitoring will be specified in the Air Permit, if issued. The PM_{10} monitoring will be conducted to verify the effectiveness of the Mine Site FEC Plan and potentially be used to improve dust control procedures within these areas. Monitoring results above action levels, as specified in the SPMP, will lead to investigation and corrective action if warranted.

Recordkeeping and reporting will be conducted as specified in Appendix 12.1 and the SPMP (Reference (63)). Records of monitoring data and corrective actions taken will be kept along with records associated with dust control measures utilized, such as road watering. Reporting will occur, per the SPMP, if monitored air concentrations are greater than air quality standards (this is not necessarily an exceedance of an air quality standard due to the monitoring location being inside the boundary controlled by PolyMet.). Deviations from the air permit requirements will be reported in the semiannual reports required by the air permit.

Emission sources related to support activities will occur at the MSFMF including a fabric filter control device associated with a lime silo, space heaters, and diesel generator combustion emissions. Monitoring for the fabric filter control device will require recording of the pressure drop across the filter control device and comparing the results against the acceptable range set forth by the manufacturer of the equipment. It is not anticipated that stack testing will be required.

14.3.4.2 Plant Site

The Plant Site will include a combination of fugitive and point sources of air emissions that will be monitored in accordance with requirements of the Air Permit that may be issued for the Project. Fugitive emissions monitoring will include:

- Tabulation of quantities of large quantity (>10,000 cubic yards) materials used to construct the FTB and HRF – This information will be used to calculate annual fugitive emissions from these activities.

- Mobile equipment – Vehicle miles traveled will be tracked to estimate annual fugitive particulate emissions.

- Application rates of water or other dust suppressants – In accordance with the Plant Site FEC Plan (Appendix 12.2), the rates of application of water and other dust suppressants to on-site roadways will be tracked.

- Monitoring will include daily visual emission checks for potential fugitive dust sources at the Plant Site (including the FTB and HRF)
- If dusty conditions are observed, any corrective action taken will be recorded.

Point sources will also be subject to certain monitoring requirements. Generally, fabric filter control devices or liquid scrubbers will be used for particulate matter control. Many of the particulate emission control equipment will be subject to federal New Source Performance Standard (NSPS), which will require certain monitoring. Appropriate monitoring will be specified for non-NSPS subject emission sources per applicable air permitting rules. Typical types of monitoring include:

- fuel usage tracking for combustion sources
- performance stack tests for sources covered under NSPS requirements or other emission limitations
- continuous pressure drop measurements for fabric filter control devices
- pressure drop and liquid flow rates for liquid scrubber control devices
- visual opacity measurements for certain point sources of particulate emissions

More details on air quality monitoring at both the Mine Site and Plant Site will be specified in the Air Permit, if issued for the Project.

14.3.5 Water Appropriation Permit Monitoring

Monitoring in connection with water appropriation permits will measure flow rates and water levels to document appropriation rates and monitor potential effects of permitted dewatering. A proposed monitoring plan for water appropriations, included in the Project's Consolidated Water Appropriation Permit Application, outlines the proposed monitoring strategy, including station locations and numbers, frequency of water level monitoring, and flow data collection.

In addition to stations that will monitor the potential effects of permitted appropriations, the Consolidated Water Appropriation Permit Applications also includes stations that will monitor stream augmentation to evaluate potential hydrologic or ecological effects associated with changes in the surface water flow in creeks downstream of the FTB seepage capture systems. The Consolidated Water Appropriation Permit Application proposed four types of monitoring:

- Groundwater level monitoring – The purpose of groundwater monitoring is to identify the effects of permitted appropriations on groundwater levels.
- Surface water monitoring – This type of monitoring will identify the effects of permitted appropriations, changes in watershed areas, and stream augmentation on surface water flow downstream of the Mine Site, Transportation and Utility Corridors, and Plant Site.

- Appropriation source monitoring – This monitoring will document the volume of water appropriated by the Project, including appropriations associated with Project infrastructure such as the mine pits and the Category 1 Stockpile Groundwater Containment System, and appropriation from Colby Lake. Internal waste stream monitoring locations at the Mine Site are shown on Figure 11-11, Figure 11-12, and Figure 11-13. Internal waste stream monitoring locations at the Plant Site are shown on Figure 11-15.
- Stream augmentation monitoring – This monitoring will document the collected seepage flows, the augmentation flows, and ecologic conditions in the four creeks that will receive augmentation flows: Unnamed (Mud Lake) Creek, Trimble Creek, Unnamed Creek, and Second Creek, as well as a reference stream, Bear Creek. Ecologic conditions will be monitored by annual macroinvertebrate surveys.

The proposed monitoring that was included in the Consolidated Water Appropriation Permit Application (Reference (5)) is included in the Water Management Plan – Mine (Appendix 11.2) and the Water Management Plan – Plant (Appendix 11.3). Upon Water Appropriation Permit issuances, details of required monitoring will be incorporated into updated versions of these documents.

14.3.6 Dam Safety Permit Monitoring

14.3.6.1 Geotechnical Monitoring

PolyMet will employ geotechnical monitoring and construction quality assurance (QA) and quality control (QC) practices to maintain the stability of the FTB and HRF dams throughout construction, operations, closure, and postclosure maintenance. Construction QA/QC activities will comply with the requirements of Minnesota Rules, part 6132.2200, subpart 2, item C(1) and part 6132.2500, subpart 2, item B(2). QA/QC activities will also comply with requirements of the Quality Control section of the FTB construction specifications, and with the QA/QC plan for construction of the HRF.

14.3.6.2 Instrumentation

PolyMet will employ stability monitoring throughout operations, reclamation, and initial portions of closure to verify that the FTB and HRF dam design specifications are met. Stability monitoring will include installation of piezometers to monitor the piezometric surface in the dams, and installation of inclinometers and survey points to monitor dam movements to comply with Minnesota Rules, part 6132.2200, subpart 2, item C(2) and 6132.2500, subpart 2, item B(3). Appendix 11.5 includes an FTB Instrumentation and Monitoring Plan, and Appendix 11.6 includes an HRF Instrumentation and Monitoring Plan.

Piezometers

Existing and proposed piezometers will monitor the phreatic surface within the dams. PolyMet will periodically compare piezometer measurements to phreatic surface location estimated by slope stability and seepage modeling to confirm that the location of the phreatic surface is within acceptable limits.

Inclinometers

PolyMet will install inclinometers to monitor the internal movement of the FTB dams. Actual movement, as monitored by the inclinometers, will be compared with movements estimated by deformation modeling of the FTB dams.

Survey Monitoring Hubs

PolyMet will establish survey monitoring hubs to monitor horizontal and vertical surface deformation of the FTB and HRF dams.

Geotechnical monitoring (further described in Appendix 11.5 and Appendix 11.6) to fulfill the Dam Safety Permit requirements is anticipated to fulfill the PTM stability monitoring requirements. In addition, certain periodic inspections will be performed to obtain visual data that will be used to fulfill PTM and Dam Safety Permit requirements.

In accordance with Dam Safety Permit requirements, PolyMet will submit an annual report that will include the following information for both the FTB and HRF, where applicable:

- summary and analysis of geotechnical monitoring
- summary of construction completed and associated costs
- photographic record of dam conditions
- summary of annual dam safety inspections and dam safety reviews
- summary of routine inspections for the previous year
- summary of unusual events/observations for the previous year
- summary of the Flotation Tailings and Residue deposition for the previous year
- identification of planned changes in operations that could impact dam stability
- submittal of raw instrumentation monitoring data in digital format

The annual dam safety report will be submitted by the end of January each year.

Table 14-1 Monitoring Overview

Monitoring Type	Time Period				
	Construction	Operations	Reclamation	Closure	Postclosure
Mine Pit Monitoring					
Mine Pit Stability		X	X	X	
Blasting Management		X			
Mine Pit Inflow	[1]	X	X	X	
Dust	[2]	X			
Stockpile Monitoring					
Placement Verification	X	X			
Survey	X	X	X		
Stability	X	X	X		
Drainage		X	X	X	
Dust	[2]	X			
Category 1 Waste Rock Stockpile Confirmation Sampling		X			
Transportation and Utility Corridors Monitoring					
Ore Car Inspections		X			
Quarterly Track Inspections		X			
Surface Water	X	X	X		
Dust	[2]	X	[3]	[3]	[3]
FTB and HRF Monitoring					
Flotation Tailings Characteristics Verification		X			
Hydrometallurgical Residue Characteristics Verification		X			
HRF Geosynthetics Evaluation	X				
HRF Stability		X	X	X	X
FTB Stability	X	X	X	X	X
Vegetation		X	X	X	X
FTB Seepage		X	X	X	X

Monitoring Type	Time Period				
	Construction	Operations	Reclamation	Closure	Postclosure
Flotation Tailings Deposition		X			
Dust Monitoring	[2]	X			
Other Permit Monitoring					
NPDES/SDS	X	X	X	X	X
Construction Stormwater	X	X	X		
Industrial Stormwater		X	X		
Wetlands	X	X	X	X	
Air Quality		X	[4]	[4]	[4]
Water Appropriation	X	X	X		
FTB Dam Safety	X	X	X	X	X
HRF Dam Safety		X	X	X	X

[1] Inflow will be monitored during overburden stripping, prior to commencement of blasting.

[2] The requirements of the Air Permit (including FEC Plans) would not apply during the construction phase, but PolyMet would be required to comply with Minnesota Rules, part 7011.0150 and other applicable rules during this phase.

[3] Regardless of whether PolyMet is required to maintain an Air Permit during these phases, there will likely be traffic on unpaved roads along the Transportation Corridor, and PolyMet will be required to control fugitive dust per Minnesota Rules, part 7011.0150 and other applicable rules.

[4] Air permitting rule applicability will be re-evaluated at the end of the operations phase commences. An air permit with appropriate monitoring will be maintained/obtained at the end of operations as required by applicable state and federal rules.

15.0 Reclamation, Closure, and Postclosure Maintenance

PolyMet has developed, and presents in this Application, a Mining and Reclamation Plan for the Project consistent with the requirements of PTM Regulations, specifically Minnesota Rules, part 6132.1000 and part 6132.1100, subparts 6 and 7. Section 3.0 provides an overview of the Mining and Reclamation Plan, including references to the sections in this Application that detail the various components of the Plan. Each of the Application sections summarized in Section 3.0 identifies the applicable permitting goals for the elements of the Project discussed in that section, and then describes how the Project will meet the applicable regulatory requirements so as to achieve these permitting goals.

This Section 15.0, which is part of the Mining and Reclamation Plan, summarizes how PolyMet will comply with the requirements of the PTM Regulations with respect to reclamation activities that will take place after the operations phase ends. In particular, this addresses the reclamation standards and requirements of Minnesota Rules, parts 6132.1000 – 6132.3200 that are applicable in the various phases following the operations phase, which the PTM Regulations define as the "closure" and "postclosure maintenance" phases. Closure is defined in Minnesota Rules, part 6132.0100 as beginning "when, as prescribed in the permit to mine, there will be no renewed use or activity by the permittee." Therefore, for the purpose of this Application, PolyMet has identified an interim phase between operation and closure referred to as the "reclamation phase", where any remaining activities required to clean up the Mining Area will be accomplished prior to the start of closure (Section 15.3.1). This term "reclamation phase" is used for simplicity in this Application. The applicable statutory and regulatory definitions regarding reclamation, including those provided in Minnesota Rules, part 6132.0100, are incorporated into this Section 15.0, as further discussed below. Progressive reclamation, which occurs during the LOM, is discussed in Section 7.5.6, Section 8.7, Section 10.2.5, 10.3.3.2, and Section 10.4.5.4.

The Reclamation, Closure, and Postclosure Maintenance Plan is provided in Appendix 14. Discussion on the transition from mechanical to non-mechanical water treatment is provided in Section 15.8, with additional details for non-mechanical treatment pilot-testing provided in Reference (65). Information related to contingency closure scenarios and financial assurance is provided in Section 16.0 with the details provided in Appendix 15.

15.1 Reclamation Time Periods

The reclamation phase will commence at the end of Project operations, which PolyMet currently anticipates will occur at the end of Mine Year 20. The expected timeframe for the reclamation, closure, and postclosure maintenance phases is described in Section 3.2. Figure 3-9 presents the overall anticipated schedule for the reclamation, closure, and postclosure maintenance phases. This figure also contains a summary of activities within each of these three phases. Figure 15-1 and Figure 15-2 show the Mine Site and Plant Site features that remain after closure, respectively.

15.2 Objective

The overall objective of the Reclamation, Closure, and Postclosure Maintenance Plan (Appendix 14), consistent with the requirements of PTM Regulations and good mining practices, is for the reclaimed Mining Area to meet various criteria when no renewed use or activity will occur. Specifically, these criteria seek to develop a reclaimed Mining Area that:

- is safe, stable, and free of hazards
- minimizes hydrologic impacts and the release of hazardous substances (i.e., constituents of concern) that adversely impact natural resources
- is maintenance free

In addition to meeting the foregoing criteria, PolyMet's planned reclamation, closure, and postclosure maintenance work will encourage planning of future land utilization and facilitate implementation of such future plans, as contemplated by the PTM Regulations.

PolyMet will generally reclaim areas as soon as practical during the LOM. In addition to such progressive reclamation during operations, PolyMet will evaluate conditions within the Mining Area at the start of the reclamation phase. Thereafter, PolyMet will implement the Reclamation, Closure, and Postclosure Maintenance Plan in areas not previously reclaimed. PolyMet will demolish buildings and structures, reclaim and vegetate the sites on which such buildings and structures were located, remediate any environmental hazards in compliance with applicable statutes and regulations, and implement other necessary reclamation, closure, and postclosure maintenance practices to satisfy the standards and requirements of Minnesota law, including the pertinent reclamation standards set forth in Minnesota Rules, parts 6132.0200 – 6132.3200.

15.3 Mine Site Reclamation, Closure, and Postclosure Maintenance

This Section 15.3 discusses the reclamation, closure, and postclosure maintenance phases at the Mine Site. Additional detail is provided in Section 2.0 of the Reclamation, Closure, and Postclosure Maintenance Plan (Appendix 14). Progressive reclamation that occurs at the Mine Site during the LOM is discussed in Section 7.5.6. Details regarding the Category 1 Waste Rock Stockpile design, construction, and progressive reclamation are provided in Section 10.4.4 and Section 10.4.5.

Vegetative reference areas will be used to evaluate the effectiveness of the reclamation vegetation activities. Vegetative reference area locations for the Mine Site are shown on Figure 15-3 and Figure 15-4.

15.3.1 Reclamation Phase

During the reclamation phase at the Mine Site, PolyMet will remove structures, establish a barrier system around the perimeters of the mine pits, implement necessary site management and security measures, reclaim the temporary stockpile footprints, manage water levels and water quality in the mine pits, and reclaim the water management systems (each of which is detailed in sections below).

15.3.1.1 Structure Demolition and Reclamation

Demolition and reclamation of the buildings and structures associated with the MSFMF, Railroad Spur, RTH, and other Mine Site infrastructure (powerlines, substations, culverts, etc.) will be conducted as described in Section 2.1.1 of Appendix 14. Two feet of overburden material suitable for vegetation will be placed over former building footprints.

15.3.1.2 Temporary Stockpiles and Haul Roads Reclamation

Reclamation of the temporary stockpiles will begin during Project operations, as described in Section 7.5.6. The Category 4 Waste Rock Stockpile will be completely reclaimed during Project operations. Reclamation of the Category 2/3 Waste Rock Stockpile will begin during Project operations and OSP reclamation will begin during the reclamation phase. Reclamation activities will include removal of piping, pump systems, and liner systems from the temporary stockpile foundations and the associated sumps and ponds and proper recycling or disposal at a permitted solid waste facility. Also, any material remaining in the OSLA will be reclaimed. PolyMet will reclaim the temporary stockpile and OSLA footprints to establish a mixture of upland and wetland areas, depending on the ultimate elevation of the remaining materials.

Once reclamation in these areas is complete, PolyMet will scarify and seed the haul roads to these areas to minimize surface runoff while maintaining continued access by small vehicles for long-term monitoring and maintenance.

15.3.1.3 Mine Pit Reclamation and Water Management

Mine pit reclamation and water management are key aspects of the reclamation phase. Saturated mineral overburden that was used as top dressing for pit ramps and roads will be moved down below the final pit water elevations, as listed on Table 10-16.

East Pit flooding that began during Project operations, as described in Section 10.4.6.4, will be completed in the reclamation phase. PolyMet will begin cycling East Pit water through the WWTS to remove the flushing load of constituents due to the waste rock backfill and pit wall inundation. Treatment of the East Pit flushing load is expected to be complete before the West Pit is flooded (as described in Section 2.2.1.1 of Appendix 14). PolyMet will also construct the outlet structure between the East Pit and the West Pit. Additional details are provided in Section 2.1.3 of Appendix 14. Schematics depicting Mine Site water management during reclamation, closure, and postclosure maintenance phases are provided on Figure 3-13 through Figure 3-16.

After pit dewatering systems are removed in the West Pit, the pit will begin to flood naturally with water from groundwater inflows, precipitation, and stormwater runoff from the tributary watershed. Flooding will also be accelerated with water pumped from the Plant Site.

During East Pit flushing, the WWTS will continue to treat water from the Category 1 Stockpile Groundwater Containment System. PolyMet will pump WWTS effluent to the West Pit to augment pit flooding, and to the East Pit to promote flushing. Section 2.1.3 of Appendix 14 provides additional information on mine pit reclamation, and Section 2.0 of Appendix 11.4 describes the operation of the WWTS during the reclamation phase.

15.3.1.4 Water Management Infrastructure

Selected water management infrastructure will be removed during reclamation.

Perimeter Dikes, Pit Exclusion Dikes, and Pit Rim Berms

PolyMet will maintain the perimeter dike located north of the Central and East Pits to minimize mixing of Partridge River flows with the East Pit water. PolyMet also will maintain perimeter dikes located on the northern side of the Category 1 Waste Rock Stockpile and along the western boundary of the Mine Site to provide access to groundwater monitoring locations.

Pit exclusion dikes and pit rim berms will remain, as needed, to prevent inflow to the mine pits and potential erosion (headcutting) of the pit walls. PolyMet will conduct an additional evaluation of this requirement prior to Mine Year 20. After the operations phase, PolyMet will route stormwater runoff within the Mine Site to the mine pits using a combination of existing and new ditches. Ditch construction may require removal or breaching of the pit exclusion dikes and pit rim berms. When dikes or berms are removed, the unsaturated mineral overburden material from the dikes and berms will be used for grading of disturbed surfaces prior to reclamation. Reclamation will include scarifying and revegetating disturbed surfaces.

Ditch Filling and Rerouting

For reclamation, PolyMet will maximize the use of ditches that already exist in Mine Year 20; however, a few new ditches may need to be constructed to direct stormwater runoff into the East or West Pits. Reclamation activities at the ditches will include either installing ditch blocks or filling, covering with unsaturated mineral overburden, and revegetating the surface.

Stormwater and Mine Water Pond Reclamation

During the reclamation phase, PolyMet will reclaim the stormwater sedimentation ponds, the mine water ponds, and any remaining stockpile and OSP sumps and overflow ponds by developing wetlands or by filling, covering with unsaturated mineral overburden, and revegetating the area. Outlet control structures from Ponds A and B will remain in place to prevent Partridge River floodwater from entering the Mine Site. Outlet control structures from Ponds C (East) and D will remain in place to direct water under Dunka Road and the mainline railroad to the Partridge River along natural drainage paths. PolyMet will modify the overflow weir in Pond C (West) to create a more natural transition to the remaining stormwater ditch. Additional details are provided for stormwater pond reclamation on Drawing SW-031 in Appendix 5 and mine water pond reclamation on Drawing MW-016 in Appendix 8. The mine water sumps and ponds will require cleanout and removal of the geomembrane liner. Sediment removed from the ponds will be disposed of in the East Pit. The geomembrane liners will be recycled or properly disposed of at a permitted solid waste facility.

Pipe and Pump Removal

During the reclamation phase, PolyMet will remove and recycle mine water pipes and pumps except those used in the Category 1 Stockpile Groundwater Containment System and those used for the flooding of the West Pit or cycling of the East Pit water. Detail regarding the final backfill elevation and water elevation in the East Pit is provided in Section 10.4.6.4.

Equalization Basin Area, Central Pumping Station and Mine to Plant Pipelines Removal

During the reclamation phase, PolyMet will reclaim selected pipelines and infrastructure in the Equalization Basin Area that will not be used during the closure and postclosure maintenance phases. At least one equalization basin, the CPS, and the Mine to Plant Pipelines will remain operational through the reclamation, closure, and postclosure maintenance phases, until non-mechanical treatment is implemented, as described in Section 15.8.

15.3.2 Closure Phase

During closure, PolyMet will continue flushing the East Pit water through the WWTS and will continue flooding the West Pit with water from the Plant Site. This water management plan will remain in place at the Mine Site during the closure phase as depicted on Figure 3-13 and Figure 3-14. Monitoring, reporting, and water treatment will continue as long as PTM requirements are in place. If site inspections or water monitoring data show that additional reclamation work is needed, PolyMet will develop and implement a plan for the work.

During the closure phase, PolyMet will maintain the water level in the West Pit below the estimated natural overflow elevation of 1,579’ above mean sea level by pumping water from the West Pit to the WWTS for treatment.

15.3.3 Postclosure Maintenance Phase

Postclosure maintenance activities at the Mine Site will include the transition to postclosure treatment at the WWTS and discharge to the Partridge River via the Unnamed Creek downstream of the West Pit overflow. At the beginning of postclosure maintenance, PolyMet presently expects to use mechanical treatment at the WWTS to treat water from the flooded East Pit and West Pit and water captured by the Category 1 Stockpile Groundwater Containment System as depicted on Figure 3-15. Mechanical treatment technologies will remain in place until it is determined that non-mechanical treatment can be used to meet applicable water quality standards, with the configuration depicted on Figure 3-16. PolyMet will test and assess the suitability of non-mechanical treatment technologies and the timing for implementing such technologies. When they are no longer needed, PolyMet will remove the Equalization Basin Area, the CPS, and the remaining Mine to Plant Pipelines and will reclaim and revegetate the disturbed areas. Water quality monitoring will continue in the postclosure maintenance phase as long as is necessary under terms of applicable permits.

PolyMet's postclosure maintenance activities will continue until the objectives of Minnesota Rules, part 6132.3200 have been met, including the goal that the Mining Area at the time will be stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free. At that time, DNR may release the permittee in accordance with the requirements of Minnesota Rules, parts 6132.1400 and 6132.4800.

15.4 Plant Site Reclamation, Closure, and Postclosure Maintenance

This Section 15.4 discusses the reclamation, closure, and postclosure maintenance phases at the Plant Site. Additional detail is provided in Section 3.0 of the Reclamation, Closure, and Postclosure Maintenance Plan (Appendix 14). Progressive reclamation that occurs at the Plant Site during the LOM is discussed in Section 8.7.

Vegetative reference areas will be used to evaluate the effectiveness of the reclamation vegetation activities. Vegetative references area locations for the Plant Site are shown on Figure 15-3 and Figure 15-4.

15.4.1 Reclamation Phase

During the reclamation phase at the Plant Site, PolyMet will demolish structures, establish fencing or other barriers within the Mining Area, implement necessary site management and security measures, reclaim the FTB and the HRF, and continue to manage water quality.

15.4.1.1 Structure and Infrastructure Demolition and Reclamation

PolyMet will decommission the majority of the Plant Site during the reclamation phase. PolyMet will remove the tailings pipeline and associated pumping systems and HRF infrastructure, and will also demolish and reclaim the Beneficiation Plant, Hydrometallurgical Plant, and associated facilities. The Sewage Treatment System stabilization pond liners and pipelines, Potable Water Treatment System, and fire water system will be reclaimed. A variance is being requested in Section 1.2.3 of Appendix 14 for the utility tunnels to be closed and left in-place.

As shown on Table 8-2, the Plant Site includes several areas that previous owners of the property and the MPCA have identified as AOCs for which the MPCA has oversight responsibility under its VIC program. The AOCs that will be used by the Project and managed or remediated during the reclamation, closure, and/or postclosure maintenance phases are discussed in Section 3.1.2 of Appendix 14.

During the reclamation phase, PolyMet will establish fencing or other barriers within the Mining Area and implement necessary site management and security measures, as necessary. Water management infrastructure, including stormwater ponds, ditches and culverts, and Plant Site roads that will not be used in the closure or postclosure maintenance phases will be reclaimed.

15.4.1.2 FTB Reclamation

Upon completion of ore processing operations, the FTB will be closed in accordance with Minnesota Rules, part 6132.3200. Reclamation of the FTB will include measures to control fugitive dust, reduce infiltration of oxygen and water, and manage water flows. Other details regarding geotechnical stability, dam design, and progressive reclatmion of the exterior dam slopes of the FTB are provided in Section 10.2.3.2, Section 10.2.4, and Section 10.2.5, respectively.

PolyMet will vegetate upland areas and grade interior portions of the FTB dams to provide a gently sloping surface that will effectively route stormwater runoff to the interior of the FTB, accommodate future differential settlement of the underlying Flotation Tailings, and maximize ponding of water in the reclaimed FTB Pond. During the reclamation phase, PolyMet will construct an FTB Closure Overflow to control pond water elevations in the closure and postclosure maintenance phases. The Closure Overflow weir will be located several feet below final dam crest elevation, will be constructed into bedrock, and will be sized to transmit the flow generated by the PMP rainfall event.

The pond bottom and beaches will be amended with vendor-supplied bentonite with specified clay type and particle size characteristics to reduce percolation from the FTB Pond and beaches, thereby maintaining a permanent pond that will provide an oxygen barrier above the Flotation Tailings. This will reduce oxidation and the amount of water collected by the FTB seepage capture systems. The transition zone between the bentonite amended beach and pond bottom will be covered with riprap to prevent erosion that could occur from wave action along the water's edge. Dimensions of the riprap zone will be dependent on factors such as beach slope at time of closure, projected water level bounce from precipitation on the combined pond area/beach area, and based on pond fetch and resulting wave run-up projections. These details are shown on Drawing FTB-024 of Appendix 6. Section 3.1.3 of Appendix 14 provides additional information about FTB reclamation.

15.4.1.3 HRF Reclamation

After the operations phase, PolyMet will dewater and temporarily cover the HRF. Dewatering will activate the HRF Drainage Collection System to collect the water stored in the Residue pore spaces, with this water and water remaining in the HRF Pond pumped to the WWTS. Dewatering of the HRF is expected to extend through the reclamation phase into the closure phase. Overall, dewatering will aid construction of a stable surface for reclamation and minimize the hydraulic head on the liner system, further limiting the potential for leakage. Section 3.1.4 of Appendix 14 provides additional information about HRF reclamation.

15.4.1.4 Water Quality Management and Stream Augmentation

During the reclamation and closure phases, the WWTS will continue to treat tailings basin seepage collected by the FTB seepage capture systems (except for seepage from the eastern side of the Tailings Basin which will continue to be routed to the FTB Pond, as it was during operations). PolyMet will prevent FTB overflow by pumping excess pond water to the WWTS (additional details provided in Sections 2.5 and 4.2 of Appendix 11.5). Stream augmentation will continue through the reclamation, closure, and postclosure maintenance phases, as long as the FTB seepage capture systems are in place blocking flow from downstream waterbodies.

15.4.2 Closure Phase

During the closure phase, PolyMet will continue to operate the FTB seepage capture systems and the WWTS, and continue to send water from the WWTS via the MPP to the West Pit to aid in flooding. Stream augmentation will continue as needed. Closure activities may include modification of the WWTS in preparation for postclosure treatment. Monitoring will continue to assess compliance with applicable water quality standards, as discussed in Section 14.0. Figure 3-13 and Figure 3-14 depicts water management during the closure phase.

The long-term objective is to replace the WWTS with non-mechanical water treatment systems; however, PolyMet will continue to operate the WWTS through the closure and postclosure maintenance phases until non-mechanical systems are demonstrated and approved. During the closure or postclosure maintenance phases, if PolyMet demonstrates that water in the FTB complies with applicable water quality standards, PolyMet may seek approval to allow the pond to discharge directly.

Dam stability of the FTB will be periodically evaluated during closure by a qualified geotechnical engineer at a frequency and for the duration required by the NorthMet Dam Safety Permit. It is anticipated that the frequency and intensity of these evaluations will decrease over time as vegetation becomes fully established and as it is confirmed that areas prone to erosion have been repaired and permanently stabilized.

Approximately 10 years after the end of operations, when dewatering of the HRF is complete, PolyMet will install a permanent multilayer HRF cover system that will be maintenance free. The multilayer HRF cover system will include a composite cover, composed of a GCL overlain by a 40-mil low-density polyethylene or similar MPCA-approved geomembrane barrier layer. Final grading of this new cover system will create a gently sloping closure surface that sheds surface water runoff, accommodates future differential settlement of the underlying Residue, and minimizes ponding of water on the closed HRF surface. Drainage pipes will be installed within a layer of granular material above the geomembrane, to collect and direct runoff away from the HRF cell. These actions will prevent water from collecting inside the cell resulting in a so-called "bathtub" effect. Figure 10-14 and the permit application support drawings HRF-020 through HRF-023 in Appendix 7 include detailed information regarding the permanent cover system. PolyMet estimates that final HRF reclamation activities will be completed in the closure phase, approximately 10 years after the end of operations. Section 3.1.4 of Appendix 14 provides additional information about HRF reclamation.

PolyMet will keep the HRF Leakage Collection System in service until drainage stops. Water that is collected will be pumped to the WWTS (or subsequently to non-mechanical treatment).

15.4.3 Postclosure Maintenance Phase

Postclosure maintenance activities at the Plant Site will include continued management of water, continued operations of the FTB seepage capture systems, and water treatment for discharge. Mechanical water treatment technologies will remain in place until it is determined that non-mechanical forms of treatment can be used. Water quality and dam safety monitoring will continue in the postclosure maintenance phase as long as is necessary under terms of applicable permits.

PolyMet's postclosure maintenance activities will continue until standards of Minnesota Rules, part 6132.3200 have been met, including requirements that the closed Mining Area is stable, and free of hazards, and that hydrologic impacts and any releases of substances that adversely impact other natural resources have been minimized. Postclosure maintenance will continue until the reclamation is stable and self-sustaining and no further maintenance is required, at which time DNR may issue release of the permittee once the requirements of Minnesota Rules, parts 6132.1400 and 6132.4800 have been met.

15.5 Transportation and Utility Corridors Reclamation, Closure, and Postclosure Maintenance

Transportation and Utility Corridors infrastructure that is not being used for reclamation, closure, and postclosure maintenance activities will be reclaimed and vegetated during the reclamation phase (additional details on the infrastructure that will be removed during the reclamation phase is provided in Section 4.0 of Appendix 14). Reclamation will include:

- reclamation of Dunka Road turnouts that are not required for future use by third parties
- removal of rail line components that are not required for future use by third parties and reclamation where owned by PolyMet (including the Connection Track)
- removal of powerlines and other utilities owned by PolyMet that are not required for further use during the next phase of reclamation, closure, and postclosure maintenance or future use by third parties
- site grading and revegetation

Maintenance of the portions of the Transportation and Utility Corridors that remain in use will continue through the closure and postclosure maintenance phases.

15.6 Colby Lake Pipeline Corridor Reclamation, Closure, and Postclosure Maintenance

The Colby Lake Pipeline and Pumphouse are legacy regional infrastructure intended for use by third parties after closure. The pipeline was installed in the mid-1950s, is three feet in diameter, and ranges from 7 to 25 feet below ground along its alignment. Decommissioning options will be re-evaluated in Mine Year 20 pending developments related to continued future use. A variance request to leave this pipeline in place is included in Section 1.2.3 of Appendix 14.

15.7 Acceptable Reclamation Research

The PTM Regulations allow alternative activities to be implemented in certain circumstances, including after operations cease, based upon acceptable research and findings. Minnesota Rules, part 6132.0100, subpart 2 defines "acceptable research" as “research approved by the commissioner that is site-related and is reasonably designed for the purpose of demonstrating that reclamation can be achieved by alternative methods.”

Although not “applicable research” as defined by the nonferrous mining rules, PolyMet does intend to undertake several test projects. Test projects for pilot-testing of non-mechanical treatment systems and for pilot/field-testing of bentonite amendment of tailings have already been provided to the DNR for review. Test projects have also been discussed between PolyMet and the DNR for the FTB Pond Bottom Cover System and the Category 1 Waste Rock Stockpile Cover System. Work plans for these two test projects will be submitted to DNR for review and approval during operations prior to implementation.

15.8 Plans to Transition from Mechanical to Non-Mechanical Water Treatment

An important objective of the Project is to provide water treatment for as long as necessary to meet applicable regulatory standards at groundwater and surface water compliance points. The Project includes long-term mechanical treatment at the WWTS with a goal of transitioning to a non-mechanical treatment technology requiring less maintenance over the long term. This goal is consistent with the closure and postclosure maintenance requirements of the PTM Regulations, including the regulatory goals of minimizing and eventually eliminating the need for maintenance.

This Section 15.8 provides PolyMet's plan for transitioning from mechanical water treatment to non-mechanical treatment technologies after the 20-year mine life. PolyMet plans to transition from mechanical to non-mechanical water treatment as soon as PolyMet can demonstrate that non-mechanical water treatment technologies will effectively treat water to meet the applicable water quality standards. PolyMet will conduct evaluations, including data collection and pilot-studies, during the mine operations and after operations cease to demonstrate the ability to transition to non-mechanical water treatment while maintaining compliance with applicable water quality standards. As described in Section 6.0 of Appendix 11.4, PolyMet's evaluation of non-mechanical treatment systems will include several components of the Project, including the Category 1 Stockpile Groundwater Containment System, West Pit overflow, FTB seepage capture systems, and FTB Closure Overflow (post-mechanical treatment options).

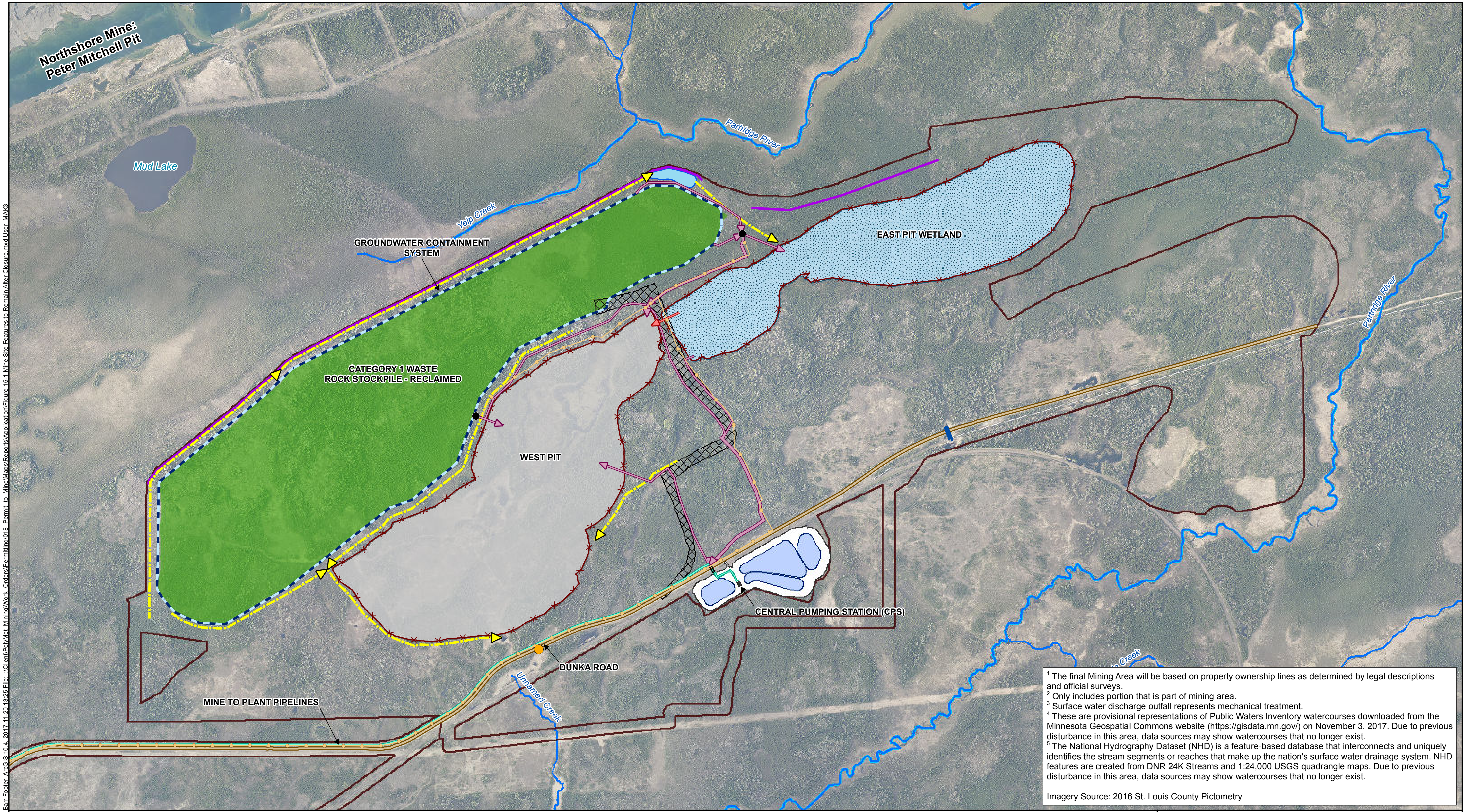
Non-mechanical water treatment technologies are proven methods of water treatment, but they need to be tailored to site-specific conditions, principally those relating to water quality. Non-mechanical water treatment technologies can be thoroughly evaluated in four steps: (1) collecting site-specific information (e.g., hydrology and influent water quality), (2) laboratory testing, (3) pilot-scale-testing, and (4) designing a system for full-scale implementation.

PolyMet to date has collected and analyzed site-specific water quality data. It also has conducted extensive modeling with respect to the anticipated performance of the Project's pollution control systems, including the Tailings Basin and the associated seepage capture systems, the WWTS, and various liners and covers to prevent groundwater infiltration and surface water runoff of constituents of concern. Subject to review and approval by the DNR, PolyMet plans to undertake a number of additional data collection and analyses during operations, such as those summarized below.

At the Tailings Basin, additional site-specific hydrologic information will be collected when the FTB Seepage Containment System is constructed and throughout operations. Also, near the end of the operations phase, the observed water quality at the toe of the basin will provide insight as to the long-term water quality expected at the Tailings Basin related to PolyMet's operation. Thus, the four steps for evaluating non-mechanical water treatment at the Tailings Basin will be implemented during Project operations, potentially allowing the non-mechanical water treatment system at the Tailings Basin to be put in place shortly after operations are complete and the FTB pond bottom cover is installed. If the transition to non-mechanical treatment is undertaken prior to the completion of West Pit flooding, Colby Lake water possibly could be used to aid in the flooding of the West Pit. If Colby Lake water were used to aid in West Pit flooding, PolyMet would apply for an amendment to its Water Appropriation Permit. Alternatively, West Pit flooding could be extended, depending on water quality results and other considerations.

At the Mine Site, the four steps for evaluating non-mechanical treatment technologies could be finalized in less than the time estimated for completion of the West Pit flooding (e.g., approximately 35 years after the end of Project operations). Additional time is included in PolyMet's current plan, however, because the water quality in the pit may take some time to reach equilibrium after the West Pit has flooded. Therefore, PolyMet anticipates implementing the four evaluation steps during the closure phase (approximately Mine Year 25 – Mine Year 28). As a result, non-mechanical water treatment technology could be implemented at the Mine Site a few years after the West Pit has been flooded during the postclosure maintenance phase, currently projected for Mine Year 55. Additional details regarding the rate and timing of pit flooding are provided in Section 6.1.2.2 of Appendix 16.19.

The water models used to support permitting for the Project were not designed to estimate when treatment for compliance with water quality standards can be ended, nor are they intended to estimate when treatment can transition from mechanical to non-mechanical systems. Rather, PolyMet will assess actual treatment requirements on a recurring basis through operations and the post-operations phases based on the actual results of monitoring discharges, performance of engineering controls, and water resource conditions. This process will rely on monitoring results and additional analyses to continuously protect groundwater and surface water in compliance with applicable water quality standards. Data collected during operations will be used to refine the timeline associated with the transition to non-mechanical treatment.



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Surface water discharge outfall represents mechanical treatment.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

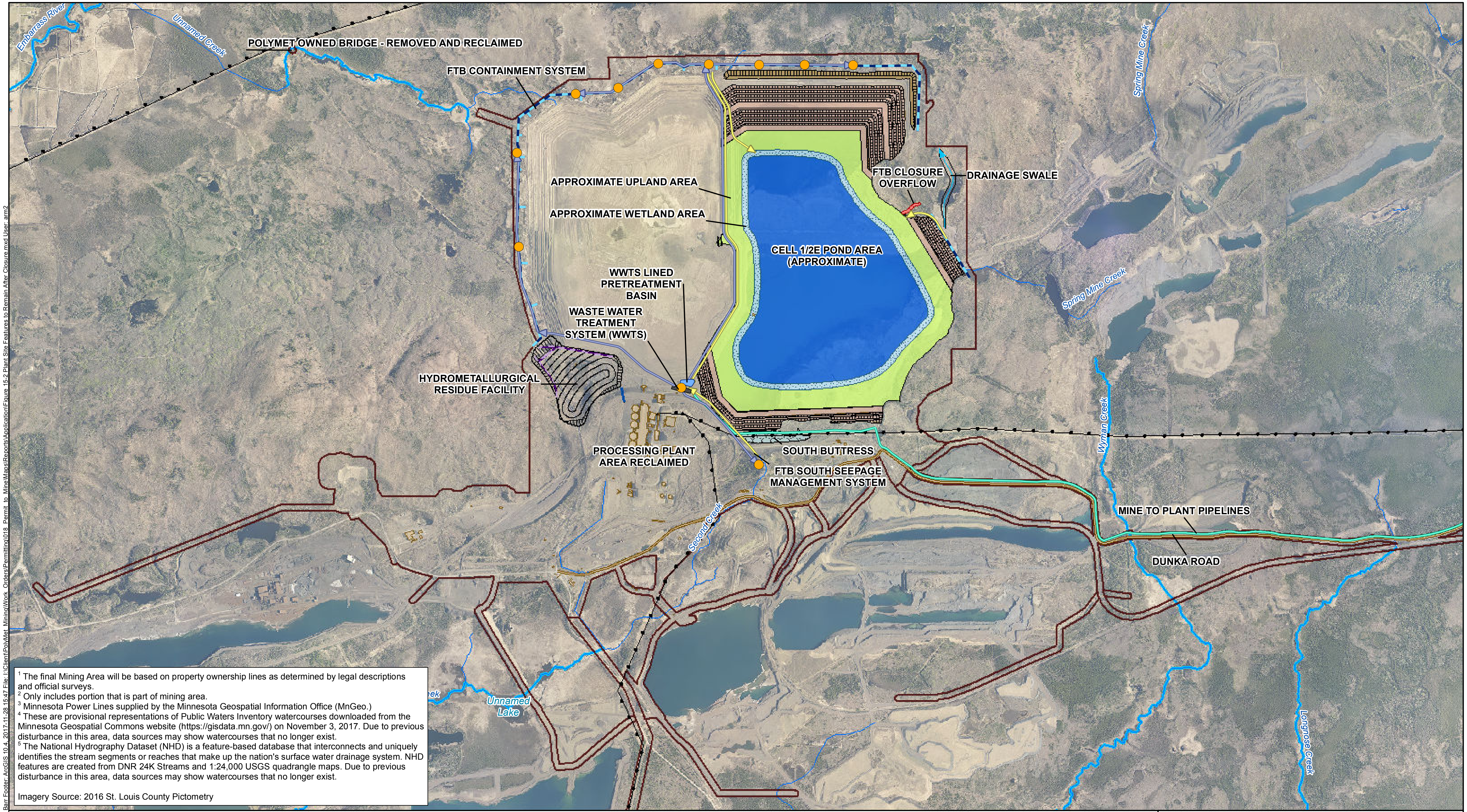
Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Covered Stockpile
- West Pit
- East Pit Wetland
- Haul Roads
- Dunka Road[2]
- Pit Perimeter Barrier System
- PolyMet Power Distribution Lines
- Surface Water Discharge Outfall[3]
- Groundwater Containment System Sumps
- Groundwater Containment System
- Mine to Plant Pipelines
- Mine Water Pipelines
- East Pit Overflow
- Stormwater Ditches
- Perimeter Dike
- Stormwater Culverts
- Stormwater Pond
- Public Waters Inventory Watercourse[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

0 1,500 3,000
Feet

MINE SITE FEATURES TO REMAIN AFTER CLOSURE
NorthMet Project
Poly Met Mining, Inc.

Figure 15-1
Permit to Mine Application



[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Minnesota Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo.)
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

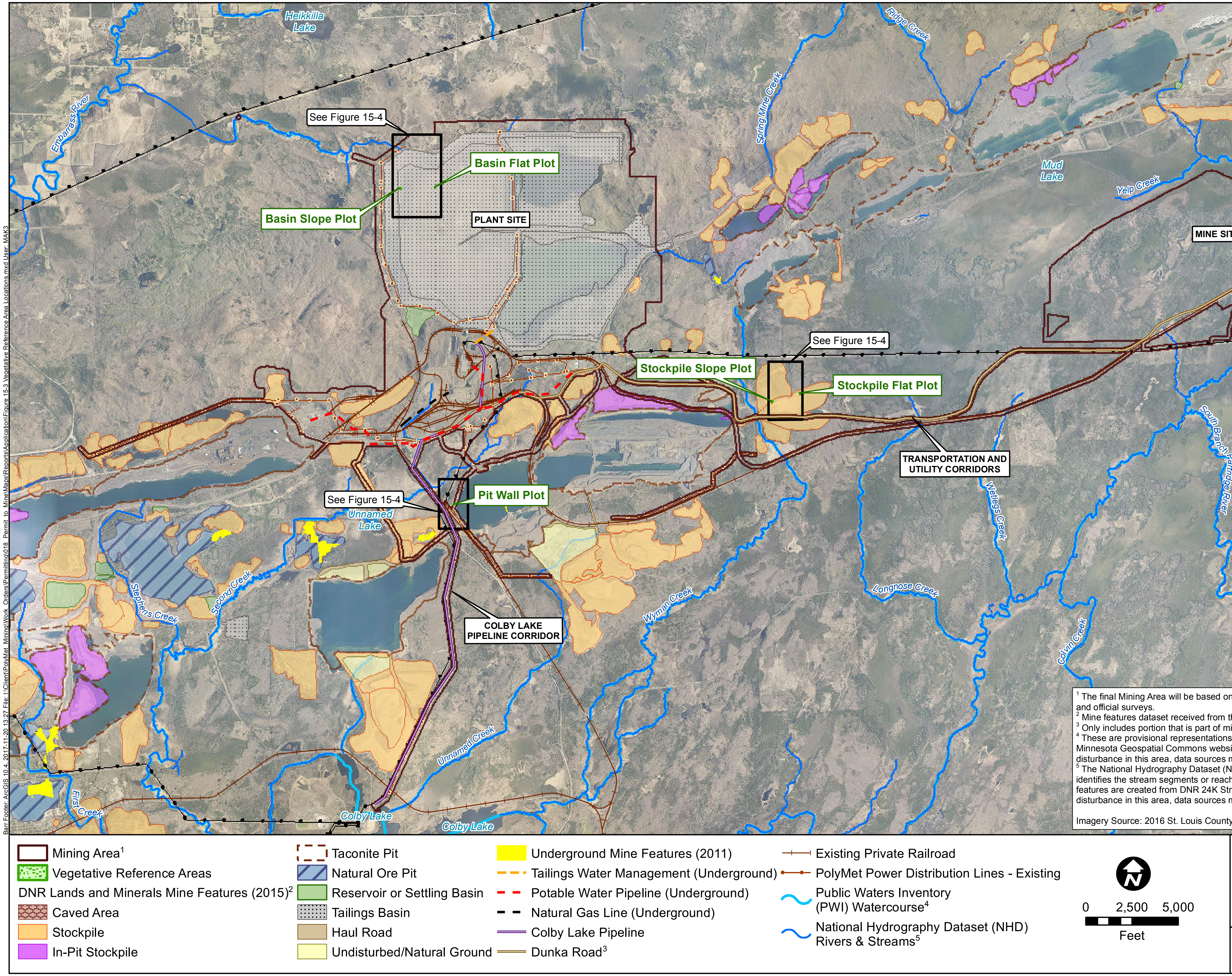
Mining Area[1]
Surface Water Discharge Outfalls
Flotation Tailings Basin
Pond
Wetland Area
Upland Area
Embankment
North Buttress
South Buttress
Overflow
Culvert
HRF Drain Tubing
Tailings Basin Seepage Water Pipe
Tailings Water Management
Treated Water Pipe
Mine to Plant Pipelines
Dunka Road[2]
Minnesota Power Line[3]
Drainage Flow Direction
Public Waters Inventory Watercourse[4]
National Hydrography Dataset (NHD) Rivers & Streams[5]

0 3,000 6,000
Feet

PLANT SITE FEATURES TO REMAIN AFTER CLOSURE
NorthMet Project
Poly Met Mining, Inc.

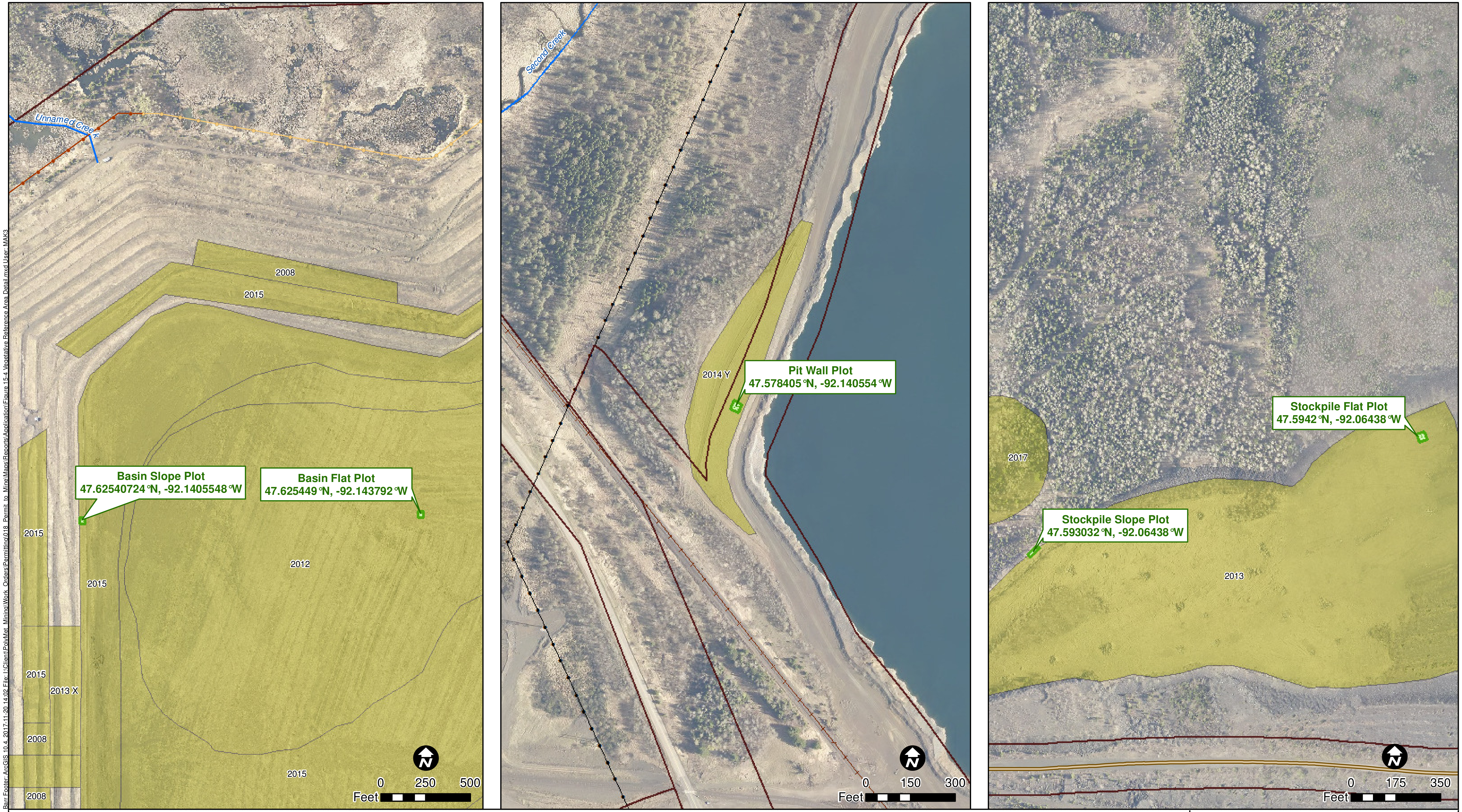
Figure 15-2
Permit to Mine Application

Bar Footer: ArcGIS 10.4, 2017-11-28 15:47 File: I:\Client\PolyMet_Mining\Work_Orders\Permitting\018_Permit_to_Mine\Maps\Reports\Application\Figure 15-2 Plant Site Features to Remain After Closure.mxd User: arm2



VEGETATIVE REFERENCE AREA LOCATIONS
NorthMet Project
Poly Met Mining, Inc.

Figure 15-3
Permit to Mine Application



- Mining Area[1]
- Dunka Road[2]
- PolyMet Power Distribution Lines - Existing
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Lines
- Vegetative Reference Areas
- Reclaimed Reference Site[3]
- National Hydrography Dataset (NHD) Rivers & Streams[4]
- 2015 Year in which 10 year inspection was passed.

[1] The final Mining Area will be based on property ownership lines as determined by legal descriptions and official surveys.
[2] Only includes portion that is part of mining area.
[3] Collection of Ferrous Mining Operation's reclamation areas required by the Taconite and Iron Ore Mineland Reclamation Rules Chapter 6130. Features in this dataset were gathered from the 2016-2017 AROP, on going, and historic archives from the DNR.
[4] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

VEGETATIVE REFERENCE AREA DETAIL
NorthMet Project
Poly Met Mining, Inc.

Figure 15-4
Permit to Mine Application

16.0 Financial Assurance

As part of the permitting process, Minnesota Statutes section 93.49 provides that the DNR "commissioner shall require a bond or other security or other financial assurance satisfactory to the commissioner from an operator. The commissioner shall review annually the extent of each operator's financial assurance." DNR has promulgated regulations to implement these financial assurance requirements, including rules to “ensure that there is a source of funds to be used by the commissioner if the permittee fails to perform [A] reclamation activities including closure and postclosure maintenance needed if operations cease; and [B] corrective action as required by the commissioner if noncompliance with design and operating criteria in the permit to mine occurs” (Minnesota Rules, part 6132.1200, subpart 1).

In accordance with Minnesota Rules, part 6032.1300, subpart 4, the permittee must annually identify the reclamation, closure, and postclosure maintenance activities that would be necessary if operations cease within the upcoming calendar year and detail them in a contingency reclamation plan. The permittee then must provide DNR with financial assurance in an amount equal to the estimated costs to carry out the contingency reclamation plan.

Section 16.1, below, provides the information necessary to support the amount and form of financial assurance PolyMet must submit before obtaining a nonferrous PTM. This information is referred to as the “Pre-Mining Financial Assurance”. PolyMet has estimated costs, which are incorporated into two contingency reclamation plans, for its proposed pre-mining financial assurance. The first plan (Section 16.1.1) summarizes legacy-related reclamation measures and associated financial assurance with respect to the existing Plant Site facilities, including the former LTVSMC tailings basin and associated infrastructure (“LTVSMC Legacy Properties”). The second plan (Section 16.1.2) summarizes the reclamation measures and associated financial assurance with respect to construction of the Project. The combination of these two plans, and their associated financial assurance, will provide the complete contingency reclamation plan and financial assurance for the pre-mining construction period. This means that there will be updated financial assurance for legacy-related reclamation costs for existing facilities, as well as all future construction-related reclamation costs for the NorthMet Project, at the time of PTM issuance.

PolyMet is also providing estimates for the costs of reclamation after Mine Year 1 of the Project. PolyMet’s mining operations (i.e., production blasting within the pit boundary) will begin in Mine Year 1. The reclamation plan and associated costs for Mine Year 1 are discussed further in Section 16.2. As required by the nonferrous PTM rules, the Contingency Reclamation Plan and associated cost estimate for Mine Year 1 will be updated to reflect costs at that time, and provided to the DNR for approval, prior to Mine Year 1.

The Mine Year 1 information in Section 16.2 include the cost estimates for both reclamation of new activities, structures, and conditions added by the Project, and reclamation of existing legacy conditions as they relate to the Project. Therefore, the pre-mining financial assurance that will be put in place at the time of PTM permit issuance will be updated and replaced with the Mine Year 1 Contingency Reclamation Plan and financial assurance before Project operations begin. Updates to the Contingency Reclamation

Plan and cost estimates will occur annually as required by Minnesota Rules, part 6132.1200, subpart 2(A) in the timeframe between PTM issuance and commencement of Project operations, as well as during operations.

PolyMet believes that the information summarized above, and discussed below, provides all of the information required by Minnesota law to establish the financial assurance for the PTM.

PolyMet proposes to use a mix of financial assurance instruments in order to provide the DNR Commissioner with access to funds as required in the Minnesota Rules. PolyMet contemplates that the mix of instruments will be modified over time through construction, operations, reclamation, closure, and postclosure maintenance, and will meet the criteria of Minnesota Rules 6132.1200, subpart 5 as well as other applicable laws and regulations. The core of PolyMet's proposed financial assurance package will comprise a combination of surety bonding, irrevocable letters of credit, and a trust fund, supplemented by environmental and liability insurance.

16.1 Pre-Mining Financial Assurance

PolyMet will combine its Legacy Closure Plan and associated legacy financial assurance (discussed further in Section 16.1.1) with its Nonferrous Construction Contingency Reclamation Plan and associated financial assurance (discussed further in Section 16.1.2) to provide the complete contingency reclamation plan and financial assurance for the pre-mining construction period.

Section 16.1 provides the information necessary to support the amount and form of pre-mining financial assurance PolyMet must submit before obtaining a nonferrous PTM, in accordance with Minnesota Rules, part 6132.1300, subpart 2. For the NorthMet Project, the financial assurance for the first year is effectively addressing a premature closure scenario where legacy conditions exist, and where only construction activities would have taken place for the Project.

16.1.1 Legacy Closure Plan, Cost Estimate and Financial Assurance for Existing Conditions

This section 16.1.1 summarizes legacy-related reclamation measures and associated financial assurance with respect to the LTVSMC Legacy Properties. These facilities are currently permitted under Minnesota Statutes, chapter 93 and are subject to Cliffs Erie's permit to mine applicable to the prior taconite mining activities at the site (the "Existing PTM").

The Project will repurpose and reuse existing facilities at the Plant Site, including the former LTVSMC tailings basin. PolyMet is acquiring these facilities, identified as the LTVSMC Legacy Properties for purposes of this Section 16, from Cliffs Erie as described in Section 4.0. As part of this acquisition, it is anticipated that PolyMet will provide a Legacy Closure Plan and associated legacy financial assurance to replace Cliffs Erie's existing Closure Plan and associated financial assurance applicable to the LTVSMC Legacy Properties under the Existing PTM.

PolyMet has drafted a Legacy Closure Plan (Appendix 15.1) to replace the current Cliffs Erie Closure Plan. The Legacy Closure Plan includes a discussion of the reclamation activities that would be needed, and the costs associated with those activities. In general, the Legacy Closure Plan includes the following provisions: AOCs will be investigated and when necessary, remediated in accordance with the requirements of MPCA's voluntary investigation and cleanup program; and existing buildings will be demolished and their footprints reclaimed. The Legacy Closure Plan also provides for dewatering and other activities that may be necessary for reclamation of the LTVSMC tailings basin, if such circumstances were deemed necessary by the DNR and MPCA. Both agencies have reviewed the elements of the Legacy Closure Plan, which includes erosion maintenance, water quality monitoring, and dam safety monitoring associated with the existing former LTVSMC tailings basin. The Legacy Closure Plan is intended to address the existing conditions associated with the LTVSMC Legacy Properties before Mine Year 1. MPCA has determined that in the event of such circumstances, water treatment would not be expected to be required for the existing LTVSMC tailings basin conditions, and accordingly, no treatment activities or costs are included in the Legacy Closure Plan.

The estimated costs associated with PolyMet's Legacy Closure Plan total $58 million (M), calculated using an effective discount rate of 2.9% for the long-term costs (closure and postclosure maintenance). A 10% contingency was also added to the estimated direct costs. Other indirect costs that account for adaptive management and engineering redesign are also included.

16.1.2 Contingency Reclamation Plan, Cost Estimate, and Financial Assurance for Nonferrous NorthMet Construction

The first year of the Project will commence with pre-mining site development work (construction), which will begin following the issuance of the PTM and other required operating permits. Activities planned include construction within four Project development areas: the Mine Site, the Plant Site, the Transportation and Utility Corridors, and Colby Lake Pipeline Corridor. This period of site development prior to mining is referred to as the "construction phase." Figure 16-1 and Figure 16-2 show the development that will occur at the Mine Site and Plant Site during the construction phase, and Figure 16-3 shows the development that will occur in the Transportation and Utility Corridors. Section 3.3 describes the activities that will take place during the construction phase, which is expected to take between 18 months and 2 years to complete. During this phase, no production blasting will occur within the pits, and no ore or waste rock will be excavated from within the pit boundaries. As a result, there will be no need for water treatment at the Mine Site if the Project were to cease during the construction phase. At the Plant Site during the construction phase, no nonferrous tailings will be deposited in the Tailings Basin.

The Construction Contingency Reclamation Plan (Appendix 15.2) describes the reclamation activities that would be needed if financial assurance forfeiture were to occur at the end of the construction phase. Direct costs are included for the following reclamation activities:

- Demolition of permittee-owned structures (buildings, railroads, power lines, pipelines, roads, and parking lots) built during the construction phase at the Plant Site and Mine Site

    - removal of those structures to grade
    - off-site disposal of demolition material
    - covering with soil and revegetating of structure footprint
- Tailings Basin
    - reshaping and reseeding of first lift of the FTB dams
    - reclamation, if needed, for construction activities at the FTB (i.e., the FTB Seepage Containment System, borrow areas from Cell 2W)
- Mine Site
    - replacement of topsoil stripped off of Mine Site feature footprints (i.e., Categories 1, 2/3, and 4 Waste Rock Stockpiles, OSP, East Pit footprint, OSLA) and revegetation of those areas
    - piping and liners installed will be removed
- Well abandonment

For the construction phase financial assurance ($16 M), the contingency amount has been calculated as 10% of the direct costs, which has been added to the total costs.

16.1.3 Form and Amount of Pre-Mining Financial Assurance to Be Submitted Prior to Permit Issuance

Under the nonferrous PTM rules, the financial assurance amount for a new nonferrous mining project must equal the Contingency Reclamation Cost Estimate (CRE). The CRE represents the cost estimate for implementing a contingency reclamation plan. Minnesota Rules, part 6132.1300, subpart 4 describes the requirements for a contingency reclamation plan. The CRE includes cost estimates for the DNR Commissioner to administer and hire a third party to implement the contingency reclamation plan in accordance with Minnesota Rules 6132.1200, subpart 2(B).

Discussions between PolyMet and DNR during the permitting process have resulted in a CRE for the Project under Minnesota Rules, part 6132.1200 that will be applicable to Project activities described in Section 16.1 and associated pre-mining financial assurance costs as summarized in Table 16-1:

Table 16-1 Pre-Mining Financial Assurance

Reclamation Cost Estimates	TOTAL
Existing Legacy Conditions Reclamation of existing buildings (Plant Site) Reclamation of AOCs Closure and postclosure maintenance (long term maintenance, monitoring and agency oversight)	$ 58,413,305
Nonferrous Construction Activities Reclamation of structures/footprints created during the nonferrous construction phase (Plant Site and Mine Site)	$ 16,272,037
TOTAL	$ 74,685,342

PolyMet will submit a financial assurance package in an amount equal to the total cost estimate shown in Table 16-1 for approval prior to PTM issuance for the Project. The financial assurance instruments in this proposal will likely be some combination of surety bond(s), irrevocable letters of credit, and a trust fund. The financial assurance package will also include commercial general liability, pollution liability, and property insurance. Insurance coverage will provide security against unknown, unanticipated, and catastrophic conditions resulting in claims against the property, should they occur.

Finally, Minnesota Rules, part 6132.1200, subpart 3 also addresses financial assurance for the estimated cost of "corrective actions." Corrective actions are defined as those actions to be conducted by the permittee in the event of a discovered condition of noncompliance. This includes notifications, investigations, and mitigations required to achieve compliance. Minnesota Rules, part 6132.3100 establishes substantive and procedural requirements relating to corrective action. If, after the Project is underway, the commissioner was to determine that a corrective action plan is required pursuant to Minnesota Rules, part 6132.3100, PolyMet will prepare and submit a documented estimate of costs to perform the corrective action together with financial assurance in an amount equal to the cost estimate. PolyMet will maintain such corrective action financial assurance until deemed unnecessary and would, in subsequent annual reports, make annual adjustments, as necessary, to cost estimates for an approved corrective action plan, pursuant to the requirements of Minnesota Rules, part 6132.1200, subparts.3, 4 and part 6132.1300, subpart 5.

16.2 Reclamation Costs for Mine Year 1

Mine Year 1 begins when Project mining operations (i.e., production blasting within the pit boundary) commence. This Section 16.2 sets forth PolyMet's evaluation of reclamation, closure, and postclosure maintenance costs that could be subject to financial assurance before PolyMet commences Mine Year 1 based on current statutory and regulatory requirements.

The nonferrous PTM rules require PolyMet to reevaluate its closure plans and financial assurance estimates annually to meet all applicable requirements. If circumstances warrant an adjustment of these amounts, the rules require such adjustments to be made.

It is important to note that the cost estimates for Mine Year 1 include both reclamation of new activities, structures, and conditions created at the Mine Site and Plant Site by the Project; and reclamation of existing facilities and conditions as they relate to the Project at the Plant Site. Combining the reclamation cost estimates in this manner will result in the contingency reclamation plan and CRE for Mine Year 1 being updated, submitted for approval to the DNR, and replacing the existing, pre-mining financial assurance that will be put in place before the PTM is issued.

16.2.1 Basis for Reclamation Costs for Mine Year 1

Cost estimates for Mine Year 1 are based on current statutory and regulatory standards, including the Minnesota wild rice sulfate standard, and include direct costs for:

- Demolition and reclamation of all permittee-owned structures (including buildings, railroads, power lines, pipelines, roads and parking lots) at the Plant Site and Mine Site
  - removing equipment and demolishing/removing structures to grade
  - off-site disposal of demolition material
  - covering structure footprint with two feet of unsaturated overburden and revegetating
  - removing selected water management infrastructure
  - remediation of AOCs
- Tailings Basin
  - vegetating upland areas
  - grading portions of the FTB dams to route stormwater to the interior of the FTB
  - amending the pond bottom and beaches with bentonite to reduce percolation from the FTB Pond and beaches, thereby maintaining a permanent pond that will provide an oxygen barrier above the Flotation Tailings to reduce oxidation and resultant production of chemical constituents
- Hydrometallurgical Residue Facility
  - grading and revegetating the HRF footprint disturbed by pre-loading activities
- Mine Site

    - relocating material in the Categories 2/3 and 4 Waste Rock Stockpiles, and OSP to the East Pit
    - piping, pump systems and liner systems from the temporary stockpile foundations will be removed and the stockpile footprints will be scarified, covered with a growth medium, and vegetated
    - constructing the cover system on the Category 1 Waste Rock Stockpile and extending the containment system to completely encircle the stockpile along the leading edge of the stockpile
    - grading and revegetating the overburden portions of the East Pit mine wall
    - grading and revegetating the OSLA
    - managing water levels and water quality in the East Pit
    - installing pit perimeter barrier system
- Water Treatment
    - operating the WWTS to remove flushing load in the East Pit
    - operating mechanical treatment (WWTS) for as long as necessary to meet water quality standards
    - modifying and replacing water treatment equipment
    - maintaining and replacing associated water management components
    - developing non-mechanical water treatment systems
- Water and stability monitoring
- Well abandonment
- Personnel

The details for the costs for Mine Year 1 incorporating the items summarized above, and the relevant assumptions, are contained in Appendix 15.3.

In addition to the direct costs, contingency has been calculated as 10% of the direct costs for reclamation activities, and 15% of the direct costs for long-term water treatment, monitoring, and maintenance activities (closure and postclosure maintenance activities). The closure and postclosure activities include the requirements in Minnesota Rule 6115.0390. The calculations also include indirect costs that account for adaptive management and engineering redesign.

Estimated costs for closure and postclosure maintenance are discounted to their present value using a 2.9% net discount rate.

16.2.2 Estimated Form and Amount of Financial Assurance

Table 16-2 shows a summary of the projected costs for Mine Year 1:

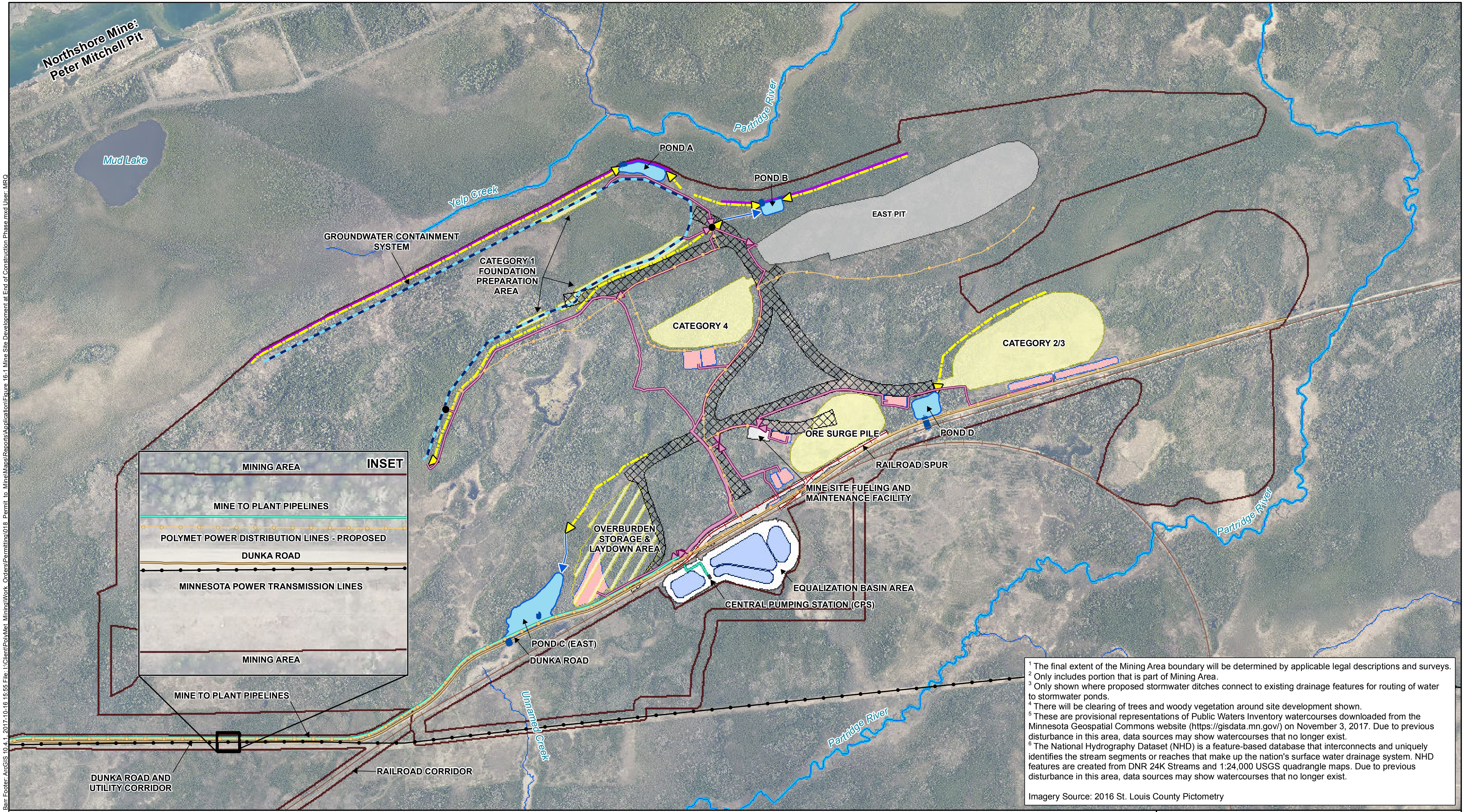
Table 16-2 Mine Year 1Cost Estimate

Cost Estimate	Amount
Mine Year 1 Reclamation	$ 133,621,573
Mine Year 1 Long Term	$ 410,101,543
Mine Year 1 Total	$ 543,723,116

The existing pre-mining financial assurance instruments (some combination of surety bonds, insurance, and irrevocable letters of credit, as commercially available) will be updated to include the Mine Year 1 financial assurance prior to the commencement of mining. A trust fund for the benefit of the state for the projected postclosure maintenance costs also is expected to be part of the financial assurance package. PolyMet expects to begin the process of establishing the trust prior to issuance of a PTM.

For each year during the life of the mine, the total combined value of bonds, irrevocable letters of credit, and cash in the trust will be at least equal to the estimated reclamation costs for the year in which operations occur. Therefore, until fully funded, the trust will be supported by bonds or irrevocable letters of credit, and there will be no risk to the state and taxpayers.

PolyMet will contribute to the trust fund on an annual basis. The amount will be dependent on conditions in the Permit to Mine. Performance of the trust fund will be evaluated annually, and adjusted accordingly, to generate sufficient funds over the long term.



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Only shown where proposed stormwater ditches connect to existing drainage features for routing of water to stormwater ponds.
[4] There will be clearing of trees and woody vegetation around site development shown.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
PolyMet Power Distribution Lines
Minnesota Power Transmission Line
Dunka Road[2]
Existing Private Railroad
Proposed Railroad Track

End of Construction Footprints
Mine Pit Stripping
Stockpile
Storage & Laydown Area
Haul Roads

Groundwater Containment System Sumps
Groundwater Containment System
Mine to Plant Pipelines
Mine Water Pipes
Mine Water Ponds and Sumps

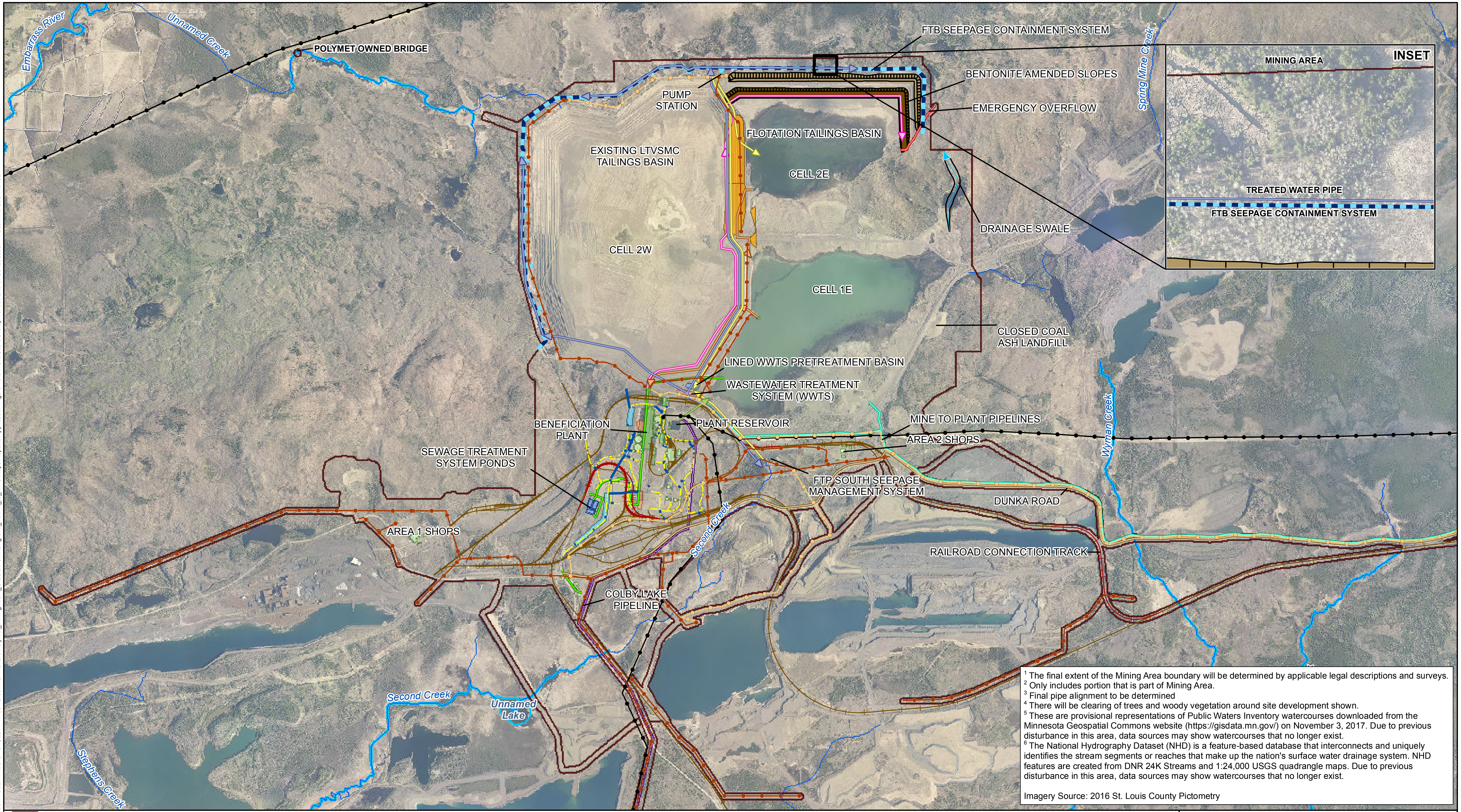
Perimeter Dike
Existing Drainage[3]
Stormwater Ditches
Stormwater Culverts
Stormwater Ponds
Public Waters Inventory (PWI) Watercourses[5]

National Hydrography Dataset (NHD) Rivers & Streams[6]

0 1,500 3,000
Feet

MINE SITE DEVELOPMENT AT
END OF CONSTRUCTION PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 16-1
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of Mining Area.
[3] Final pipe alignment to be determined
[4] There will be clearing of trees and woody vegetation around site development shown.
[5] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[6] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

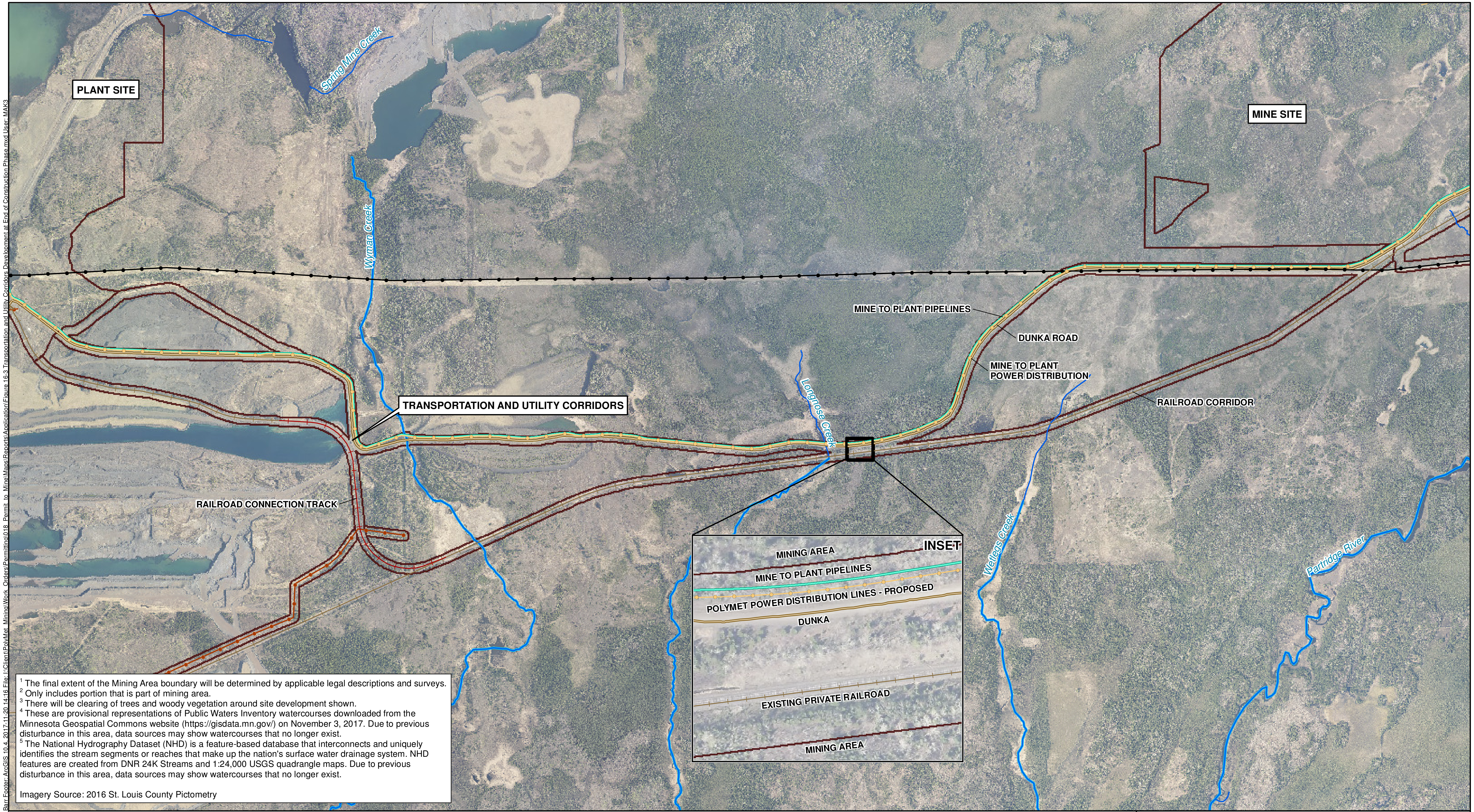
Imagery Source: 2016 St. Louis County Pictometry

Mining Area[1]
Dunka Road[2]
Existing Beneficiation Plant Building
Existing Other Plant Building
Proposed Beneficiation Plant Building
Existing Railroad
Proposed Railroad
PolyMet Power Distribution Lines - Existing
PolyMet Power Distribution Lines - Proposed
Minnesota Power Transmission Lines
FTB Seepage Containment System
FTB Water Return Pipe
FTB Tailings Discharge Pipe
Tailings Basin Seepage Water Pipe
Treated Water Pipe
Plant Reservoir Overflow
Mine to Plant Pipelines
Proposed Sewer Pipe[3]
Stormwater Pond
Stormwater Culvert
Stormwater Ditch
Flotation Tailings Basin
Dam
Partial North Buttress
Borrow Area
Public Waters Inventory (PWI) Watercourses[5]
National Hydrography Dataset (NHD) Rivers & Streams[6]

0 3,000 6,000
Feet

PLANT SITE DEVELOPMENT AT END OF CONSTRUCTION PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 16-2
Permit to Mine Application



[1] The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys.
[2] Only includes portion that is part of mining area.
[3] There will be clearing of trees and woody vegetation around site development shown.
[4] These are provisional representations of Public Waters Inventory watercourses downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/) on November 3, 2017. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.
[5] The National Hydrography Dataset (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 DNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance in this area, data sources may show watercourses that no longer exist.

Imagery Source: 2016 St. Louis County Pictometry

- Mining Area[1]
- Dunka Road[2]
- Existing Private Railroad
- Proposed Railroad Track
- PolyMet Power Distribution Lines - Existing
- PolyMet Power Distribution Lines - Proposed
- Minnesota Power Transmission Line
- Mine to Plant Pipelines
- Public Waters Inventory (PWI) Watercourses[4]
- National Hydrography Dataset (NHD) Rivers & Streams[5]

N

0 950 1,900 3,800
Feet

TRANSPORTATION AND UTILITY CORRIDORS DEVELOPMENT AT END OF CONSTRUCTION PHASE
NorthMet Project
Poly Met Mining, Inc.

Figure 16-3
Permit to Mine Application

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