NorthMet Project

Project Description

Version 9

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This document was prepared for Poly Met Mining Inc. by Barr Engineering Co.

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Acronyms, Abbreviations and Units

Acronym, Abbreviation or Unit	Stands For
ACM	Asbestos-Containing Materials
AWMP	Adaptive Water Management Plan
ARD	Acid Rock Drainage
ASTM	American Society for Testing and Materials
FTB	Flotation Tailings Basin
CFR	Code of Federal Regulations
CPS	Central Pumping Station
gpm	gallons per minute
HRF	Hydrometallurgical Residue Facility
hp	horsepower
kV	kilovolt
Lakefield	SGS Lakefield
LLDPE	linear low density polyethylene
LTVSMC	LTV Steel Mining Company
MDNR	Minnesota Department of Natural Resources
MHP	Mixed Hydroxide Product
MSFMF	Mine Site Fueling and Maintenance Facility
MPCA	Minnesota Pollution Control Agency
NPDES	National Pollutant Discharge Elimination System
OSLA	Overburden Storage and Laydown Area
OSP	Ore Surge Pile
PGE	platinum-group elements
PMP	probable maximum precipitation
Project	NorthMet Project
RC	reverse circulation
RQD	Rock Quality Designation
RTH	Rail Transfer Hopper
SDS	State Disposal System
tpd	tons per day; all tons given in this document are short tons unless otherwise specified

Acronym, Abbreviation or Unit	Stands For
TWP	Treated Water Pipeline
USS	U. S. Steel Corporation
USFS	United States Forest Service
WWTF	Mine Site Waste Water Treatment Facility
WWTP	Plant Site Waste Water Treatment Plant

1.0 Document Organization

This is Poly Met Mining Inc.'s (PolyMet) Proposed Action for the NorthMet Project (Project) as evolved through the environmental review process. The document provides a summary of the detailed scientific and engineering information contained in the reports listed in the References. It is organized into the following sections:

Section 2.0 Basic background geological information

Section 3.0 Basic land exchange information

Section 4.0 Plan of Operations for the Project which summarizes information from Management Plans and includes reclamation activities

Section 5.0 A guide to data used for impact analysis

The Management Plans summarized in Section 4.0 are designed to be living documents; that is, they currently have a level of detail appropriate for Environmental Review, they would be expanded for Permitting, and they would evolve throughout operations, reclamation and long-term closure as adaptive management tools. The Management Plans are:

- Mine Plan including reclamation of mine pits (Reference (1))
- Rock and Overburden Management Plan including reclamation of stockpiles (Reference (2))
- Adaptive Water Management Plan that describes the adaptive engineering controls that manage water quality impacts including water treatment (Reference (3))
- Water Management Plan - Mine including reclamation of Mine Site water management systems, long-term water quality monitoring and contingency mitigation (Reference (4))
- Air Quality Management Plan - Mine (Reference (5))
- Flotation Tailings Management Plan including reclamation of the Flotation Tailings Basin (FTB), (Reference (6)). In this document, the Flotation Tailings Basin (FTB) is the newly constructed NorthMet Flotation Tailings impoundment, and the Tailings Basin is the existing former LTV Steel Mining Company (LTVSMC) tailings basin as well as the combined LTVSMC tailings basin and the FTB.
- Residue Management Plan including reclamation of the Hydrometallurgical Residue Facility (HRF) (Reference (7))

- Water Management Plan - Plant including reclamation of Plant Site water management systems, long-term water quality monitoring and contingency mitigation (Reference (8))
- Air Quality Management Plan - Plant (Reference (9))
- Wetland Management Plan including mitigation of direct wetland impacts and monitoring for potential indirect impacts (Reference (10))
- Reclamation Plan, which includes the overall reclamation plan and reclamation details for all facilities not described in other management plans(Reference (11))

2.0 Geology

2.1 Introduction

This section summarizes the detailed geologic information presented in "ER-03 PolyMet NorthMet Geology and Resource Background" (Reference (12)). Extensive data from over three decades of exploration work has been used to create a geologic model which depicts the configuration of the geologic formations at the Mine Site. The geologic model is an input, along with assay data and geostatistical information, to a software package that produces a 3D block model of the deposit. Development of the Block Model is described in Attachment A of Reference (2). The Block Model is used to:

- quantify the resource (resource is generally defined as the quantity of mineralized material thought to have a reasonable chance of being mined at a profit)
- quantify and characterize the reserve (reserve is that subset of the resource that has been shown by at least a pre-feasibility study to be economically mineable)
- design the mine pit based on optimized metal recovery
- formulate the Mine Plan and sequencing, including plans for managing waste rock
- provide chemistry of waste rock for water quality modeling
- provide chemistry of pit walls for water quality modeling

2.2 Location

The NorthMet Deposit is on the southern flank of Minnesota's Mesabi Iron Range. It is located six miles south of the town of Babbitt, two miles south of the Peter Mitchell open pit taconite mine, and eight miles east of the PolyMet Plant Site (Large Figure 1).

2.3 Project Geological Summary

The NorthMet Deposit is one of twelve known copper-nickel-platinum-group element (PGE) deposits along the northern margin of the Duluth Complex. All of these deposits share a broadly similar geologic setting. The ore bearing rock is primarily found in the basal unit of the Duluth Complex, which contains disseminated sulfides with minor local massive sulfides hosted in grossly layered heterogeneous troctolitic rocks. The Duluth Complex dips to the southeast.

The NorthMet Deposit, located in the Partridge River intrusion of the Complex, is a large tonnage disseminated sulfide deposit in heterogeneous troctolitic (mineralogy of plagioclase and olivine with minor pyroxene, oxide, and biotite) rocks associated with the 1.1 billion year old Mid-Continent rift. Metals of interest are copper, nickel, cobalt, platinum, palladium, and gold. The majority of the metals are concentrated in, or associated with, four sulfide minerals: chalcopyrite, cubanite, pentlandite, and pyrrhotite, with platinum, palladium, and gold also found as elements and in bismuthides, tellurides, and alloys. At the NorthMet Deposit, Duluth complex rocks are overlain by 0 to 60 feet of overburden.

2.4 Project Exploration History

The NorthMet Deposit was discovered in 1969. Eight major exploration programs have drilled a total of 436 boreholes, providing over 300,000 feet of stratigraphic control and extensive assay results (Table 2-1). In addition to the data provided by the exploration programs, stratigraphic data is available from another seventy boreholes drilled in the area for other projects, hydrogeological studies, or water supply wells. Understanding of the depth to bedrock has been supplemented with 240 geophysical soundings and numerous test pits. All exploration data have been collected in a drillhole database used for resource evaluation, reserve calculation, and mine planning.

Since 2004 the Project drillhole database has been totally recompiled. This effort has verified and validated all drilling location, downhole survey, lithology, rock property, and assay data, organized all related records and established procedures for ongoing database maintenance.

Table 2-1 Total Exploration Drilling and Assaying for the NorthMet Deposit

Company	Drilling Years	Assaying Years	# of Drill Holes	Total Foot-age for Group	Number of Assay Intervals used in "Accepted Values" Tables	Assayed Footage used in Final Database	Assay Laboratories
US Steel (USS)	1969-1974	1969-1974, 1989-1991, 1999-2001, 2005-2006, 2008, 2009	112	133,716	11,332	70,014	USS, Acme, ALS-Chemex
NERCO	1991	1991	2 (4)	842	165	822	Acme
PolyMet reverse circulation (RC) drilling	1998-2000	1998-2000	52	24,650	4,765	23,767	Acme
PolyMet core drilling	1999-2000	2000-2001, few in 2005	32	22,156	4,058	20,727	ALS-Chemex
PolyMet RC drilling deepened with AQ core tail	2000	2000	3	2,696	524	2,610	ALS-Chemex
PolyMet core drilling	2005	2005-2006	109	77,166	11,656	71,896	ALS-Chemex
PolyMet core drilling	2007	2007	61	24,530	3,550	23,331	ALS-Chemex
PolyMet core drilling	2010	2010	65	20,132	3,019	18,587	ALS-Chemex
Totals for exploration drilling			436	305,888	39,069	231,754	

2.4.1 Bulk Sample History

Metallurgical tests conducted on bulk samples from the site have produced consistent results, confirmed the overall quality of the supporting data (i.e., the samples have shown the characteristics estimated from drilling data prior to testing) and supported the lack of variability in the deposit. Each PolyMet metallurgical test has built on the success of the previous in refining the ability to create a bulk concentrate that minimizes the sulfide left in tailings and improves recovery in the hydrometallurgical process. Table 2-2 summarizes the bulk sampling history. Results of metallurgical tests are covered in USS and SGS Lakefield (Lakefield) reports.

Table 2-2 Larger Metallurgical Samples Collected at the NorthMet Deposit

Bulk Sample	Year	Tons	Location of sample
USS Bulk sample pit No. 1	1971	Unknown, but small	Pit in center of property
USS Bulk sample pit No. 2	1971	300	Pit at east end of property
USS Bulk sample pit No. 3	1971	20	Pit at east end of property
NERCO PQ drill core	1991	Est at 4.5 tons or less by drill core size	One PQ drill hole from each end of property
Argosy Mining	1995	Unknown, but small	Composited from USS coarse rejects
PolyMet RC drill cuttings	1998	26	One composite, mostly from what is now considered east part of 10 year pits
PolyMet RC drill cuttings	2000	33	One composite, mostly from what is now considered east part of 10 year pits
PolyMet 4 inch and PQ core	2005	10.5, 21.5, and 10.7	Three composites from within ten year pits across property
PolyMet coarse reject	2006	4.2 and 4.94	One composite from 10 year east pit, one from 20 year pit across property
PolyMet coarse reject	2007	8.8	One composite from 2005 drilling
PolyMet core	2008	4.5 and 4.5	Composites from 2005 and 2007 drilling
PolyMet core	2009	6.7	Composite from 2005 and 2007 drilling

2.4.2 Assay History

Assay testing has been used to determine the mineral content of the NorthMet Deposit. There are eight generations of sample preparation and analyses that contribute to the overall Project assay database, as summarized in Table 2-1.

Most of the assays were processed at Acme or ALS-Chemex, which are contract assay laboratories, both located in Vancouver, British Columbia. Sample selection and splitting since 1989 has been at the University of Minnesota Coleraine Minerals Research Laboratory or the Project site(s). Sample preparation has been at the above laboratories or Lerch Brothers Laboratory in Hibbing, Minnesota. The Acme and ALS-Chemex work has all been aqua regia or (since 2005) four acid digestion with various multi-element, PGE, and LECO sulfur methods. Fleck Resources, referenced in Table 2-2, became PolyMet in June, 1998. Less than 200 original USS assays are in use in the database for geological modeling.

2.4.2.1 Assay Quality Control

Quality control procedures have varied and improved since the initial drilling, as they have for the industry in general. USS used standards for laboratory calibration rather than ongoing insertion into the sample stream. Fleck relied on the laboratories internal quality control, insertion of commercial standards, some field duplicates, and checks of USS copper-nickel grades against Acme grades.

PolyMet in 1999-2001 used standards, duplicates, and blanks in the sample stream and was successful at detecting (and correcting) calibration problems at ALS-Chemex. During this time, extensive check sampling was done through Acme and ALS-Chemex.

In 2004, three property specific standards were created for the 2005 and future drilling programs from coarse rejects of USS samples. Besides these standards, blanks were created from iron-formation, field duplicates were selected from core, and coarse reject and pulp duplicates were selected at the analytical laboratory. ALS-Chemex performance has been, and continues to be, reliable relative to the “round robin” expected values calculated by Analytical Solutions Ltd. of Toronto, who were retained to help monitor analytical laboratory performance.

The assay results on the standards are consistent with results based on original USS assays of drill core as shown in Table 2-3. The original USS results are slightly understated relative to the modern ALS-Chemex values.

Table 2-3 Standards: ALS-Chemex 2004 Assays Compared with Older USS Assays

Standards expected values and assayed values:	Cu %	Ni %	S %
Standard 4-1 expected value based on 1969 to 1974 USS assays	0.18	0.08	1.04
Standard 4-1 assayed value-2004 – ALS-Chemex-average of 20 samples	0.20	0.11	1.08
Standard 4-2 expected value based on 1969 to 1974 USS assays	0.36	0.14	0.88
Standard 4-2 assayed value-2004 – ALS-Chemex- average of 20 samples	0.37	0.15	0.82
Standard 4-3 expected value based on 1969 to 1974 USS assays	0.55	0.18	1.17
Standard 4-3 assayed value-2004 – ALS-Chemex- average of 20 samples	0.57	0.21	1.04

Approximately every twelfth sample submitted to ALS-Chemex since 2005 has been a standard, blank, or field duplicate. The standards were distributed to match the expectation of grade in the surrounding samples. ALS-Chemex ran a crusher duplicate every 20 samples, and a pulp re-run every 10-12 samples. In total there were 762 standards, 697 blanks, 734 field duplicates, 1,088 crusher duplicates, and 2,079 pulp duplicates tested since the start of the 2005 drilling program and up until the end of 2010.

In the 2005-2010 programs, ALS-Chemex has had very few standard or blank failures (broadly, a failure in this case is an assay result varying by more than 10% from accepted "round robin" value). These were random, non-consecutive, non-systematic errors. Because PGEs have a wider range of values than the base metals, those failures are not considered as critical as those for base metals if the failures do not seem to be systematic and consecutive.

2.5 Regional Geology

The regional geology includes Archean granite-greenstone terrane, Paleoproterozoic sedimentary rocks, and Mesoproterozoic intrusive, volcanic, and sedimentary rocks. The Mesoproterozoic intrusive rocks include the Duluth Complex, which is comprised of many sub-intrusions, the oldest of which is the Partridge River intrusion.

The Partridge River Intrusion, which is host to the NorthMet Deposit, has been extensively drilled (about 1,350 drill holes). Holes within the deposit area intersect seven, grossly layered, medium to coarse-grained troctolitic rock units that are light gray to dark gray in color. The units are composed primarily of troctolitic anorthosite to pyroxene (augite) troctolite and in lesser amounts, gabbroic anorthosite to olivine gabbro. At the NorthMet Deposit the igneous rocks directly overlie the Paleoproterozoic Virginia Formation and do not contact iron-formation or granite. This basic igneous stratigraphy is present in hundreds of drill holes along a 15-mile strike length in the Partridge River intrusion.

2.6 Rock Type and Unit Classification

Mafic igneous rock types in the Complex are classified in logging by visual percentages of plagioclase, olivine, and pyroxene, using a rock classification scheme modified from Phinney. Units are defined on cross-section from logging data (and assay data where available) generally working up or down from known marker horizons. Units 2, 6, and 7 have ultramafic bases with diffuse tops, sharp bases, and these ultramafics are commonly serpentinized and foliated. These ultramafics are continuous enough to define the igneous stratigraphy from hole to hole.

Figure 2-1 is a generalized geologic map of the deposit area showing lease boundaries, drill holes, and potential Mine Year 20 pit outlines. Figure 2-2 is a stratigraphic section for the deposit.

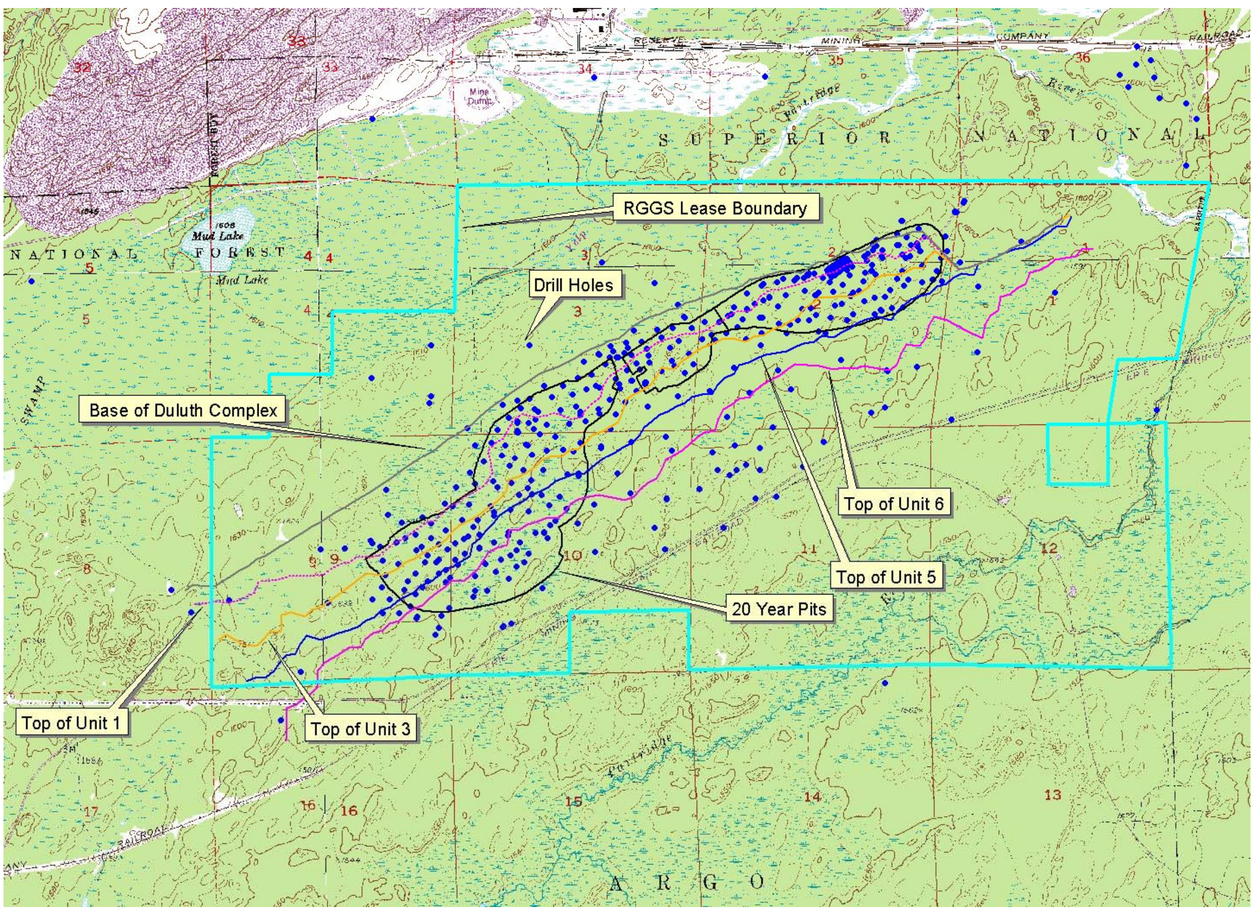

Figure 2-1 Generalized Geologic Map of the NorthMet Deposit

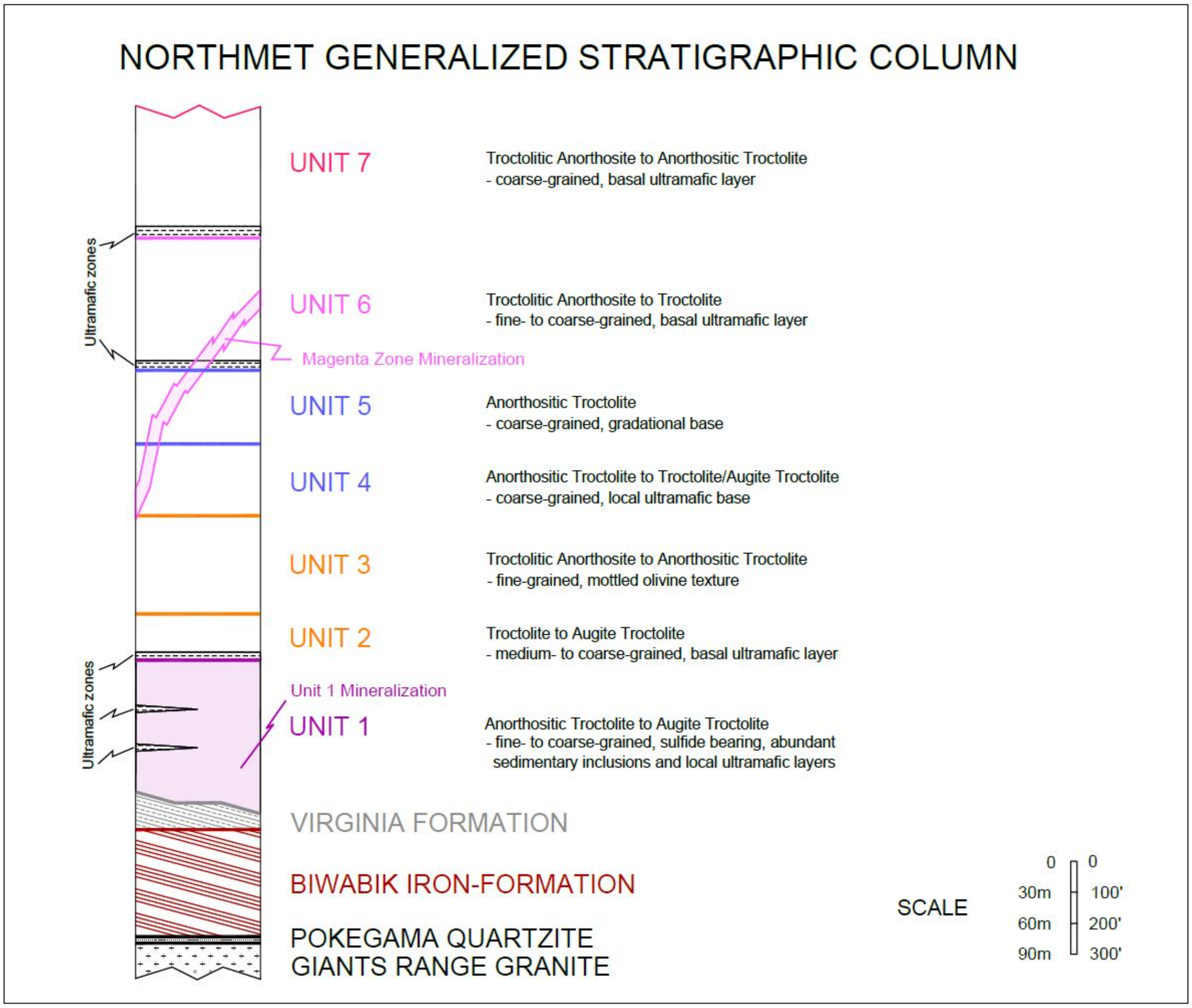

Figure 2-2 Composite Stratigraphic Section for the NorthMet Deposit

2.7 NorthMet Deposit Unit Descriptions and Definitions

2.7.1 Unit 7

Unit 7 is the uppermost bedrock unit intersected in drill holes at the NorthMet Deposit. It consists predominantly of homogeneous, coarse-grained anorthositic troctolite and troctolitic anorthosite, characterized by a continuous basal ultramafic subunit that averages 20 feet thick. The ultramafic consists of fine- to medium-grained melatroctolite to peridotite and minor dunite. The average thickness of Unit 7 is unknown due to erosion removing the upper parts. Basalt inclusions are common in the western part of the deposit.

2.7.2 Unit 6

Very similar to Unit 7, though slightly more mafic, Unit 6 is composed of homogeneous, fine- to coarse-grained, troctolitic anorthosite to troctolite. It averages 400 feet thick and has a continuous basal ultramafic subunit that averages 15 feet thick but can thin dramatically.

2.7.3 Unit 5

Unit 5 exhibits an average thickness of 250 feet and is composed primarily of homogeneous, equigranular-textured, coarse-grained anorthositic troctolite. Anorthositic troctolite is the predominant rock type, but can locally grade into troctolite and augite troctolite towards the base of the unit. The lower contact of Unit 5 is gradational and lacks any ultramafic subunit or other bounding horizon, therefore the transition into Unit 4 is a somewhat arbitrary pick. Due to the ambiguity of this contact, thicknesses of both units vary dramatically. However, when Units 5 and 4 are combined (as they are in the geologic solids model), the thickness is fairly consistent deposit-wide.

2.7.4 Unit 4

Somewhat more mafic than Unit 5, Unit 4 is characterized by homogeneous, coarse-grained, ophitic augite troctolite with some anorthosite troctolitic. Unit 4 averages about 250 feet thick. At its base, Unit 4 may contain a local thin (usually no more than 6 inch) ultramafic layer or oxide-rich zone. The lower contact with Unit 3 is generally sharp.

2.7.5 Unit 3

Unit 3 is used as the major “marker bed” in determining stratigraphic position in the Partridge River Intrusion. It is composed of fine- to medium-grained, poikilitic and/or ophitic, troctolitic anorthosite to anorthositic troctolite. Characteristic poikilitic olivine gives the rock an overall mottled appearance. On average Unit 3 is 300 feet thick. The lower contact of Unit 3 can be disrupted, with multiple “false starts” into typical Unit 2 homogenous rocks, only to go back to mottled Unit 3 with depth. This sequence is common in drill holes in the southwestern portion of the deposit and can span for many tens of feet along core before finally settling into “definitive” Unit 2. This probably represents dissagregation of Unit 3-pieces falling by gravity into Unit 2. As with Units 4 and 5, the thickness of Units 2 and 3 tend to be variable, whereas if combined into one unit, it is more consistent deposit-wide (though not as consistent as Units 4 and 5).

Unit 3 can contain both footwall metasedimentary (Virginia Formation) and hanging wall metabasalt inclusions, which seems to indicate its earliest emplacement within the intrusive sequence of the deposit. This is exemplified by the fact that few sedimentary inclusions are found above Unit 3 and few basalt inclusions are found below it, as if Unit 3 was initially intruded between these units and eventually acted as barrier between them as later units were emplaced.

2.7.6 Unit 2

Unit 2 is characterized by homogeneous, medium- to coarse-grained troctolite and augite troctolite with a consistent basal ultramafic subunit. The continuity of the basal ultramafic subunit, in addition to the relatively uniform grain size and homogeneity of the troctolite, makes this unit distinguishable from Units 1 and 3. Unit 2 has an average thickness of 100 feet. The ultramafic subunit at the base of Unit 2 is the lowermost continuous basal ultramafic horizon at the NorthMet Deposit, averages 25 feet thick, and is composed of melatroctolite to peridotite and minor dunite.

In some ways the characteristics of Unit 2 and how it fits into the stratigraphy are ambiguous, it can be interpreted as the lower part of Unit 3, the upper part of Unit 1, or a separate unit. Based on continuity of the ultramafic boundary it seems to be a lower, more mafic, counterpart to Unit 3 or a separate unit. However, even though Unit 2 has been historically described as barren, in the western part of the deposit it appears to have mineralization grossly continuous with that at the top of Unit 1. The general lack of footwall inclusions would argue against Unit 2 being older than Unit 1.

2.7.7 Unit 1

Of the seven igneous rock units represented within the NorthMet Deposit, Unit 1 is the only unit that contains significant deposit-wide sulfide mineralization. Sulfides occur primarily as disseminated interstitial grains between the silicate framework and are chalcopyrite > pyrrhotite > cubanite > pentlandite. Unit 1 is also the most complex unit, with internal ultramafic subunits of limited lateral extent, increasing and decreasing quantities of mineralization, complex textural relations and varying grain sizes, and abundant sedimentary inclusions. It averages 450 feet thick, but is locally 1,000 feet thick and is characterized lithologically by fine- to coarse-grained heterogeneous rock ranging from anorthositic troctolite (more abundant in the upper half of Unit 1) to augite troctolite with lesser amounts of gabbro-norite and norite (becoming increasingly more abundant towards the basal contact) and numerous sedimentary inclusions. By far the dominant rock type in Unit 1 is medium-grained ophitic augite troctolite, but the textures can vary wildly. Two internal ultramafic subunits occur in drill holes in the southwest, and have an average thickness of 10 feet.

2.7.8 Footwall: Animikie Group and Archean Rocks

The footwall rocks of the NorthMet Deposit consist of Paleoproterozoic sedimentary rocks of the Animikie Group. These rocks are represented by the following three formations, listed from youngest to oldest: the Virginia Formation, the Biwabik Iron Formation, and the Pokegama Quartzite. They are largely underlain by Archean granite of the Giants Range Batholith, but there are Archean basalts and metasediments mapped in outcrop near the Project area. The Duluth Complex is only in contact with the Virginia Formation at the NorthMet Deposit.

Intrusion of the Duluth Complex metamorphosed the Virginia Formation. Non-metamorphosed Virginia Formation (as found to the north and west of the site) consists of a thinly-bedded sequence of argillite and graywacke, with lesser amounts of siltstone, carbonaceous-sulfidic argillite/mudstone, cherty-limey layers, and possibly some tuffaceous material. However, in proximity to the Duluth Complex, the grade of metamorphism (and associated local deformation) progressively increases, and several metamorphic varieties and textures are superimposed on the original sedimentary package at an angle to the original stratigraphy. At least four distinctive Virginia Formation varieties are present at NorthMet and informally referred to as: Cordieritic Metasediments; Disrupted Unit; Recrystallized Unit; and Graphitic Argillite (often with pyrrhotite laminae). These subunits are fully described in Severson, 1999 (Reference (13)).

2.8 NorthMet Deposit Controls on Mineralization

The majority of economic mineralization at the NorthMet Deposit occurs in the basal horizon, Unit 1, with copper and nickel in the sulfide mineral species chalcopyrite, cubanite, and pentlandite, all in the presence of pyrrhotite. Cobalt is in sulfides pyrrhotite and pentlandite with minor cobalt minerals. Gold and PGEs occur as native elements and show good correlation with sulfur and the other metals, because they form under similar conditions as sulfides.

Microprobe analyses on the major gangue mineral assemblage show that nickel and cobalt are also present in the silicate crystal lattices of olivine (0.104% Ni and 0.064% Co) and pyroxenes (0.041% Ni and 0.027% Co). The spinels, magnetite and ilmenite both contain nickel and cobalt in amounts that average less than 0.1% Ni and 0.1% Co, which are comparable to cobalt and nickel amounts in the sulfide minerals pyrrhotite and chalcopyrite. Plagioclase contains negligible amounts of nickel and cobalt.

There is a smaller zone of economic mineralization at the western end of the property in the upper units (3, 4, 5 and 6), known as the “Magenta Zone.” This zone is generally copper and PGE-rich (sulfur-poor relative to metals) mineralization of moderate metals grade.

For all Duluth Complex deposits the major control(s) on mineralization, in an exploration sense, are: proximity to the footwall and presence of heterogeneous, troctolitic, host rocks.

Virtually all sulfide mineralization at the NorthMet Deposit moved in with pulses of magma that were metal enriched in a deeper chamber. Therefore, the main controls on the location of mineralization within the deposit become the specific magmatic pulse or pulses making up the individual units. While textures in Unit 1 are described as heterogeneous, there is also a broad homogeneity in regards to mineral occurrence, mineral chemistry, whole rock and rare earth element (REE) chemistry, and gross rock type which all reinforce the view of a large system of magma pulses replenishing the resident magma at the NorthMet Deposit. The exception to this is that some sulfur, particularly in Unit 1, was derived from assimilation of footwall rocks. The main effect of this assimilation has been to dilute the sulfide grade with additional pyrrhotite in Unit 1, rather than this sulfur scavenging base metals from the magma.

Resource modeling treats the NorthMet Deposit as five separate domains:

- Virginia Formation footwall rocks
- a domain including the upper, higher grade parts of Unit 1, locally merged with the higher grade zones at the base of Unit 2
- the remainder (lower part) of Unit 1
- the Magenta zone in Units 3, 4, 5 and 6 in the western part of the deposit
- the remainder of Units 2 through 7

Unit 1 is mineralized throughout the deposit area, with other units (2 through 7) showing some economic mineralization in the western and central parts of the deposit, but essentially no continuous zones in the east. There is no known economic mineralization in the footwall rocks. Deposit wide, Unit 1 has the highest grades near its top.

Though grades vary, Unit 1 is also mineralized to the east of the deposit, down-dip (south) to depths of at least 2,500 feet, and well past the limits of expected pit development in the west. The development of waste rock stockpiles over these areas is not expected to encumber any material that could reasonably be classed as ore because the upper units are barren and the Unit 1 mineralization in these areas is from 1,700 to over 2,500 feet below ground surface.

While generally barren, Unit 2 has mineralization at its base in the western half of the deposit area.

Units 3, 4, 5, and 6 host mineralization which is modeled as the Magenta Zone. This copper-rich, sulfur-poor zone (of moderate overall grade) occurs in more than eighty drill holes in Units 3, 4, 5, and 6. The zone transitions across the ultramafic base of Unit 6. There is no evidence for this mineralization being hydrothermally remobilized, which could cross boundaries, but would presumably alter large masses of rock.

Metals and sulfur grades in Unit 4 are proportional to Unit 1 where mineralized, but consistently lower. Unit 4 has few high copper or sulfur assay intervals. There is some near surface mineralization, modeled as part of the Magenta Zone. Otherwise there is only low grade, discontinuous material at the unit base.

Unit 6 and Unit 7: These units are very similar in nature. Both are homogenous anorthositic troctolites with well-defined ultramafic bases. No top for Unit 7 has been seen in drill core. Overall, sulfide mineralization is generally minimal, although a number of drill holes in the southwestern portion of the NorthMet Deposit contain significant sulfides and associated elevated PGEs in Unit 6. Sulfides within Unit 6 generally occur as disseminated chalcopyrite/cubanite with minimal pyrrhotite. Unit 7 has a few good assay intercepts, but no apparent continuity for sulfides.

2.9 Density Determinations

Density measurements can provide information about ore grade, however for the NorthMet Deposit no strong relation between grade and density has been defined. Density appears to be more a function of the local rock type. The NorthMet Deposit's density / specific gravity dataset includes about 10,075 data points as of January 2011. Many of these points have readings by multiple methods, weight in water (specific gravity) and weight checked against volume from graduated cylinder readings (density). The values in the final database are "accepted values" that represent a sub-set of the total data package.

2.10 Structural Geology

The general structure of the NorthMet Deposit, including individual beds within the Biwabik Iron-Formation and Virginia Formation, is dominated by an overall dip ranging from 15-25 degrees to the southeast, striking about N56E. In the East Pit area, where the Duluth Complex steeply cross-cuts the Virginia Formation footwall, the rocks within the mineralized zone dip up to 60 degrees.

Many faults have been proposed across the deposit. The extensive drill core logging and analysis to-date have not yielded enough evidence to indicate with certainty and precision the presence and/or exact location of major offsets or faulting within the igneous rock units or the footwall rocks. Some offset or faulting exists within the footwall rocks, but it may not extend far into the Complex due to the different geologic histories of the footwall and Complex rocks. Many of the footwall offsets can be correlated between adjacent cross-sections, but cannot be correlated into the Complex itself. Drill core shows brecciated intervals, gouge mineralization, slickensides on serpentinized fracture faces, and severely broken zones but these do not correlate well on a hole-to-hole basis.

The influence of faulting on mining is expected to be minimal. The geometry of regional and known local faulting, as well as information from oriented core drilling, has been considered in pit planning and slope angle recommendations. There is no apparent relation between inferred fault zones and mineralization or the planned mine pits.

2.11 Recovery and Rock Quality Designation

Recovery and Rock Quality Designation (RQD) are parameters that indicate how complete the core record is and how fractured the rock units are, respectively.

Recovery is the percent of core recovered for a given length of drilling (usually in 5 to 10 foot intervals). Prior to sampling all core is fit back together and a line drawn from one piece to the next. The total amount of core retrieved is measured along that line and divided by the amount expected. The higher the number the greater the competency of the rock mass, as incompetent or fractured rock would be lost in the drilling process. Because of variations in the length of core retrieved in a particular run, Recovery naturally varies by a few percent and can be over 100%.

Geotechnical logging since 2005 bears out the overall strength and competence of the rock mass. At the NorthMet Deposit, the mean Recovery is 99.82% for 23,542 drill core intervals. Figure 2-3 shows the mean value for Recovery by elevation range and the number of data points within that elevation range (elevation is relative to sea level, drill collar elevations at the NorthMet Deposit range from 1550 feet to 1636 feet).

RQD measures the sum of the length of all pieces greater than 4 inches against the length drilled (after accounting for drillers breaks, generally fresh and rough; versus natural breaks, generally smooth and planar). This is done following American Society for Testing and Materials (ASTM) Standard “ASTM D6032 - 08 Standard Test Method for Determining RQD of Rock Core”. RQD infers rock strength from amount of fracturing. An RQD of <25% is very poor, 25-50% is poor, 50-75% is fair, 75-90% is good and 90-100% is excellent. The higher the number, the more competent and less fractured the rock mass.

At the NorthMet Deposit, 94% of the RQD results are good to excellent and RQD averages 94.04% for 11,820 drill core intervals. Figure 2-4 shows the mean value for RQD by elevation range and the number of data points within that elevation range. Details on recovery and RQD are found in Reference (12).

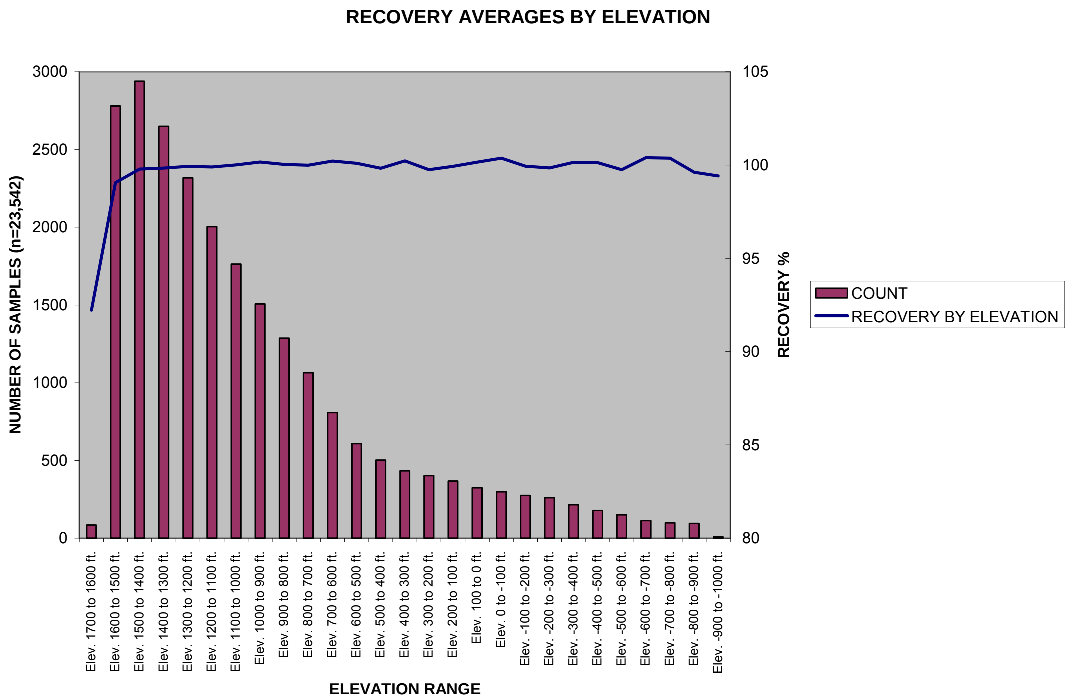

Figure 2-3 Recovery versus Elevation

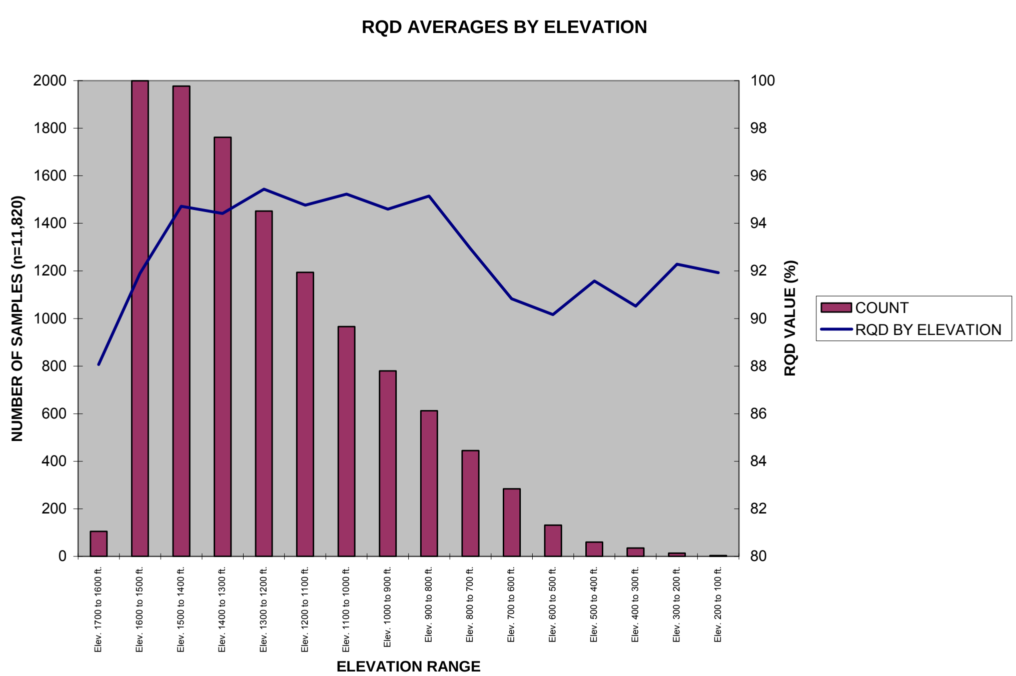

Figure 2-4 RQD versus Elevation

2.12 Fracturing and Alteration

Fracturing in the bedrock at the NorthMet site is characterized by near-surface fractures (generally less than 30 feet deep) that formed as a result of overpressure release due to recent glaciation. The footwall rocks, which are sedimentary in origin, also contain some amount of bedding-plane fractures, although many of these fractures are closed or healed at a depth below the Duluth Complex contact. Lastly, fractures may be present in association with deep-seated faults, the presence, location, and extent of which remain uncertain, as discussed above in Section 2.10 (Reference (14)).

The vast majority of rock within the NorthMet Deposit is unaltered or very weakly altered. The types of alteration most commonly observed in NorthMet Deposit rocks are serpentinization / chloritization of olivine, sericitization and saussuritization of plagioclase, and uralitization of pyroxenes. Most alteration is related to the close proximity of fractures and/or joints that cross-cut the troctolitic rocks. The vast majority of sulfide mineralization is independent of alteration.

2.13 Geophysics

Existing geophysical work is largely regional in its resolution, and as drilling data density has increased less use is being made of the geophysical data. The geophysical data set includes:

- USS aeromagnetic survey data from the late 1960's
- Minnesota Geological Survey 1/4 mile spacing aeromagnetic survey (reprocessed in 2009)
- PolyMet aeromagnetic data / electro-magnetic data 1997
- USS electromagnetic survey data from the late 1960's
- Regional gravity survey data available from the Minnesota Geological Survey
- Depth to Bedrock Geophysics from 2006-2007 - vertical electrical soundings were used to investigate overburden depths in areas of sparse drilling for stockpile design and general site engineering. Where these were done near exploration drill holes the comparison is quite good.

2.14 Additional Geological Data

PolyMet has collected a great deal of data from the drilling program and waste characterization effort, including:

- 182 thin sections for 2005-2006 characterization work
- 1,000's of microprobe data points for 2005-2006 characterization and metallurgical work
- 938 whole rock analyses from 2005 drilling
- 323 Rare Earth Element analyses from 2005 drilling

Note that there is uncompiled historical work to match each category listed above.

Because the NorthMet Deposit has been the subject of study by academics and industry for over 35 years, a large amount of geological background has been assembled, including:

- various resource estimates
- numerous metallurgical reports
- a number of University reports and theses on geologic and assay aspects of the deposit

3.0 Land Ownership and Land Exchange

This section provides an overview of land ownership and needs for the Project. PolyMet currently owns or leases the majority of the surface rights required for the Project with the exception of the Mine Site, as shown on Large Figure 2. PolyMet has leased the mineral rights at the Mine Site that are needed for the Project, but the U.S. Forest Service (USFS) currently owns surface rights to the majority of the land at the Mine Site. PolyMet has purchased surface rights to several privately-held parcels of land within the Superior National Forest and proposes to exchange that land with the USFS for land at the Mine Site.

Parcel sizes for the Land Exchange are given in acres as measured by the General Land Office (GLO). GLO acres represent the acreages associated with the legal descriptions of the parcels based on original surveys performed by the GLO surveyors between 1858 and 1907.GLO acreages are used in this document to define the real estate transaction of the Land Exchange. Unless noted as GLO acreages, acreages listed in this document are calculated in GIS based on the Minnesota Public Land Survey System.

3.1 Land Exchange

The proposed land exchange between the United States of America, acting through the USFS, U.S. Department of Agriculture (Superior National Forest) and PolyMet is an assembled land exchange. The exchange is proposed under the authority of the Weeks Act of March 1, 1911 as amended; General Exchange Act of March 20, 1922; Federal Land Exchange Facilitation Act of 1988; and the Federal Land, Policy and Management Act of October 21, 1976.

The federal land consists of a single contiguous tract of mostly forested land, approximately 6,650.2 acres (GLO) in size, located in the west/central part of the Superior National Forest (Forest) on the Laurentian Ranger District (Large Figure 3). The tract lies immediately south of the Forest proclamation boundary and is bounded on the south by the former LTVSMC (now Cliffs Erie LLC) railroad grade and the Dunka Road (Large Figure 2). The Dunka Road is a private road with sections owned and leased by Cliffs Erie, PolyMet and Minnesota Power. Access is primarily via the Dunka Road and the Cliffs Erie railroad grade. Privately-owned properties to the north and west of the federal land have been extensively impacted over the years by open-pit mines, mine waste rock stockpiles, tailings basins, mine processing facilities, railroad grades and general mining activities. The federal land encompasses 4,164 acres (GLO) of wetland including part of 100 Mile Swamp, a large black spruce tamarack and cedar wetland. Yelp Creek and the Partridge River flow through the tract. Mud Lake is also located on the federal land.

The proposed exchange complies with the 2004 Superior National Forest Land and Resource Management Plan (Forest Plan) when the current and future use of the lands is compared to the specific Management Areas involved. The federal land is located entirely within the General Forest – Longer Rotation Management Area. The theme of this Management area emphasizes land and resource conditions that provide a wide variety of goods, uses and services. Land ownership adjustment direction for this Management Area allows the exchange of federal land, with the desired condition described as “Land ownership patterns (federal, state, county, corporation and private) are consolidated, promote efficient administration and reduce the costs of managing resources.”

As stated in the USFS Land Exchange Scoping Information, the proposal meets four of the seven USFS Strategic Plan FY 2007-2012 Goals:

1. Provided and sustain benefits to the American people (desired outcome is forest with sufficient long-term multiple socioeconomic benefits to meet the needs of society)

2. Conserve open space

3. Sustain and enhance outdoor recreation opportunities

4. Maintain basic management capabilities of the USFS by reducing landlines and mineral conflicts

Various tracts of non-federal lands which lie within the Forest have been assembled by PolyMet for the proposed exchange (Large Figure 3). Provisions of 36 CFR 254.5 state “the parties to an exchange may agree to such an (assembled) arrangement where multiple ownership parcels of non-federal lands are consolidated into a package for the purpose of completing one exchange transaction.” PolyMet has acquired non-federal properties that encourage efficient landownership patterns, with the desired condition of consolidating federal, state, county, corporate and private ownership to promote efficient administration and reduce the cost of managing resources to the USFS. The mineral rights to these non-federal properties are generally outstanding, meaning mineral ownership is severed from the surface ownership of these properties. PolyMet has not pursued ownership of the mineral rights to these non-federal properties as part of this land exchange.

PolyMet proposes to use the federal lands that would be acquired in this land exchange as follows: approximately 2,719 acres (GLO) of the land would be used as the site of the mine portion of the Project; while the remaining federal property conveyed (approximately 3,776 acres (GLO), about 58%) would be utilized as buffer lands to the Project. As shown on Large Figure 2, this buffer is outside the Mine Site development area. There would be very little development on these buffer lands with the exception Project monitoring stations (e.g., groundwater monitoring wells), the Treated Water Pipeline and Dunka Road improvements and a substation owned by Minnesota Power. Management of the buffer areas may include some upland timber management to enhance wildlife habitat, however, wetland areas in the buffer zone would be maintained in their natural state for the foreseeable future.

The non-federal lands assembled include five different tracts totaling approximately 6,722.5 acres (GLO) which are predominately forest and wetland habitat. The tracts are as follows (Large Figure 3):

- Tract 1 – Hay Lake lands consisting of approximately 4,651.5 acres (GLO), is the largest of the non-federal tracts. The tract lies north of the town of Biwabik in St. Louis County and is west of and adjoining County Road 715. The tract includes Hay Lake, identified as a Wild Rice Water by the Minnesota Department of Natural Resources (MDNR) and Little Rice Lake.

- Tract 2 – Lake County lands consisting of approximately 319.5 acres (GLO) is land formerly owned by Lake County. The tract consists of various 40 acre (GLO) parcels southeast of Seven Beaver Lake. These lands are mostly surrounded by Superior National Forest lands and offer a high percentage of wetland habitat.

- Tract 3 – Wolf lands consisting of approximately 1,559.4 acres (GLO) and four separate parcels of land, is land west and southwest of Isabella, MN in Lake County. This tract also includes a high percentage of wetland habitat. These parcels supplement National Forest ownership by reducing federal exterior boundaries and would eliminate several private in-holdings.

- Tract 4 – Hunting Club lands consisting of approximately 160.0 acres (GLO), located five miles southwest of Crane Lake, in northwestern St. Louis County. This tract partially includes two small, unnamed lakes and a high percentage of wetland habitat.

- Tract 5 – McFarland Lake lands consisting of approximately 32.1 acres (GLO) is lakefront property on McFarland Lake. McFarland Lake is an entry point to the Boundary Waters Canoe Area Wilderness. This property is located approximately 10 miles north of Hovland, MN in northeastern Cook County.

The non-federal lands would be incorporated with adjacent federal ownership and managed in accordance with Forest Plan direction for that particular area. Lands with obvious recreational values would be managed to enhance those public recreation opportunities.

3.2 Mine Site Ownership

PolyMet has acquired the necessary mineral rights for the Project and proposes to acquire surface rights via the land exchange described in Section 3.1. Mine Site surface and mineral ownership is shown on Large Figure 4.

The majority of the mineral rights at the Mine Site were originally held by U.S. Steel (USS). In 1989, mineral rights to 4,162 acres covering the deposit and adjacent areas were leased to PolyMet (previously Fleck Resources). Subsequently, USS sold the mineral and mining rights to RGGS Inc. (RGGS), but RGGS maintained PolyMet’s exclusive lease on the minerals. As shown on Large Figure 4, there are three 40-acre areas within the Mine Site in which the mineral rights are owned by the Longyear Mesaba Company but are under lease to PolyMet.

The USFS owns surface rights to the majority of the land at the Mine Site, with smaller portions owned by PolyMet, Cliffs Erie and the State of Minnesota. In 2007, PolyMet entered into discussions with the USFS to acquire surface ownership of lands totaling approximately 6,495 acres that are on top of and adjacent to its existing mineral lease through a land exchange (Section 3.1). The environmental review required for the land exchange is being integrated with environmental review for the Project. PolyMet also acquired approximately 400 acres around the Mine Site from Cliffs Erie in 2006. Of the approximately 6,900 acres for which PolyMet would hold surface rights, approximately 3,000 acres are included in the Mine Site boundary, most of which are estimated to have ground-level impacts due to Project development, as shown on Large Figure 4.

3.3 Plant Site and Rail Connection Area Ownership

For the Plant Site, PolyMet acquired surface ownership of approximately 7,000 acres of real property and portions of the former LTVSMC taconite processing facility and approximately 8,000 additional acres from Cliffs Erie. Some of this land is additional acreage that would not be used for the Project (Large Figure 5). PolyMet also acquired the necessary surface licenses, easements and rights-of-way (e.g., roadways, railroad, electrical service, gas pipeline and water facilities) to enable production at the Plant Site.

To connect the Plant Site and the Mine Site, PolyMet has acquired the necessary easements and rights-of-way to use an 8-mile segment of Dunka Road, parts of which are owned by Minnesota Power, PolyMet or Cliffs Erie. PolyMet has also acquired ownership or the right to use additional lands, trackage and other railroad assets to secure the rail access between the Mine Site and the Plant Site.

In summary, at the Plant Site and rail connection area, PolyMet owns or has leased surface rights to 15,000 acres, of which approximately one-third would have ground-level disturbance due to Project operations (Large Figure 2). Most of the area that would be disturbed at the Plant Site has already been impacted by LTVSMC operations (Large Figure 5).

4.0 Plan of Operations

This section describes the Plan of Operations including reclamation. PolyMet would mine and process approximately 225 million tons of ore over approximately 20 years. The Project would primarily consist of a greenfield Mine Site and a brownfield Plant Site (Large Figure 2). The Mine Site, which contains the NorthMet Deposit (copper-nickel-PGE), is located approximately eight miles east of the Plant Site.

The following sections provide an overview of the Plan of Operations by summarizing information from the management plans. Sections 4.1 and 4.3 describe the Mine Site and the Plant Site respectively, including the engineering controls designed to manage water and air quality impacts. Section 4.2 describes transport of ore from the Mine Site to the Plant Site. Section 4.4 describes Project reclamation and long-term closure.

4.1 Mine Site

The Project would use open pit mining methods, similar to those used at nearby taconite mines. A layout of the Mine Site is shown on Large Figure 6. Key Project features at the Mine Site would include:

- supporting infrastructure (such as roads, electrical supply, rail connections, fueling and maintenance facilities)
- an Overburden Storage and Laydown Area (OSLA) to provide space to sort and store overburden used for construction and reclamation
- mine pits
- ore handling facilities, including an Ore Surge Pile (OSP) and a Rail Transfer Hopper (RTH)
- waste rock stockpiles with engineered systems to manage potential water resource impacts (such as liners, covers and a groundwater containment system)
- a Waste Water Treatment Facility (WWTF) and process water collection systems to collect and treat water from the mine pits, the stockpiles, the ore handling facilities and the haul roads
- a Central Pumping Station (CPS) and Treated Water Pipeline (TWP) to transport water from the Mine Site to the Plant Site
- stormwater management systems

4.1.1 Preproduction Mine Development

Mine Site infrastructure would be constructed during the estimated 12 to 18 months of pre-production mine development. Preproduction mine development is detailed in the Mine Plan (Section 2 of Reference (1)). These activities would include:

- infrastructure - upgrading the existing Dunka Road, constructing site access and haul roads, installing rail connections and spur, and constructing the Mine Site Fueling and Maintenance Facility (MSFMF)
- removing overburden from the pit area and other areas on site as necessary (Section 4.1.2)
- constructing the RTH
- constructing the liners and containment systems for the OSP and waste rock stockpiles (Section 4.1.4)
- constructing water management features, including the WWTF, CPS and TWP, and dikes, ditches and ponds to manage surface water (Section 4.1.5)
- constructing the substation drop from the 138 kilovolt (kV) transmission line (by Minnesota Power) and installation of a 13.8 kV Mine Site power distribution system

Electrical service would be provided by a new Minnesota Power electrical substation located on Minnesota Power property southwest of the Mine Site near the Dunka Road. This substation would feed the newly constructed 13.8 kV Mine Site power distribution line that would supply electrical service to the Mine Site. This power line is shown on Large Figure 7.

Heating fuel would be provided by propane suppliers. No natural gas service or heating fuel oil tanks would be required. Domestic wastewater service would be provided by portable facilities serviced by a supplier. A bottled water supplier would provide drinking water.

The pre-production mine development would be followed by a gradual ramp-up of ore output over 6 to 12 months.

4.1.2 Mining Activities

PolyMet expects to mine a total of 533 million tons of waste rock and ore over 20 years, which would include 225 million tons of ore and 308 million tons of waste rock. After the initial ramp up period, the planned maximum annual average ore production rate would be 32,000 tons per day. Ore would be shipped to the Plant Site, as described below and in Section 4.2, and waste rock would be managed as described in Section 4.1.4.

The Mine Plan (Reference (1)) includes detailed plans for Mine Years 1, 2, 11 and 20. Mine Year 1 would be the first year that ore would be delivered to the Process Plant. These years were selected because the Mine Plan would be updated on an annual basis to provide detailed plans for the next two years (Mine Year 1 and 2, in this case) and Mine Years 11 and 20 would be years when there would be significant changes in the mine configuration. Mine Year 20 would be the final year of mining.

Mine Site maps, which include the mine pits, stockpiles and mining infrastructure, for Mine Years 1, 2, 11 and 20 are shown in Large Figure 8 through Large Figure 11. Cross-sections of the pits showing their planned depths for Mine Years 1, 2, 11 and 20 are shown in Large Figure 12. Cross-sections of the stockpiles are shown in Large Figure 13 and Large Figure 14.

Mining activities include overburden removal (pre-stripping), open pit mining, drilling and blasting, excavation and haulage, ore loading for transport to the Process Plant via the RTH, and temporary ore storage in an OSP.

4.1.2.1 Overburden Removal

Marketable timber would be cleared and overburden removed from the footprints of the mine pits, the OSP, and the waste rock stockpiles if necessary. Overburden management is described in Section 4.1.4.1 and detailed in Section 2.2 of Reference (2).

The OSLA would be constructed to temporarily store Peat and Unsaturated Mineral Overburden while it is screened and sorted prior to being used for construction, wetland restoration (Section 2.2.3 of Reference (1)). Overburden has been defined for this Project as the material that lies on top of the underlying bedrock.

Overburden would be stripped in campaigns as needed for mine development thereby minimizing the amount of bedrock exposed at any one time. After removal of overburden from the initial mining area, additional overburden stripping could take place concurrently with the mining of ore and waste rock. Approximately 32% of the required overburden stripping for the pit development would be done in the first two years of mine life. All of the overburden that needs to be stripped from the pits would be removed by the end of Mine Year 11.

4.1.2.2 Open Pit Mining

The Project would use open pit mining methods similar to those currently in use at ferrous metallic mining operations on the Iron Range. Details on pit design and configuration are in Section 3 of Reference (1).

The mine would consist of three separate open pits known as the East, Central and West Pits, as shown in Large Figure 6. For approximately the first half of operations, mining would take place in the East and West Pits simultaneously. East Pit mining would end in Mine Year 11. Central Pit mining would occur between Mine Years 11 and 16. During Central Pit mining, the East and Central pits would converge into one pit which would then be referred to as the East Pit.

Because the Process Plant feed rate would progressively increase as plant operations ramp up in the first year, mining would be scheduled so that the excavated area in the mine pits would also progressively increase to provide an adequate supply of ore and ensure continuity of plant feed. The pit configuration, staging, mine schedule and stockpile layout would be progressively refined prior to the start of mining and throughout the projected 20-year life of the mine to account for changes in the price of metals, energy, labor and other factors.

The final pit configuration, prior to filling any pit with waste rock, is anticipated to be as shown in Large Figure 11 and Large Figure 12. At maximum size, each pit is projected to have the approximate maximum area and depth shown in Table 4-1.

Table 4-1 Maximum Pit Dimensions – Approximate

Mine Pit	Area (acres)	Maximum Depth (feet below ground surface)
West	321	630
Central	52	356
East	155	696

The northwest edge of the mine would be constrained by the northward extent of the Duluth Complex, which hosts the mineral deposit. The northwest side of the pit would follow the mineralization, which dips southeast at about 25 degrees and roughly parallels the top of the Virginia Formation. The mine would be developed in a series of benches that would be approximately 40 feet high. These benches would be accessed by ramps with a driving surface approximately 85 feet wide to accommodate mine traffic, with additional width for safety berms and possibly ditches, power lines/cables and pipes as needed. Pit slope angles, overall, would be approximately 51 degrees. This would be continuously monitored and refined during the mine life.

4.1.2.3 Drilling and Blasting

The general blasting parameters, based on drilling and blasting models, are presented in Table 4-2. PolyMet would conduct all blasting in accordance with Minnesota Rules, part 6132.2900 Air Overpressure and Ground Vibrations from Blasting. The details of the drilling and blasting design would be refined and optimized as the mining operation continues.

Table 4-2 Blasting Parameters

Blasting Parameter	Specification
Blast hole diameter (range)	10 – 16 inches
Explosive type / blasting agent	Ammonium Nitrate Fuel Oil (ANFO), emulsion and emulsion blends (ANFO and emulsions)
Burden (distance from free face) and spacing (distance between holes)	Approximately 25 feet x 28 feet with five feet of subdrilling for ore and 29 feet x 33 feet with six feet of subdrilling for waste rock, based on a 12-¼ inch diameter blast hole
Powder factor	Approximately 0.69 pounds per ton for ore and 0.45 pounds per ton for waste rock, based on a 12-¼ inch diameter blast hole
Drilling rate – approximate (assumed drilling time / rig 24 hours / day)	50 to 70 feet/hour based on a 12-¼ inch diameter drill bit
Feet drilled / month	Average of 34,425 feet per month
Drilling rigs required	2 drills

Conventional electric or diesel powered rotary drilling rigs would be used. Because Project ore has physical characteristics very similar to Project waste rock, drilling and blasting would share a common drilling fleet and similar blast design specifications. Based on a planned annual ore movement rate of 11.7 million tons and a blast design as shown in Table 4-2, approximately 8.0 million pounds of blasting agent would be used per year for breaking ore, not including initiators and blasting accessories. Similarly, based on the planned annual waste rock movement rate of approximately 15 million tons and a blast designs as shown in Table 4-2, approximately 7.3 million pounds of blasting agent would be used per year for waste rock breakage, not including initiators and blasting accessories. Secondary breaking of oversize pieces of both ore and waste rock would be done using a wheel loader or excavator-mounted drop weight hammer. Blasting of ore and waste rock is anticipated to take place approximately every 2 to 3 days. This would usually include separate blasts of ore and waste rock benches totaling about 200,000 – 300,000 tons broken rock per blast.

4.1.2.4 Excavation and Haulage

After being drilled and blasted, the ore and waste rock would be loaded by excavators into haul trucks that would transport the ore to either the RTH to be loaded for transport by train to the Process Plant or to the OSP for temporary storage and the waste rock to stockpiles or the East Pit. Electric-hydraulic excavators with approximately 31 cubic yard capacity would be the primary rock loading tools in the mining fleet with a large diesel front-end loader (approximately 21.5 cubic yard capacity) available to provide operational flexibility and additional loading capacity.

The haul truck fleet would initially consist of five conventional 240 ton diesel-powered rear dump trucks and grow to a maximum of nine trucks as hauls get longer and temporary stockpiles are relocated to the East Pit. Haul trucks would be able to be re-assigned between excavators loading ore, waste rock and overburden.

4.1.2.5 Rail Transfer Hopper (RTH)

PolyMet would use the same type of RTH system that was used by LTVSMC to load rail cars. The RTH would consist of a raised platform from which haul trucks dump into a hopper over a pan feeder. The pan feeder would pass through an opening in a retaining wall and discharge into a rail car positioned under the feeder outlet. The pan feeder and the control gate would be hydraulically powered and could be controlled by the locomotive operator using controls located in the RTH operator’s cab. The locomotive would be controlled by the locomotive operator using remote controls. Loading time would be approximately one minute per 100-ton rail car, or about 20 to 30 minutes to load a 16-car train due to car spotting and operator moving between the locomotive and the RTH operator’s cab.

The RTH would be located to the south of the mine pits and would be connected to the existing Cliffs Erie main line track by a new spur line. The rail track in the area of the RTH would be designed to allow rail cars to be loaded directly by front-end loader at the OSP should the RTH be unavailable.

4.1.2.6 Ore Surge Pile (OSP)

An OSP would be constructed near the RTH to allow for temporary storage of ore until it could fit into the processing schedule or as required by operational delays. Use of the OSP would allow for delivery of a steady annual flow and assist in providing a uniform grade of ore to the Process Plant. Ore would flow into and out of this pile during the life of the mine as needed to meet mine and plant operating conditions. The footprint has a capacity of 2.5 million tons in one 40 foot lift with side slopes at the angle of repose, and an additional lift could be added to increase storage capacity.

The OSP would be constructed with a lined foundation. Drainage from the OSP would be collected on the liner and routed to a sump for pumping to the WWTF, as shown in Large Figure 15 to Large Figure 17. Because material in the OSP would have a sulfur content similar to Category 4 waste rock, the liner system foundation would be constructed to Category 4 specifications (Section 4.1.4.2). The OSP would be removed at the completion of mining activities.

4.1.3 Mine Equipment and Services

In addition to the drilling, excavating and hauling equipment described in Section 4.1.2.4, the Project would use the approximate fleet of auxiliary and support equipment as shown in Table 4-3 at the Mine Site.

Table 4-3 Mine Auxiliary Equipment Fleet

Typical Machine Type	Power	Number	Duties
Cat D10R tracked dozer or equivalent	582 horsepower (hp)	2	Stockpile maintenance, construction, stockpile reclamation
Cat 834G wheel dozer or equivalent	450 hp	1	Clean-up at the pit loading faces and the RTH
Cat 16H Grader or equivalent	275 hp	2	Haul road maintenance
Cat 777D Water Truck or equivalent	937 hp	2	Haul road maintenance, dust suppression, auxiliary firefighting duties
Cat 992G Wheel Loader or equivalent	800 hp	1	General purpose loading, reclamation
Cat 446D Backhoe with Hammer or equivalent	110 hp	1	Secondary breakage
Cat IT62H Integrated Tool Carrier or equivalent	230 hp	1	Miscellaneous tasks (e.g., snow plowing, fork lift, sweeper, etc.)
Field service trucks	114 hp	6(1)	Field maintenance flatbed trucks fitted with hydraulic arm lift
Fuel truck	150 hp	2(1)	Field fueling of mobile equipment and drills
Line truck	100 hp	1(1)	Powerline maintenance, excavator and RTH service
Off-road lowboy trailer and tractor	200 hp	1(1)	Transporting tracked equipment around mine and to service area/workshops
Drills	Electric and/or 1,600 hp	2(2)	Blasthole drilling for waste rock and ore
Excavators	Electric	2(1)	Excavation of ore and waste materials (waste rock and overburden)
Haul Trucks	2,500 hp	Up to 9	Haulage of ore and waste materials (waste rock and overburden)

Typical Machine Type	Power	Number	Duties
Haul truck retriever	1,120hp	1(1)	Retrieving and transporting haul trucks unable to move under their own power
Light vehicles (pickups and SUVs)	150-250 hp	Up to 20(1)	Supervisors transport, general duties

(1) Tailpipe emissions from these units are not included individually in air emissions calculations.
(2) The air emissions calculations include 1 diesel drill and 1 electric drill.

Equipment fueling and minor service and repair work would be done at the MSFMF located northeast of the RTH. The MSFMF would consist of two buildings, one for fueling mobile equipment (Fueling Station) and the second for mobile equipment maintenance (Maintenance Building).

The Fueling Station would be a roofed structure with enclosed sides but open at each end to allow equipment to drive through. The structure would have a reinforced concrete floor sloped to drain to a sump to collect any fuel, hydraulic oil, engine oil and coolant/antifreeze spillage. A licensed disposal contractor would periodically pump out the sump. In addition to the fuel dispensing system, there would also be dispensing equipment for lubricating and hydraulic oils, antifreeze/coolant, windshield washer fluid and compressed air for tires. The building would contain limited-capacity storage tanks containing lubricating and hydraulic oils and antifreeze. Two to three 12,000 gallon bulk diesel storage tanks, enclosed within a spill containment system, would be provided at a safe distance. Interior and area lighting would be provided to enable safe operation at night. In addition, a metering system would record the amount of fuel dispensed to each vehicle, and emergency shut-off valves would be present at all necessary locations.

Stationary or slow-moving equipment such as excavators, dozers, drill rigs and light plants would be fueled in the field from mobile fuel tankers specially equipped with pumping and metering devices. The fueling tankers would arrive at the Mine Site with fuel or be replenished at the Fueling Station.

The Maintenance Building would be a roofed structure with enclosed sides and ends with doors to allow entry of haul trucks. The structure would have a reinforced concrete floor sloped to drain to a sump to collect any spillage and oil-contaminated water. Minor mobile equipment maintenance such as oil changes, filter changes, maintenance of fluid levels, tire changes, lamp changes, haul truck box welding and other short duration maintenance that could be done without the need of a large overhead crane would be done at the Maintenance Building.

Major scheduled maintenance and repair work lasting several days on mobile equipment such as haul trucks, front end loaders, dozers and graders would be done in the refurbished and reactivated former LTVSMC Area 1 Shop located about one mile west of the Process Plant.

Examples of these types of repairs include engine changes and final drive repairs. Because of the size and weight of the primary excavators and blast hole drill rigs, as well as the distance to the Area 1 Shop, most of their maintenance and repair work would be done at the Mine Site in accordance with the facility's Mine Site Storm Water Pollution Prevention Plan (Attachment D of Reference (4)).

4.1.4 Waste Rock Management and Overburden

Waste rock and overburden characterization, uses and management are detailed in Sections 2.1 and 2.2, respectively, of Reference (2) and summarized in Sections 4.1.4.1 and 4.1.4.2. As described in Section 4.1.4.1, Unsaturated Overburden would be the general on-site construction material without restriction on use at the Mine Site due to its waste characterization. Other materials to be used for construction and reclamation needs of the Project include Saturated Overburden, as described in Section 4.1.4.1; Peat, as described in Section 4.1.4.1; Category 1 waste rock, as described in Section 4.1.4.2; and waste rock from the state-owned waste rock stockpile located approximately five miles west of the Mine Site (Large Figure 2). Between these material types, there would be ample materials to cover the on-site construction and reclamation needs of the Project.

4.1.4.1 Overburden Management

Three types of overburden are present at the site; Unsaturated (mineral) Overburden, Saturated (mineral) Overburden and Peat (organic soils). Each type of overburden would be managed according to its characteristics.

Unsaturated Overburden is the material that has been above the natural water table. Waste characterization has shown that Unsaturated Overburden has been exposed to air long enough for reactions to be complete, so it would be usable as general on-site construction material. Peat and Unsaturated Overburden that exceed immediate construction and reclamation needs would be stored in unlined overburden stockpiles at the OSLA (described in Section 4.1.2). Of the 3,014-acre Mine Site, approximately 1,298 acres have been identified as wetland (Section 3.2.1 of Reference (15)); the remaining 57% or 1,716 acres of upland area on the Mine Site would have Unsaturated Overburden at the surface.

Saturated Overburden is the material that has been below the natural water table. It has not been exposed to air; so it would only be usable for specific on-site construction applications as approved by the MDNR. Applications for Saturated Overburden include those where water contacting the construction material would be collected or drains to the mine pits, where it would be placed back below the water table, where it would be placed above a membrane liner system or other applications where modeling has demonstrated that applicable surface and groundwater standards would be met. Saturated Overburden not used for construction would be commingled with waste rock in temporary waste rock stockpiles that have membrane liners.

Peat would be used for restoration and reclamation activities at the Mine Site. This may include the development of wetlands in the East Pit and within the reclaimed temporary stockpile footprints. Peat would also be mixed with Unsaturated Overburden to increase the organic content for restoration material across the Mine Site, including over the geomembrane cover of Category 1 Waste Rock Stockpile.

4.1.4.2 Waste Rock Management

Waste rock would be managed according to its geochemical properties determined through a sampling and analysis program approved by the MDNR. PolyMet has categorized waste rock into four categories defined according to its sulfur content, in ascending order of reactivity. These waste rock categories are summarized in Table 4-4 and described in more detail below.

Table 4-4 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content (%S)[1]	Approximate % of Waste Rock Mass	Applications[3]
Category 1	%S ≤ 0.12	70%	Construction and East Pit Backfill
Category 2	0.12 < %S ≤ 0.31	24%	East Pit Backfill
Category 3	0.31 < %S ≤ 0.6	3%	East Pit Backfill
Category 4[2]	0.6 < %S	3%	East Pit Backfill

(1) In general, the higher the rock's sulfur content, the higher its potential for generating acid rock drainage (ARD) or leaching heavy metals.
(2) Includes all Virginia formation rock
(3) Applications include uses of the material other than stockpile storage

Category 1 – Least reactive waste rock (based upon waste characterization studies). This material is not projected to generate acid rock drainage (ARD), but may leach heavy metals in excess of anticipated water quality compliance levels. PolyMet proposes to use some of this waste rock for construction purposes such as Mine Site haul roads and ramps, foundations for Mine Site facilities and other applications as approved by the MDNR during permitting. Category 1 waste rock not used as construction material would be placed in the permanent Category 1 Waste Rock Stockpile (Large Figure 8 through Large Figure 11) or the East Pit.

Category 2 – Low reactivity waste rock (based upon waste characterization studies). This material may generate ARD and is projected to leach heavy metals resulting in drainage with metal concentrations in excess of anticipated water quality compliance levels. Category 2 material would be placed in the temporary Category 2/3 Waste Rock Stockpile (Large Figure 8 through Large Figure 11) and ultimately relocated to the East Pit.

Category 3 – Medium reactivity waste rock (based upon waste characterization studies). This material would generate ARD and is projected to leach heavy metals resulting in drainage with heavy metal concentrations in excess of anticipated water quality compliance levels. Category 3 material would be placed in the temporary Category 2/3 Waste Rock Stockpile (Large Figure 8 through Large Figure 11) and ultimately relocated to the East Pit.

Category 4 – High reactivity waste rock (based upon waste characterization studies). This material would generate ARD and leach heavy metals resulting in drainage with heavy metal concentrations in excess of anticipated water quality compliance levels. Category 4 material would be placed in the temporary Category 4 Waste Rock Stockpile (Large Figure 8 through Large Figure 11) and ultimately relocated to the East Pit.

Table 4-5 shows the plan for waste rock placement. The Category 1 Waste Rock Stockpile would be the only permanent stockpile. During Mine Years 1 through 11, Category 2, 3 and 4 waste rock would be placed on the temporary Category 2/3 or Category 4 Waste Rock Stockpiles (Large Figure 8 through Large Figure 11). When at its maximum size, each stockpile is projected to have the approximate area, height and elevation shown in Table 4-6.

Starting in Mine Year 11, when mining in the East Pit ceases, the temporary Category 2/3 and Category 4 Waste Rock Stockpiles would be relocated to the East Pit, and all future Category 2, 3 and 4 waste rock would be placed in the East Pit or the Central Pit, once mining ceases in that pit. By placing Category 2, 3 and 4 waste rock into the East and Central Pits, it would be stored in a subaqueous environment, thereby reducing the environmental impact associated with further oxidation and decomposition of sulfide minerals. Most Category 1 waste rock mined after Mine Year 12 (approximately 49 million tons) would also be placed in the East Pit. Ultimately, approximately 45% of the total waste rock mined would be backfilled to the East and Central pits.

Table 4-5 Waste Rock Placement

Mine Year	Category 1 Waste Rock Stockpile (tons)	Temporary Category 2/3 Waste Rock Stockpile (tons)	Temporary Category 4 Waste Rock Stockpile (tons)	East Pit[1] (tons)	Total Rock Moved[1] (tons)
0	0	0	0	0	0
1	18,707,500	5,238,800	1,489,200	0	25,435,500
2	15,016,700	4,432,900	762,500	0	20,212,100
3	16,139,000	4,297,100	1,127,700	0	21,563,800
4	12,796,600	3,655,600	827,500	0	17,279,700
5	11,741,300	2,415,000	441,900	0	14,598,200

Mine Year	Category 1 Waste Rock Stockpile (tons)	Temporary Category 2/3 Waste Rock Stockpile (tons)	Temporary Category 4 Waste Rock Stockpile (tons)	East Pit[(1)] (tons)	Total Rock Moved[(1)] (tons)
6	16,842,200	4,349,000	665,600	0	21,856,800
7	10,405,000	2,566,000	549,000	0	13,520,000
8	16,939,800	4,332,200	110,600	0	21,382,600
9	12,556,200	4,660,200	133,500	0	17,349,900
10	12,974,200	4,070,500	76,800	0	17,121,500
11	10,180,400	4,003,900	22,400	6,206,800	20,413,500
12	10,773,100	0	0	10,574,200	21,347,300
13	2,850,000	0	0	16,772,200	19,622,200
14	0	0	0	17,917,200	17,917,200
15	0	0	0	16,689,400	16,689,400
16	0	0	0	14,838,800	14,838,800
17	0	0	0	12,695,000	12,695,000
18	0	0	0	14,581,100	14,581,100
19	0	0	0	15,788,600	15,788,600
20	0	0	0	14,128,000	14,128,000
Total	167,922,000[(2)]	44,021,200	6,206,700	140,191,300	358,341,200[(1)]
% Total Rock[(1)]	54.5%	14.3%	2.0%	45.5%	116.3%[(1)]

(1) The total rock listed includes movement of rock from the temporary Category 2/3 and Category 4 Waste Rock Stockpiles to the East Pit and the movement of rock from the West and Central Pit to the East Pit. There would be approximately 308 million tons of waste rock, with about 50 million tons being double-handed for disposal in the East Pit. At reclamation, waste rock storage will be in either the Category 1 Waste Rock Stockpile or the East Pit.

(2) A portion of the Category 1 waste rock may be used for MDNR-approved on-site construction. The balance will be placed in the Category 1 Waste Rock Stockpile.

Table 4-6 Maximum Stockpile Dimensions – Approximate

Stockpile	Mine Year of Maximum Footprint	Maximum Footprint (acres)	Volume (tons)		Height (feet)		Maximum Elevation (feet above sea level)
			Planned (1)	Maximum Capacity	Planned (1)	Maximum Capacity	
Category 1 (Permanent)	6/21(2)	508/526(2)	168.0M	178.0M	240	280	1,880
Category 2/3 (Temporary)	6	180	44.0M	60.6M	160	200	1,770
Category 4 (Temporary)	3	57	6.21M	15.0M	80	180	1,790
Ore Surge Pile (Temporary)	N/A(3)	31	2.50M	4.37M	40	120	1,690

(1) The planned volume of the stockpile is the volume of waste rock in the current Mine Plan. The maximum capacity reflects the full capacity of the stockpile based on its planned footprint. Maximum capacities of the temporary stockpiles and planned capacity of the permanent stockpile were used for impact evaluations.
(2) The Category 1 Waste Rock Stockpile has a maximum footprint of 508 acres while active. It will reach this size by Mine Year 6. The stockpile will be re-graded as part of reclamation with a final footprint of 526 acres in Mine Year 21.
(3) The OSP is a surge pile that would have ore moving in and out as needed to meet mine and plant conditions.

All waste rock stockpiles would be engineered to manage water resource impacts. Overburden would be removed if necessary, and foundations would be built with suitable overburden material or waste rock from the state-owned waste rock stockpile located approximately five miles west of the Mine Site (Large Figure 2) or Category 1 waste rock. The state-owned waste rock stockpile (Stockpile 2012) is material from LTVSMC Area 3 and/or 2.

The temporary Category 2/3 and Category 4 Waste Rock Stockpiles, which have the potential to generate ARD, would have liner systems to capture water passing through the stockpile. The permanent Category 1 Waste Rock Stockpile, which does not have the potential to generate ARD, would have a groundwater containment system with a cover system added when placement of rock into the stockpile is complete. Stockpile construction is detailed in Section 2.1 of Reference (2).

The temporary Category 2/3 and Category 4 Waste Rock Stockpiles would be constructed with liner systems consisting of an impermeable barrier layer (that limits the downward infiltration of water through the liner system) and an overliner drainage layer constructed above the impermeable barrier layer (that promotes the conveyance of water that reaches the barrier layer to a collection removal point along the barrier layer via gravity). Foundation underdrains would be used if necessary to provide gravity drainage where elevated groundwater is encountered to prevent or minimize the potential for excess pore pressures as the stockpile is loaded. These three design details (impermeable barrier, overliner drainage layer and underdrains) enhance liner effectiveness and integrity.

The Category 1 Waste Rock Stockpile would be constructed with a groundwater containment system to collect stockpile drainage from around the entire stockpile (Section 2.1.2 of Reference (2)). The containment system would consist of a cutoff wall (a low permeability compacted soil hydraulic barrier) combined with a drainage collection system surrounding the perimeter of the stockpile near the stockpile toe.

The cutoff wall would be constructed by excavating a trench near the toe of the stockpile down to bedrock and backfilling the trench with a compacted soil material having a hydraulic conductivity specification of no more than $1x10^{-5}$ cm/sec or by placing a manufactured geosynthetic clay barrier in the trench. The drainage collection system would 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 minimizing the potential for drainage passing through the cutoff wall.

The drainage collection system component of the containment system would consist of a slotted or perforated horizontal drain pipe surrounded by aggregate within the trench excavated to bedrock and backfilled with granular, free-draining material. The horizontal pipe would have vertical risers extending upward into a process water ditch to collect surficial seeps and surface runoff. The trench would intercept stockpile drainage, collect it in the horizontal drain pipe and convey it by gravity flow to collection sumps. Initially stockpile drainage collected in the horizontal drain pipe would flow by gravity to a low point near the northeast corner of the stockpile. From the northeast corner of the stockpile, a non-perforated pipe would convey the drainage to a collection sump where it would be pumped to the WWTF described in Section 4.1.5. As the stockpile development progresses to the west, an additional section of the containment system would collect and convey drainage from the southwest corner of the stockpile by gravity flow to a second collection sump where it would be pumped to the WWTF. The two collection sumps would have emergency overflows to the East or West Pits.

Category 1 Waste Rock Stockpile reclamation would begin in Mine Year 14 with progressive installation of a 3-foot engineered cover with a 40-mil geomembrane barrier to limit water percolation into the stockpile. The design of this cover system is discussed in Section 4.4.2 and in detail in Section 3 of Reference (3).

The planned liner and cover systems are shown in Table 4-7. Liner and cover system designs are based on the degree of projected heavy metal leaching expected from each waste rock classification type. Local glacial till overburden soils, generated from the processing of overburden removed from the Mine Site, could be used in constructing the liner and cover systems.

Table 4-7 Summary of Stockpile Liners and Covers

Stockpiles	Stockpile Duration	Stockpile Area (after Reclamation)	Liner System	Cover System
Category 1 Waste Rock	Permanent	526 acres	No liner system; a groundwater containment system would collect and pump drainage to the WWTF	3-foot engineered cover with a 40-mil geomembrane barrier
Category 2/3 Waste Rock	Temporary	0 acres (max of 180 acres during operations)	12-inch compacted ($1x10^{-5}$ cm/s) subgrade overlaid by 80 mil linear low density polyethylene (LLDPE) geomembrane, covered by a 24-inch overliner drainage layer	Stockpile to be completely removed and reclaimed
Category 4 Waste Rock	Temporary	0 acres (max of 57 acres during operations)	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer	Stockpile to be completely removed and reclaimed
Ore Surge Pile	Temporary	0 acres (max of 31 acres during operations)	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer	Stockpile to be completely removed and reclaimed

4.1.5 Mine Site Water Management

This section summarizes information from the Water Management Plan – Mine Site (Reference (4)) and Adaptive Water Management Plan (Reference (3)), which would become reference documents for the MDNR Permit to Mine and Water Appropriations permit applications and Minnesota Pollution Control Agency (MPCA) NPDES/SDS permit application. These plans include WWTF designs, operating and maintenance plans, preliminary water quality monitoring plans, preliminary reporting requirements, and adaptive management approach. Final water quality monitoring and reporting requirements would be determined in the permits.

During operations, water management at the Mine Site would include pit dewatering, the WWTF, stormwater dikes and ditches, and the stockpile liner, cover, and groundwater containment systems. Water management would continue in reclamation and long-term closure, as described in Sections 4.4.2 and 4.4.4.

Water management strategies vary depending on whether the water has contacted surfaces disturbed by mining operations. Process water, which includes pit dewatering water, stockpile drainage, and runoff that has contacted surfaces disturbed by mining operations would be treated at the WWTF, as described in Section 4.1.5.2. Process water collected from the OSLA would only be treated for sedimentation and would be routed directly to the CPS pond from the OSLA process water pond.

Stormwater, the result of precipitation that falls on natural or reclaimed vegetated surfaces, would be separated from process water using a system of dikes, ditches, and sedimentation ponds prior to discharge off-site to the Partridge River.

4.1.5.1 Pit Dewatering

It would be necessary to dewater the pits during mining to remove groundwater, direct precipitation, and runoff. Direct precipitation, runoff and groundwater flow would be directed to low areas in the pits, collected in sumps, and pumped to the WWTF. The mine pit sump areas and pump capacities would be designed to minimize delay to mining operations during the typical spring snowmelt or major precipitation events.

4.1.5.2 Waste Water Treatment Facility (WWTF)

The purpose of the WWTF is to maintain the overall water quality in the FTB at or below process water quality targets in order to manage the water quality of groundwater seepage from the FTB. The design of the WWTF is discussed in Section 2.2 of Reference (3). The WWTF would be constructed on approximately 40 acres and would include two process water equalization basins, the construction water equalization/treatment basin and the building that would house the treatment equipment. During operations, the effluent from the WWTF and runoff from the OSLA would be pumped via the CPS and the TWP to the FTB for use as plant make-up water or used to supplement flooding during backfilling of the East Pit (Section 4.4.2). Reuse of the Mine Site process water at the Plant Site would eliminate the need to discharge any process water to surface waters at the Mine Site during operations.

The WWTF would treat three streams of wastewater during operations: construction water, process water containing relatively higher levels of metals and sulfate and process water containing relatively lower levels of metals and sulfate. Construction water would be routed to the Construction Water Basin, treated by chemical addition, and then discharged to the CPS pond. Construction water treatment would only be needed during the first half of operations.

Process water containing relatively high levels of metals and sulfate (drainage from the temporary waste rock stockpile liners, OSP liner and reject concentrate (i.e., brine) from the

Waste Water Treatment Plant (WWTP) (Section 4.3.8)) would be stored in the West Equalization Basin (West EQ Basin) and routed to the chemical precipitation treatment train. Process water containing relatively low concentrations of metals and sulfate (drainage from haul roads, the RTH, pit dewatering and the Category 1 Waste Rock Stockpile drainage) would be stored in the East Equalization Basin (East EQ Basin) and routed to the membrane filtration treatment train.

The reject concentrate stream from the membrane filtration system would contain metals and sulfate concentrations similar to the relatively high concentration process water stream and would be blended with that stream to form the influent to the chemical precipitation treatment train. The effluent from the membrane filtration treatment train would be blended with the effluent from the chemical precipitation treatment train to form WWTF effluent.

A portion of the solids generated in the chemical precipitation treatment train would be recycled to the reactor tanks to improve precipitation characteristics. Excess sludge from the chemical precipitation would be stored in sludge storage tanks and dewatered utilizing filter presses. The filtered sludge would be disposed offsite in an appropriately permitted solid waste landfill. When the Hydrometallurgical Plant becomes operational, the filtered sludge would be introduced to the autoclave to recover metals or placed directly into the HRF (Section 4.3.7).

Large Figure 15 through Large Figure 17 show the process water management systems in Mine Years 1, 11 and 20, including the pump and pipe networks that dewater the pits and the groundwater containment system around the Category 1 Waste Rock Stockpile.
Large Figure 18 shows the existing subwatershed boundaries and drainage flows at the Mine Site.

4.1.5.3 Mine Site Perimeter and Pit Rim Dike and Ditch Systems

Stormwater would be managed with a system of dikes and ditches constructed at the Mine Site perimeter. The layout of drainage ditches is illustrated in Large Figure 19 through Large Figure 21 for Mine Years 1, 11 and 20, respectively. The dikes and ditches would minimize the amount of surface water flowing onto the site, minimize the amount of surface runoff flowing into the mine pits, manage the amount of process water collected and control stormwater flowing off the site (Large Figure 19 through Large Figure 21).

Dikes would be constructed of silty sands or glacial till material that would be excavated during construction of ditches and removal of overburden. Side slopes would be vegetated to control erosion. Small dikes would be constructed at the rims of the mine pits in all areas where the existing ground surface does not naturally drain surface runoff away from the pit and would be rebuilt as the pit perimeter expands. Small dikes would also be constructed, as needed, along interior stormwater ditches and around stockpile construction areas to separate stormwater and process water.

Ditches would be constructed along the interior of most of the perimeter dike system and throughout the interior of the Mine Site in order to convey stormwater adjacent to the dikes, prevent surface runoff from entering the mine pits, intercept stormwater prior to reaching process water areas and prevent water from pooling in areas where the dikes cut across low areas. In some areas along the site perimeter the existing ground is already relatively high so that a ditch would be able to capture the site surface runoff without a dike. Stormwater captured by the ditches would be directed to sedimentation ponds and then routed into a natural drainage system offsite.

Dike design can be modified for shallow groundwater control if needed. Where Peat or high-permeability glacial till is present in the dike foundation zone below the water table, seepage control measures would be installed to restrict groundwater movement. In areas where Peat is present, seepage would be prevented by compressing the Peat with earthen dike materials to create a low-permeability layer. If a sand seam or other high-permeability material is found in the dike foundation zone below the Peat deposit, a soil cutoff trench, slurry wall, or sheetpile wall would be installed (depending on depth to bedrock) to cut off seepage. In areas where glacial till is present, seepage control measures would include soil cut-off trenches constructed of compacted silty sand or compacted glacial till, or slurry trenches. Seepage control measure design would depend on soil type and depth to bedrock. Geotechnical testing indicated that silty sand soils found at the Mine Site are a relatively low-permeability material in their natural state. As described in Section 4.1 of Reference (16), permeability of the silty sand soil samples taken at the Mine Site in 2006 and 2010 ranged from $1.1\text{x}10^{-7}$ to $9.4\text{x}10^{-7}$ centimeters per second. Therefore, seepage cutoffs are generally not planned to be used in these areas.

4.1.6 Mine Site Air Quality Management

Fugitive sources would be the primary concern at the Mine Site. All active areas at the Mine Site would be subject to a Fugitive Dust Control Plan approved by the MPCA for managing fugitive dust generated from unpaved roads and at rock dumping and loading locations.

The Air Quality Management Plan – Mine (Reference (5)), which is a support document for the MPCA Air Emissions Permit application, provides details on Mine Site air quality management and includes the Fugitive Dust Control Plan as Attachment A. This plan includes air quality management system design, air quality modeling outcomes, preliminary air quality monitoring requirements and preliminary reporting requirements. The final air quality monitoring and reporting requirements would be in the Air Emissions Permit.

4.2 Transport of Ore

Three to four trains, each consisting of 16 to 20 100-ton side-dumping ore cars and one 2,100 hp (approximate) six-axle diesel-electric “GenSet” or “Multi-Engine” locomotive, would transport the ore from the Mine Site to the Plant Site. Trains would run on a new spur at the RTH, to existing track between Mile Posts 8.4 and 3.9 on the Cliffs Erie private railroad, to a new approximately 5,750-foot connecting track between the Cliffs Erie track and existing PolyMet track that serves the Coarse Crusher Building at the Process Plant (Large Figure 22).

The side-dumping ore cars proposed for use for the Project are the same ore cars that LTVSMC used, with hinged sides that drop down when the cars are tipped at the Coarse Crusher for unloading. There is evidence of spillage from rail cars at the LTVSMC site, however this spillage is taconite pellets from pellet cars, not ore from ore cars. There are significant differences in the way that pellets and ore were transported at LTVSMC.

The taconite pellets (size 1/2 to 5/8 inch) were transported in bottom-dump cars with lengthwise hinged doors. This means that the joint between the movable dump door and the stationary car body was directly below the load of pellets in the car and any gaps in this joint were potential areas for pellets or fines to spill out. The pellet car sides had a top and bottom structural piece that was several inches wide. These and other flat surfaces on the pellet cars would collect pellets during loading, and the pellets would fall off of the car as the car moved along the track. Figure 4-1 (upper) shows the configuration of the LTVSMC pellet rail cars.

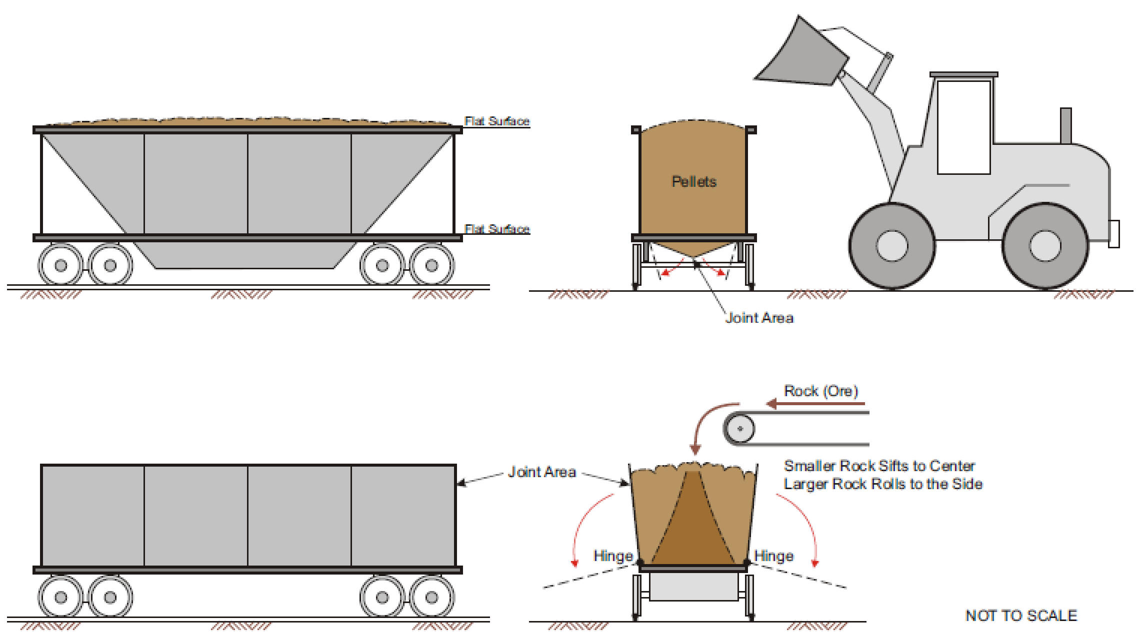

Figure 4-1 LTVSMC Rail Cars (upper = pellet cars, lower = ore cars)

The LTVSMC ore was transported in side-dump cars with two hinged doors that are the sides of the car. There is a joint between the movable dump door and stationary car body along the outside edge of the car at the edge of the load of ore in the car, and any gaps in this joint were potential areas for small pieces of ore or fines to spill out. Figure 4-1 (lower) shows the configuration of the ore cars. Ore was loaded by LTVSMC 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 would result in minimal potential for spillage of ore fines and resultant potential for soil and water body contamination.

PolyMet plans to use an existing but currently decommissioned fleet of LTVSMC ore cars. This ore car fleet currently shows wear at the hinges and joint areas, which has resulted in gaps in these areas where couplings and linkages have loosened over time. Prior to the start of operations, PolyMet would refurbish these ore cars, which would include tightening or replacement of the couplings and linkages to minimize gaps along the hinges and joint areas. This would significantly reduce the potential for spillage from these ore cars.

Project ore loading procedures are also designed to minimize spillage. To minimize the potential for fines to spill, the RTH discharge feeder and track alignment have been designed so that cars would be loaded along the centerline. This naturally classifies the ore by size during loading of the car, with the larger ore pieces at the edge of the car trapping fines at the center, away from the hinge gaps. 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.

In order to guard against possible adverse impacts from spilled ore, monitoring and mitigation activities can be developed. It is expected that the surface water quality sampling in the two streams traversed by the rail line would be included in permit monitoring. Mitigation measures could include alterations to the stream crossings (bridges or culverts) to collect any spilled material or the physical collection of spilled ore from the top of the rail ballast.

4.3 Plant Site

The Plant Site was previously used as a taconite processing facility by LTVSMC. The Project would upgrade existing facilities and construct new facilities. Layouts of the Plant Site are shown on Large Figure 22 and Large Figure 23. Key Project features of the Plant Site would include:

- supporting infrastructure (such as roads, electrical supply, rail connections, Area 1 Shop, and Area 2 Shop)
- a Beneficiation Plant which would use existing buildings for crushing and concentration operations and new buildings for flotation and concentrate dewatering, storage, and shipping

- a Hydrometallurgical Plant
- a Hydrometallurgical Residue Facility (HRF)
- the existing former LTVSMC tailings basin (Tailings Basin), with a new Flotation Tailings Basin (FTB) constructed atop
- a FTB Cover System, a FTB South Surface Seepage Management System, and a FTB Containment System to manage seepage from the FTB
- a Waste Water Treatment Plant (WWTP)

With ore delivery of 32,000 tons per day and assuming 90% availability of processing equipment, annual production would total about 94,000 tons of copper concentrate and 123,000 tons of nickel concentrate without the Hydrometallurgical Plant operational and about 113,000 tons of copper concentrate, 18,000 tons of mixed nickel-cobalt (Ni/Co) hydroxide and 500 tons of Gold and Platinum-Group Elements (Au/PGE) precipitate with the Hydrometallurgical Plant operational. All tons given in this document are short tons unless otherwise specified.

4.3.1 Infrastructure

The majority of the Plant Site infrastructure already exists at this brownfield site as follows:

- County Road 666 ends at the Main Gate for the industrial area that would include the Process Plant, Area 1 Shop, and Area 2 Shop.
- The Canadian National Railroad serves the Process Plant area and existing PolyMet track connects to the Area 1 Shop and the Area 2 Shop.
- Three Minnesota Power Company 138 kV transmission lines serve the Project substation.
- The existing Mechanical Sewage Treatment Plant would be replaced with a new sewage treatment system stabilization pond facility and the existing sewage treatment collection system would be upgraded to meet current performance standards and sized as appropriate.
- The existing Process Plant potable water treatment plant located near the Plant Reservoir would be refurbished and reactivated. The potable water distribution system extends to the Area 1 Shop and Area 2 Shop. This water would be used for showers and sinks and would be treated (chlorinated) to be drinkable. However, bottled water would be brought in for drinking as well.

- Area 1 Shop and Area 2 Shop, as described below.

The Area 1 Shop is a fully enclosed maintenance facility built specifically to handle maintenance and repair work on large mining equipment. A heavy-duty low bed transporter and tractor would be used to transport some equipment (e.g., dozers and front end loaders) to the Area 1 Shop from the Mine Site. A haul truck retriever (large scale tow-truck) would tow haul trucks that would be unable to move on their own, otherwise haul trucks would be driven to Area 1 Shop. It is estimated that each haul truck would be moved to Area 1 Shop two times per year for major repairs. To access the Area 1 Shop, mine vehicles would follow an established route utilizing existing gravel and blacktopped roads through parts of the former LTVSMC taconite mine area.

Used oils and antifreeze/coolant as well as residue from steam cleaning equipment would be collected and stored at the Area 1 Shop. Used oils, antifreeze/coolant and solvents would be collected by a specialist contractor for recycling, while used filters, oily rags and other oil-contaminated waste would be collected for proper offsite disposal in suitably licensed disposal facilities.

The former LTVSMC Area 2 Shop, located about seven miles west of the Mine Site, would be reactivated to provide office space for mining and railroad operations supervision and management, as well as change house facilities, toilets, lunch rooms, first aid facility, emergency response center and training and meeting rooms for mining and railroad crews. The Area 2 Shop facilities would include a Locomotive Fueling Station, Locomotive Service Building and Mine Reporting Building. The Locomotive Fueling Station, where locomotives would be fueled and lubricated, has a roof and sides but is open at the ends to allow access. The concrete floor, equipped with drip trays, would collect any spilled fuel and route it to a collection sump for proper disposal. It also has a 15,000-gallon bulk fuel storage tank with containment systems.

4.3.2 Beneficiation Plant

The Process Plant would consist of a Beneficiation Plant and a Hydrometallurgical Plant. The purpose of the beneficiation process would be to produce a copper concentrate for shipment to customers and different grades of nickel concentrate that could be shipped to customers, used as a feedstock to the hydrometallurgical process, or divided for both uses. PolyMet expects that the Beneficiation Plant would be operational two to four years before the Hydrometallurgical Plant and during that period, all concentrates would be shipped to customers. Once the Hydrometallurgical Plant becomes operational, some or all of the nickel concentrates would be feedstock to the hydrometallurgical process. The decision to ship or process concentrates would be based on equipment maintenance schedules, customer requirements and overall Project economics.

The Beneficiation Plant processes would include ore crushing, grinding, flotation, dewatering, storage and shipping. Crushing and grinding would occur in the existing Coarse

Crusher Building and Concentrator Building, both of which remain from the LTVSMC operations. Ore would be fed from the secondary crusher in the Coarse Crusher Building, into a semi-autogenous grinding (SAG) mill and ball mill in the Concentrator Building. Flotation would occur in a new Flotation Building located on disturbed ground immediately to the west of the Concentrator Building. Dewatering, storage, and shipping would occur in a new Concentrate Dewatering/Storage Building located on disturbed ground near the Heating/Additive Plant, which would be demolished. A simplified process flow diagram for the beneficiation process is shown on Figure 4-2.

4.3.2.1 Ore Crushing

Ore pieces as large as 48 inches in diameter would be delivered by rail from the Mine Site to the Coarse Crusher Building where each car would be emptied into a primary crusher at an average (calculated using the hours the primary crusher would be actually running, as it would not run continuously) feed rate of 1,667 tons per hour. From the primary crusher, ore would move by gravity to four parallel secondary crushers. A conveyor system would move the ore, 80% of which would now be smaller than 4.25 inches, to the ore storage bins located in the Concentrator Building.

The existing Coarse Crushing Building emission control systems would be replaced with components that meet or exceed the particulate emission standard required of new sources at taconite plants. To reduce space heating requirements, the building insulation would be improved and, where practical, emission control system exhaust would be recycled to the buildings. The material collected by the emission control systems would be mixed with water and added to the milling circuit. This means that the solids removed from the air stream would be recycled to the process, no solid waste management would be required, and no water would be lost.

4.3.2.2 Ore Grinding

The coarse, crushed ore would be fed into the SAG mill and ball mill in the existing Concentrator Building. The SAG mill output would feed a ball mill via cyclone feed pumps, also located in the Concentrator Building. The ground ore would re-circulate through the milling circuit until the particle size would be small enough for flotation (80% less than 120 microns [4.7×10^{-3} inches]).

The existing emission controls in the Concentrator Building would be replaced with components that meet or exceed the particulate emission standard required of new sources at taconite plants. To reduce space heating requirements the building insulation would be improved and, where practical, emission control system exhaust would be recycled to the buildings. The material collected by the emission control systems would be mixed with water and added to the milling circuit. This means that the solids removed from the air stream would be recycled to the process, no solid waste management would be required, and no water would be lost. Because water would be added to the mill lines and the beneficiation process would be wet from that point on, there would be no need for particulate emission control systems downstream of the feed to the SAG mill.

In the event of a power failure, all process fluids would be contained within the Concentrator Building and recycled to the process when power has been restored. This same containment and recycle system would contain and control any minor spills.

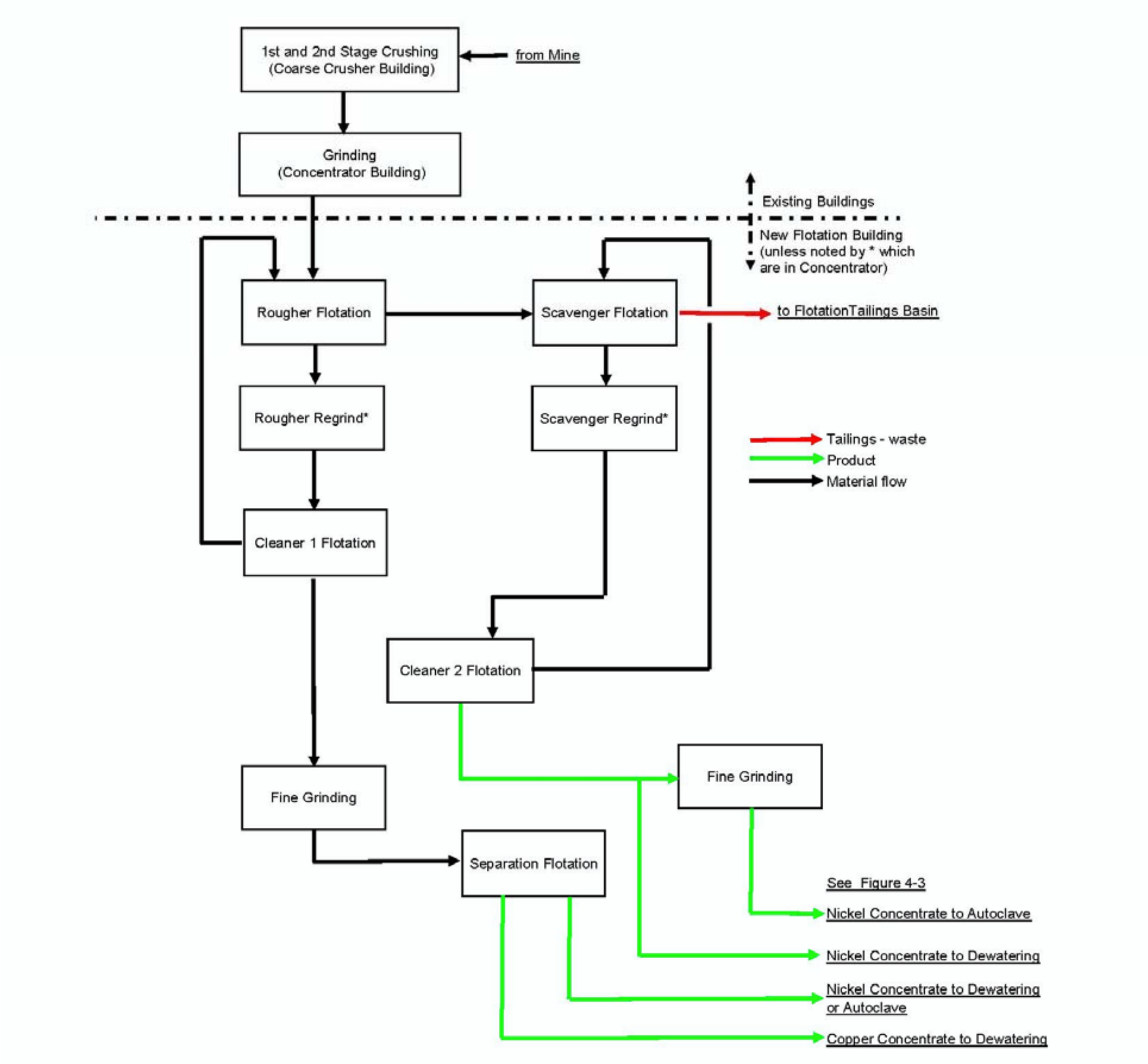

Figure 4-2 Beneficiation Plant Simplified Process Flow Diagram

4.3.2.3 Flotation

Once at a size of 120 microns, the ore would be processed in Flotation to recover the base and precious metal sulfide minerals. Flotation would consist of rougher and scavenger flotation lines followed by cleaner stages in a new Flotation Building and would produce separate nickel and copper concentrates.

In Flotation, separation of the sulfide minerals would be achieved using a collector/frother combination. Air would be injected into each flotation cell and the cell would be mechanically agitated to create air bubbles that would pass upward through the slurry in the cell. The frother (methyl isobutyl carbinol and polyglycol ether, or MIBC/DF250), would provide strength to the bubbles and the collector (potassium amyl xanthate, or PAX) would cause the sulfide minerals to attach to the air bubbles. The material attached to the bubbles would be concentrate and the material remaining in the slurry would be tailings.

The Rougher Flotation tailings would go to Scavenger Flotation where collector and frother would be added, along with copper sulfate as a flotation activator. The activator would ensure that the particles that would be difficult to float (i.e., contain minor amounts of sulfide) would be recovered in the concentrate, which reduces the total sulfur content of the tailings. The concentrate from Scavenger Flotation would go through Scavenger Regrind to Cleaner 2 Flotation. Cleaner 2 Flotation tailings would go back to Scavenger Flotation feed, while the nickel rich Cleaner 2 Flotation concentrate would be sent through Fine Grinding 2 to the Hydrometallurgical Plant or directly to Concentrate Dewatering. The Flotation Tailings from Scavenger Flotation would be sent to the FTB. Rougher Flotation concentrate would be fed through Rougher Regrind to Cleaner 1 Flotation. Cleaner 1 Flotation tailings would go back to Rougher Flotation feed, while the concentrate would be sent through Fine Grinding 1 to Separation Flotation. Separation Flotation would produce a copper concentrate and two nickel concentrates. The copper concentrate would go to Concentrate Dewatering. The nickel concentrates would go to Concentrate Dewatering or to the Hydrometallurgical Plant. A pH Modifier (hydrated lime) would be added in Separation Flotation which would result in a highly basic process water stream. Because this stream would be combined with other process water streams and makeup water, buildup of basicity is not expected. If there is a buildup of basicity, the basicity can be neutralized at the highly basic process water stream before it is combined with other process water streams.

The Scavenger Flotation Tailings would be pumped to the FTB where the solids would settle and be stored permanently. The clear water would be re-circulated to the mill process water system.

In the event of a power failure, all process fluids would be contained within the Flotation Building and recycled to the process when power has been restored. This same containment and recycle system would contain and control any minor spills.

4.3.2.4 Concentrate Dewatering/Storage

Concentrate Dewatering/Storage would be used to dewater and store copper and nickel concentrates and to load those concentrates into covered rail cars. Concentrate Dewatering/Storage would be within the new Concentrate Dewatering/Storage Building.

Additional railroad tracks on disturbed ground would also be part of this area.

The copper and nickel concentrates would each be delivered to separate dewatering lines each with a filter that would reduce concentrate moisture content to approximately 8 to 10%. The water removed by the filter would be returned to the Beneficiation Plant.

Each filtered concentrate would be conveyed to separate stockpiles within an enclosed 10,000 ton storage facility for loading into covered rail cars. The storage facility would store about 15 days of production when all flotation concentrate would be directed to Concentrate Dewatering/Storage and about 32 days of production when only copper flotation concentrate would be directed to Concentrate Dewatering/Storage. The storage facility would have a concrete floor and provisions to wash wheeled equipment leaving the facility to prevent concentrates from being tracked out of the facility.

In the event of a power failure, all process fluids would be contained within the Concentrate Dewatering/Storage Building and recycled to the process when power has been restored. This same containment and recycle system would contain and control any minor spills.

4.3.2.5 Processing Parameters

Table 4-8 shows PolyMet's estimates for daily production rates and size reduction through the processing steps in the beneficiation process. The rates and sizes provided are the values PolyMet would use to design plant piping and equipment.

Water needed for the milling and flotation circuits would primarily be water from the FTB Pond, which would include seepage collected by the FTB seepage capture systems and treated Mine Site process water. Any shortfall in water requirements would be made up by raw water from the Plant Reservoir which is supplied from Colby Lake using an existing pump station and pipeline. The average annual make-up water drawn from Colby Lake would vary throughout operations between 260 and 1,760 gallons per minute (gpm), with an average annual demand of 760 gpm for the total potential raw water demand from the Beneficiation Plant and the Hydrometallurgical Plant. Colby Lake make-up water demand is presented in the Water Modeling Data Packages (Reference (17), Reference (18)).

Table 4-8 Design Processing Parameters

Step	Input			Output		
	Material	**Rate (tons per day)**	**Average Size (inches)**	**Material**	**Rate (tons per day)**	**Average 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 Hydro-metallurgical 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 concentrates	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.

4.3.2.6 Process Consumables

PolyMet anticipates the raw materials shown in Table 4-9 would be consumed by the Beneficiation Plant processes.

Table 4-9 Beneficiation Plant Consumables

Consumable	Estimated Quantity (tons/year)	Mode of Delivery	Delivery Condition	Storage Location	Containment
Grinding Media (metal alloy balls)	10,000	Rail (9 rail cars/ month [mo])	Bulk	Concentrator Building	None required
Flotation Collector (PAX)	1,171	Truck (2-3 trucks/mo)	Bulk bags	Reagents Building	None required
Flotation Frother (MIBC and DF250)	1,007	Tank truck (2-3 trucks/mo)	Bulk	Reagents Building	Separate 13,200 gallon storage tanks
Flotation Activators (copper sulfate)	592	Truck (1-2 trucks/mo)	Bulk bags	Reagents Building	9,200 gallon Activator Storage Tank
Flocculant (MagnaFlox 10)	16.5	Truck (1 truck/2 mo)	1,875 pound bulk bags	Reagents Building	None required
Gangue Depressant (CMC)	1,073	Truck (2-3 trucks/mo)	Bulk bags	Reagents Building	None required
pH Modifier (hydrated lime)	10,279	Tank Truck (1-2 trucks/day)	Bulk	Reagents Building	Storage Silo

4.3.3 Hydrometallurgical Plant

Hydrometallurgical processing technology would be used for the treatment of nickel concentrates. This process would involve high pressure and temperature autoclave leaching followed by solution purification steps to extract and isolate platinum-group elements, precious metals, and base metals. All equipment used in the hydrometallurgical process would be located in a new Hydrometallurgical Plant Building. Should spillage of process fluids occur, it would remain within the Hydrometallurgical Plant buildings and be returned to the appropriate process streams. Once the Hydrometallurgical Plant becomes operational, some of the concentrates produced in the Beneficiation Plant would be feedstock to the hydrometallurgical process. The feedstock would be a combination of the separate nickel concentrates produced by the Beneficiation Plant. The decision to ship or process concentrates would be based on equipment maintenance schedules, customer requirements and overall Project economics.

PolyMet expects that the autoclave would be operational two to four years after the Beneficiation Plant becomes operational. A simplified process flow diagram for the hydrometallurgical process is shown on Figure 4-3.

4.3.3.1 Autoclave

In the Autoclave, the sulfide minerals in the concentrate would be oxidized and dissolved in a solution. Gold and platinum-group elements would dissolve as soluble chloride salts. The solid residue produced would contain iron oxide, jarosite and any insoluble gangue (non-ore silicate and oxide minerals) from the concentrate. Generation of acid from the oxidation of major sulfide minerals would result in leaching of the silicate, hydroxide and carbonate minerals present in the concentrate.

WWTF filtered sludge (to recover metals and provide disposal of remaining solids) and hydrochloric acid (to maintain the proper chloride concentration in the solution to enable leaching of the gold and platinum-group elements) would be added to the concentrate before the Autoclave. The Autoclave would be injected with oxygen gas supplied by a cryogenic oxygen plant at a rate that would be controlled to ensure complete oxidation of all sulfide sulfur in the concentrate.

Slurry discharging from the Autoclave would be sent to the Leach Residue Thickener where solids would be settled with the aid of a flocculant. The Leach Residue Thickener underflow would be filtered to produce a filter cake, which would be washed, re-pulped, combined with other hydrometallurgical residues and pumped to the HRF (Section 4.3.7). The Leach Residue Thickener overflow would go to Au/PGE Recovery.

4.3.3.2 Gold and Platinum-Group Elements (Au/PGE) Recovery

The product produced by Au/PGE Recovery would be a filter cake made up of a mixed gold and platinum-group elements sulfide precipitate. The filter cake would be put into either bulk bags or drums for sale to a third party refinery. The remaining solution would go to Copper Cementation.

4.3.3.3 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. All solutions would remain in the hydrometallurgical process. The remaining solution would then go Solution Neutralization.

4.3.3.4 Solution Neutralization

Solution Neutralization would be used to neutralize acids formed as a result of the upstream process. Solution from Copper Cementation would go to Solution Neutralization. Calcium in the form of either limestone or lime would be added. The result of the calcium addition would be the formation of gypsum that would be filtered to produce a gypsum filter cake. This filter cake would be washed, re-pulped, combined with other hydrometallurgical residues and pumped to the HRF. The solution remaining after neutralization would go to Iron and Aluminum Removal.

4.3.3.5 Iron and Aluminum Removal

Solution Neutralization would feed Iron and Aluminum Removal. Limestone, steam and air would be added to cause the aluminum and iron to precipitate. The precipitated metals would be filtered to produce a filter cake, which would be washed, re-pulped, combined with other hydrometallurgical residues and pumped to the HRF. The remaining solution would be sent to Mixed Hydroxide Product Recovery.

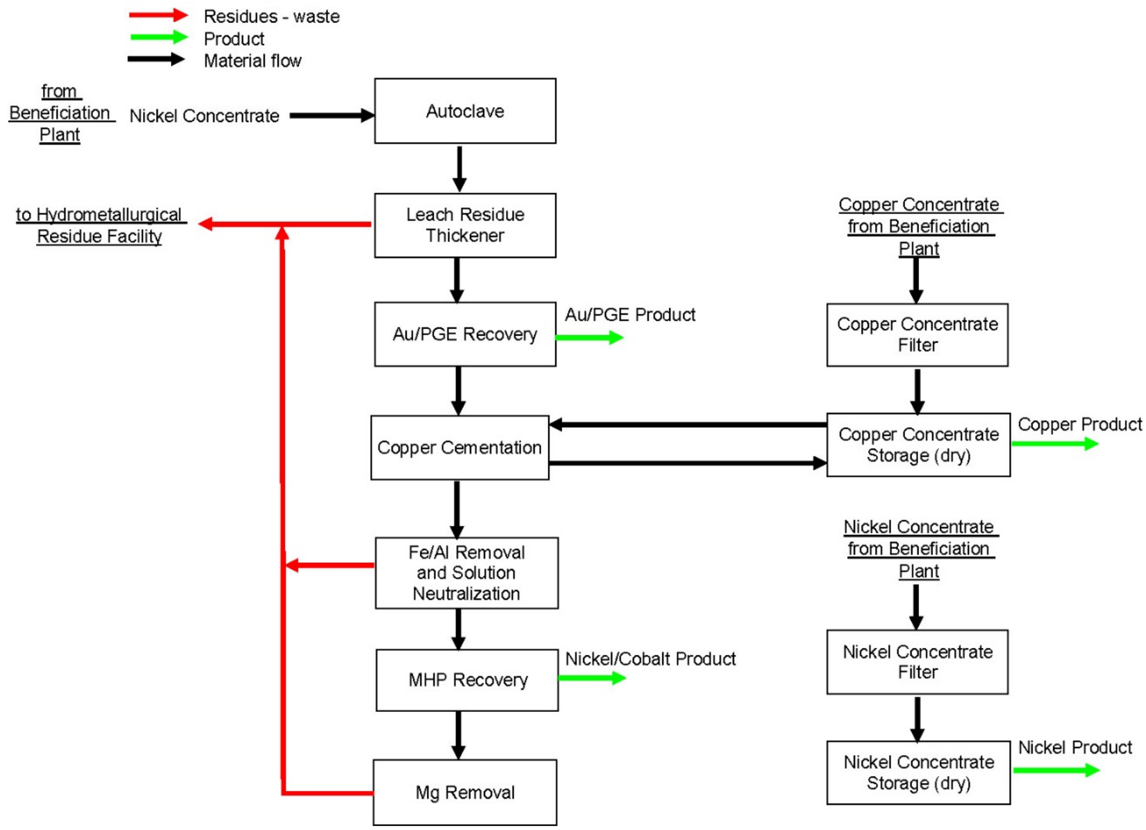

Figure 4-3 Hydrometallurgical Plant Simplified Process Flow Diagram

4.3.3.6 Mixed Hydroxide Product (MHP) Recovery

Copper-free solution from Iron and Aluminum Removal would be reacted with magnesium hydroxide to produce nickel and cobalt precipitate. The precipitated metals would be filtered to produce a filter cake. The final mixed hydroxide product (MHP) would have an approximate composition of 97% nickel and cobalt hydroxides with the remainder as magnesium hydroxide. The high quality mixed hydroxide filter cake would be packaged for shipment to a third party refiner. The remaining solution would go to Magnesium Removal.

4.3.3.7 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.

4.3.3.8 Process Consumables

The raw materials consumed by the Hydrometallurgical Plant processes are summarized in Table 4-10, which provides information regarding quantities, mode and condition of the deliveries, storage and containment at the site.

Table 4-10 Materials Consumed by the Hydrometallurgical Plant Processes

Consumable	Quantity (tons/year)	Mode of Delivery	Delivery Condition	Storage Location	Containment
Sulfuric acid	1,500	Tanker (2 tank cars/ month [mo])	Bulk	Adjacent to General Shop Building	31,965 gallon storage tank with secondary containment
Hydrochloric acid	3,590	Tanker (3 tank cars/mo)	Bulk	Adjacent to General Shop Building	36,120 gallon storage tank with secondary containment
Liquid Sulfur Dioxide	1,433	Tanker (2 tank cars/mo)	Bulk	Adjacent to General Shop Building	30,000 gallon pressurized storage tank with secondary containment
Sodium Hydrosulfide	513	Tanker Truck (2-3 tankers/mo)	Bulk as a 45% solution with water (w/w)	Adjacent to General Shop Building	25,750 gallon storage tank
Limestone	125,000	Rail (1 100-car trains/week from April to October)	Bulk	Stockpiled on site	Berms/ditches around outdoor stockpile with water that has contacted limestone collected and added to the plant process water

Consumable	Quantity (tons/year)	Mode of Delivery	Delivery Condition	Storage Location	Containment
Lime	4,344	Freight (75 loads/mo)	Bulk	Adjacent to General Shop Building	Lime Silo and 21,000 gallon storage tank
Magnesium Hydroxide	4,866	Tanker (7 tank cars/mo)	60% w/w magnesium hydroxide slurry	Adjacent to General Shop Building	Magnesium Hydroxide 270,000 gallon Storage Tank
Caustic (NaOH)	33	Tanker Truck (1 load/mo)	50% w/w solution	General Shop Building	1,300 gallon storage tank
Flocculant (MagnaFloc 342)	14	Freight	1,543 pound (lb) bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.3% w/w solution
Flocculant (MagnaFloc 351)	90	Freight	1,543 lb bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.3% w/w solution
Nitrogen (used in Hydrometallurgical Plant)(1)	19,113	NA	NA	NA	NA

(1) Nitrogen used in the Hydrometallurgical Plant would be produced as a byproduct in the Oxygen Plant, and no shipping or storage would be required.

4.3.3.9 Hydrometallurgical Process Water

A separate Hydrometallurgical Plant process water distribution system would be required due to the different nature of the process solutions involved in the hydrometallurgical and beneficiation processes. Hydrometallurgical process water would contain significant levels of chloride relative to the water in the milling and flotation circuits. The system would distribute water to various water addition points throughout the Hydrometallurgical Plant and would receive water from the HRF (water that was used to transport hydrometallurgical residues to the facility). Make-up water would come from flotation concentrate water and raw water. Raw water demand for ore processing is described in Section 4.3.2.

4.3.4 Transport of Consumables and Products

A 1,500 to 2,000 horsepower GenSet locomotive, similar to the locomotives that would be hauling ore from the Mine Site to the Plant Site, would transfer loaded and empty cars carrying process consumables and concentrates to and from the interchange location with the

Canadian National Railroad. Cars carrying process consumables and concentrate would meet rail common carrier requirements.

Nickel/cobalt hydroxide and precious metal precipitate products would be shipped in sealed bulk bags or sealed containers. Copper and nickel concentrates would be shipped in solid bottom rail cars with weather tight covers. Cars would be checked before loading and any debris removed and holes plugged. Loading operations would be conducted in a building via a conveyor system. Car exteriors would be inspected before leaving the buildings and any concentrate on the car exterior would be recovered and returned to storage. The concentrate is expected to be 8 to 10% moisture and would not generate dust during loading.

Locomotive fueling and routine inspection facilities used by LTVSMC would be reactivated, while locomotives needing major repair would be sent offsite or repaired by a contractor in the reactivated General Shop facility used by LTVSMC. The ore cars would be maintained at the General Shop facility.

4.3.5 Services

The Plant Site would require various services to perform its functions. These services would be in addition to plant switching and site infrastructure needs that are described in Section 4.3.1. These services are summarized in Table 4-11.

Table 4-11 Plant Site Services

Service	Source	Source Location	Needed for
Compressed Air	Duty/standby arrangement of rotary screw type compressors	General Shop Building	Provide air at a pressure of 100 pounds per square in gage (psig) for plant services
Instrument Air	Air withdrawn from the plant air receiver to an instrument air accumulator and dried in a duty/standby arrangement of driers and air filters	General Shop Building	Provide air for instruments
Steam	Natural gas-fired boiler	Hydrometallurgic al Plant	Generates heat needed for startup of the autoclaves
Diesel Fuel Storage	Existing Locomotive Fuel Oil facility (storage is discussed in more detail in Section 4.3.1)	Area 2 Shop	Diesel for locomotives
Gasoline Storage	Existing storage facility – two 6,000 gallon tanks	Main Gate	Gasoline for vehicles
Raw Water	Water from Colby Lake via an existing pumping station and pipeline (Section 4.1)	Stored in the Plant Reservoir	Plant fire protections systems, plant potable water systems, make-up water for grinding and flotation process water and hydrometallurgical plant process water
Potable Water	Existing Process Plant potable water treatment plant would be refurbished and reactivated	Near the Plant Reservoir	Potable water distribution system includes the Area 1 Shop and Area 2 Shop
Fire Protection	Existing fire protection system would be refurbished, reactivated and extended to new buildings	Plant Reservoir	Area 1 Shop and Area 2 Shop have independent fire protection systems
Oxygen	770 tons per day Oxygen Plant. Plant process takes in ambient air, compresses it and separates the oxygen from nitrogen and other trace atmospheric gases. Oxygen would be transported via pipeline to plant processes and nitrogen and trace gases would be returned to the atmosphere	Adjacent to Concentrator (Large Figure 23)	Plant processes

4.3.6 Flotation Tailings Basin (FTB)

Flotation Tailings from the flotation process at the Beneficiation Plant would be pumped to the FTB. The FTB would be constructed on top of a portion of the existing Tailings Basin and is described in detail in the Flotation Tailings Management Plan (Reference (6)). Treated water from the WWTP and Mine Site would also be pumped to the FTB, enabling the FTB to serve as the primary source of process water at the Plant Site. Seepage capture systems would be constructed to manage water resource impacts of the Tailings Basin (Section 4.3.8). Flotation Tailings would be placed on Cells 1E and 2E of the Tailings Basin (Large Figure 24). The Tailings Basin is unlined and was constructed in stages beginning in the 1950's. It was configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E and Cell 2W and was developed by first constructing perimeter starter dams and placing tailings from the iron-ore process directly on native material. Perimeter dams were initially constructed from rock, and subsequent perimeter dams were constructed of coarse tailings using upstream construction methods. The Tailings Basin operations were shut down in January 2001 and have been inactive since then except for reclamation activities consistent with a MDNR-approved Closure Plan currently managed by Cliffs Erie.

The future FTB perimeter dams (Large Figure 25) would be raised in an upstream construction method using compacted LTVSMC bulk tailings that consist primarily of coarse tailings with limited amounts of LTVSMC fines and slimes mixed in. The LTVSMC bulk tailings would be removed from the existing LTVSMC dams to the north and east of Cell 2W, from the southeast dam of Cell 1E and from the south dam of Cell 2E. The LTVSMC tailings would then be mechanically placed and compacted to Project specifications. A bentonite amended oxygen barrier layer (at a depth of 30 inches from the surface of the dams) on exterior sides of dams would be added as part of construction. Upon exhaustion of LTVSMC tailings available for dam construction, offsite borrow from MDNR-approved sources would be utilized. Material from LTVSMC Area 5 would be a likely source, but other sources could also be considered, especially other former LTVSMC waste rock stockpiles. The design includes a mid-slope setback and construction of buttresses, using material from LTVSMC Area 5.

To augment the proposed buttress, internal shear walls will be constructed within portions of the existing LTVSMC slimes and fine tailings in Cell 2E. The shear walls will be constructed using Cement Deep Soil Mixing, a technique where cement is injected into multiple boreholes augured into the slimes/fine tailings layer. The cement would mix with the tailings to form rows of overlapping, 3 foot diameter (approximate) columns parallel to the existing groundwater flow paths. The resulting shear walls would increase the slope stability safety factor and the overall resistance to slope movement. These shear walls would be constructed during Mine Year 0 in parallel with site preparation activities. Cement Deep Soil Mixing techniques have been used for decades as a means to improve slope stability safety factors; see Section 2.2.4 of Reference (6).

The Flotation Tailings would be deposited in slurry form through a system of pumps and moveable pipelines. Flotation Tailings would go into Cell 2E for the first seven years of operation, then into both Cells 1E and 2E, eventually forming a single cell (Cell 1/2E). Flotation Tailings would be deposited by gravity flow over discharge beaches when necessary and otherwise subaqueously via movable diffusers throughout the pond. The small and fairly uniform grind size of the Flotation Tailings would allow for a fairly consistent particle size distribution to be achieved, minimizing segregation of coarse and fine portions. The dam would be raised using the LTVSMC bulk tailings. Flotation Tailings beaches would exist along the northern and northeastern dams of Cell 2E and the southern and eastern dams of Cell 1E.

The Flotation Tailings would settle out of the slurry, and the decanted water would be allowed to pond and be returned to the beneficiation process by a barge pump back system. The barge system would consist of a primary pump barge in Cell 1E, an auxiliary pump barge in Cell 2E, piping from the primary pump barge to the Beneficiation Plant and piping from the auxiliary pump barge to Cell 1E. The auxiliary pump barge would not be needed once the cells combine to form one cell. The return water pipelines would be moved as dams are raised (up to the maximum of 1,732 feet Mean Sea Level) to keep the pipeline at or near the top of the dam. The return water pipes would be fitted with a relief drain valve to allow for water to be drained back to ponds in case of shutdown during winter operations to avoid damage to the pipes from freezing or suction. Pumps would also be fitted with deicing mechanisms to avoid freezing.

An emergency overflow channel for operations would be constructed to carry stormwater from Cell 1E or Cell 1/2E in case of an extreme storm, such as a probable maximum precipitation (PMP) rainfall event or some fraction thereof. The 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 it is usually assumed by hydrologists to be on the order of 100 million to 10 billion years. Based on an extrapolation of the 72-hour rainfall depth data from the U.S. Weather Bureau-Office of Hydrology Technical Paper TP 49 and the assumed return period of 100 million years, a 1/3 PMP event could occur roughly once in 1,000 years and a 2/3 PMP could occur once in 500,000 years. On this basis, there is a low likelihood of overflow, however it is standard practice in dam design to accommodate even low probability overflows in a manner that protects the integrity of the dams. The overflow channel would consist of a precast concrete channel constructed in the northeast corner of the FTB as shown on Large Figure 25 and would be raised incrementally with the dam raises. A separate overflow channel would be constructed during reclamation, as described in Section 4.4.3.1.

During LTVSMC operations, fly ash, dredging spoil, and coal pile cleanup material were placed in a solid waste storage site (Coal Ash Landfill) upgradient and to the east of Cell 1E. The location of the Coal Ash Landfill would be inundated by the FTB in approximately Mine Year 7, therefore the contents would be relocated to the Hydrometallurgical Residue Facility prior to that time, or disposed of off-site in accordance with all federal and state regulations. The Coal Ash Landfill is shown on Large Figure 24.

4.3.7 Hydrometallurgical Residue Facility (HRF)

An HRF would be constructed to manage residues generated by the hydrometallurgical process, including:

- Autoclave residue.
- High purity gypsum from Solution Neutralization (depending on the market, this may become a saleable product but is currently planned to be managed as a waste).
- Gypsum, iron and aluminum hydroxide from Iron and Aluminum Removal.
- Gagnesium hydroxide precipitate from Magnesium Removal which is entrained in the water used to repulp the Autoclave residue, Solution Neutralization and Iron and Aluminum Removal filter cake for transport to the HRF.
- Other minor plant spillage sources.
- Filtered sludge from the WWTF not recycled to the hydrometallurgical process would be placed directly into the HRF. The WWTF filtered sludge would be similar to the HRF materials, consisting primarily of gypsum, metal hydroxides and calcite.

If all nickel flotation concentrate streams were used as feedstock, the projected hydrometallurgical residue generation rate would be 313,000 tons annually. If some nickel concentrate were sold, the annual hydrometallurgical residue generation would be less.

The HRF would consist of one double-lined cell located adjacent to the southwest corner of Cell 2W of the Tailings Basin (Large Figure 25 and Large Figure 26). The cell would be developed incrementally as needed, expanding vertically and horizontally from the initial construction and would initially be designed to accommodate approximately 3,760,000 cubic yards or 6 years of operations prior to expansion of the cell, with a total design capacity of 6,170,000 cubic yards.

The first increment of the cell would be constructed over several construction seasons. Most of the site preparation activities and major earthwork would occur in approximately the first two construction seasons. Placing the liner would occur in the construction season of the year preceding placing the HRF into service. The remaining earthwork and completion of the liner installation for the upper elevations of the cell would occur as needed to maintain adequate capacity. Cell layout and cross-sections are shown in Large Figure 26 through Large Figure 28. The HRF would be lined to minimize release of water that has contacted the hydrometallurgical residue. The double liner would consist of a composite liner system utilizing a geomembrane liner above a geosynthetic clay liner with a second liner placed above the first, separated by a leakage collection system, substantially removing all hydraulic head from the lower liner and thereby virtually eliminating leakage from the HRF.

The cell would be filled by pumping the combined hydrometallurgical residue (Residue) as slurry from the Hydrometallurgical Plant. A pond would be maintained within the cell so that the solids in the slurry would settle out, while the majority of the liquid would be recovered by a pump system and returned to the plant for reuse. The Residue discharge point into the cell would be relocated as needed to distribute the Residue evenly throughout the cell.

4.3.8 Plant Site Water Management

This section summarizes information from the Water Management Plan – Plant and Adaptive Water Management Plan (Reference (8) and Reference (3)), which would become reference documents for the MDNR Permit to Mine and Water Appropriations permit applications and MPCA NPDES/SDS permit application. These plans include WWTP designs, operating and maintenance plans, preliminary water quality monitoring plans, preliminary reporting requirements and adaptive management approach. Final water quality monitoring and reporting requirements would be determined in the permits.

During operations at the Plant Site, the primary source of process water would be the FTB Pond, which would contain water from the flotation process, treated water from the Mine Site, and water collected from the FTB seepage capture systems. Collected FTB seepage would be returned to the FTB Pond, with excess water and that needed for stream augmentation discharged via the WWTP, as described in Section 4.3.8.5. Leakage from the HRF would be collected by the leakage collection component of the double liner system and returned to the hydrometallurgical process. Water management would continue in reclamation and long-term closure, as described in Sections 4.4.3 and 4.4.4.

4.3.8.1 Hydrometallurgical Plant

All water that enters the Hydrometallurgical Plant would be consumed within the hydrometallurgical process, exiting as steam or becoming entrained within the Residues or products generated through the hydrometallurgical process. Hydrometallurgical residues would be disposed in the lined HRF, where the solids would settle out and the water would pond within the cell. To the extent possible, water that would be used to transport Residue to the HRF would be returned to the Hydrometallurgical Plant, however some losses would occur through evaporation or storage within the pores of the deposited Residue. The double liner system described in Section 4.3.8 would virtually eliminate liner leakage to groundwater. Leakage collected by the double liner system would be recycled back into the process.

For the most part, water operations within the Hydrometallurgical Plant would operate independently of water operations in the Beneficiation Plant. The only exceptions would be the transfer of flotation concentrate from the Beneficiation Plant to the Hydrometallurgical

Plant and the combining of filtered copper concentrate and solution from Au/PGE Recovery in the Copper Cementation process step.

4.3.8.2 Beneficiation Plant

Within the Beneficiation Plant, water would be used to carry the ore through the grinding, flotation and separation steps, then to transport the Flotation Tailings to the FTB. To the extent possible, water that would be used to transport Flotation Tailings to the FTB would be returned to the Beneficiation Plant; however some losses would occur through evaporation, storage within the pores of the deposited Flotation Tailings, or seepage to groundwater under the Tailings Basin which would be collected by the FTB Containment System or FTB South Surface Seepage Management System.

4.3.8.3 Flotation Tailings Basin (FTB)

During operations, the FTB would be the primary collection and distribution point for water used in the beneficiation process. The primary sources of water to the FTB Pond would include direct precipitation, stormwater run-on, process water from the Mine Site, and seepage water collected by the FTB seepage capture systems. The FTB would also receive process water from the Beneficiation Plant used to transport Flotation Tailings to the FTB.

The FTB Containment System and the FTB South Seepage Management System are collectively referred to as the FTB seepage capture systems. They would be installed to collect water seeping from the Tailings Basin via surface and shallow groundwater flow. During operations this water would be returned to the FTB Pond for reuse to the extent possible with any excess water treated at the WWTP and discharged at currently permitted locations.

The FTB Containment System would surround the western, and northern sides and extend to a portion of the eastern side of the Tailings Basin. Along the remaining portion of the eastern side of the FTB, high bedrock would eliminate any additional groundwater seepage. The design of the FTB Containment System would be similar to the Category 1 Waste Rock Stockpile Groundwater Containment System described in Section 4.1.4. It would consist of a cutoff wall placed into existing surficial deposits with a collection trench and drain pipe installed on the upgradient side on the cutoff wall. The design of the FTB Containment System is discussed in Section 2.1.4 of Reference (8).

The FTB South Surface Seepage Management System would collect seepage on the southern side of the FTB. Along the southern side, bedrock and surface topography create a narrow valley at the headwaters of Second Creek. Due to this topography, it is expected that all existing seepage from the Tailings Basin to the south emerges as surface seeps within a short distance from the dam toe. An existing seepage management system currently captures the majority of the seepage leaving the Tailings Basin to the south. This system consists of a cutoff berm and trench placed approximately 200 to 250 feet downstream of the seepage face. A seep collection sump, pump and pipe system is being used to route this south seepage back into the Tailings Basin Pond. PolyMet and Cliffs Erie are currently working together to assess the efficiency of the existing South Surface Seepage Management System. PolyMet has committed to collecting essentially all of the seepage from the Tailings Basin in this area and will implement additional improvements to the seepage management system if necessary. During operations, PolyMet will pump water collected by the seepage management system to the FTB Pond or to the WWTP, as described in Section 2.1.3 of Reference (8).

4.3.8.4 Waste Water Treatment Plant (WWTP)

The purpose of the WWTP is to treat water for discharge to the environment when the Project has excess water that cannot be stored in the FTB and to augment flows in streams west, north, and south of the Tailings Basin. The design of the WWTP is discussed in Section 4.2 of Reference (3). The WWTP would be constructed south of the Tailings Basin near the Coarse Crusher and would include a reverse osmosis unit or similar membrane separation technologies that can best achieve an effluent sulfate concentration that meets the sulfate standard for waters used for the production of wild rice (10 mg/L). The reject concentrate stream from the WWTP would be transported to the WWTF via rail tank cars where it would be added to the West EQ Basin (Section 4.1.5).

WWTP effluent would be discharged to three tributaries around the Tailings Basin (Unnamed Creek, Second Creek, and Trimble Creek). The WWTP would discharge to Unnamed Creek near existing NPDES discharge SD006 (outside the FTB Containment System) and Second Creek near existing NPDES discharge SD026. The exact location to which the WWTP would discharge to the Trimble Creek watershed is not yet determined. Discharging to the downstream side of the FTB Containment System would most closely mimic existing conditions, where seepage from the Tailings Basin emerges in the wetland areas north of the basin. The effluent from the WWTP would be distributed to these tributaries in proportion to the flow required to prevent significant hydrologic impacts, as described in Section 4.3.8.5 and Section 2.5 of Reference (8).

4.3.8.5 Stream Augmentation

Construction of the FTB Containment System and FTB South Surface Seepage Management System would significantly reduce the amount of seepage leaving the FTB, consequently reducing the stream flow in four tributaries around the Tailings Basin, including Unnamed Creek, Second Creek, Trimble Creek and Mud Lake Creek. Flow to Unnamed Creek, Second Creek and Trimble Creek would be augmented by WWTP effluent, as described in Section 4.3.8.4 and Section 2.5 of Reference (8).

Flow to Mud Lake Creek would be augmented by the construction of a drainage swale east of the FTB. Currently, an area east of Cell 1E drains into that cell. A drainage swale would be constructed near the east dam to reroute this watershed north to Mud Lake Creek. The primary purpose of this drainage swale is to prevent water from pooling at the toe of the east dam; however, the swale would be constructed at the start of the Project to augment flow to Mud Lake Creek.

4.3.9 Plant Site Air Quality Management

All active areas at the Plant Site, including the FTB, would be subject to a Fugitive Dust Control Plan approved by MPCA for managing fugitive dust generated at material handling locations, unpaved roads and areas potentially subject to wind erosion. The emission control systems on plant processes would have automated monitoring and alarming of operating parameters that indicate off-spec performance with auditable procedures to track the actions taken by operating and maintenance personnel in response to the alarm. Periodic stack testing would demonstrate compliance and confirm the proper alarm points.

The Air Quality Management Plan – Plant (Reference (9)), which is a support document for the MPCA Air Emissions Permit, details air quality management system design, visibility mitigation, air quality modeling outcomes, preliminary air quality monitoring requirements and preliminary reporting requirements and includes the Fugitive Dust Control Plan as Attachment A. The final air quality monitoring and reporting requirements would be in the Air Emissions Permit.

4.4 Reclamation and Long-Term Closure

Mining is expected to be completed approximately 20 years after operations begin. PolyMet has developed a Reclamation Plan as part of its application for the Permit to Mine. The Reclamation Plan would be finalized to provide details and schedule for the final reclamation of the actual as-built facilities. In addition, PolyMet would submit an annual Contingency Reclamation Plan, per Minnesota Rules, part 6132.1300, subpart 4, to identify activities that would be implemented if operations cease in that upcoming year. Reclamation details are presented in the Reclamation Plan (Reference (11)) and the Management Plans (Reference (1), Reference (2), Reference (3), Reference (4), Reference (6), Reference (7), Reference (8)), and summarized in the following sections.

In general, Project facilities have been designed and would be operated to allow for progressive reclamation, or "mining in a manner that creates areas that can be reclaimed as soon after initiation of the operation as practical and as continuously as practical throughout the life of operation" (Minnesota Rules, part 6132.0100). This would leave a smaller portion of the Project area needing to be reclaimed at mine closure. The Project features that lend themselves best to this progressive reclamation approach would be the waste rock stockpiles, the East Pit and the exterior slopes of the FTB and HRF.

Reclamation activities at the Mine Site are shown in Large Figure 29 and Large Figure 30, with features that would remain at the Mine Site during reclamation and long-term closure shown in Large Figure 30. Reclamation activities at the Plant Site are shown in

Large Figure 31. Note that the WWTF and the WWTP would remain during reclamation and in long-term closure.

4.4.1 Building and Structure Demolition and Equipment Removal

Buildings and structures at the Mine Site and Plant Site would be removed and foundations razed and covered with a minimum of two feet of soil and vegetated according to the applicable Minnesota Rules, part 6132.2700 and part 6132.3200. Demolition waste from structure removal would be disposed in the existing on-site industrial landfill located northwest of the Area 1 Shop. Concrete from demolition, with the exception of oil-stained concrete, would be crushed and used for structural fill, placed in the basements of the Coarse Crusher Building, Fine Crusher Building and Concentrator Building or placed in the existing on-site industrial landfill. Oil-stained concrete requires different handling and is addressed in Section 4.4.1.2.

Most roads, parking areas, or storage pads built to access these facilities would be demolished according to the planned schedule or as approved by the MDNR commissioner. Utility tunnels would be sealed and reclaimed in place. Asphalt from paved surfaces would be removed and recycled and the disturbed areas reclaimed and vegetated according to Minnesota Rules, part 6132.2700. Railroad track and ties that were not used by common carriers would be removed and recycled. Any roads, which include Mine Site access roads (Minnesota Rules, part 6132.3200) that may develop into unofficial off-road vehicle trails, would require a variance from MDNR reclamation rules to allow a 15-foot-wide unpaved, unvegetated track down the centerline of the road. Such approvals would also be coordinated with the St. Louis County Mine Inspector's Office.

All mining, dewatering and electrical equipment would be moved from the pit to ensure they would be above final pit water elevations until they could be scrapped, decommissioned or sold. Debris and equipment would be removed from the Mine Site and Plant Site.

4.4.1.1 Rail Transfer Hopper (RTH) Demolition and Reclamation

At mine closure, it is possible that the RTH could contain ore residuals, which would have acid generation and metal leaching potential. Therefore, a specific plan for handling the demolition and reclamation of this structure has been developed. Aboveground concrete and steel structures would be razed and the area covered with at least two feet of soil and vegetated according to Minnesota Rules, part 6132.2700 and chapter 3200. If constructed with Category 1 waste rock, the rock platform from which trucks dumped into the hopper would be covered in the same manner as the Category 1 Waste Rock Stockpile (Section 4.4.2.2) or the rock would be relocated to the East Pit for subaqueous disposal. If the RTH is constructed of inert material, the platform would be sloped and vegetated according to Minnesota Rules, part 6132.2700 and part 6132.3200.

Any ore remaining in the RTH, the OSP, or anywhere else in the vicinity of the RTH as well as sediment removed from ditches and process water ponds, would be placed in the East Pit. Any remaining material located at the top of the rail loading platform would be tested and placed in an appropriate waste disposal location (e.g., the East Pit or covered with at least two feet of soil and vegetated according to Minnesota Rules, part 6132.2700 and part 6132.3200).

4.4.1.2 Special Material Disposal

Special materials on-site at mine closure would be disposed of as follows:

- Asbestos-Containing Materials (ACMs) – a detailed survey of ACMs (e.g., pipe and electrical insulation in existing LTVSMC utility tunnels, siding, hot water heating system insulation, lube system insulation, floor tile) has been completed of the existing LTVSMC facilities. New facilities will not have ACMs. A detailed inventory of ACM locations will be maintained as part of the Project documentation. Appropriate controls would be put in place or ACMs would be removed intact, properly packaged and disposed in the on-site industrial landfill. ACM locations in the landfill would be noted on the property deed. Any ACMs found in utility tunnels would be sealed before the utility tunnel is sealed.

- Nuclear sources (i.e., nuclear density gages used to measure slurry density during processing) – these sources would be removed and properly disposed.

- Partially used paint, chemical and petroleum products – these materials would be collected and properly recycled or disposed.

- Fluorescent and sodium halide bulbs – these would be removed from fixtures, collected and properly disposed.

- Oil-stained concrete – this material would be tested to characterize the material for beneficial reuse such as structural fill. If the material does not meet the solid waste criteria for beneficial reuse, the oil-stained concrete will be removed and properly disposed.

4.4.1.3 Product and Product Tank Disposal

The reagent suppliers, which would be under contract to PolyMet, would remove any reagents remaining at mine closure. In many cases, the suppliers of chemicals and equipment would be responsible for furnishing tanks and would therefore be required to remove and dispose of those tanks during reclamation. Those tanks for which PolyMet would be responsible would be demolished as follows:

- clean tanks to remove remaining materials and sludge

- send remaining materials and sludges and wash materials to an appropriate recycling or waste disposal facility
- test large aboveground storage tanks for lead paint prior to demolition and, where found, disposal/recycling would be modified to accommodate the lead content
- disassemble all tanks for disposal or recycling, as appropriate
- leave below-grade foundations in place and buried with a minimum of two feet of soil and vegetated
- clean smaller aboveground storage tanks and remove without disassembly

4.4.1.4 Other Reclamation Details

There would be several places where concentrate having up to 20% sulfur could accumulate (e.g., dry concentrate storage bins, froth launders/sumps, concentrate thickeners, concentrate filters). Because this would be a high value material, there would be an effort to ship as much as could be recovered. However, material remaining in the equipment and process piping would be properly disposed in the HRF or other MPCA-approved locations.

PolyMet would also close on-site sewer and water systems, powerlines, pipelines (including Residue pipelines) and culverts according to proper regulatory requirements.

4.4.2 Mine Site Reclamation

Mine Site reclamation would include building and structure demolition and equipment removal (as described in Section 4.4.1), mine pit reclamation, stockpile reclamation and watershed restoration. Mine Site reclamation would begin as soon as practical throughout operations, with reclamation of the East Pit and waste rock stockpiles commencing before mining activities cease.

4.4.2.1 Mine Pit Reclamation

Pit walls would be sloped and graded in accordance with Minnesota Rules, part 6132.2300. The toe of the overburden portion of all pit walls would be set back at least 20 feet from the crest of the rock portion of the pit wall. Lift heights would be no higher than 60 feet and would be selected based on the need to protect public safety, the location of the pit wall in relation to the surrounding land uses, the soil types and their erosion characteristics, the variability of overburden thickness and the potential uses of the pit following mining. The overburden portions of the pit walls would be sloped and graded at no steeper than 2.5 (horizontal) to 1 (vertical) and would be vegetated to conform to Minnesota Rules, part 6132.2700. Finally, safe access would be provided to the bottom of each mine pit (Minnesota Rules, part 6132.3200) via selected original haul roads built during pit development. The access road would be selected such that, as the pits flood, there would always be a clear path to the water surface.

Mine pits would be allowed to flood, and the dewatering systems, including power lines, substations, pumps, hoses, pipes and appurtenances would be removed. All areas disturbed during pipe removal would be graded and revegetated. Some piping and temporary pumps may remain in the pits for selected dewatering that would be performed during reclamation.

Pit perimeter barrier systems would be installed consisting of fences, rock barricades, ditches, stockpiles and berms. A gated entrance would be placed at each pit access location. The barrier system plan would be submitted to the St. Louis County mine inspector for review and approval before installation. As required by the St. Louis County mine inspector and in accordance with Minnesota Statutes 2014, section 180.03, fencing would consist of five strands of barbed wire in most locations and five foot non-climbable mesh fencing with two strands of barbed wire at the top in areas where roads would remain adjacent to the fences unless other means are agreed to with the mine inspector.

The East Pit would be the first pit to be reclaimed. Starting in Mine Year 11, when East Pit mining is completed, backfilling would begin using Category 2, 3 and 4 waste rock from the temporary waste rock stockpiles and from ongoing operations. The East Pit would be flooded with groundwater, in-pit runoff, direct precipitation and treated process water from the WWTF to minimize the amount of pit wall and backfilled waste rock exposed to the atmosphere, thus limiting the oxidation of the sulfide minerals and reducing the amount of metals leaching to the pit water. Lime may be added to the East Pit during East Pit backfilling, as needed, in order to maintain circumneutral pH in the pit pore water, as described in Section 5.1.2.3 of Reference (17).

The quantity of waste rock placed in the combined East and Central Pit (herein called East Pit) would change every year of operation, depending on the quantity of Category 2, 3 and 4 waste rock generated. During backfilling, the water elevation would be maintained below the surface of the waste rock for safety reasons to avoid equipment working in the water and to maximize the amount of material used to fill the pit. The water pipes between the WWTF and the East Pit would be left in place during backfilling to manage the water elevation in the East Pit. If natural inflow of water into the East Pit is insufficient, water could be pumped from the WWTF to keep the water surface at the required level. During periods of high precipitation or during spring snowmelt, dewatering (to the WWTF and ultimately to the FTB) may be required to allow placement of the waste rock in a safe manner.

Once backfilling of the East Pit is complete, a wetland would be constructed over the backfilled material (Large Figure 30). The water depth in the backfilled East Pit would be maintained within the wetland by a gravity overflow structure to the West Pit. The East Pit overflow structure would be formed out of bedrock or a cast-in-place reinforced concrete weir.

West Pit reclamation would commence when mining activity ceases. Primary dewatering systems would no longer be operated, and the West Pit would begin to flood naturally with groundwater, precipitation and surface runoff from the tributary watershed. Flooding would also be accelerated with treated water from the Plant Site. With the addition of water pumped from the Plant Site to the West Pit, West Pit flooding is projected to be completed before the end of Mine Year 55. When the West Pit is full, the discharge would be controlled via a lift station and pumped to the WWTF for treatment. The WWTF would be upgraded to include reverse osmosis treatment or similar membrane separation technologies that can best achieve an effluent sulfate concentration that meets the sulfate standard for waters used for the production of wild rice (10 mg/L). After the upgrade, WWTF effluent would be discharged into a culvert through Dunka Road to an existing wetland (Large Figure 30) and eventually into the Partridge River through an existing tributary channel. The reject concentrate from the membrane treatment would be added to the West EQ Basin at the WWTF.

4.4.2.2 Stockpile Reclamation

Temporary stockpile reclamation would begin during operations. Material in the Category 2/3 and Category 4 Waste Rock Stockpiles would be relocated to the East Pit starting in Mine Year 11, as described in Section 4.4.2.1. The ore in the OSP would be processed as operations wind down, and any remaining material being transported to the Process Plant or disposed of in the East Pit after operations cease. Material may still remain in the OSLA, but the area would be graded to stable conditions and reclaimed. Infrastructure associated with the temporary stockpiles (pipes, pumps, liners, etc.) would be removed, and the footprint of each area would be reclaimed.

Reclamation of the permanent Category 1 Waste Rock Stockpile would start in Mine Year 14. This stockpile would be incrementally covered with an engineered geomembrane system and vegetated to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item B. This cover system would consist of, from top to bottom: 18 inches of rooting zone soil consisting of on-site overburden mixed with Peat as needed to provide organic matter, 12 inches of granular drainage material with drain pipes to facilitate lateral drainage of infiltrating precipitation and snowmelt off the stockpile cover, the 40-mil geomembrane barrier layer and a 6-inch soil bedding layer below the geomembrane. Based on the preliminary geotechnical investigation described in Reference (16), the soils at the Mine Site are projected to perform favorably as soil cover materials. The engineered geomembrane cover would be designed to promote runoff with minimal erosion. The design of this cover system is discussed in Section 3 of Reference (3).

To provide an adequate base for sloping of cover materials, Category 1 Waste Rock Stockpile side slopes would be re-shaped to no steeper than 3.75 (horizontal) to 1 (vertical), with the cover system placed on top of the re-shaped waste rock. The outermost layer would consist of local till soils (also known as “overburden” per Minnesota Rules, part 6132.0100, subpart 32) adequate for vegetation growth. To provide further erosion control, catch benches at least 30 feet in width would remain on the stockpile.

Upon full reclamation of the Category 1 Waste Rock Stockpile, runoff from the top and sides of the stockpile would be classified as non-contact stormwater and would be routed through a system of ditches prior to being discharged into the natural drainage system. Ditches on the reclaimed stockpile surface would direct stormwater flows into channels that would route flows down the sides of the stockpile.

The Category 1 Waste Rock Stockpile Groundwater Containment System would continue to collect seepage from the stockpile during reclamation, with drainage treated at the WWTF.

4.4.2.3 Watershed Restoration

During mining operations, stormwater runoff from reclaimed stockpile areas and natural (undisturbed) areas would be routed via dikes and ditches to stormwater sedimentation ponds. Upon completion of stockpile reclamation, these water management systems would be modified.

Perimeter dikes that would be no longer needed to provide access or separation from the areas outside the Mine Site would be removed (Large Figure 29). The dike located north of the East Pit would remain in place to minimize mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit in the segments not protected by ditches (Large Figure 30). In addition, the dike located north of the Category 1 Waste Rock Stockpile would remain in place to allow access to groundwater monitoring locations.

Surface runoff would be routed to the mine pits using a combination of existing and new ditches (Large Figure 30). Some portions of the pit rim dikes may be left in place, if needed to prevent an uncontrolled flow to or from the pits and potential erosion (head cutting) of the pits walls. A more detailed evaluation of this requirement would be conducted prior to mine closure.

In all cases of dike removal, material from the main body of the dikes would be removed and used at the site for restoration of disturbed surfaces. To minimize disturbance of subsurface soils, any subsurface seepage control components of the dikes would remain in place.

As part of the dike removal work, typical construction erosion control measures would be used. These might include installing silt fencing on the down slope side of disturbed areas and controlling surface water runoff. The reclaimed surface would then be scarified, topsoil placed and the area revegetated with native species.

Ditches would be filled or rerouted during reclamation. Large Figure 21 shows the alignment of the ditches and the location of five sedimentation ponds and outlet structures that would convey stormwater runoff collected in the ditches to the Partridge River during operations.

Large Figure 29 shows the ditches that would be rerouted or filled during the reclamation period, and Large Figure 30 shows the alignment of ditches that would be maintained to direct stormwater into the West Pit for flooding. Use of existing ditches would be maximized, but some new ditches may need to be constructed to direct stormwater runoff from the Mine Site into the East Pit or West Pit.

All ponds would either be filled or converted into wetlands; this includes the stormwater ponds, the OSLA and RTH process water ponds, the haul road process water ponds and all remaining stockpile sumps and overflow ponds. Once filled, the ponds would be covered with topsoil and revegetated with the goal of restoring these areas. If the process water ponds would be converted into wetlands, any sedimentation that occurred within the pond would be evaluated to determine if removal or covering would be necessary prior to restoration.

Stormwater pond outlet control structures would remain in place as necessary to manage water resource impacts. The outlet control structure on the stormwater pond located immediately north of the East Pit and the Category 1 Waste Rock Stockpile (and associated dike, as shown on Large Figure 30) would remain in place to minimize the mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit. The outlet control structures on the two stormwater ponds next to Dunka Road would remain in-place to direct water under the road and the railroad to a tributary to the Partridge River along natural drainage paths. As a requirement of the NPDES permit and/or Reclamation Plan for the facility, discharges from these outlet control structures may be monitored as necessary to ensure that runoff to the Partridge River would meet water quality discharge limits.

4.4.3 Plant Site Reclamation

Plant Site reclamation would include building and structure demolition and equipment removal (as described in Section 4.4.1), FTB reclamation and HRF reclamation.

4.4.3.1 Flotation Tailings Basin (FTB) Reclamation

Reclamation of the FTB would include measures to control fugitive dust, reduce infiltration and manage water flows. Dam stability would be periodically evaluated by a qualified geotechnical engineer.

Fugitive dust would be controlled on upland areas of the Basin by mulching and permanent vegetation.

Infiltration would be reduced through the dam faces, beaches and pond bottom of the FTB by bentonite amendment.

- the exterior face of the dams would be reclaimed progressively, with a bentonite layer added as they are constructed to limit oxygen diffusion (Section 7.1 of Reference (6))

- exposed beaches and dam tops would be amended with a bentonite layer to limit oxygen diffusion (Section 7.2 of Reference (6))

- the pond bottom would be covered with a bentonite layer to maintain a permanent pond that would limit oxygen diffusion (Section 5 of Reference (3))

Water management would include maintenance of a pond and wetland within the reclaimed FTB, stormwater management and continued operation of the WWTP, the FTB Containment System and the FTB South Surface Seepage Management System (Large Figure 31).

- A pond would remain in the reclaimed FTB with a wetland around the perimeter of the pond (Large Figure 31). In general, the pond's maximum lateral extent would be maintained to be no closer than 625 feet from the interior edge of the Cell 1/2E dams. The pond and wetland would receive surface water runoff from the crest and beaches of the basin and natural terrain adjacent to the FTB. The pond and wetland would continue to lose water via seepage, but at a reduced rate as compared to operations as a result of the bentonite amendment of the Flotation Tailings surface. Excess water would be pumped from the FTB Pond to the WWTP for treatment prior to discharge, as described in Section 4.3.8.4.

- Stormwater management would include grading to provide a gently sloping surface that effectively routes surface water runoff to the interior of the FTB, accommodates future differential settlement of the underlying Flotation Tailings and maximizes ponding of water in the reclaimed FTB Pond for the development of wetlands.

- An emergency overflow channel would be constructed to carry stormwater from the pond to the adjacent wetland in case of an extreme storm or snowmelt event after reclamation. The channel would be sized and designed to safely discharge at a flow sufficient to protect the FTB dams and would be constructed into bedrock to protect the channel from erosion and minimize maintenance requirements. A riprap delta would be installed where the channel ends to distribute the stormwater. Additional sediment control and energy dissipation structures would be incorporated at the channel discharge point if needed based on final design determinations. The conceptual location of the emergency overflow channel from the combined Cell 1/2E to the adjoining land is shown in Large Figure 31.

- The WWTP and the FTB seepage capture systems would continue to operate during reclamation, although seepage rates would be progressively reduced. Seepage would be recycled back into the FTB Pond, treated at the WWTP (with discharge used for stream augmentation), or sent to the Mine Site to aid in West Pit flooding (along with excess water from the WWTP not needed for stream augmentation). The WWTP and the FTB seepage capture systems would be periodically inspected to ensure continuing integrity.

4.4.3.2 Hydrometallurgical Residue Facility (HRF) Reclamation

Reclamation of the HRF would include removal of ponded water from the cell surface, removal of pore water from the Residue, construction of the cell cover system and establishment of vegetation and surface water runoff controls (Section 7.2 of Reference (7)).

Once the cell becomes full, it would be dewatered by an initial decanting of ponded water and then drainage from the Residue would be collected using a geocomposite drainage net and system of sidewall riser and pump systems.

Ponded water remaining in the cell would be removed and treated at the WWTP. At mine closure, the Residue void spaces in the cell would be full of water, a portion of which would be retained in the Residue (stored water) while the other portion would drain from the Residue (drainage). Drainage would be collected from the base of the cell at the geocomposite drainage system and managed as described previously for ponded water.

The rate of drainage would decrease over time as the pore water within the Residue was collected and removed. Once the entire facility was reclaimed, the volume of water draining from the drainage collection systems would decline. In the long-term, the volume of water requiring treatment would decline to the point that the remaining reclamation activity may consist of periodic pumping of remaining drainage to the WWTP and of inspection of the reclaimed cell to verify integrity of the reclamation systems.

The cell area would be graded into a gently sloping surface. The cover would consist of a layer of LTVSMC tailings and/or local till soil layer above the drained Residue, placed to provide a suitable foundation layer for subsequent reclamation construction activity. This would be topped, if necessary, with a non-woven needle-punched geotextile fabric. Next, a geosynthetic clay barrier layer and 40-mil low density polyethylene (LDPE) or similar agency-approved barrier layer system would be placed. Finally, additional LTVSMC tailings and/or local till soils would be placed to create a surface capable of sustaining a vegetated cover. Turf and final cover would be inspected and maintained by mowing once per year or as needed, fertilizing when visual inspection indicates poor vegetation growth and implementing repairs.

The cover would slope gently toward the site perimeter to accommodate natural drainage of the runoff. Final cover slopes on the cell interior would be relatively shallow to minimize surface water runoff flow velocity and the associated erosion. Runoff channeled along the cell perimeter would be routed down-slope via rip-rapped drainage swales or plug-resistant inlet structures and piping systems. Once runoff conveyed down the cell exterior dam slope, it would be routed to the surrounding natural drainage system. All runoff would be from reclaimed cover or dam exterior slopes which would constructed of MDNR-approved material (LTVSMC tailings or local till soils).

4.4.4 Long-Term Closure Activities

Mechanical water treatment systems (WWTF and WWTP) would continue to operate during long-term closure. The water collected by the Category 1 Waste Rock Stockpile Groundwater Containment System and the West Pit water would be treated using the WWTF (upgraded to reverse osmosis or similar membrane separation technologies that best meet permit requirements) to ensure that the discharge meets applicable water quality discharge limits. The WWTP at the Plant Site would treat water collected by the FTB Containment System and the FTB South Surface Seepage Management System and excess FTB pond water to meet applicable water quality discharge limits. The WWTF and WWTP would be upgraded to include evaporator/crystalizers to convert the reject concentrate to residual solids which would be disposed in appropriate off-site facilities. Inspection, water treatment maintenance and reporting activities would continue while the mechanical treatment systems operate during long-term closure.

Surface water and groundwater would be monitored as required by relevant permits. These long-term closure activities would be expected to be ongoing until such time as the various facility features are deemed environmentally acceptable, in a self-sustaining and stable condition.

Other maintenance activities that would continue throughout reclamation and long-term closure would include repair of stockpile and Tailings Basin dam slope erosion, constructed wetland and outflow structure up-keep to ensure proper functioning, woody species and tree removal on the HRF cover system and Category 1 Waste Rock Stockpile cover system and on-going operation/maintenance and inspection of the Category 1 Waste Rock Stockpile and FTB seepage capture systems.

The ultimate goal of long-term closure is to transition from the mechanical treatment provided by the WWTF and WWTP to non-mechanical treatment (Section 6 of Reference (3)). Transitions to the non-mechanical treatment systems would begin after the performance of the non-mechanical treatment methods have been proven. The non-mechanical treatment systems are expected to include constructed wetlands or permeable reactive barriers to remove sulfate, trace metals, and other dissolved or suspended constituents from water and may also include permeable sorptive barriers and aeration ponds, if necessary. Non-mechanical treatment systems could be used for long-term treatment of water from the Category 1 Waste Rock Stockpile Groundwater Containment System, the West Pit overflow, the FTB seepage capture systems, the FTB overflow, and the HRF, as described in Section 6 of Reference (3).

When PolyMet has completed all reclamation required by the Permit to Mine, a Request for Release per Minnesota Rules, part 6132.1400 would be submitted. This request would provide the Commissioner of the MDNR with detailed information on the final reclamation status of the Project.

4.4.5 Contingency Reclamation Cost Estimate

PolyMet's Reclamation Plan summarizes the methods and schedule for reclamation activities that will meet all regulatory requirements. It will also include the Contingency Reclamation Cost Estimates, which would be completed for the Permit to Mine application. The estimates would also include remediation obligations PolyMet acquired with the acquisition of the Cliffs Erie property.

Contingency Reclamation Cost Estimates are required according to Minnesota Rules, part 6132.1200 subpart 2. Two Contingency Reclamation Cost Estimates would be submitted with the Permit to Mine application; one would assume that the facility closes at the end of construction and the other would assume that the facility closes one year after operations begin. The Contingency Reclamation Cost Estimates would be updated annually as part of the Permit to Mine annual report and would be the basis for computing financial assurance requirements for the Project.

Any additional detail regarding the amount of financial assurance associated with reclamation actions is more typically made available during the Permit to Mine permitting process. Therefore, further discussion of financial assurance cost figures and instruments are not included in this document at this time. However, it is recognized that Minnesota regulations require that financial assurance requirements be determined at the Permit to Mine permitting phase and prior to issuance of the Permit to Mine.

5.0 Data for Impact Analysis

This section is a guide to the data packages and other studies that have been used to estimate environmental impacts of the Project. References below are to current versions of this information.

5.1 Waste Characterization Data

The Waste Characterization Data Package (Reference (19)) presents:

- the data used to characterize the overburden, waste rock, ore, Flotation Tailings, LTVSMC tailings and hydrometallurgical residues, along with descriptions of the sampling and testing programs that generated the data
- the geochemical parameters for modeling the overburden, waste rock, pit lake, Flotation Tailings, LTVSMC tailings and hydrometallurgical residues

5.2 Water Modeling Data

Water Modeling Data Packages for the Mine Site (Reference (17)) and the Plant Site (Reference (18)) present:

- the modeling framework for water quantity and quality modeling
- the baseline data used for water quantity and quality modeling
- the approach used for water quantity and quality modeling
- the water balance
- the water quantity and quality model results

5.3 Air Quality Modeling Data

The Air Data Package (Reference (20)) presents:

- emissions calculations
- the approach used for air modeling
- Class I modeling, Class II modeling, AERA modeling
- greenhouse gas analysis
- cumulative effects analysis

5.4 Geotechnical Data

Geotechnical data and engineering models are presented three separate volumes.

Volume 1 describes the Flotation Tailings Basin (FTB) design (Reference (21)), including:

- field and laboratory data used to determine the physical properties of materials
- description of modeling to assess FTB dam stability
- results of modeling to assess FTB dam stability

Volume 2 describes the Hydrometallurgical Residue Facility (HRF) design (Reference (22)), including:

- data on physical properties of materials included in geotechnical analyses for the HRF
- description of geotechnical modeling for HRF design
- results of geotechnical modeling for HRF design

Volume 3 describes the waste rock stockpile design (Reference (16)), including:

- existing conditions
- physical properties of the materials
- stockpile analysis and design inputs
- stockpile analysis and design outcomes

5.5 Wetland Data

The Wetland Data Package (Reference (15)) presents:

- data on wetlands in the vicinity of the project
- discussion of the approach to evaluating direct, potential indirect and cumulative wetlands impacts due to the project
- evaluation of direct, potential indirect and cumulative wetland impacts due to the project

5.6 Other Studies and Surveys

Other studies that were utilized for impact analyses include:

- wildlife data (Reference (23), Reference (24))
- botanical data, including wild rice (Reference (25), Reference (26), Reference (27), Reference (28), Reference (29), Reference (30))
- socioeconomic (Reference (31)) and cultural data (Reference (25), Reference (32))
- data on underground mining (Reference (33), Reference (34))
- data on West Pit backfill (Reference (35), Reference (36))

5.7 General References for Legacy Components

The Reclamation Plan (Reference (11)) summarizes a number of documents have been used by the Project as reference for details associated with the LTVSMC legacy components, including:

- Phase 1 Environmental Site Assessment (Reference (37))
- Consent Decree Documents, including the short-term mitigation evaluation and plans, the field studies plans, and data on LTVSMC legacy remediation within the Project being managed via the MPCA Voluntary Inspection and Cleanup program and a Consent Decree
- Areas of concern (AOCs) documents of AOCs identified by the Voluntary Inspection and Cleanup process and their status

Revision History

Date	Version	Description
2/23/11	1	Initial release – First release of complete document - Section 1.1.3 (currently Section 4.2) only was submitted on 2/5/11 in response to information request
4/15/11	2	First release as a complete document. Most changes are complete sections eliminating placeholders
9/13/11	3	Changed “closure” to “reclamation” [reclamation activities are performed at closure] throughout and redundant text removed in Section 4.8.2 Clarified that new surface seeps would be collected in Section 4.6.5 Removed notes on incomplete information and updated in Section 4.2 and 4.6.5 Clarified timing of relocation of temporary stockpiles to pit in Section 4.2.2 Clarified extent of groundwater containment system in Section 4.3 Clarified disposition of potential East Pit dewatering during backfilling in Section 4.3.1 Moved rail car spillage estimate from Section 4.4 to Waste Characterization Data Package Section 8.5.3 Added pH Modifier discussion and clarified concentrate storage in Section 4.6.1 also updated Table 4.6.2 Changed “embankment” to “dam” in Sections 4.6.4 and 4.8.3 Clarified depth of bentonite layer in Sections 4.6.4 and 4.8.3 Clarified double liner for HRF in Section 4.6.4 Clarified double liner results in virtually no leakage in Section 4.6.5 Revised text to describe WWTP at Tailings Basin rather than Area 5 in Sections 4.6.5 and 4.8.3 Removed references to timing of reclamation activities in Section 4.8 (to be determined in permitting) Clarified water movement to/from WWTF and control of West Pit outlet in Section 4.8.2 Changed NorthMet tailings to LTVSMC tailings in Section 4.8.3 Clarified HRF cover runoff in Section 4.8.3 Added Section 5.7
10/31/12	4	Project Description was updated to reflect additional engineering controls identified as part of the adaptive water management plan.
3/8/13	5	Modified document to incorporate Project changes related to the decisions made in the AWMP Version 4 and 5 respectively). These project changes include: Reorganized the document so Section 3 includes all land ownership and land exchange information, moving land exchange to Section 3.1 (previously 3.0), Mine Site Ownership to Section 3.2 (previously 4.1.1) and Plant Site and Rail Connection Area Ownership to Section 3.2 (previously 4.3.1)

Date	Version	Description
		Split the from ore and waste rock movement and blasting agent quantities in Section 4.1.2.3 into separate descriptions Removed the waste rock to ore stripping ratio from Section 4.1.3 due to the difference with the reserve stripping ratio Updated Table 4-3, including the duties of the Cat 834G wheel dozer and the description of the off-road lowboy trailer and tractor Updated Section 4.1.4 to include a description of construction materials and a description of peat uses Updated Table 4-5 to the nearest hundred Updated the description of the Category 1 Waste Rock Stockpile Groundwater Containment System described in Section 4.1.4.2 Updated the purpose of the WWTF in Section 4.1.5.2 Added a statement about permeability of silty sand to Section 4.1.5.3 Updated Section 4.3 to include reference to the FTB South Surface Seepage Management System and the FTB cover system Updated Section 4.3.2.5 to include stream augmentation and FTB seepage capture systems and updated the average annual make-up required Updated Table 4-8 to discuss average size of Flotation and Concentrate Dewatering Updated Section 4.3.6 to include reference to emergency overflow channel Updated Sections 4.3.8, 4.3.8.2, 4.3.8.3 and 4.3.8.4 to include both FTB seepage capture systems Updated Section 4.3.8.4 to include stream augmentation and developed Section 4.3.8.5 to describe stream augmentation Changed Section 4.4.1.1 to state RTH excess material to be covered similar to Category 1 Waste Rock Stockpile or be relocated to East Pit Updated Section 4.4.2.1 to include discussion of lime addition to East Pit Updated Section 4.4.2.2 to state that remaining ore in OSP to go to Process Plant or East Pit rather than West Pit Updated Section 4.4.3.1 to include both FTB seepage capture systems and to describe long-term pumping rather than have an overflow in the FTB (although there will still be an emergency overflow) Updated Section 4.4.4 to include both FTB seepage capture systems Updated Section 4.4.5 to remove the blank tables until permitting
11/3/14	6	Project Description was updated to reflect the five main changes that have been incorporated into the Project since publishing of the SDEIS: 1) addition of the SAG mill, 2) Coal Ash Landfill relocation, 3) the addition of the east side of the FTB Containment System, 4) adjustments made to the stream augmentation plan and West Pit flooding, and 5) changes made for the sewage treatment system. Additional changes made to this document are as a result of agency review and comment. Changes are as follows: Consolidated references to PGE (platinum-group elements) and PGM (platinum-group metals) all to PGE.

Date	Version	Description
		Updated Section 2.8 for the description of the NorthMet Deposit Updated Section 2.10, 2.11, and 2.12 based on further analysis of the hydrogeology of fractured bedrock Updated Section 3.1 for refined acreages Corrected Table 4-1 maximum depths Corrected Section 4.1.4 reference to Unsaturated Overburden Refined Section 4.1.4.2 method of categorization Expanded Table 4-6 to include planned and maximum volumes Updated Section 4.1.4.2 to include origin of material in the state-owned stockpile. Updated Section 4.1.5 to be consistent with Section 4.3.8 introduction. Simplified Section 4.1.5 water descriptions Updated Section 4.1.5.1 to include direct precipitation Updated Section 4.1.5.2 to be consistent with AWMP changes Updated Section 4.2 to include a description of PolyMet's plans for refurbishment of the ore cars Clarified in Section 4.3 that concentrate storage and shipping are needed Updated Section 4.3.1 to include the sewage treatment system upgrades Expanded in Section 4.3.2 and 4.3.3 the years before the Hydrometallurgical Plant is operational to allow flexibility to this addition Updated Sections 4.3.2, 4.3.2.1, and 4.3.2.2 to include the addition of the SAG mill and associated changes Simplified Section 4.3.2.5 to remove reference to the Colby Lake flows Updated Tables 4-8 and 4-9 based on the addition of the SAG mill Updated Section 4.3.6 to simplify text, clarify that LTVSMC waste rock may be used for the dam buttress, provide context for the storm event the FTB and overflow channel was designed to, and update text for the Coal Ash Landfill relocation Clarified in Section 4.3.7 that the HRF is double-lined, to update the capacity of the HRF, and clarify the plan for construction Clarified in Section 4.3.8 the future use of the management plan and refined text associated with the FTB seepage capture systems for the stream augmentation adjustments Updated Section 4.3.8.3 for the addition of the east side of the FTB Containment System and to clarify the text associated with the FTB South Surface Seepage Management System Updated Sections 4.3.8.4 and 4.3.8.5 for the adjustments made to the stream augmentation plan and to refine the text for the treatment system and associated need Updated Sections 4.4.1 and 4.4.1.2 for beneficial reuse and disposal of concrete and to clarify the timing of the ACM survey

Date	Version	Description
		Updated Sections 4.4.2.1, 4.4.3.1, and 4.4.4 for the adjustments made to the stream augmentation plan, resulting impact on West Pit filling, and clarification of the treatment system and associated need Updated Section 4.4.2.3 for the ponds to be reclaimed Updated Section 4.4.4 to include the types of non-mechanical treatment systems that may be used and to add the HRF as another area they may be used Clarified text in Sections 4.4.5, 5.0, and 5.6
12/2/2014	7	Project Description was updated to address agency comments. Changes are as follows: Clarified FTB and Tailings Basin definition in Sections 1.0, 4.3.6, 4.3.8.2, 4.3.8.3, 4.3.8.4, 4.4.4, Updated Section 3.0 and 3.2 to include GLO acreages for Land Exchange Corrected Section 4.1.5 to refer to WWTF rather than WWTP Updated Section 4.3.6 to include description of Cement Deep Soil Mixing Update Sections 4.3.8.4 and 4.3.8.5 to refer to the Water Mgmt Plan-Plant for expected flows for stream augmentation Correct text in Section 5.6 that was changed in Version 6
12/12/2014	8	Project Description was updated to address agency comments, updated estimates of Colby Lake flows, and updated estimates of the West Pit flooding. Changes were made to the following Sections 4.3.2.5, 4.3.8.4, 4.4.2.1 and 4.4.4, and Tables 4-5, 4-6, and 4-7
2/19/2015	9	Project Description was updated to address agency comments incorporated from other documents. Changes were made to Table 4-5 and to Large Figures 4, 25, and 31. Sections 5 and 5.6 were modified to reference the relevant documents directly.

References

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3. —. NorthMet Project Adaptive Water Management Plan (v7). February 2015.

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5. —. NorthMet Project Air Quality Management Plan - Mine (v5). December 2014.

6. —. NorthMet Project Flotation Tailings Management Plan (v5). February 2015.

7. —. NorthMet Project Residue Management Plan (v4). December 2014.

8. —. NorthMet Project Water Management Plan - Plant (v4). February 2015.

9. —. NorthMet Project Air Quality Management Plan - Plant (v8). December 2014.

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11. —. NorthMet Project Reclamation Plan (v5). January 2015.

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35. **U.S. Army Corps of Engineers; U.S. Forest Service; Minnesota Department of Natural Resources.** NorthMet Environmental Impact Statement Co-lead Agencies' Consideration of a West Pit Backfill Alternative Interagency Memorandum (for Poly Met Mining Inc.). April 11, 2013.

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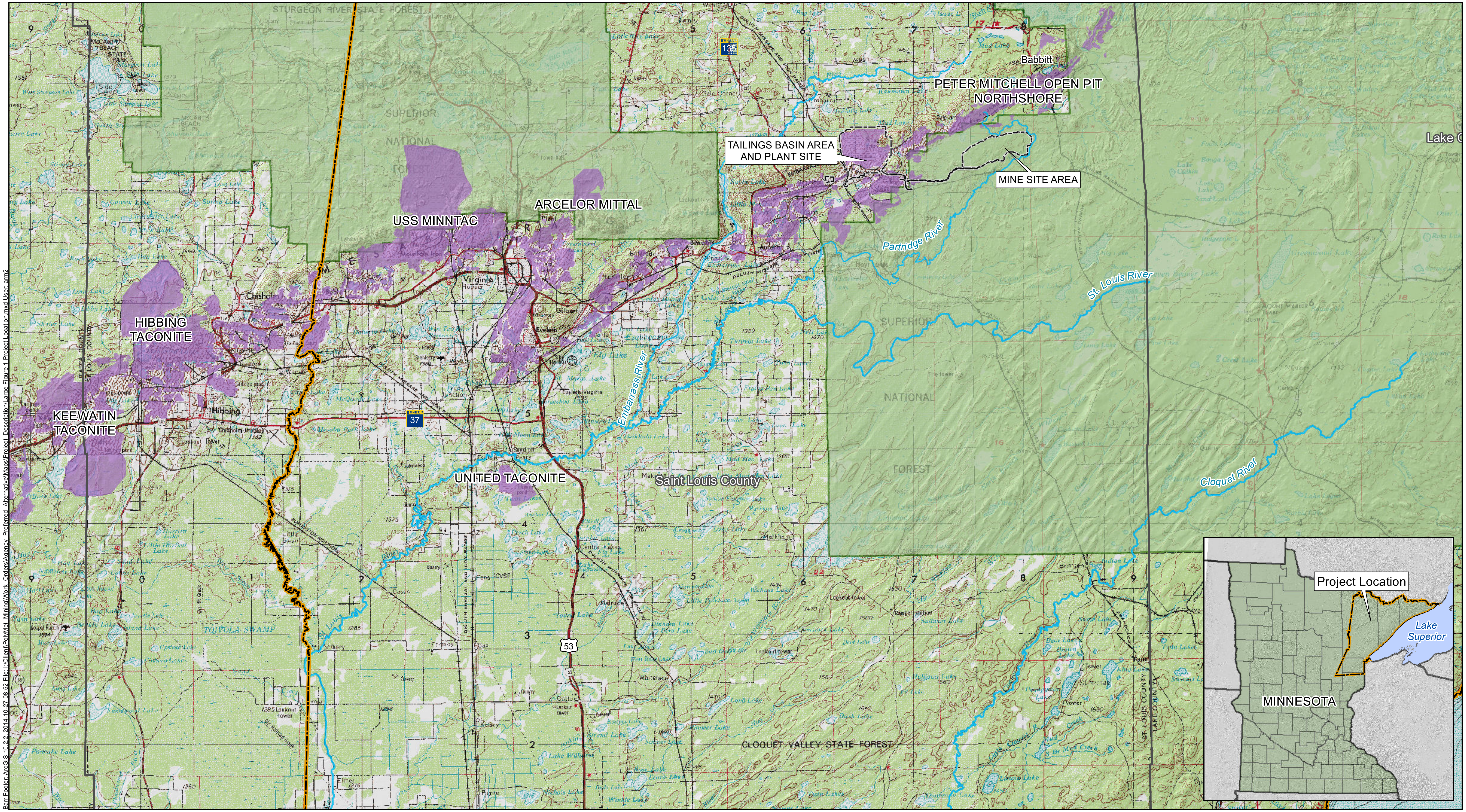


Mesabi Range (existing mine pits, tailings basins, stockpiles and other mine features)

1854 Chippewa of Lake Superior Treaty Boundary

National Forest Boundary

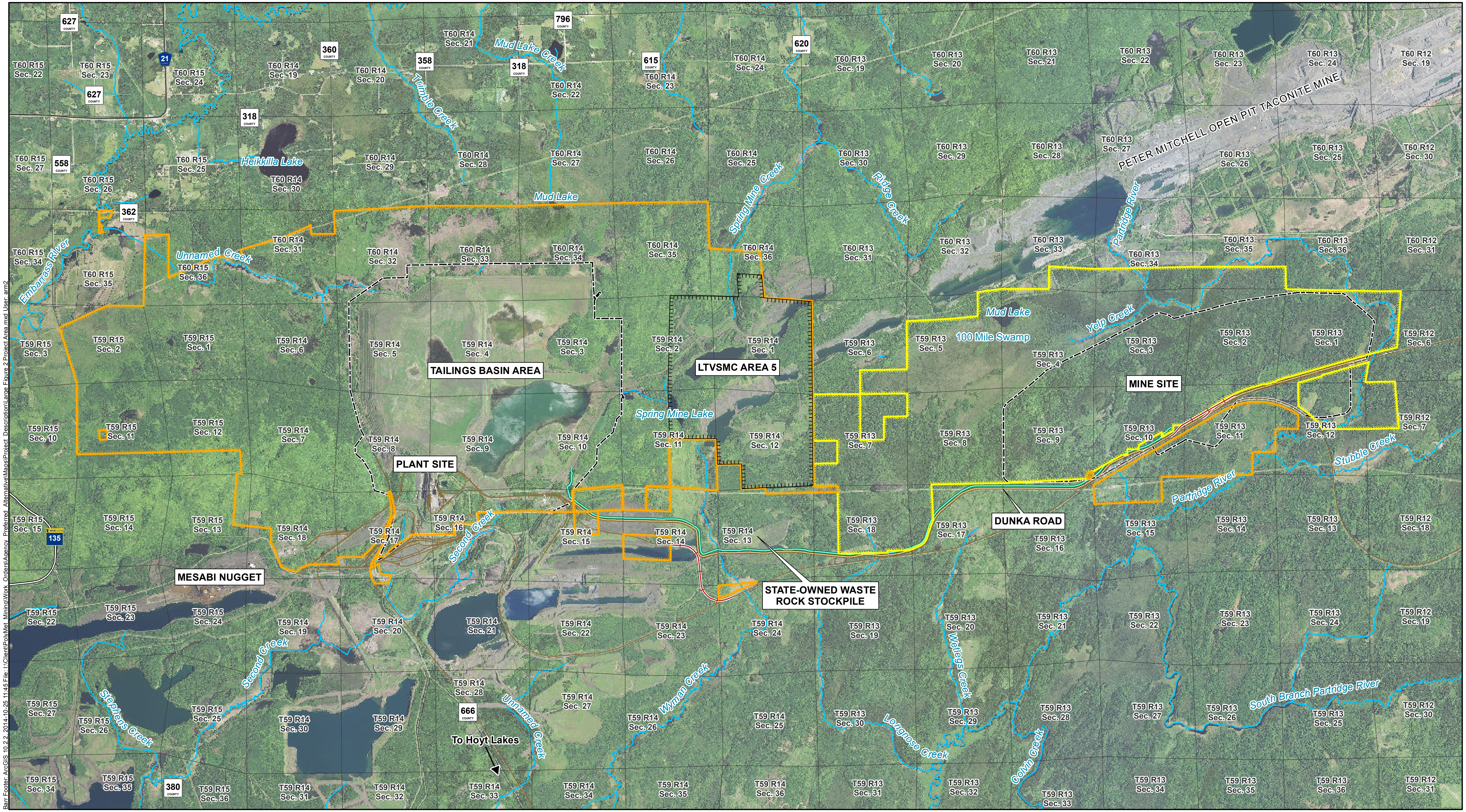
County Boundary

Rivers

0 2.5 5 10

Miles

Large Figure 1
PROJECT LOCATION
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



PolyMet Owned/Leased Area

USFS Federal Land Exchange Parcel

LTVSMC Area 5

Section Lines

Project Areas

Proposed Railroad Track

Existing Railroad Track

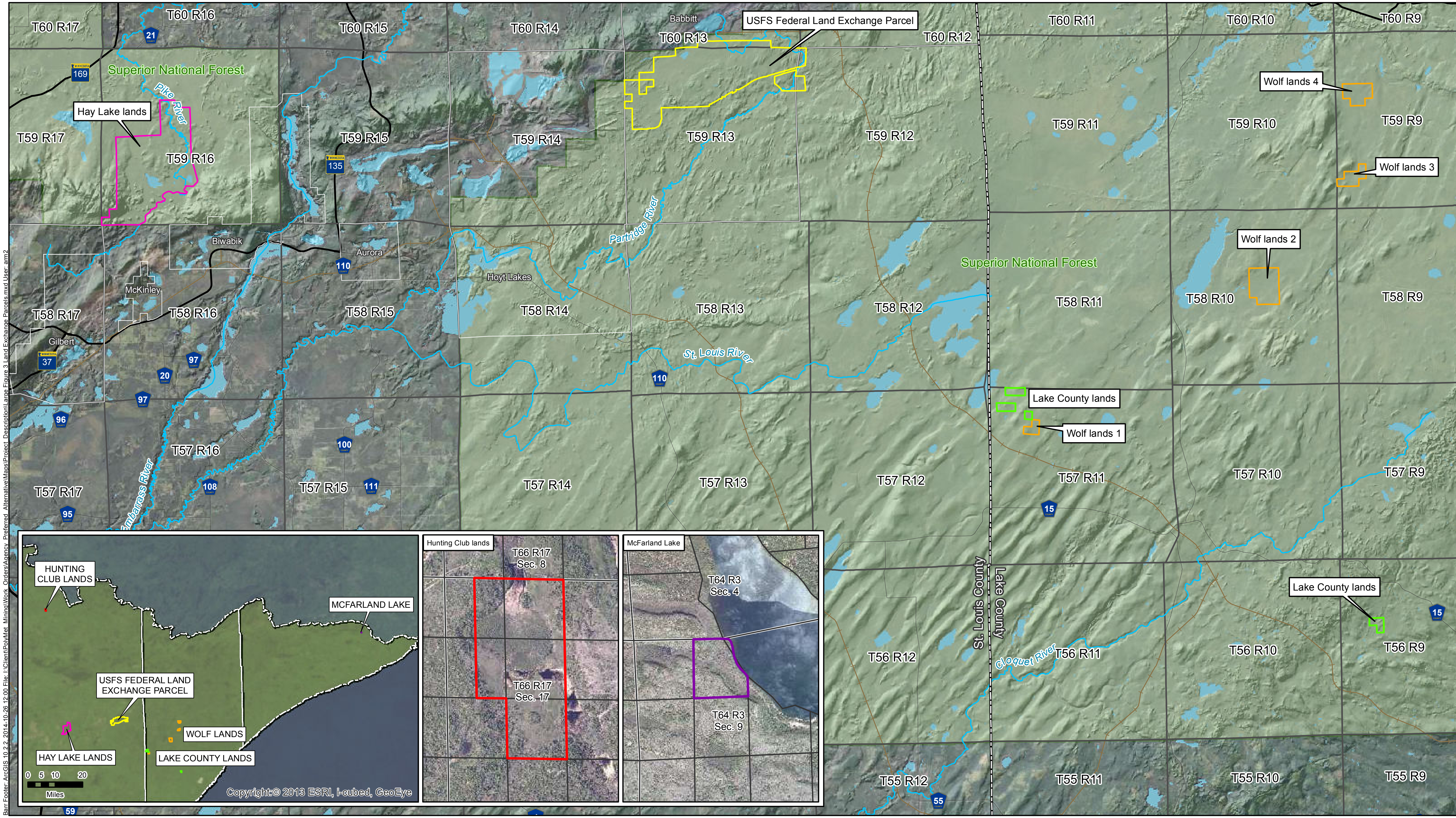
Treated Water Pipeline

Rivers & Streams

0 0.5 1 2

Miles

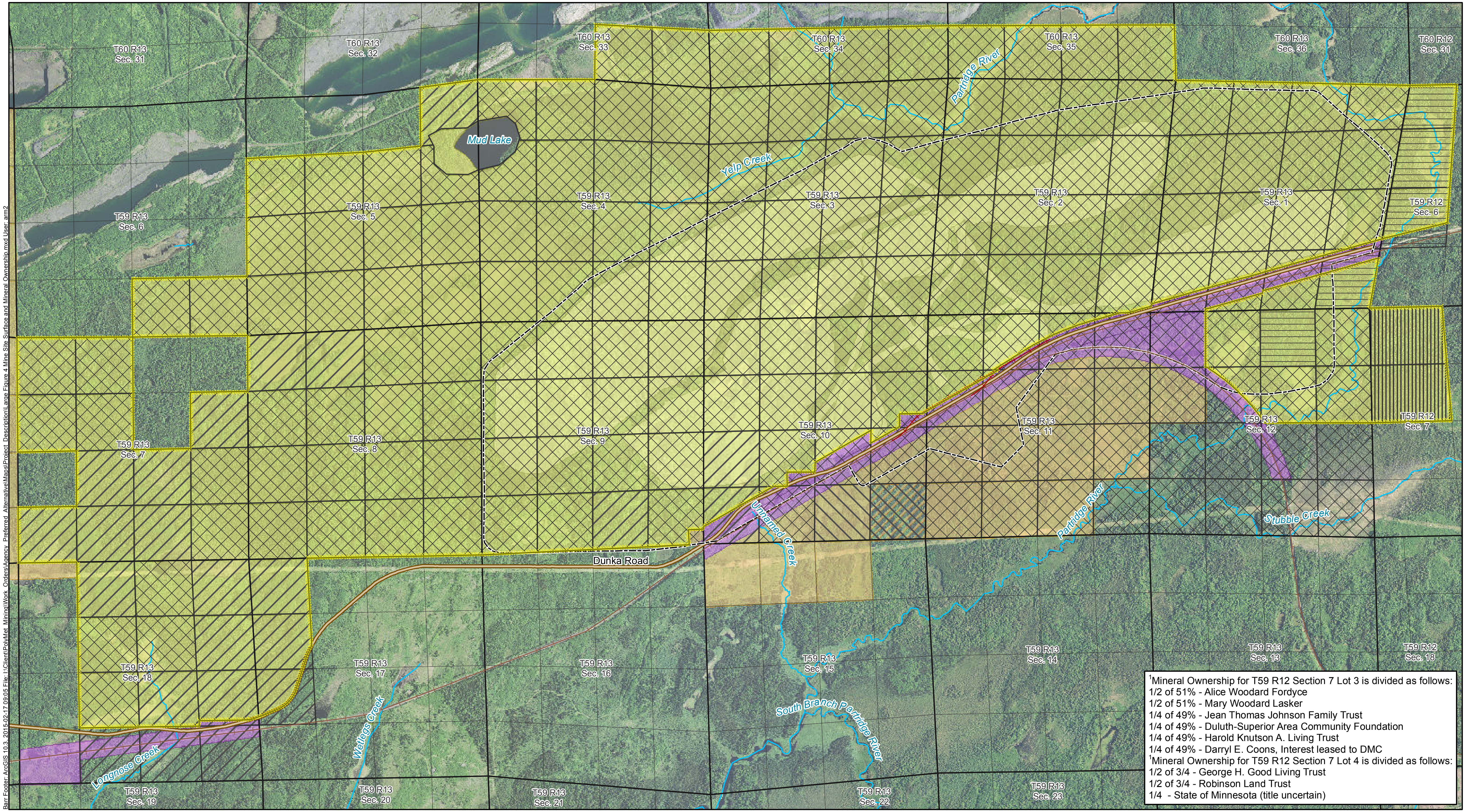
Large Figure 2
PROJECT AREA
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



- USFS Federal Land Exchange Parcel
- Hay Lake lands
- Lake County lands
- Wolf lands
- McFarland Lake
- Hunting Club lands

0 1.25 2.5 5
Miles

Large Figure 3
LAND EXCHANGE PARCELS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



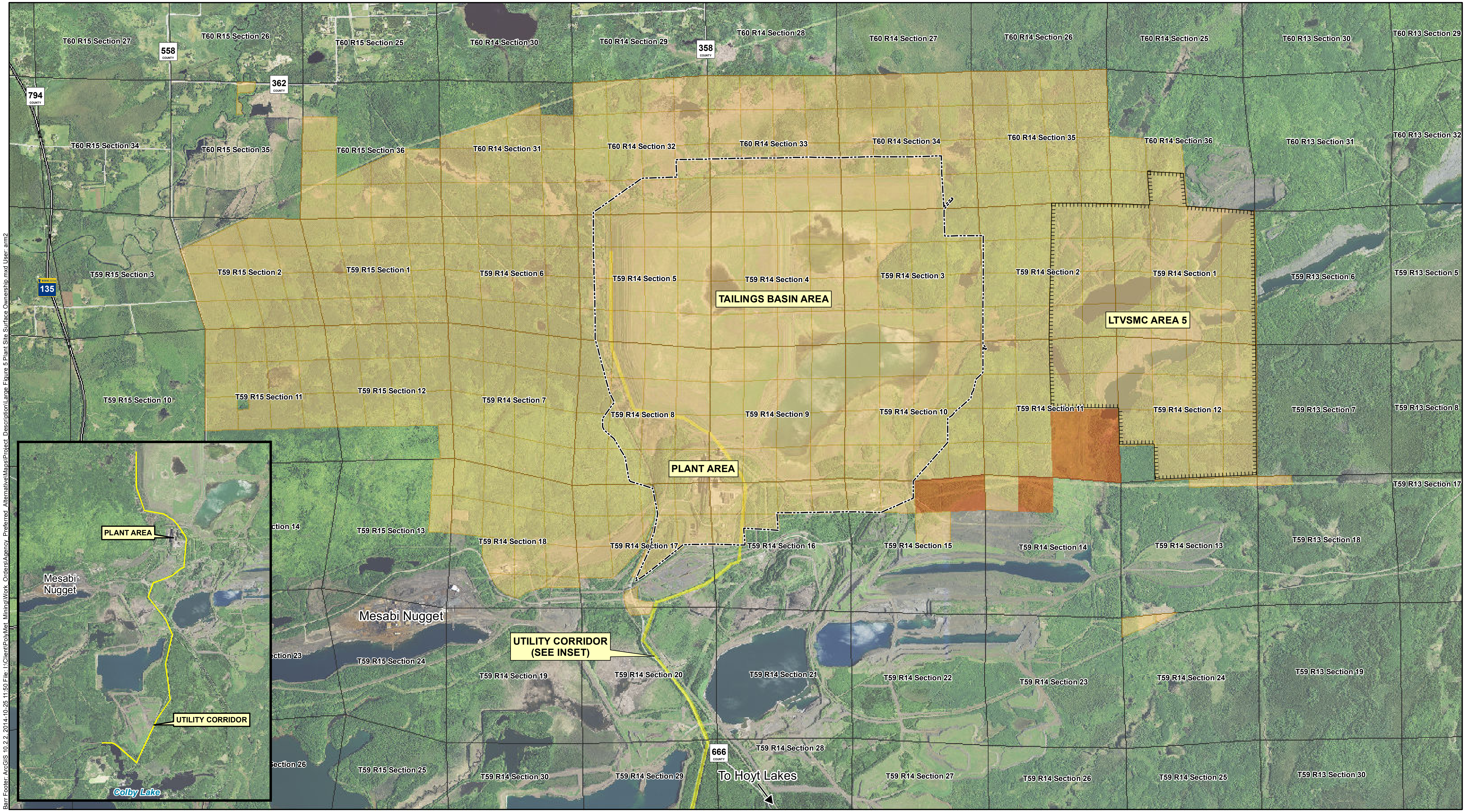
Land Exchange Area
Mine Site
Proposed Mine Features

Mineral Ownership
RGGS
Longyear Mesaba
State of Minnesota
USA
Multiple Owners[1]

Surface Ownership
Cliffs Erie
PolyMet
PolyMet Pursuing Ownership
USA

0 1,000 2,000 4,000
Feet

Large Figure 4
MINE SITE SURFACE AND MINERAL OWNERSHIP
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Project Area

Section Lines

Surface Ownership

PolyMet Owned Area

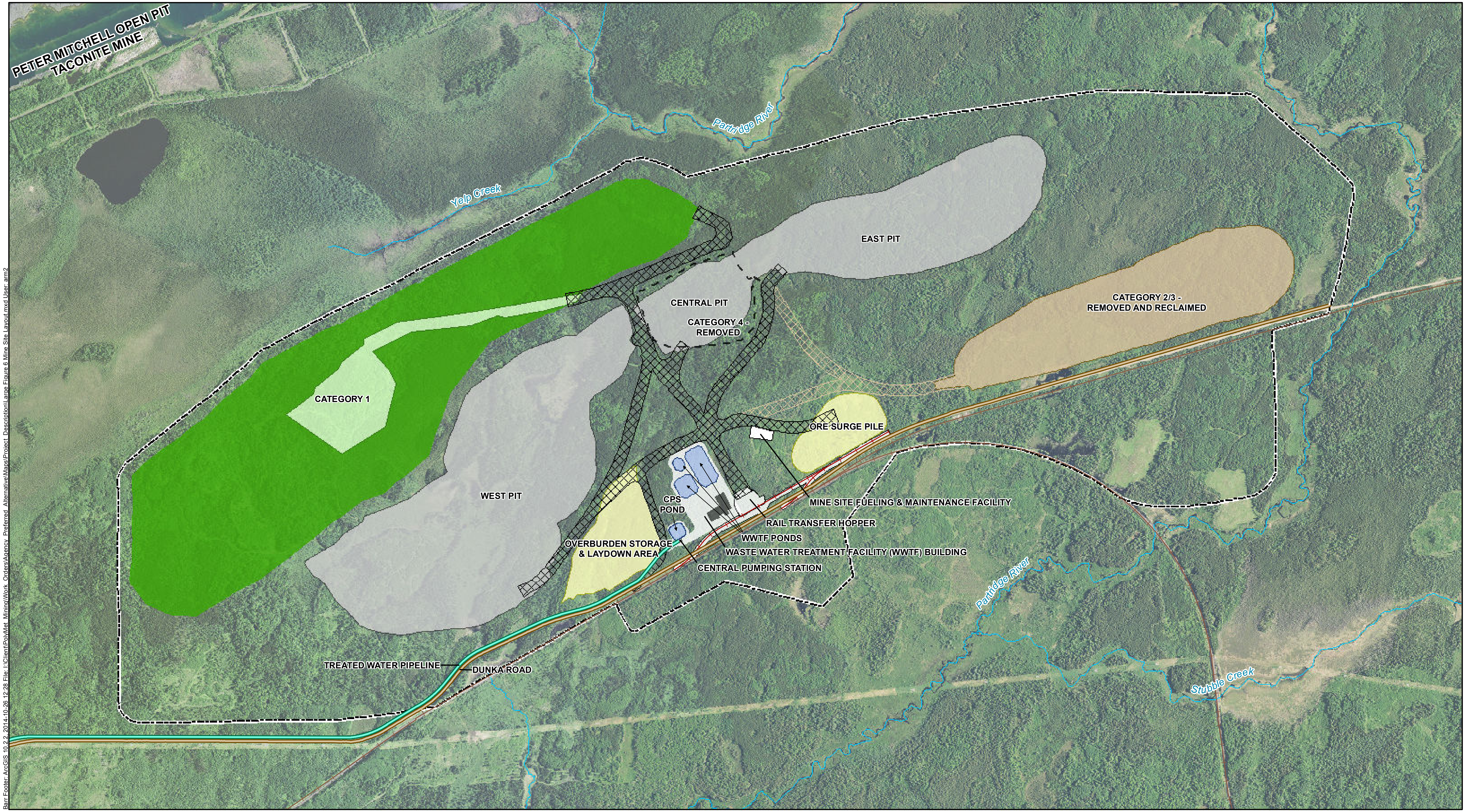
Area Leased by PolyMet

LTVSMC Area 5

0 1,750 3,500 7,000

Feet

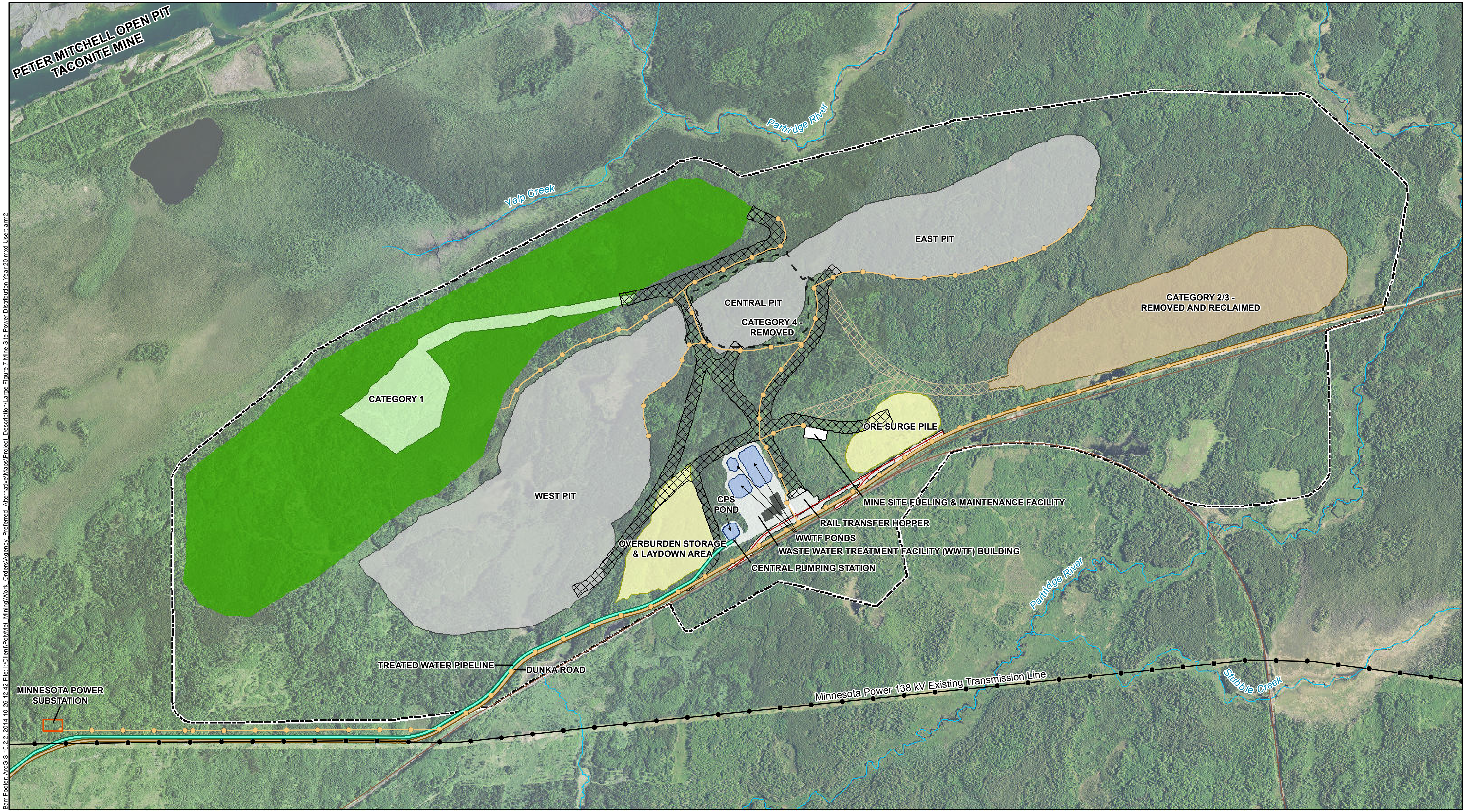
Large Figure 5
PLANT SITE SURFACE OWNERSHIP
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Mine Site
Open Stockpile
Covered Stockpile
Active Stockpile
Removed and Reclaimed Stockpile
Removed Stockpile
Mine Pits
Haul Roads
Reclaimed Haul Roads
Existing Private Railroad
Proposed Railroad Track

0 750 1,500 3,000
Feet

Large Figure 6
MINE SITE LAYOUT
MINE YEAR 20
North Met Project
Poly Met Mining Inc.
Hoyt Lakes, MN

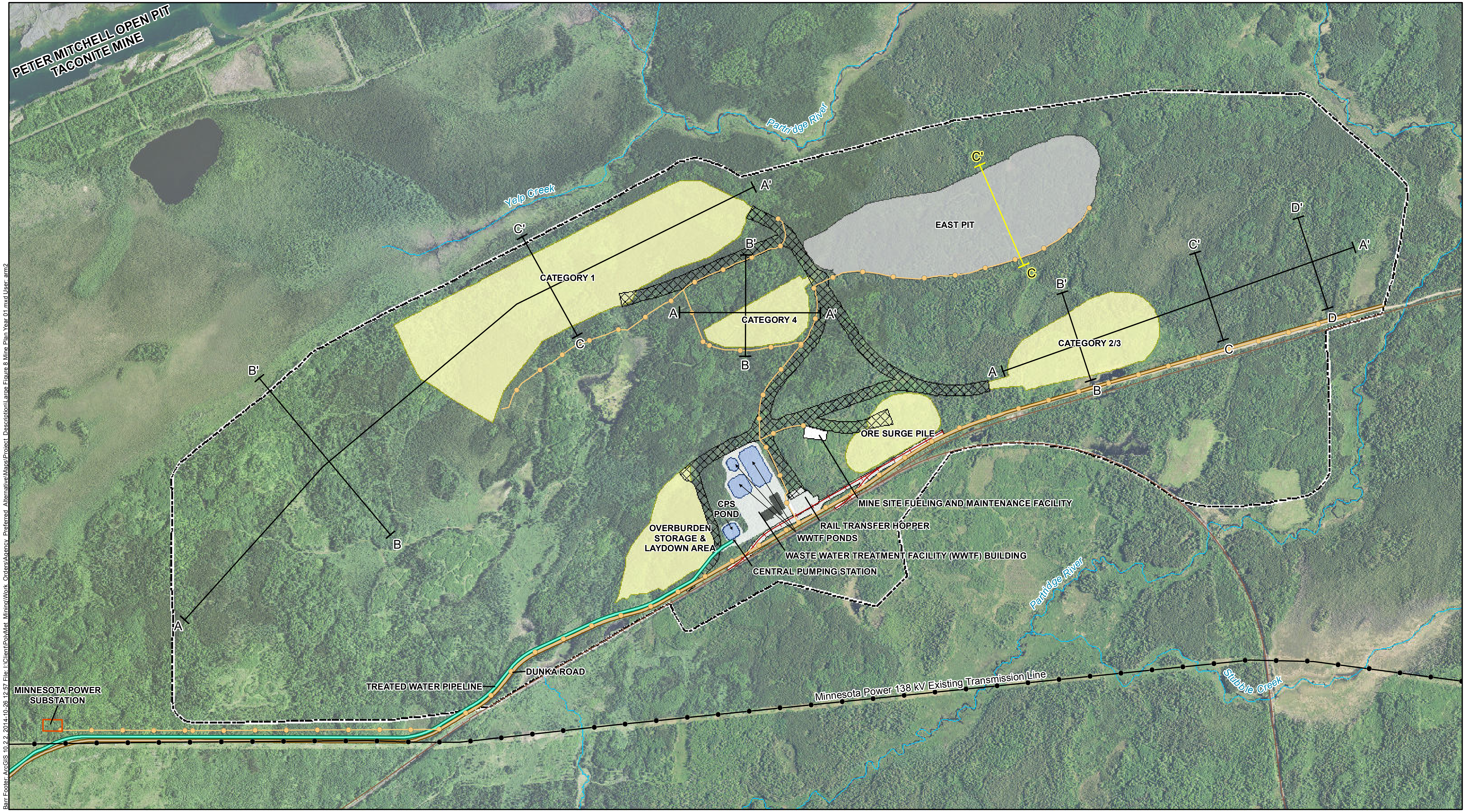


Barr Footer: ArcGIS 10.2.2, 2014-10-26 12:42 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Project_Description\Large Figure 7 Mine Site Power Distribution Year 20.mxd User: arm2

- Mine Site
- Open Stockpile
- Covered Stockpile
- Active Stockpile
- Removed and Reclaimed Stockpile
- Removed Stockpile
- Mine Pits
- Haul Roads
- Reclaimed Haul Roads
- Proposed Transmission Lines
- Electric Transmission Lines

0 750 1,500 3,000
Feet

Large Figure 7
MINE SITE POWER DISTRIBUTION
MINE YEAR 20
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

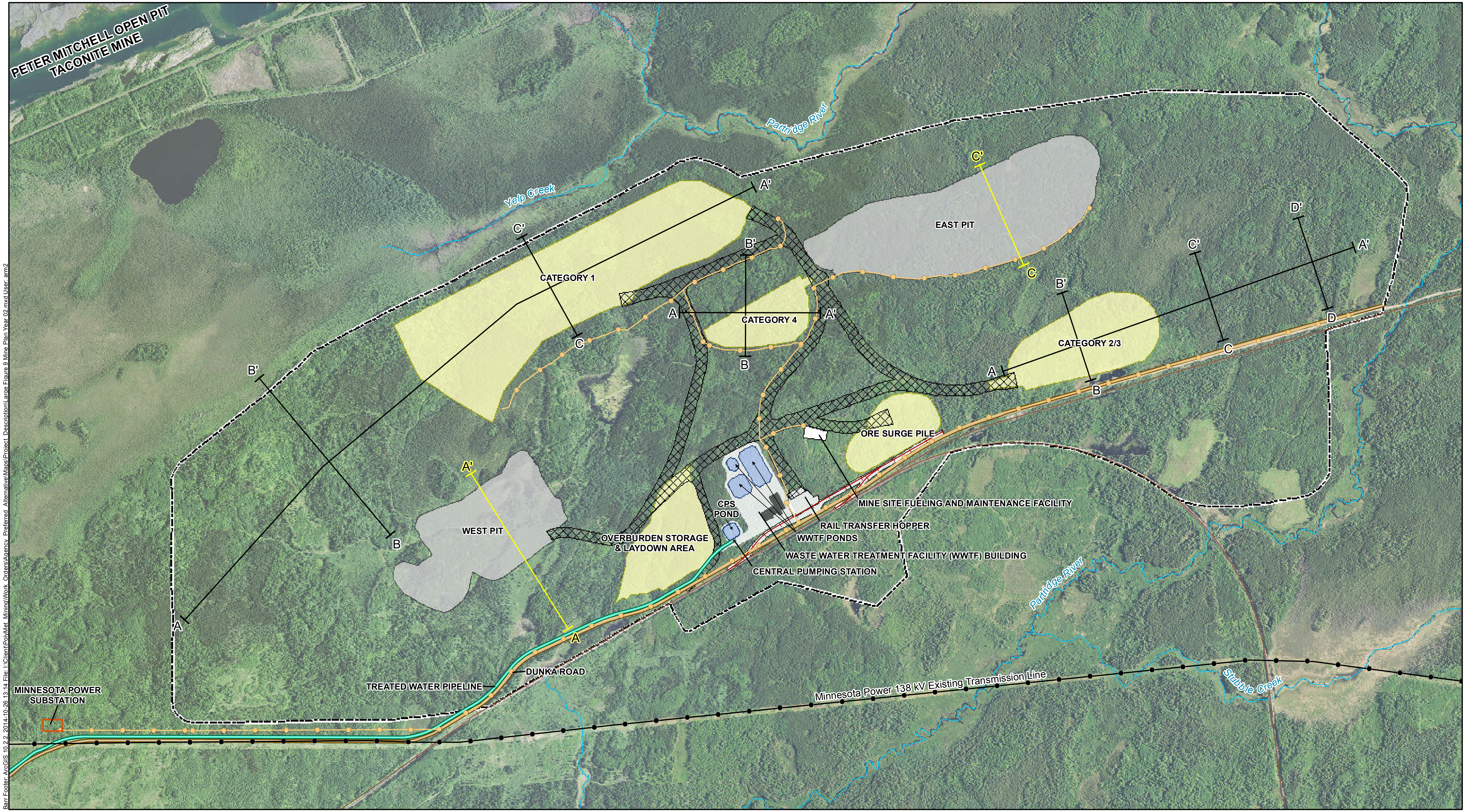


Barr Footer: ArcGIS 10.2.2, 2014-10-26 12:57 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Project_Description\Large Figure 8 Mine Plan Year 01.mxd User: arm2

- Mine Site
- Mine Pit
- Active Stockpile
- Haul Roads
- Mine Pit Cross-Sections
- Stockpile Cross-Sections
- Proposed Transmission Line
- Existing Private Railroad
- Proposed Railroad Track

0 750 1,500 3,000
Feet

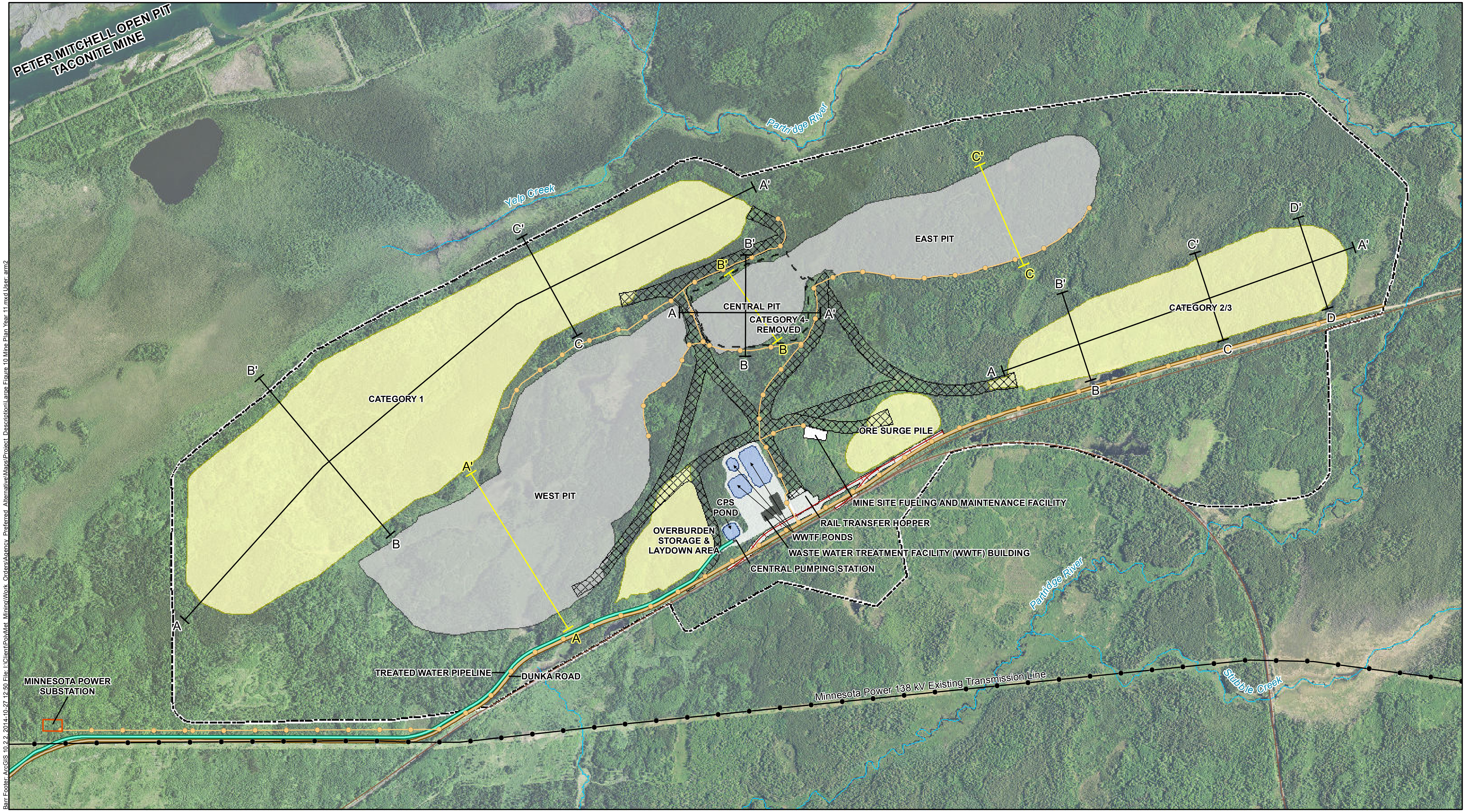
Large Figure 8
MINE PLAN - MINE YEAR 1
NorthMet Project Poly Met
Mining Inc. Hoyt Lakes, MN



- Mine Site
- Mine Pits
- Active Stockpiles
- Haul Roads
- Mine Pit Cross-Sections
- Stockpile Cross-Sections
- Proposed Transmission Line
- Existing Private Railroad
- Proposed Railroad Track

0 750 1,500 3,000
Feet

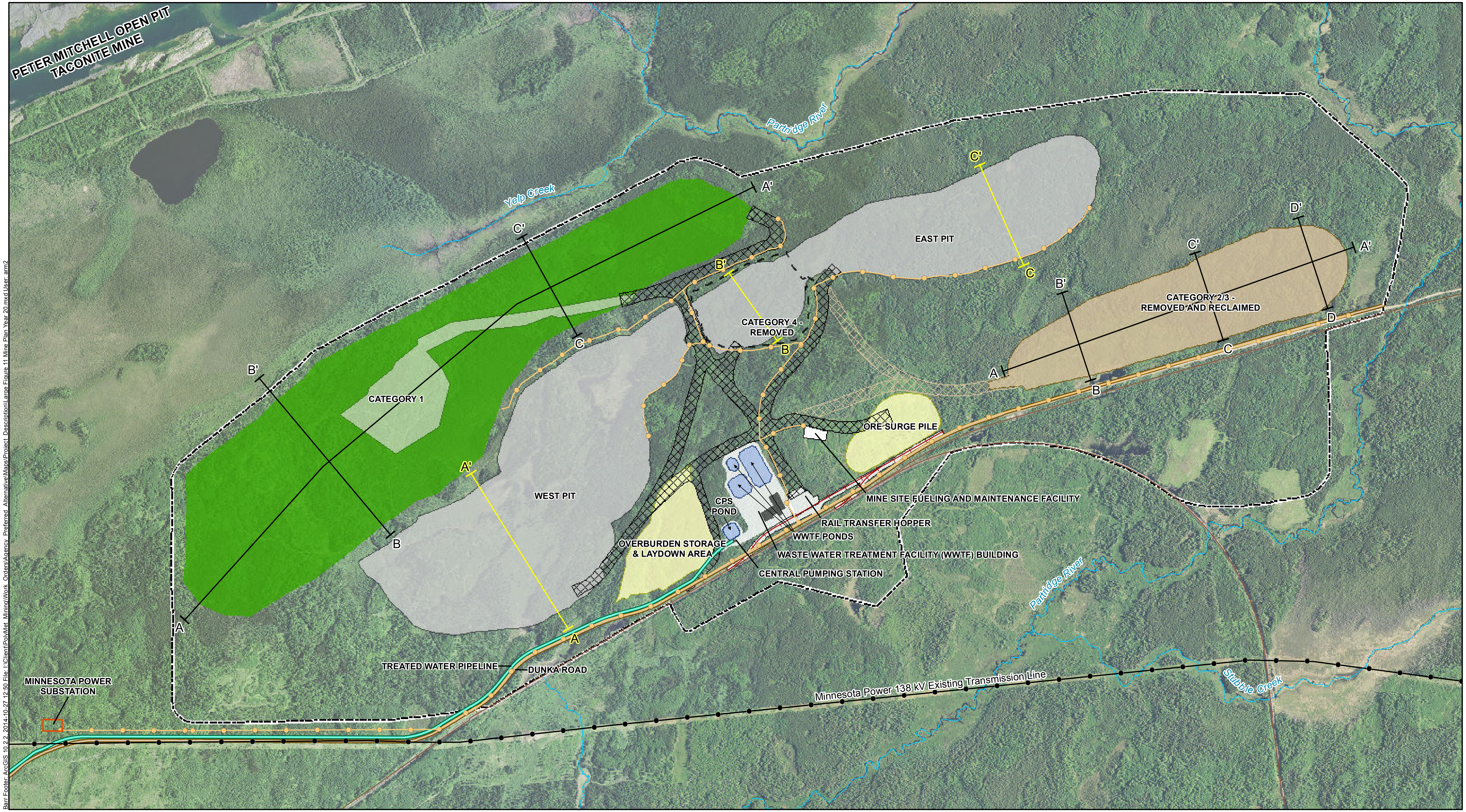
Large Figure 9
MINE PLAN - MINE YEAR 2
NorthMet Project Poly Met
Mining Inc. Hoyt Lakes, MN



Mine Site
Mine Pits
Active Stockpiles
Removed Stockpiles
Haul Roads
Mine Pit Cross-Sections
Stockpile Cross-Sections
Proposed Transmission Lines
Existing Private Railroad
Proposed Railroad Track

0 750 1,500 3,000
Feet

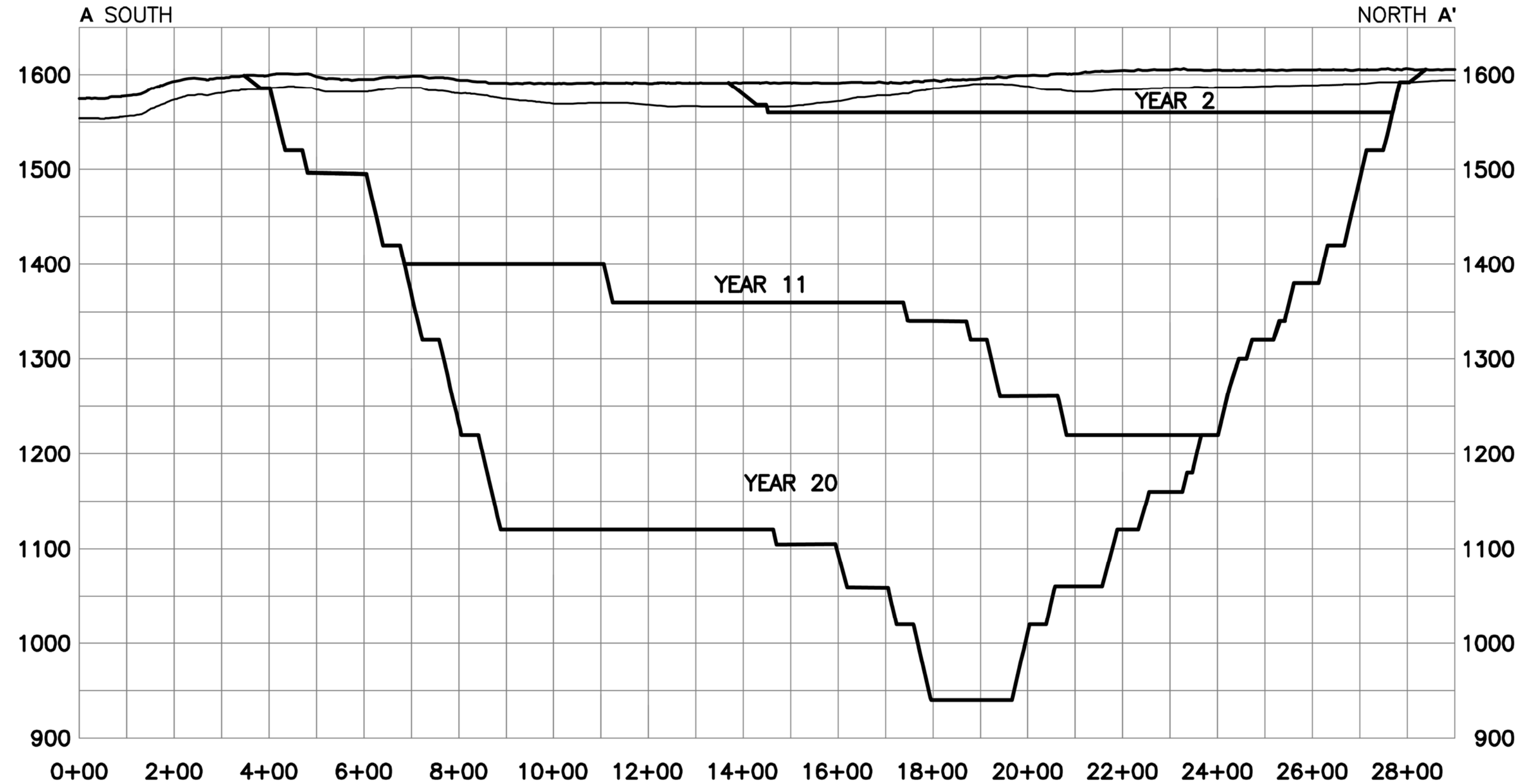
Large Figure 10
MINE PLAN - MINE YEAR 11
NorthMet Project Poly Met
Mining Inc. Hoyt Lakes, MN



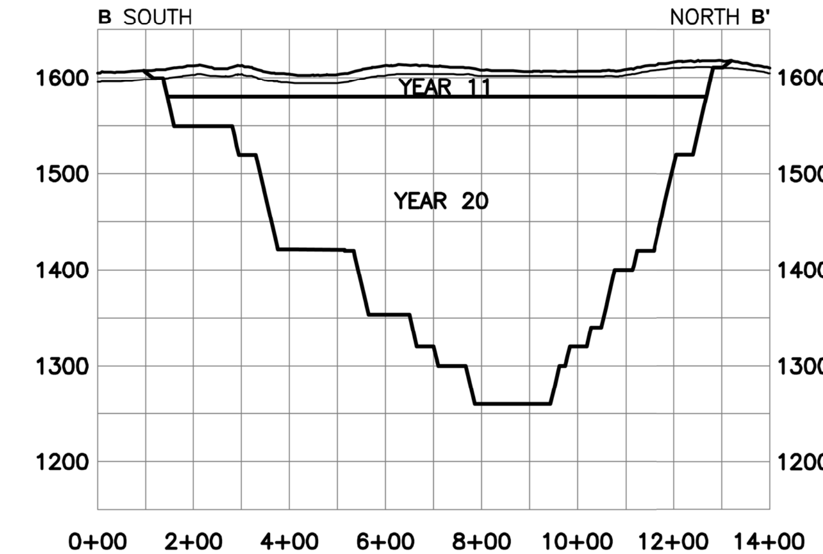
Mine Site
Open Stockpile
Covered Stockpile
Active Stockpile
Removed and Reclaimed Stockpiles
Removed Stockpile
Mine Pits
Haul Roads
Reclaimed Haul Roads
Stockpile Cross-Sections
Mine Pit Cross-Sections
Proposed Transmission Lines
Existing Private Railroad
Proposed Railroad Track

0 750 1,500 3,000
Feet

Large Figure 11
MINE PLAN - MINE YEAR 20
NorthMet Project Poly Met
Mining Inc. Hoyt Lakes, MN

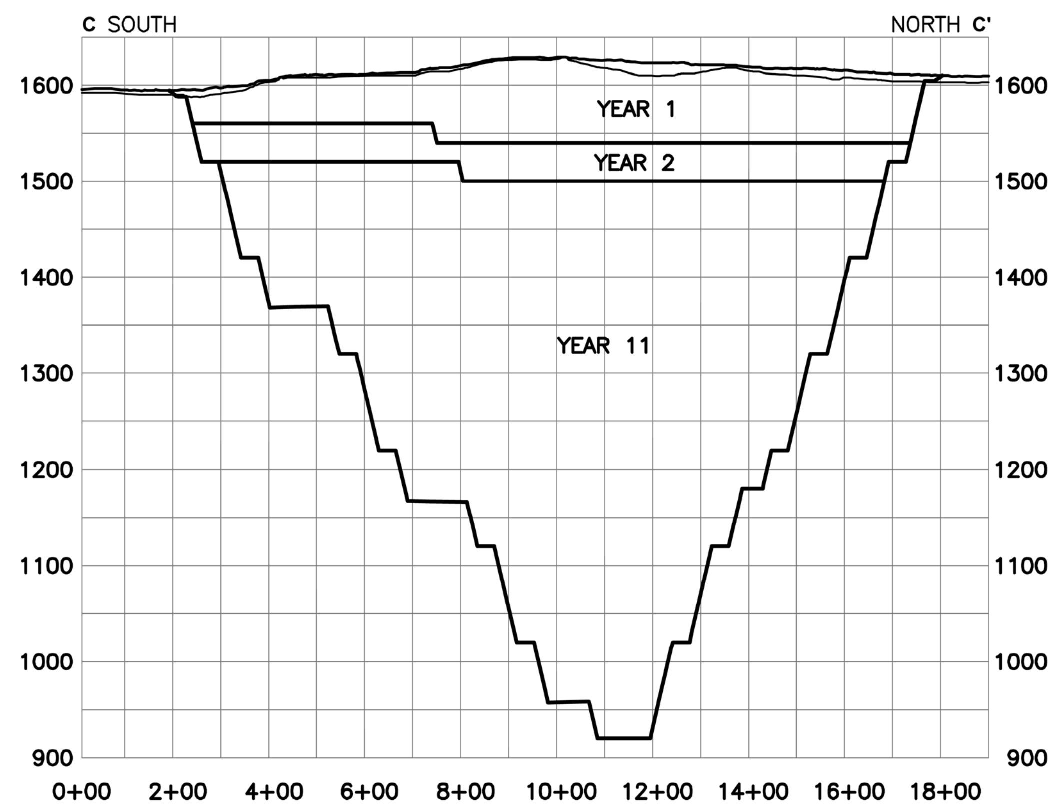


(A) SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



(B) SECTION: CENTRAL PIT
2:1 VERTICAL EXAGGERATION

NOTE: CENTRAL PIT MINING WILL BE COMPLETED IN MINE YEAR 16.

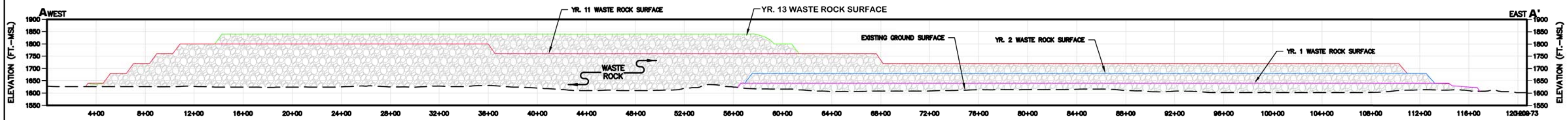


(C) SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION

HORIZONTAL 0 400 800 SCALE IN FEET

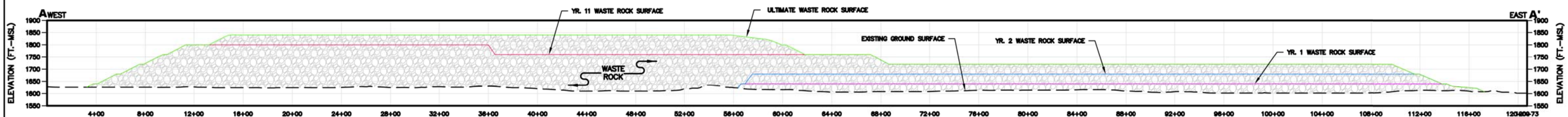
VERTICAL 0 200 400 SCALE IN FEET

Large Figure 12
PIT CROSS-SECTIONS
NorthMet Project
PolyMet Mining Inc.
Hoyt Lakes, MN



A OPERATIONAL CONFIGURATION SECTION
CATEGORY 1 STOCKPILE

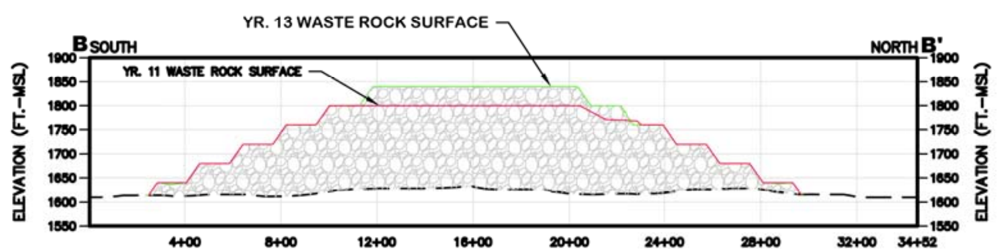
0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



A RECLAMATION CONFIGURATION SECTION – INTERBENCH SLOPES 3.75H:1V
CATEGORY 1 STOCKPILE

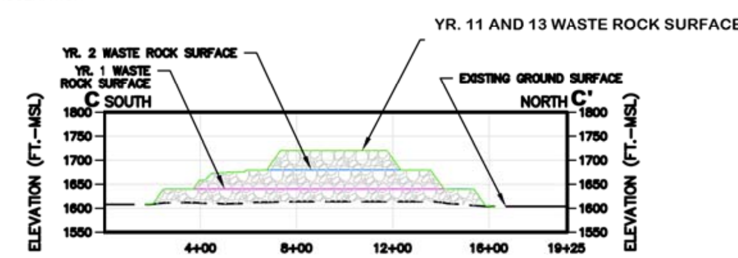
0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION

NOTE: THE RECLAMATION CONFIGURATION IS SHOWN FOR EACH MINE PLAN FIGURE YEAR FOR ESTIMATION OF CONTINGENCY CLOSURE AND FINANCIAL ASSURANCE.



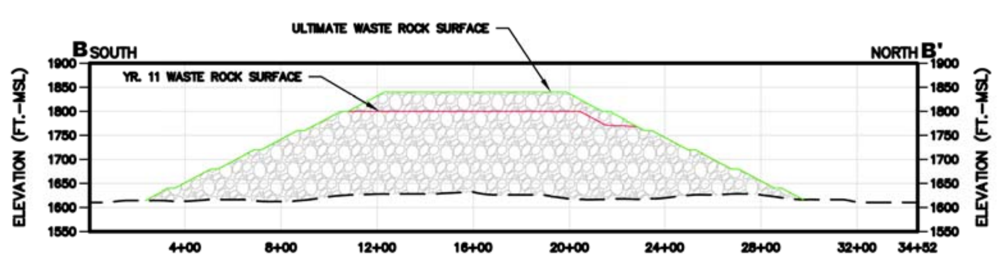
B OPERATIONAL CONFIGURATION – WEST SECTION
CATEGORY 1 STOCKPILE

0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



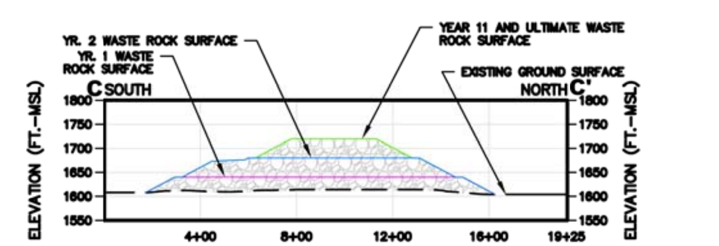
C OPERATIONAL CONFIGURATION – EAST SECTION
CATEGORY 1 STOCKPILE

0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



B RECLAMATION CONFIGURATION – WEST SECTION, INTERBENCH SLOPES 3.75H:1V
CATEGORY 1 STOCKPILE

0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION



C RECLAMATION CONFIGURATION – EAST SECTION, INTERBENCH SLOPES 3.75H:1V
CATEGORY 1 STOCKPILE

0 400 800
HORIZONTAL SCALE IN FEET
2X VERTICAL EXAGGERATION

LEGEND
- YEAR 1 LIMITS
- YEAR 2 LIMITS
- YEAR 11 LIMITS
- YEAR 12, ULTIMATE LIMITS
- EXISTING GROUND SURFACE

CADD USER: Gjeropic, Gordon FILE: E:\113-2209\N-DRIVE-07-18-2012_E CAT1 MODIFIED\1132209E014-REV1.DWG PLOT SCALE: 1:2 PLOT DATE: 9/21/2012 8:59 AM

DRAFT

0 500 1000
SCALE IN FEET

VER NO	DATE	DESCRIPTION
A	06/05/12	ISSUED FOR CLIENT REVIEW
B	09/21/12	ISSUED FOR CLIENT REVIEW

DRAWING STATUS		
ISSUED	VERSION	DATE
FOR PERMITTING		
FOR CONSTRUCTION		

PERMIT DRAWINGS – NOT APPROVED FOR CONSTRUCTION.

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE ______
PRINTED NAME ______
DATE ______ REG. NO. ______

DRAWN: MTM 06/05/12
CHECKED: GG 06/05/12
GOLDER PROJECT NO.: 113-2209
SCALE: AS SHOWN

PLANT DRAWING NUMBER:

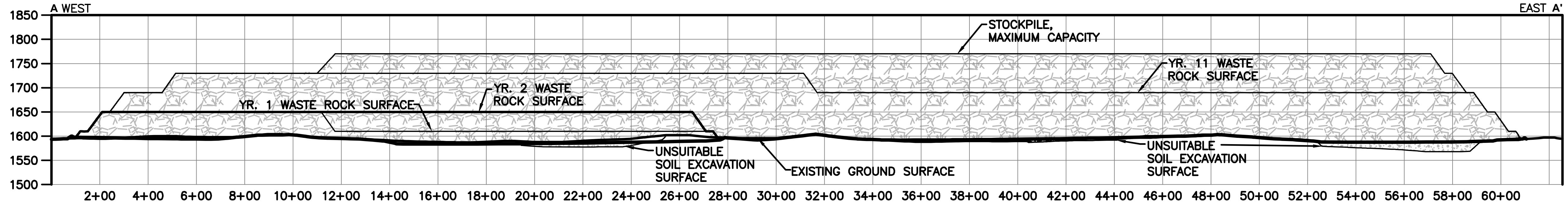
STOCKPILE CROSS-SECTIONS
CATEGORY 1 STOCKPILE

POLYMET MINING

POLYMET MINING CORPORATION
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

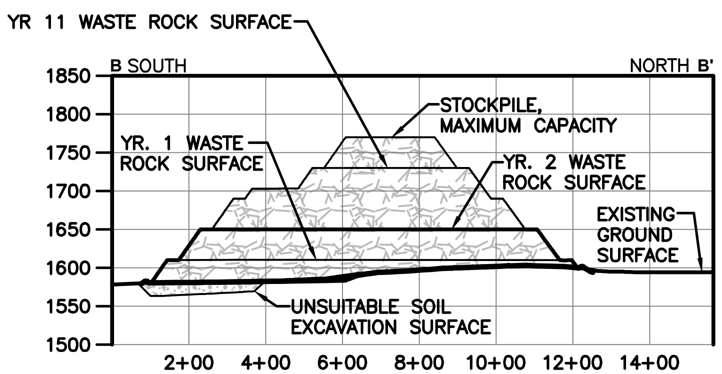
Golder Associates
GOLDER ASSOCIATES INC.
44 UNION BOULEVARD, SUITE 300
LAKEWOOD, CO USA 80233
Ph: (303) 980-0540
Fax: (303) 985-2080
www.golder.com

DWG. NO. 8 Project Description Large Figure 13 REV B



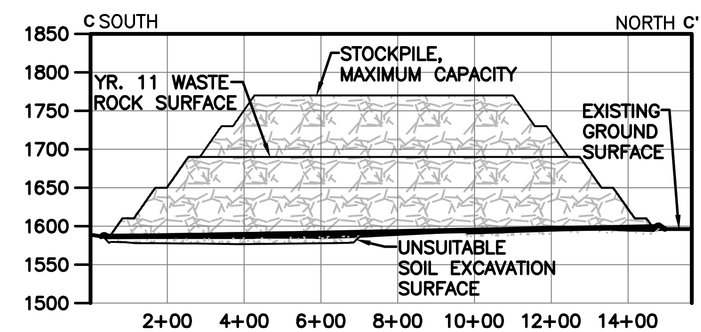
A SECTION: CATEGORY 2/3 STOCKPILE

2:1 VERTICAL EXAGGERATION



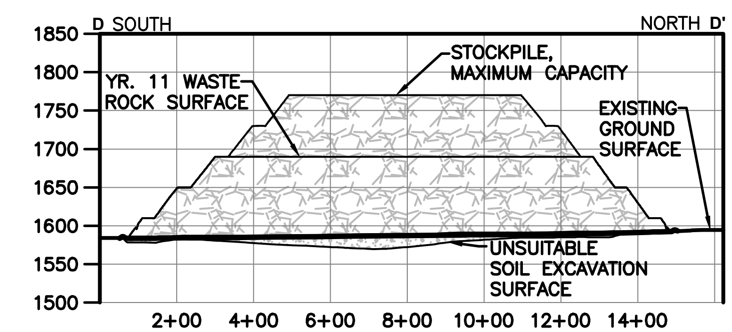
B SECTION: CATEGORY 2/3 STOCKPILE

2:1 VERTICAL EXAGGERATION



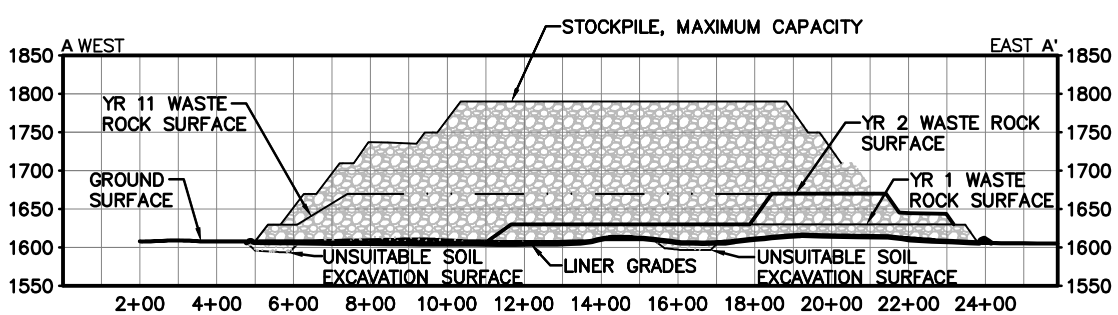
C SECTION: CATEGORY 2/3 STOCKPILE

2:1 VERTICAL EXAGGERATION



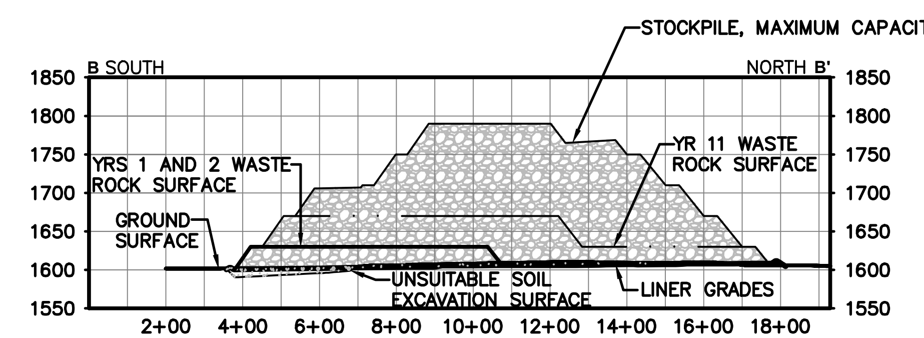
D SECTION: CATEGORY 2/3 STOCKPILE

2:1 VERTICAL EXAGGERATION



A SECTION: CATEGORY 4 STOCKPILE

2:1 VERTICAL EXAGGERATION



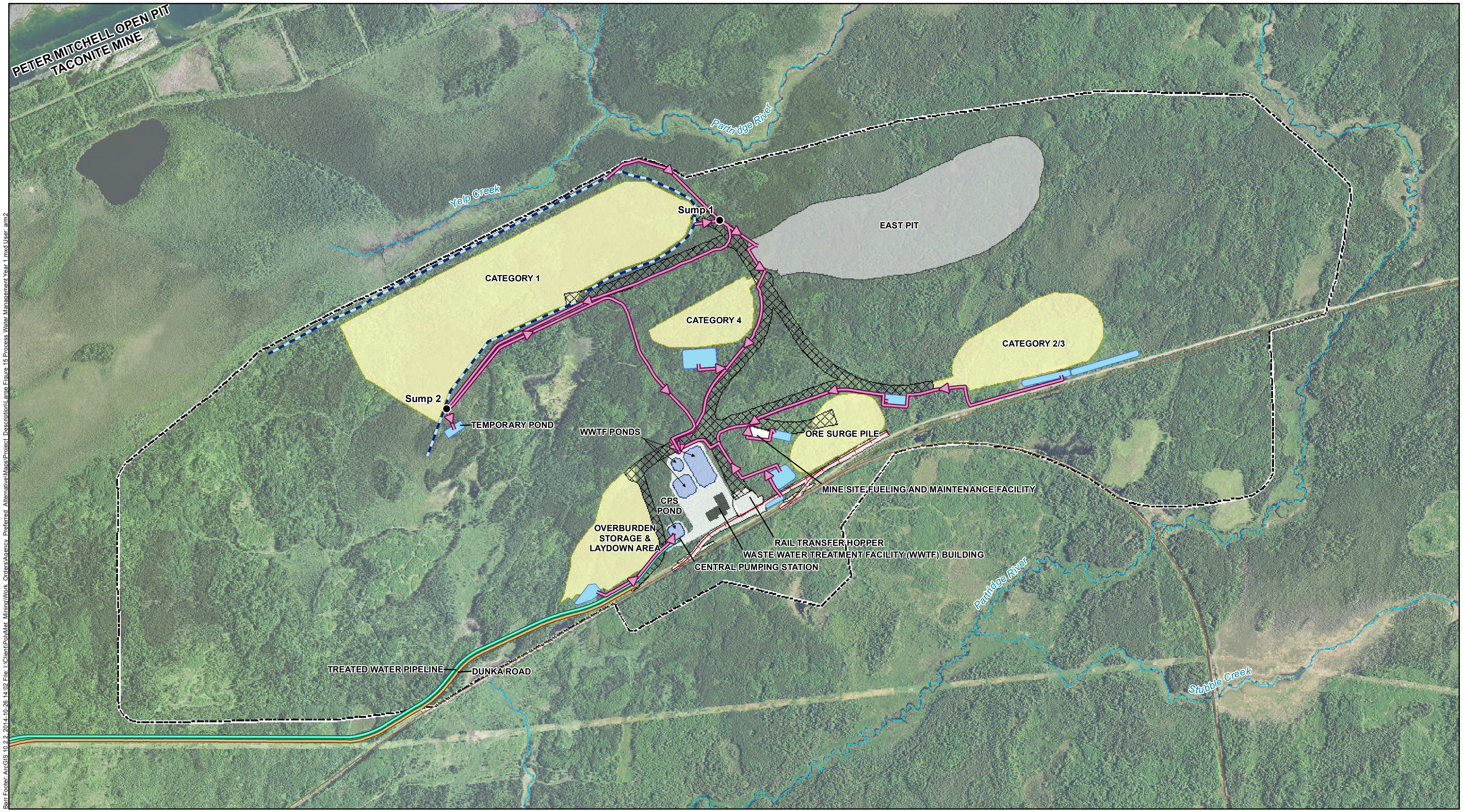
B SECTION: CATEGORY 4 STOCKPILE

2:1 VERTICAL EXAGGERATION

HORIZONTAL 0 500 1000 SCALE IN FEET

VERTICAL 0 250 500 SCALE IN FEET

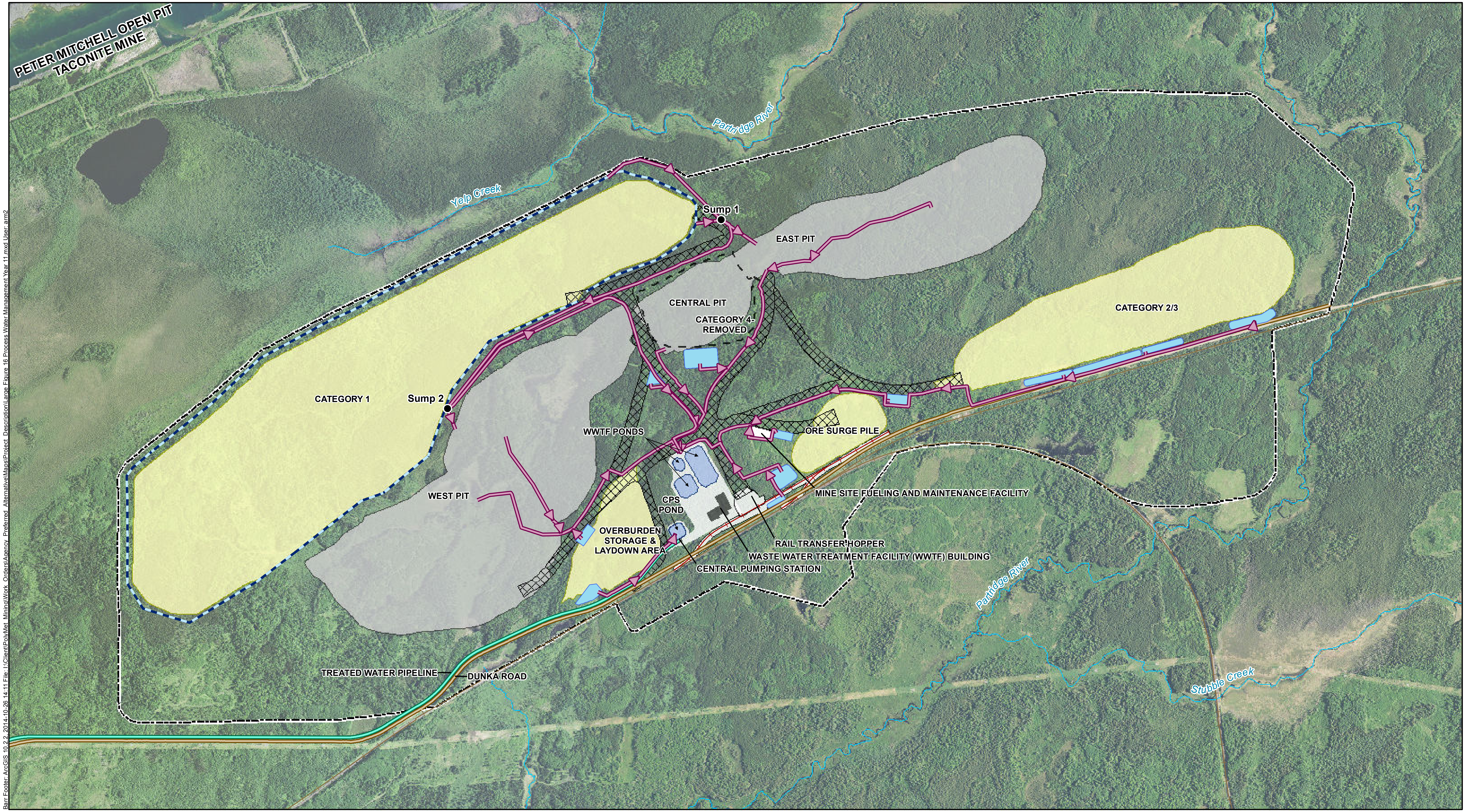
Large Figure 14
STOCKPILE CROSS-SECTIONS
NorthMet Project
PolyMet Mining Inc.
Hoyt Lakes, MN



Mine Site
Mine Pit
Active Stockpile
Haul Roads
Proposed Railroad Track
Existing Private Railroad
Process Water Pipe
Groundwater Containment System
Ponds and Sumps

0 750 1,500 3,000
Feet

Large Figure 15
PROCESS WATER MANAGEMENT
MINE YEAR 1
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

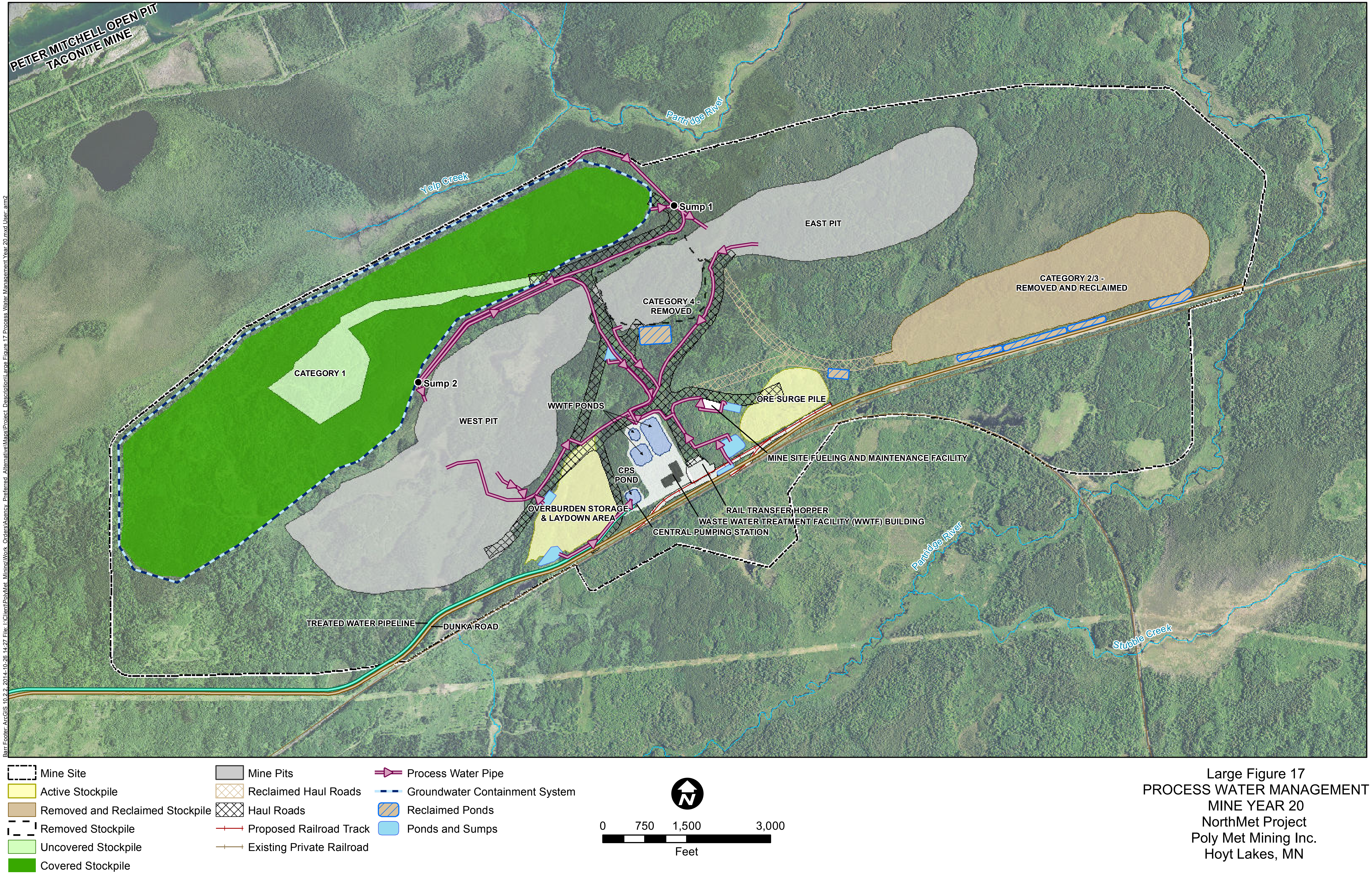


Mine Site
Mine Pits
Active Stockpiles
Removed Stockpile
Haul Roads
Proposed Railroad Track
Existing Private Railroad
Process Water Pipe
Groundwater Containment System
Ponds and Sumps

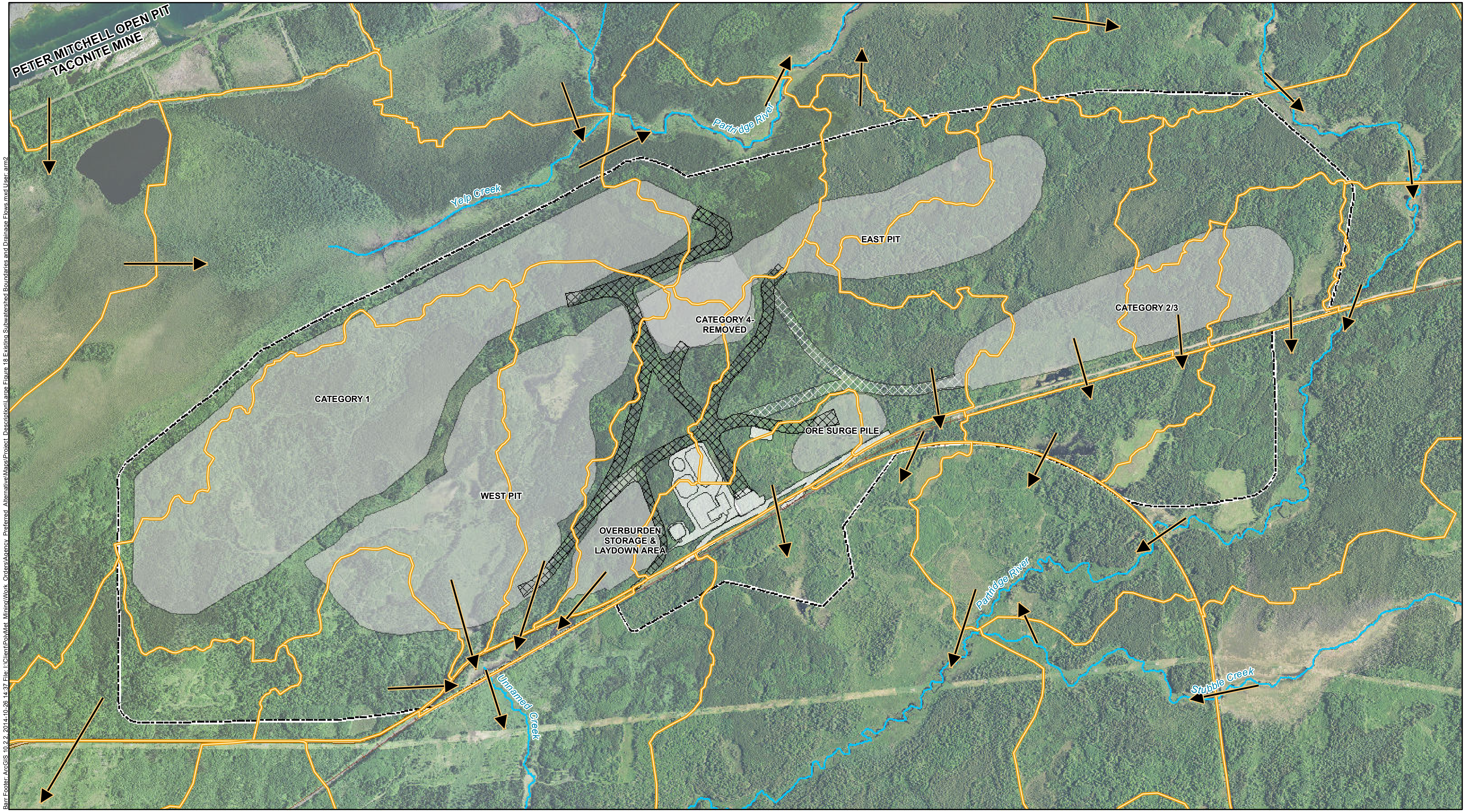
N

0 750 1,500 3,000
Feet

Large Figure 16
PROCESS WATER MANAGEMENT
MINE YEAR 11
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



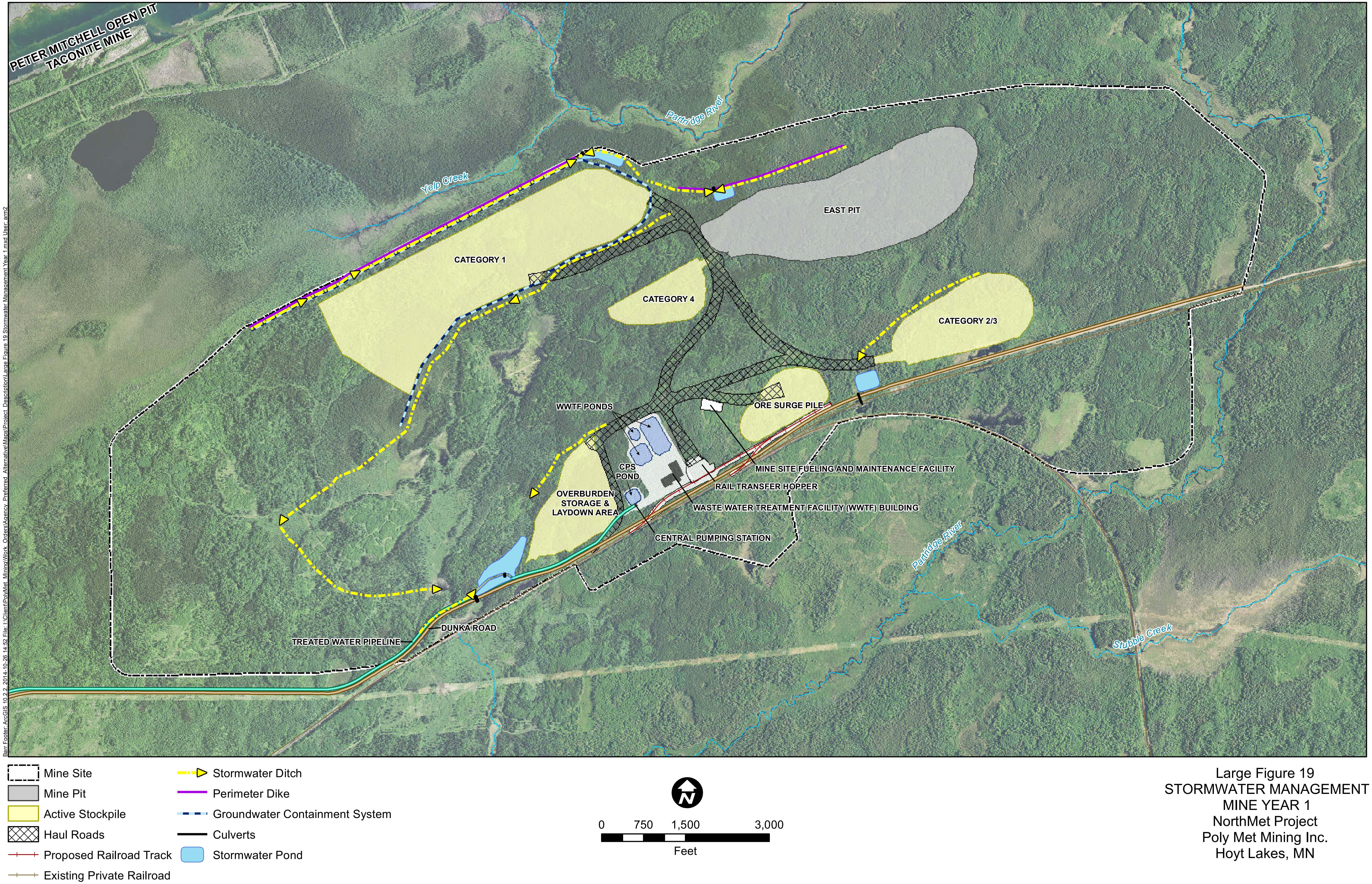
Large Figure 17
PROCESS WATER MANAGEMENT
MINE YEAR 20
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



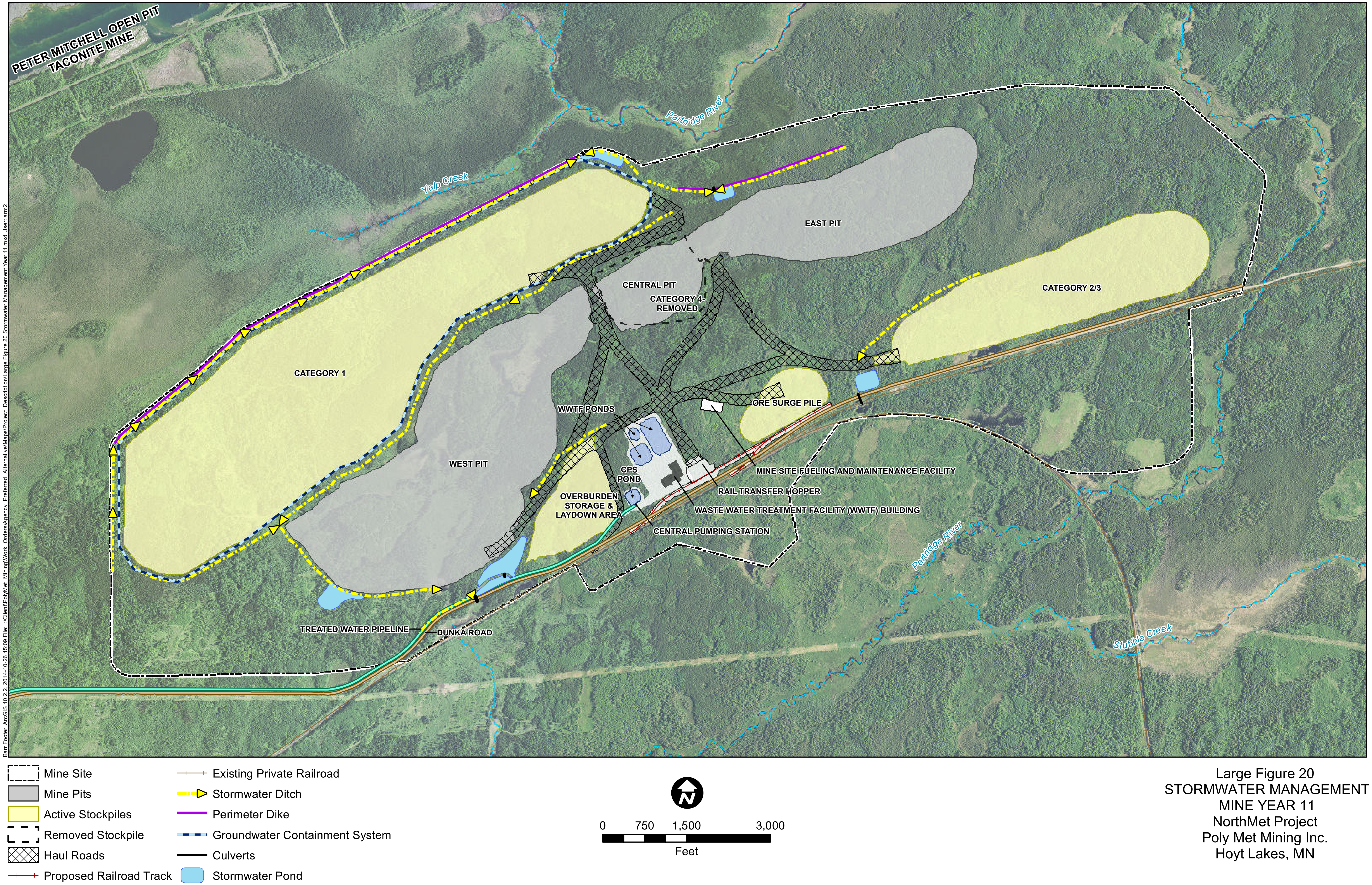
Drainage Flow Direction
Rivers and Streams
Partridge River Subwatersheds
Mine Site
Mine Footprint - Mine Year 20
Haul Roads

0 750 1,500 3,000
Feet

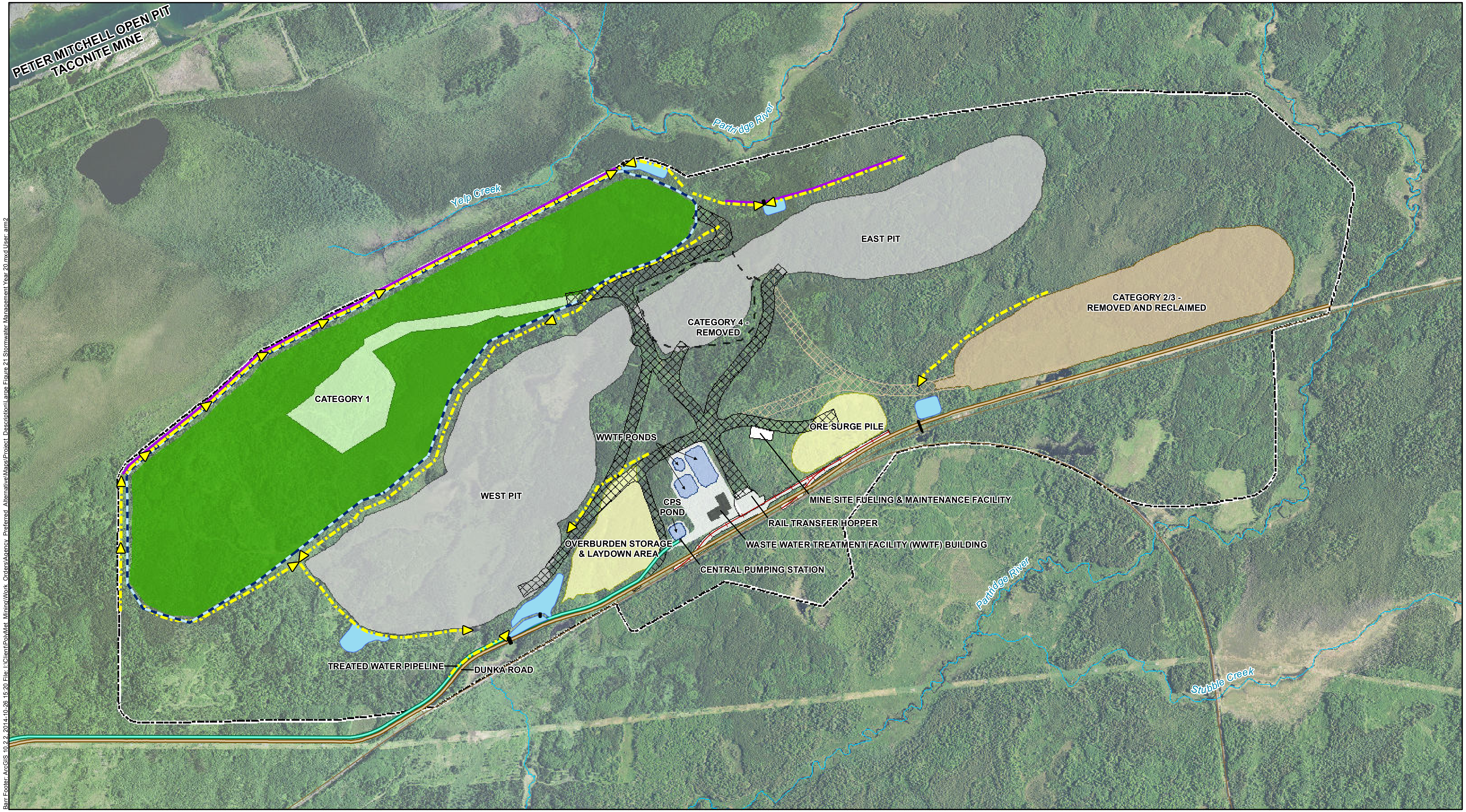
Large Figure 18
EXISTING SUBWATERSHED BOUNDARIES
AND DRAINAGE FLOWS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Large Figure 19
STORMWATER MANAGEMENT
MINE YEAR 1
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Large Figure 20
STORMWATER MANAGEMENT
MINE YEAR 11
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

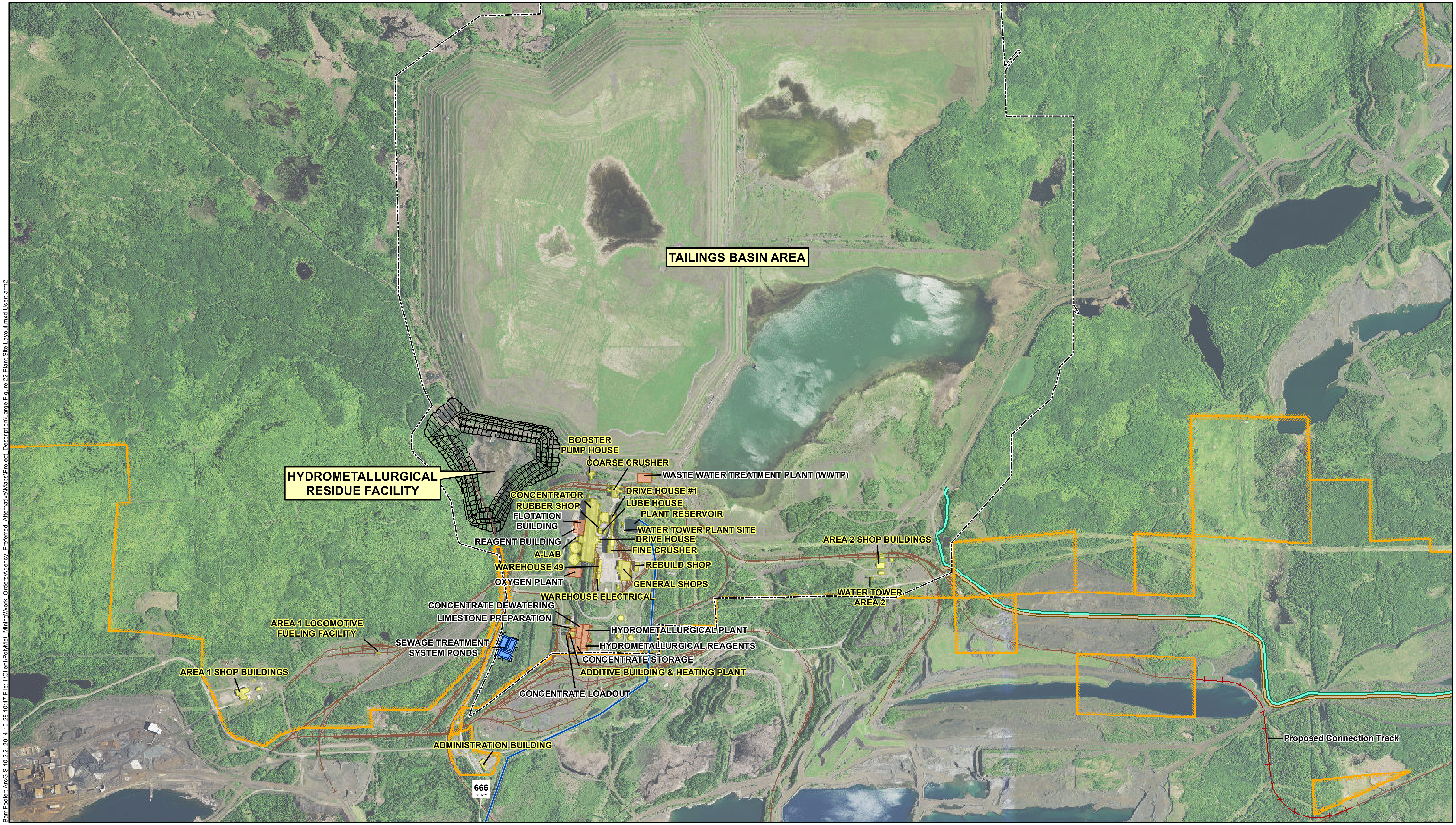


Mine Site
Uncovered Stockpile
Covered Stockpile
Active Stockpile
Removed & Reclaimed Stockpiles
Removed Stockpile
Mine Pits
Haul Roads
Reclaimed Haul Roads
Proposed Railroad Track
Existing Private Railroad
Stormwater Ditch
Perimeter Dike
Groundwater Containment System
Culverts
Stormwater Pond

N

0 750 1,500 3,000
Feet

Large Figure 21
STORMWATER MANAGEMENT
MINE YEAR 20
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



- Plant Site
- Existing Buildings
- New Project Buildings
- PolyMet Ownership Boundary
- Water Supply Pipeline
- Treated Water Pipeline
- Dunka Road
- Existing Private Railroad
- Proposed Railroad Track

N

0 2,000 4,000

Feet

Large Figure 22
PLANT SITE LAYOUT
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

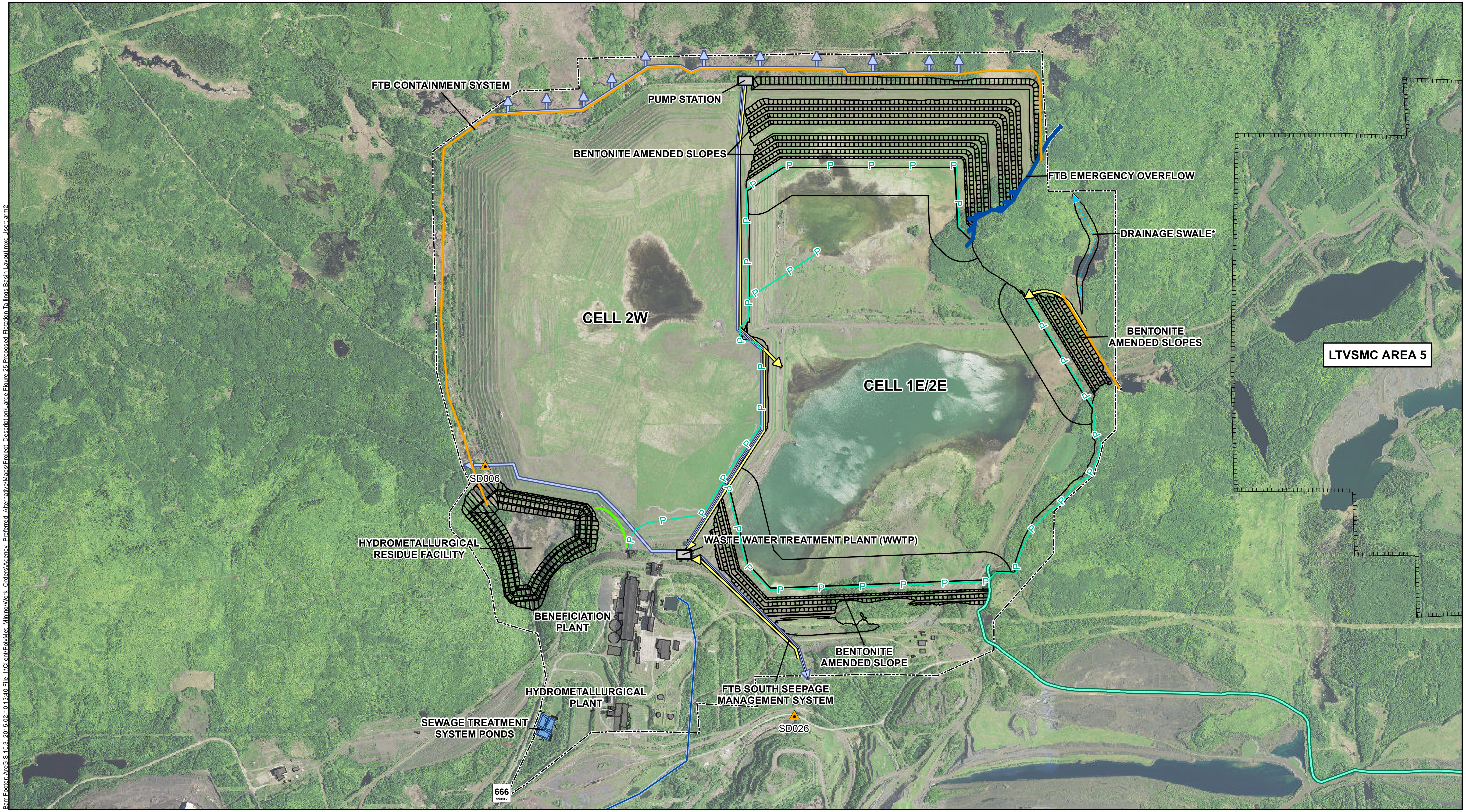
Barr Footer: ArcGIS 10.2.2, 2014-12-02 13:04 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Project_Description\Large Figure 23 Process Plant Area.mxd User: arm2

New Buildings
Existing Buildings
Plant Site

0 250 500 1,000
Feet

Large Figure 23
PROCESS PLANT AREA
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, Minnesota

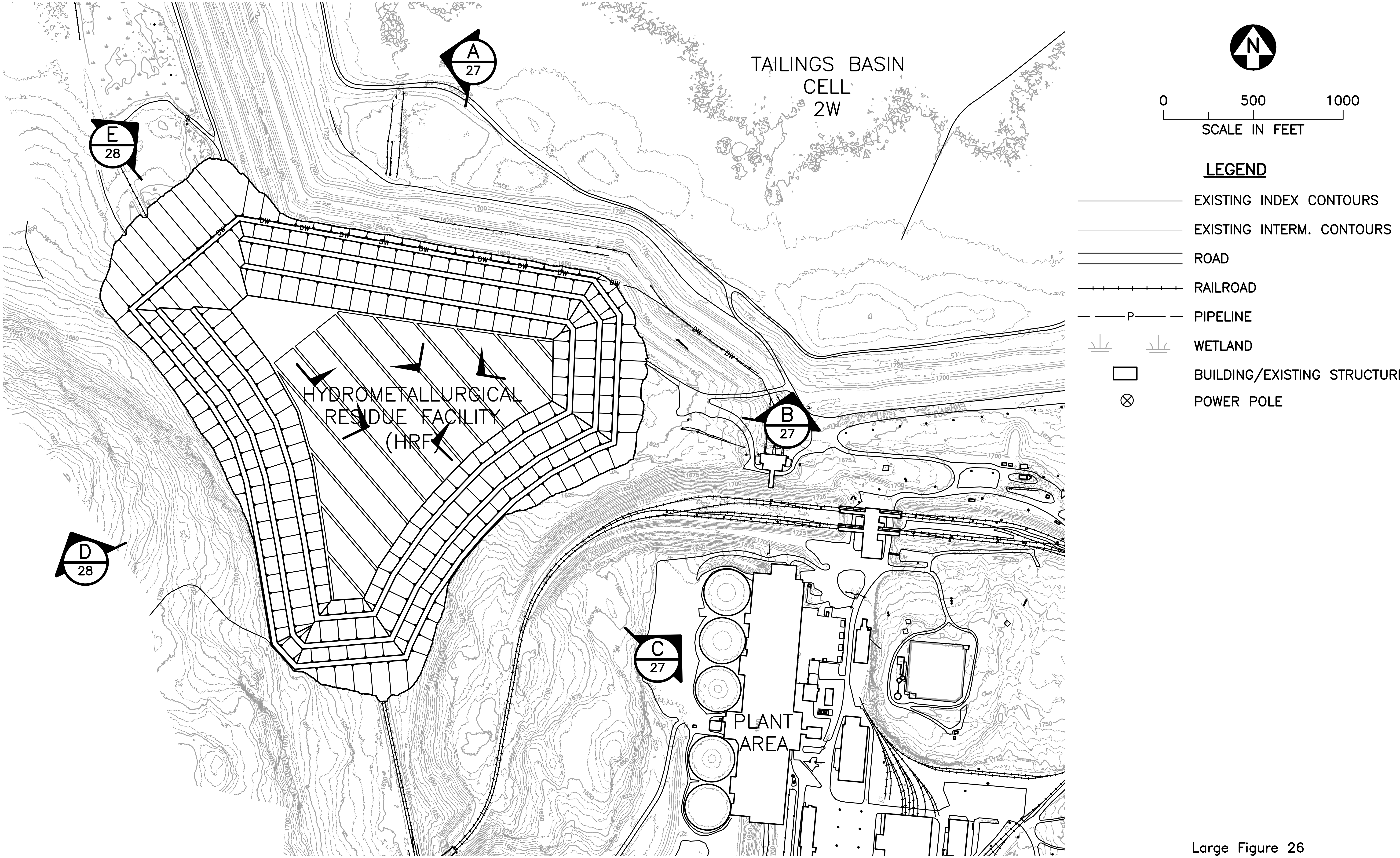
Large Figure 24
EXISTING TAILINGS BASIN
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Existing NPDES Discharge Stations
Treated Water Discharge Pipe
Seepage Water Pipe
Plant Site
LTVSMC Area 5
FTB Containment System
Flotation Tailings Pipeline
Hydrometallurgical Residue Pipeline
Treated Water Pipeline
Drainage Flow Direction
*The drainage swale drains stormwater away from the toe of the dam.

0 2,000 4,000
Feet

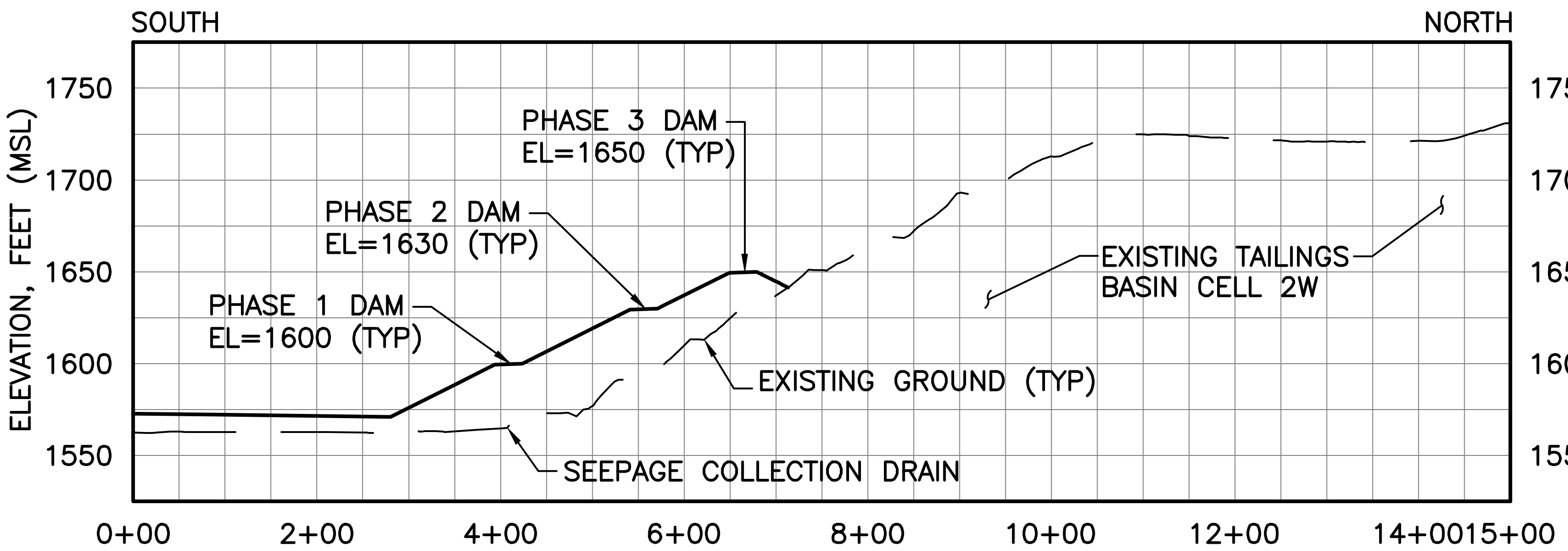
Large Figure 25
PROPOSED FLOTATION TAILINGS BASIN LAYOUT
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



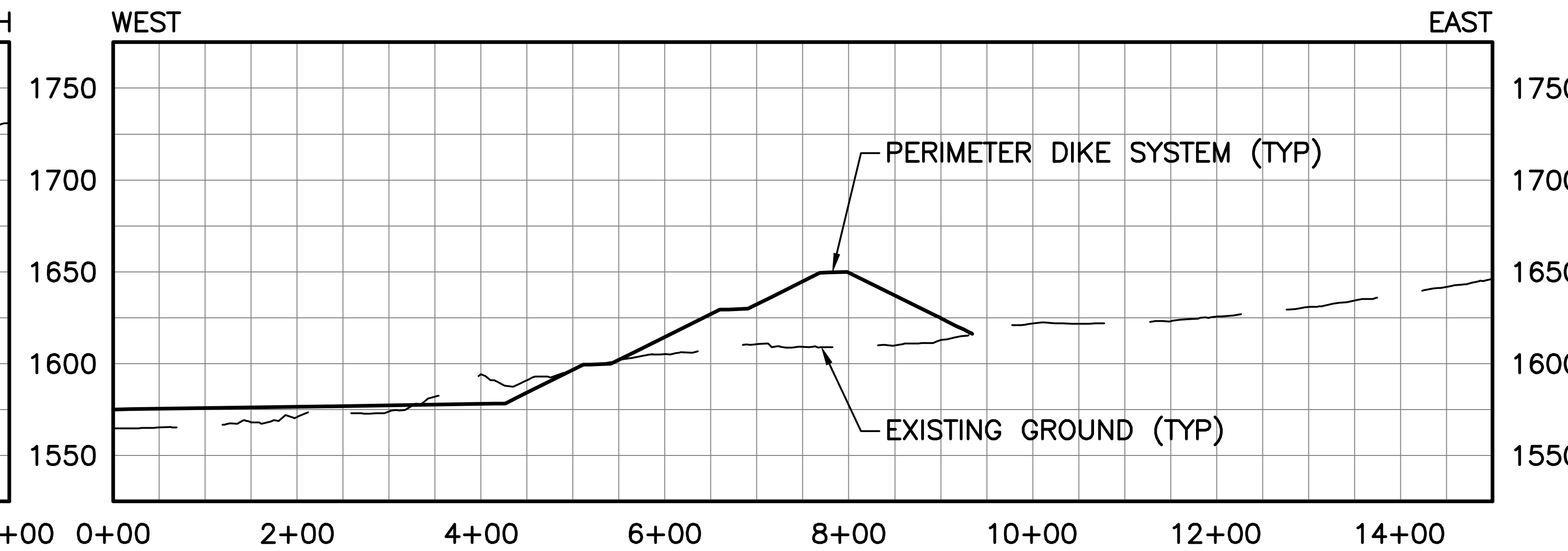
Large Figure 26

HYDROMETALLURGICAL RESIDUE FACILITY – CELL LAYOUT

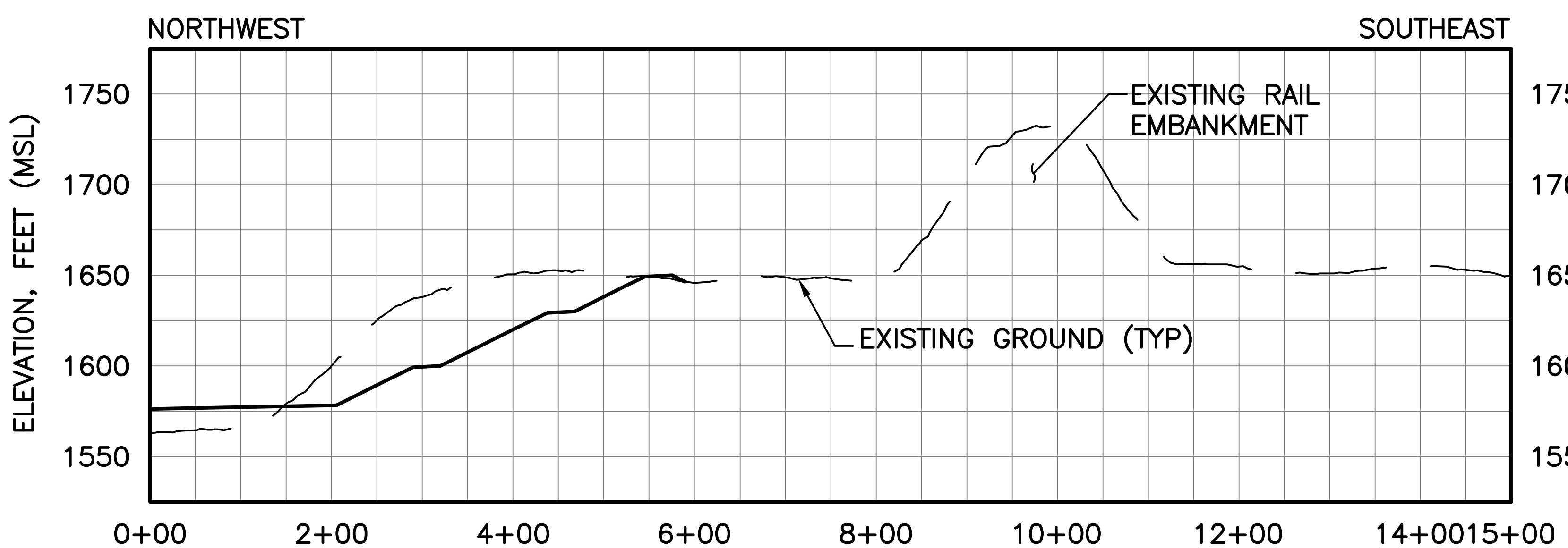
Hoyt Lakes, Minnesota



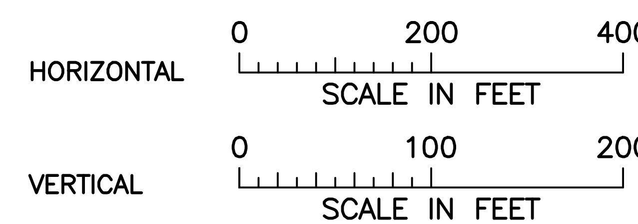
SECTION: SECTION A, HRF NORTH DAM (A/26)



SECTION: SECTION B, HRF EAST DAM (B/26)



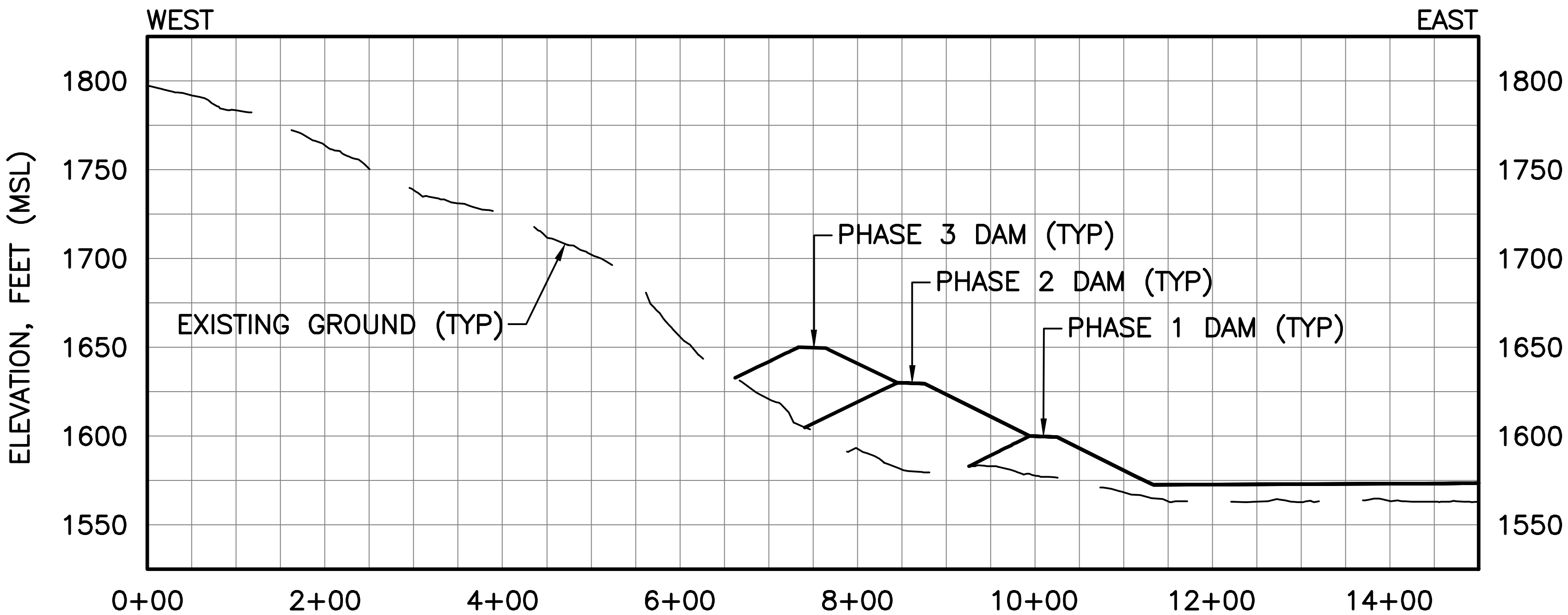
SECTION: SECTION C, HRF SOUTHEAST DAM (C/26)



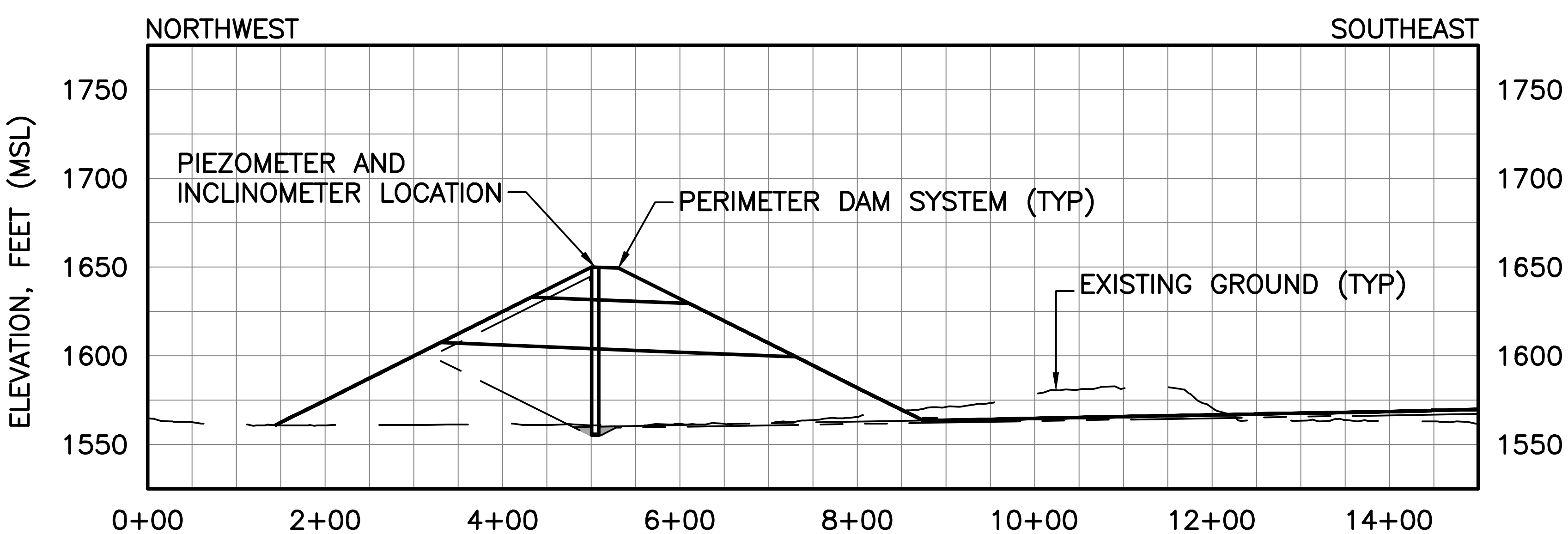
Large Figure 27

HYDROMETALLURGICAL RESIDUE
FACILITY CROSS SECTIONS

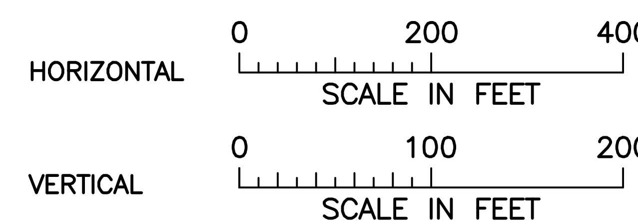
Hoyt Lakes, Minnesota



D 26 SECTION: SECTION D, HRF SOUTHWEST DAM



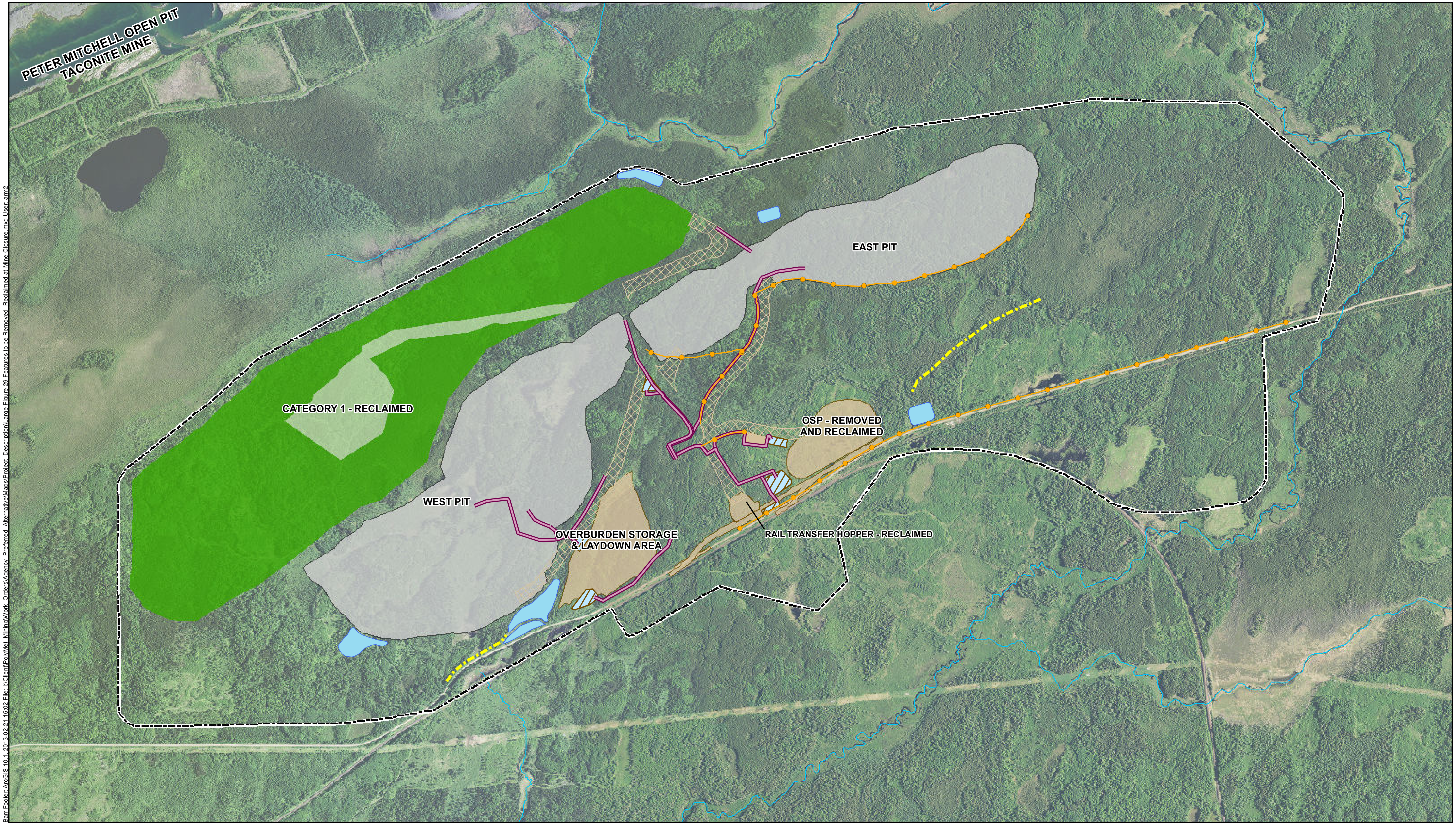
E 26 SECTION: SECTION E, HRF NORTHWEST DAM



Large Figure 28

HYDROMETALLURGICAL RESIDUE FACILITY CROSS SECTIONS

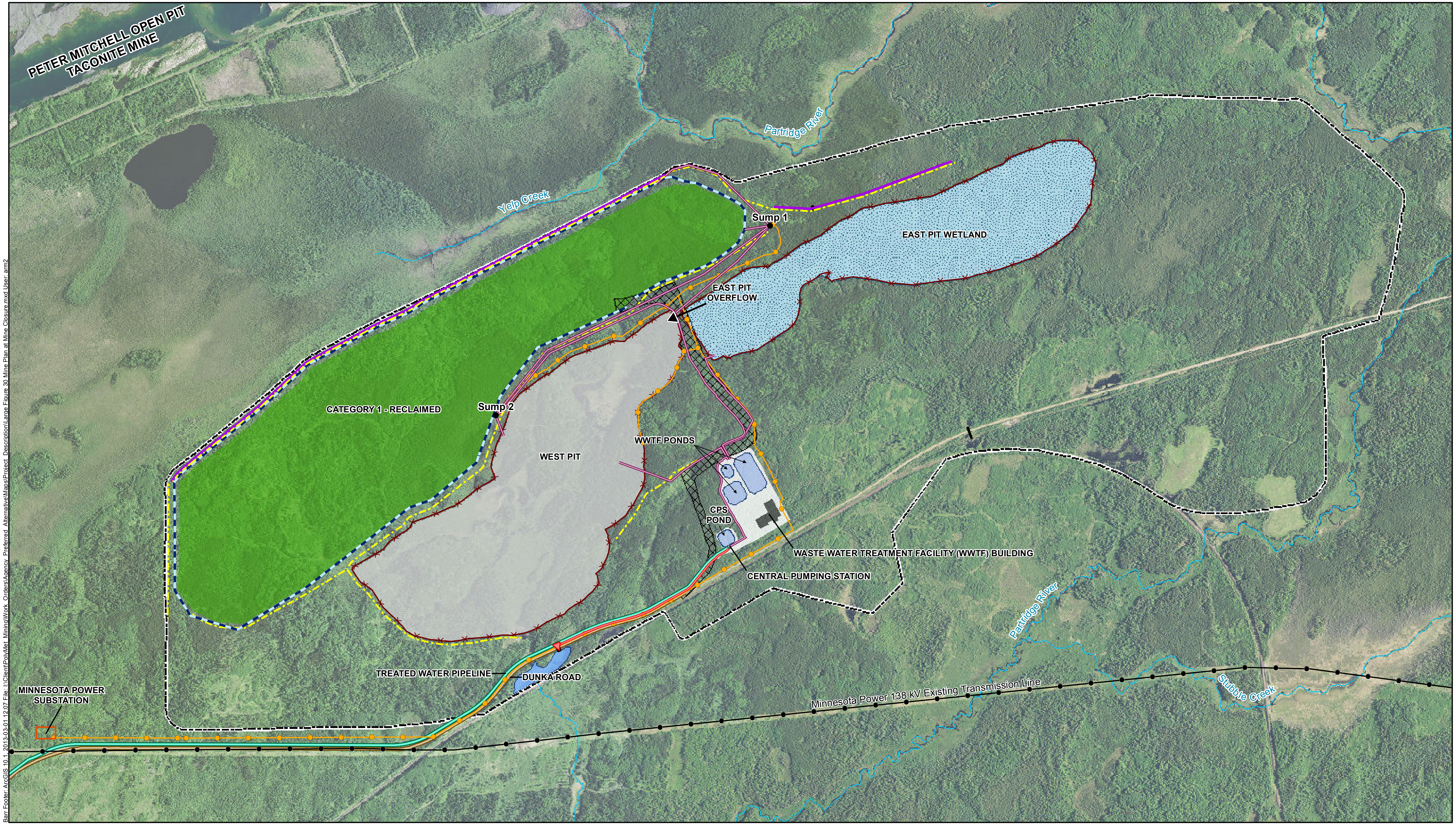
Hoyt Lakes, Minnesota



Mine Site
Mine Pits
Stockpile Covered in Previous Years
Stockpile Covered Upon Mine Closure
Removed and Reclaimed Features
Haul Roads - Reclaimed
Removed Transmission Lines
Stormwater System
Stormwater Collection Ditches - Reclaimed
Stormwater Ponds - Reclaimed
Process Water Systems - Removed/Reclaimed
Process Water Ponds and Sumps - Reclaimed

0 750 1,500 3,000
Feet

Large Figure 29
FEATURES TO BE REMOVED/
RECLAIMED AT MINE CLOSURE
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Barr Footer: ArcGIS 10.1, 2013-03-01 12:07 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Project_Description\Large Figure 30 Mine Plan at Mine Closure.mxd User: arm2

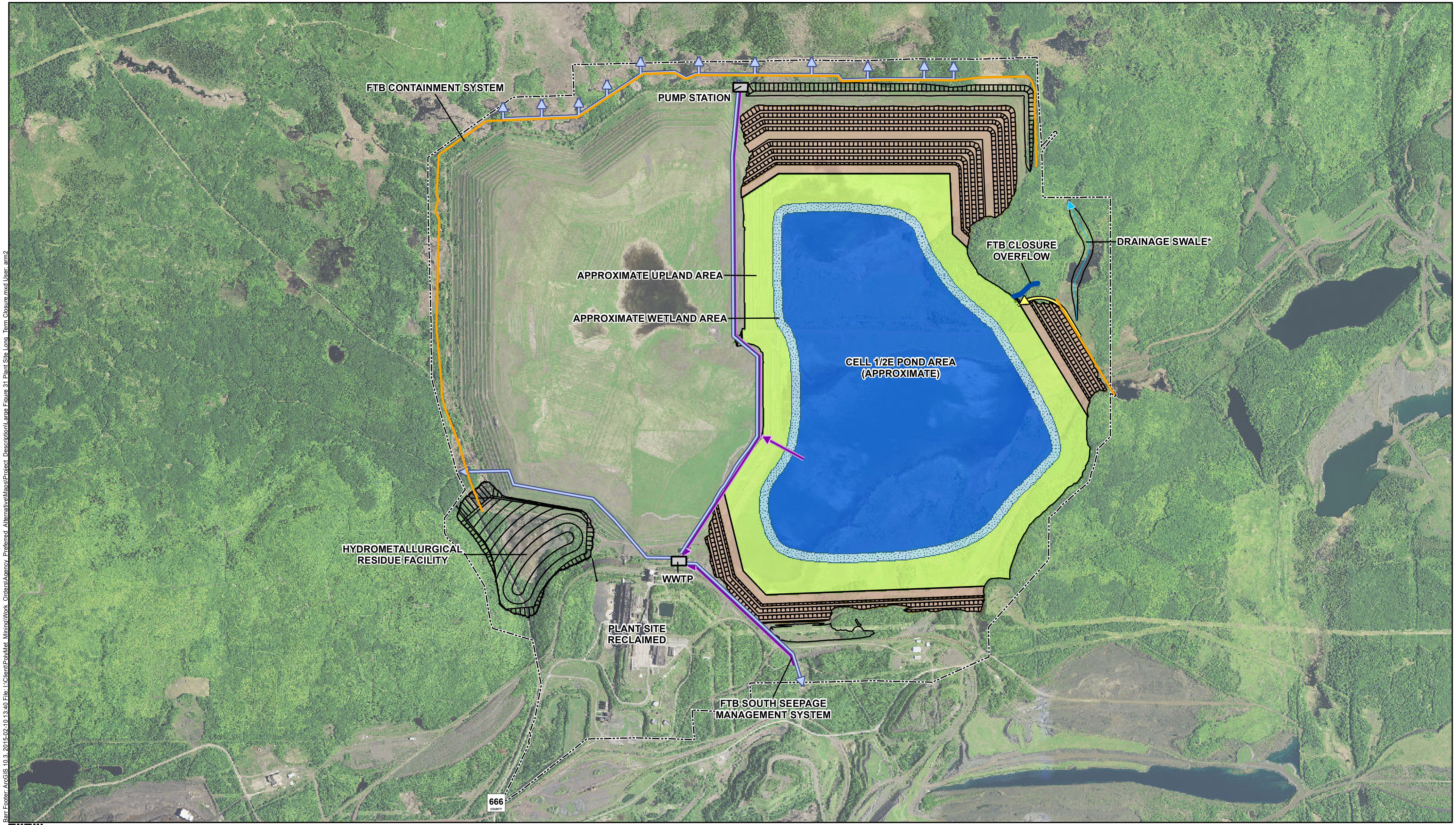
- Mine Site
- Covered Stockpile
- West Pit
- East Pit Wetland
- Haul Roads
- Groundwater Containment System
- Stormwater Collection Ditch
- Perimeter Dike
- Process Water Pipe
- Discharge Pipe
- Treated Water Pipeline
- Culverts
- Fence
- Proposed Transmission Lines

N

0 750 1,500 3,000

Feet

Large Figure 30
MINE PLAN AT MINE CLOSURE
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



- Plant Site
- Pond
- Wetland Area
- Upland Area
- Embankment
- FTB Containment System
- Treated Water Discharge Pipe
- Pipes to Treatment Plant
- Seepage Water Pipe
- Drainage Flow Direction

*The drainage swale drains stormwater away from the toe of the dam.

0 2,000 4,000
Feet

Large Figure 31
PLANT SITE LONG-TERM CLOSURE
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN